15th April 2024

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Response to Submissions, Further Mitigation
Plan Change 95 – Pencarrow Estate Pongakawa

Dear Abi,

We write to respond to submission points made during the submission period ending Friday 10th November 2023 in respect of this private plan change request. We also respond to points made through further submissions made in respect of original submissions, which closed 19th February 2024, and as raised through a meeting with submitters on 21st March 2024.

Summary of Submissions and Further Submissions

A summary of submissions and further submissions has been compiled and published by WBOPDC, released 12th March 2024. A total of 39 individual submitters provided submissions through either the initial or further submission processes. Of the 39 submitters, 17 are in support. Two are in 'support in part', one being Waka Kotahi NZ Transport Agency which concludes a 'neutral' position. The remaining 20 submissions are in opposition. This includes a position of opposition from Bay of Plenty Regional Council (BOPRC).

The submissions have been reviewed and considered, and further engagement with submitters undertaken to better understand concerns held by submitters. This has been in the form of the following:

- Invitation issued to all submitters, and meeting held 21st March 2024, to discuss further the proposed plan change, design features, submission points and effects mitigation measures provided for.
- Meeting with Waka Kotahi, 27th March 2024;
- Meeting with BOPRC 15th December 2023, and further meetings scheduled for April 2024, concerning strategic and technical submission points raised by BOPRC.

The recurring themes of concerns within all submissions are summarised as follows:

- Strategic spatial planning considerations, including productive land impacts
- Rural character and amenity effects
- Traffic and transport effects
- Infrastructure and hazard risk effects

- Ecological and cultural effects

Further discussion of responses to these concerns are explained below under the same sub-headings. The exceptions to this are the submissions of BOPRC and Waka Kotahi, which are addressed individually below.

Strategic Spatial Planning, Productive Land Considerations:

Several submissions contend the plan change is contrary to the Bay of Plenty Regional Policy Statement (RPS). This is understood to be referring to the fact that the RPS, or the emerging Future Development Strategy being prepared by Smartgrowth for Western Bay of Plenty, does not spatially signal further growth to occur specifically at Pongakawa.

Distinct to spatial allocations is the sequencing of when growth demand is expected to be met. Independent economic analyses commissioned by Smartgrowth in the form of Housing and Business Capacity Assessments across 2021-2023 have repeatedly highlighted the actual and future-predicted shortage of housing in the Western Bay of Plenty sub-region, with particular direction in 2022 being pointed to investigating further the need to bring forward housing provision in the 'Eastern Corridor' of the sub-region (Baypark – Pongakawa/Rangiuru) given the shortages expected from 2025 onwards[1]. The same economic analyses revealing that the with supply added by Plan Change 92 in Te Puke, a shortfall exists, and year-on-year the estimated shortfall has increased. The only budgeted new growth to meet demand in the Eastern Corridor is a future Eastern Town Centre near Paengaroa/Rangiuru which is not forecast to deliver dwellings until 2034 at the earliest[2].

Spatial delineations for growth aside, there are two important pathways for sites to alternatively be considered as appropriate for accommodating growth. These exist in this context under the applicable National Policy Statement for Urban Development (NPS-UD), and the National Policy Statement for Highly Productive Land (NPS-HPL) which have come into existing since 2020. Regional policy statements and district plans must give effect to these documents.

The NPS-UD provides for unanticipated/out-of-sequence development both within and outside of urban environments, where specified criteria under either RPS Policies UG 7A or UG 14 are met. Assessment against both these policies is included in the plan change application[3] which demonstrates the rationale as to why these specific criteria are met, enabling the plan change through the NPS-UD path.

[1] Housing Development Capacity Assessment for Tauranga and WBOP – July 2021, pg 6; Housing and Business Capacity Assessment 2022 Summary – December 2022, pages 12, 25; Smartgrowth Strategy 2023-2073 Draft for Consultation – September 2023, pg 143
[2]Smartgrowth Strategy 2023-2073 Draft for Consultation – September 2023, pg 147
[3] Plan change application report dated 9th November 2023, pages 40-44.

The second important pathway is under the NPS-HPL. Specifically with reference to Clause 3.6 which provides guidance as to the implementation of the NPS-HPL in respect of re-zoning of HPL land.

Clause 3.6(1)(a)-(c) contains three thresholds, all to be met, where re-zoning of highly productive urban land is entertained as justified by the NPS-HPL. The plan change application has previously worked through why these thresholds are considered to be met[4]. Given general objections to loss of productive land, and correlated questions concerning the need for housing in Pongakawa (including from BOPRC), independent economist expert advice has been obtained to further investigate these issues. Please see **Appendix A** to this letter. This demonstrates from an economic perspective the satisfaction of the criteria at 3.6(1)(a)-(c), particularly point (a) regarding the insufficiency of development capacity to meet expected growth.

Further commentary on this point is also provided later in responses directly to the BOPRC submission. The above commentary and further information is considered to address further the substance of submissions regarding spatial planning justification for promoting the site for the plan change, and related submissions concerning loss of productive land and the actual need for housing in the area.

Rural Character and Amenity Effects:

Numerous submissions discuss the general loss of rural character and amenity that accompanies urbanisation. This change is acknowledged, particularly in respect of Rural-zone properties on Arawa Road abutting the plan change site to the south-east. Adverse effects attached to this change have been sought to be reduced, by way of restricting the height and siting of future built form adjacent to eastern boundary of the site. Future building height adjacent to the eastern boundary is restricted to one storey.

Initially a set-back of 5m was applied to the eastern boundary of the plan change site, in combination with the height restriction. This being derived from considering the range of setback distances/boundary-constructed buildings along the rear boundary of Arawa Road properties. Noting concerns about outlook and spatial separation to future built form that have been raised in submissions, this setback has been increased to 8m. Trees have also been specified in this setback for greater natural elements within outlook towards the plan change area. This is reflected in revised proposed wording of rules to apply within Chapter 13 of the District Plan, see **Appendix B**, and revised structure plan drawings at **Appendix C**.

Other submissions raise the following points, which are addressed as follows:

- Minimum lot sizes of 800m^2 and 30m side/rear yards:

[4] Section 9.2, plan change application report dated 9th November 2023.

- This pattern of development was initially considered, however fails to deliver housing choice and affordability for the employment demand growing proximate to Pongakawa. As directed by WBOPDC earlier in the plan change process, reversion to this pattern of development is not considered further.

- Introduction of state housing/rentals, associated potential loss of existing character and amenity, potential crime risks:
  - Given minimum lot size within the plan change area of 350m^2, it is unlikely contemporary state housing would be sought here;
  - Renting versus owner occupying is a private owner decision, no interference from the RMA/planning processes.
  - Not considered further.

Traffic and Transport:

Numerous submissions raise concerns with increases in traffic, both as a function of residential amenity and change in residential character owing to larger volumes, and safety risks particularly at the SH2 / Arawa Road intersection. These are responded to as follows:

- The design of Arawa Road has been amended to balance recommendations of the safety audit, and preferences of WBOPDC and the Arawa Road community, by maximising the width of Arawa Road to 8.5m outside of areas subject to recommendations within the safety audit. This is to the satisfaction of WBOPDC and Waka Kotahi. See meeting minutes and amended plan at **Appendix D**.
- Both the traffic engineer, and safety auditor reviewers, have visited Arawa Road and the intersection on multiple occasions to inform recommended design and safety features.
- The increase in traffic is acknowledged. However with the levels of service and safety improvements to be implemented, traffic change on Arawa Road is not considered to be unacceptably altered relative to the character of Arawa Road and ease of convenience in using it.
- Concern raised in submissions and at the submitter meeting regarding additional traffic to the site as a result of the proposed commercial zone is acknowledged. Additional trip generation is being investigated further. As a general observation, the commercial area is only expected to service the local population so low levels of traffic over and above traffic into the residential area is expected.
- Additional footpath on the plan change side of Arawa Road has been added.
- Car dependence is repeatedly raised in submissions. Whilst this is acknowledged, the plan change is seeking to enable alternatives to cars, by way of providing for active and public transport (bus) journeys within, and to and from, the plan-change site. Infrastructure enabling the uptake of other modes of transport are included in staged pre-requisites to be met within each stage of development.

Infrastructure and Hazards

Points raised in submissions concerning infrastructure and hazards are responded to as follows, and on specific items in the Lysaght addendum and revised engineering report (**Appendix E**) and Innoflow wastewater specialist addendum (**Appendix F**):

- Adequacy of water supply/potential to affect existing water supply issues in the area. Pressure and resilience of water supply to Arawa Road and Penelope Place would only improve with the delivering either of the identified options (upgraded main from Maniatutu Road or reservoirs).
- Risk of wastewater disposal field failure from flooding/groundwater levels. Please see further information memorandum from Innoflow Wastewater Specialists. Floating and disruption to the system is not expected given the inherent weight and also anti-floatation concrete rings accompanying the design of tanks. Innoflow further advise that the land application area can be raised if needed, with suitable soils (see 'depth to groundwater' comments, page 7, **Appendix F**). The location of the all plan change development has sought to reduce susceptibility to flooding risk, with dwellings on higher ground, and the wastewater field on lower ground which remains largely outside of the mapped 100-year flood risk area.
- Odour from wastewater infrastructure – Innoflow maintain that when installed correctly as buried wastewater fields, discerning odour is not present from the field or infrastructure.
- Adequacy of the wastewater field – this has been re-sized based on information contained in the BOPRC submission.

Ecology and Cultural Effects:

Ecological and related cultural effects are raised in submissions, and are responded to as follows:

- Environmental improvement at water intake area and robust environmental protection for stormwater disposal (Ngati Whakahemo). Water supply will be from the nearest reticulated source (Maniatutu Road network). In terms of water intake into the Puanene Stream through the site, all overland flowpaths are required to be planted for passive treatment of overland flows conveying upstream water passing to the Puanene Stream. This does not occur at present. Similarly, a comprehensive stormwater treatment wetland is also proposed for site stormwater prior to discharge into the stream.
- A corridor of proposed reserve space east of and parallel to the stream has been widened in response to numerous submissions. It is also subject to development pre-requisites to be planted with riparian plants so as to restore and improve stream quality, character and biodiversity.
- The widened width to 8m is considered sufficient for riparian planting, and access (including for maintenance vehicles).

- The above requirements are secured by structure plan pre-requisites to be met prior to development of dwellings, and would be the subject of further regional consents. Further engagement with tangata whenua would be undertaken at this time.
- The above improved measures from the plan change as notified, are expected to deliver further improvements to downstream ecosystems by way of robust and appropriate treatment of stormwater and overland flowpath water from the site.
- There is general concern around the potential for floodable land to be developed. Residential development areas have been sited to stay out of areas of land subject to flooding in the 100-year flooding event as much as possible. Where 100-year flooding is mapped to occur (as per WBOPDC modelling data), this corresponds to existing overland flowpaths at the site. These have been provided for to continue to convey floodwater as well as regular overland flows from upstream, through the site. These will have to be in-place where within a stage of development, prior to dwellings being constructed, as secured by structure plan pre-requisites proposed at Section 12 of the District Plan. Residential dwellings will not be permitted in these overland flowpaths and outside of these sufficient freeboard will be provided to meet the District Plan and Building Code standards.

Bay of Plenty Regional Council:

An itemised response to all strategic and technical submission points from BOPRC original submission is appended at **Appendix G**. These responses are the basis of further meetings scheduled with BOPRC.

A further submission was also submitted by BOPRC during the further submissions period. This further submission opposes several submissions in support of the scheme, with support being based on a need for dwellings. The economic report attached at **Appendix A** further independently confirms a predicted shortage of dwellings specific to Pongakawa, contrary to BOPRC's position.

Waka Kotahi/NZ Transport Agency:

The Waka Kotahi submission has been reviewed and is responded to as follows:

- Predicted car-dependency of future residents of the development is acknowledged. The plan change is seeking however to actively enable use of non car-based transport options.
- This through delivering walkability to a neighbourhood commercial centre and multiple reserves, and transferring an unsafe bus stop astride SH2 to a safer location more centrally located to the Arawa Road residential population.
- The economic report at **Appendix A** confirms expected viability of a convenience store to establish in the commercial area.

- Driving the plan change is addressing housing shortfall proximate to growing employment land and demands nearby. Accepting substantial reliance on private vehicles, the plan change would provide housing closer to horticultural land and equidistant from Te Puke to the Rangiuru Business Park as an alternative, albeit likely to have a shorter driving time. Thereby facilitating a potential reduction in vehicle kilometres travelled by private vehicles between places of residence and places of work.
- The submission refers to potential other alternatives to providing the dwelling capacity of the plan change. The s.32 geographic analysis has considered multiple other hypothetical locations for development in the locality, with larger constraints appearing to face development elsewhere.
- The growth enabled at the site is incomparable in potential/forecast yields within Te Puke and at the future Eastern Town centre, which are much larger. The village/hamlet growth enabled by PC95 is not considered to have any potential to compromise delivery of housing capacity in other planned locations.
- A Safe System Audit of the proposed SH2/Arawa Road intersection has been completed by Abley transportation consultants, as previously provided to NZTA. The three changes to the intersection within the control of the applicant (concerning the geometry of the deceleration lane, width of Arawa Road, and barriers at the intersection) have been reflected in the conceptual intersection design included in Structure Plan drawings. This has been resolved to Waka Kotahi and WBOPDC satisfaction since making the submission, see **Appendix D**.
- A ten-year intersection capacity assessment discussed in the submission has been included in the Transport Assessment Report, section 8.6. This confirms in that scenario the intersection is expected to operate with an acceptable level of service to traffic with minimal queues.
- The intersection is required to be upgraded as a prerequisite to Stage 1, which must be completed before or at the same time as any other stages. As such, Waka Kotahi concern at the timing of the upgrade will not realise – it will be upgraded prior to any dwellings being occupied within the plan change area.

A further submission from NZTA supports BOPRC commentary on potential exacerbation of flooding risks (to the new development) should culverts under SH2 be upgraded. For the same reasons as discussed in the response to BOPRC's original submission, this is not considered to be the case due to provision for overland flows as they exist through the plan change site.

Western Bay of Plenty District Council:

A meeting with WBOPDC technical officers to address clarification requirements occurred 29th February 2023, see meeting record at **Appendix G**.

To summarise changes made in response to technical officer concerns or queries:

- The planned recreational upgrades to Arawa Road are recognised on structure plan drawings. Further reserves and playground provisions of the Structure Plan are considered to complement this investment.
- A widened riparian margin, sufficient for riparian planting, and parallel access (including for maintenance), is now proposed as a reserve to vest. This would be in tandem with the stormwater reserve and village green within the plan change, owing to ecological and conservation benefits to accrue in delivering this infrastructure. This is in-lieu of commentary for a Conservation or Natural Open Space zoning for reserves and stream corridors, which do not exist in the WBOPDC District Plan outside of Omokoroa.
- The playground, intended to be privately managed alongside the operation of the commercial area, has not been shifted across the internal structure plan road. The intent is to keep these activities together, ensure an activated, family-friendly space is delivered comprising small-scale community amenities including the playground and bus stop in one location. Isolating these activities is not preferred and transferring them entirely to the opposite side of the structure plan road would result in greater adverse reverse sensitivity effects to west-side Arawa Road residents (due to closer proximity). Keeping the playground space in its current location also enables green space to be efficiently used as an overland flowpath.
- Water supply, firefighting supply – addressed at page 12 of Lysaght addendum, **Appendix E**. Both water supply options (water main upgrade, reservoir approach) remain as options, however it is acknowledged the water main upgrade approach is the preferred approach.
- Width of Arawa Road to 8.5m as much as possible – reflected on plans since agreed with NZTA and WBOPDC as appropriate, see **Appendix D**.
- Footpath to western side of Arawa Road – included, see revised structure plan drawings, **Appendix C**.
- SH2 intersection compatibility with existing infrastructure (swales, power poles etc) at that intersection – design plans (as-builts not available from Council) have been reviewed, and further investigation with CMW engineers undertaken. CMW confirm as steep as 1:1 batter slopes can be achieved with intersection construction (with engineered ground solutions), and on that basis conflicts or appropriate re-provision of existing infrastructure at the intersection is not expected to be an issue.
- Overall effects upon groundwater resource, nitrogen loading – CMW has commented as follows:

CMW does not expect any major long-term effects to the groundwater regime as a result of preloading because:

- *The change in void ratio due to the preloading is relatively small, the change in the soft soil permeability will be negligible.*
- *The surcharge pressures are relatively low so the volume of water pushed out of the soft soil will be small and be redistributed to the surrounding soils.*
- *The areas to be preloaded are just the areas underlain by peat which are isolated.*

- See further consideration of nutrient/nitrogen loading change in response to BOPRC submission.
- Operating costs of the wastewater system. Estimates are provided within the Innoflow addendum, **Appendix F**. The operating costs are expected to be the same as Ongare Point on a pro-rata basis, as the same system and manufacturer is being pursued in this instance. The system is a STEP system, with on-lot primary treatment and secondary treatment of liquid prior to disposal within disposal field area.
- Risks to Little Waihi Drainage Scheme – addressed in response to BOPRC, see **Appendix G**, and by extension revised Lysaght engineering information at **Appendix E**. Velocity and volumes of stormwater to be discharged to the Puanene Stream which drains to the Little Waihi private drainage scheme will be reduced from pre-development levels, so no risk to integrity and operation of the scheme.
- Revised Lysaght engineering investigation utilises RCP 8.5 rainfall information, and works to BOPRC Stormwater Management Guidelines.

Other Submission Points:

Other submission points raised through written or spoken submissions received to-date are responded to as follows:

- Reverse sensitivity of additional dwellings is raised in respect of the orchard immediately east of the end of Arawa Road. Such effects are only considered to arise when Stage 3 proceeds, where dwellings are at the northern end of the plan change site closest to this orchard. Residential occupiers have to expect permitted rural activities including horticulture to operate in neighbouring Rural Zones, and reverse sensitivity can be reduced by way of covenants upon future titles. This is included in staged pre-requisites for Stage 3.
- Precedent to be created, enabling further subdivision and loss of rural land elsewhere. This is not considered to be likely as, like circumstances would have to exist for a like plan change proposal to be approved. Circumstances to be replicated would have to include:
    - Shortage of housing would have to continue to exist;
    - Consolidating and adjoining an existing urban area, so close to SH2 and areas of employment;

- Land would need to be similarly devoid of susceptibility to hazards as the subject land, and lacking interruption to greenfield farming.

- Impacts on rates for existing residents. Given the rateable population to be added, and the delivery of reserve infrastructure prior to vesting, existing rates rises as a result of the plan change are not expected to occur.

Conclusion

The above responses, amendments and further information seek to address the substance and repeated themes of submissions made in respect of Plan Change 95.

The following changes/additional investigations have been made/undertaken to address concerns in submissions:

- Independent expert economic advice confirming a shortfall and need for dwellings at Pongakawa.
- Greater residential yard setback distance (8m), further interface tree planting, adjoining Arawa Road properties.
- Wastewater primary field size increased, reserve field added, adhering to areas outside of mapped flood risks.
- Stream improvements through riparian planting and wider riparian corridor, partially to vest as Council reserve.
- Footpath added to frontage of commercial zone;
- Conceptual design includes Arawa Road widened to 8.5m where possible without affecting delivering on the recommendations of the safety audit of the intersection.
- Revised stormwater investigation to ensure adverse effects to Puanene Stream and Little Waihi Drainage scheme do not occur.

Next steps:

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

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Vincent Murphy

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Appendix A – Economic Report – Kevin Counsells, NERA

Appendix B – Amended Chapter 12 (Subdivision – Stage Pre-Requisites) and 13 (Residential) District Plan Rules

Appendix C – Revised Structure Plan Drawings

Appendix D – NZTA/WBOPDC Meeting Minutes and Amended Intersection Concept Plan

Appendix E – Lysaght Consultants – Engineering Addendum and Revised Report

Appendix F – Innoflow Wastewater Specialists Addendum

Appendix G – Response to BOPRC Strategic and Technical Submission Points

Appendix H – Clarification Responses to WBOPDC Technical Officers

Appendix A

Kevin Counsell
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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

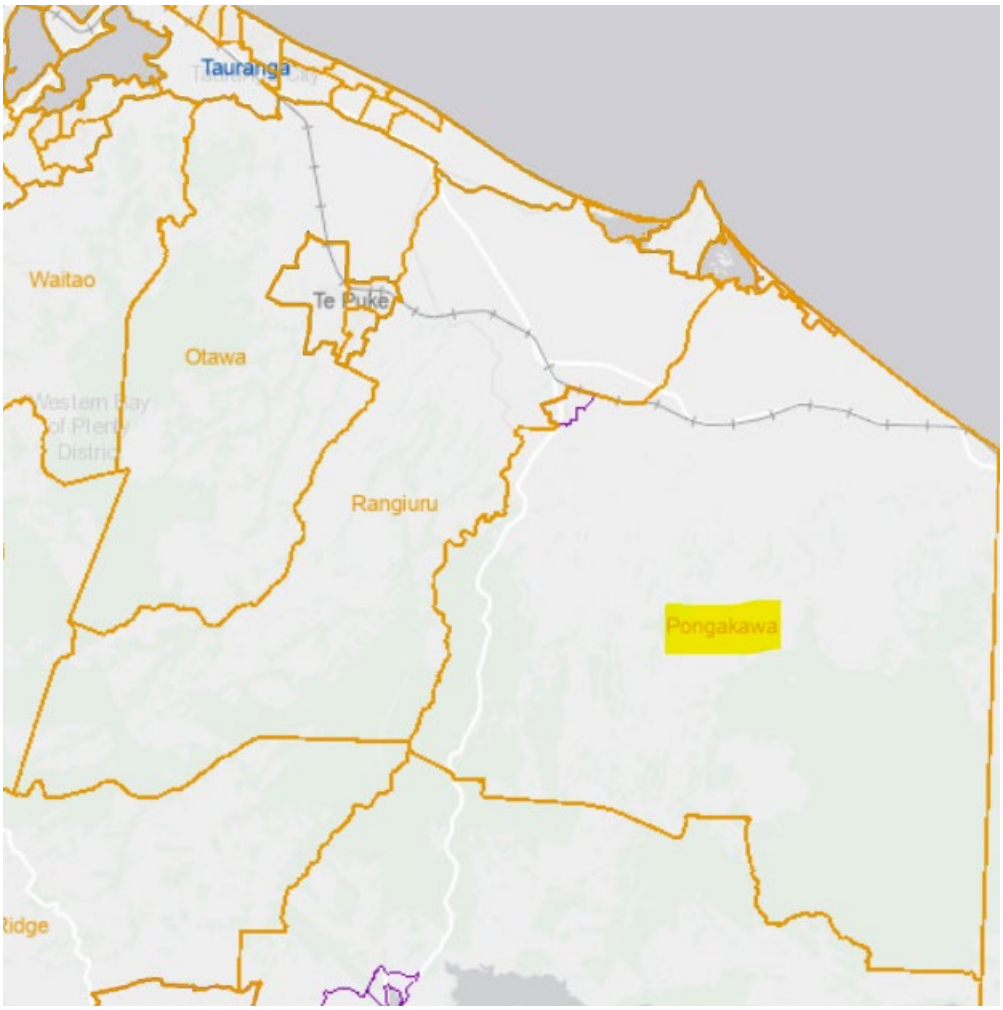
[1] As per the area figures provided within the Pencarrow Estate Pongakawa – Structure Plan drawing set dated 31 October 2023 submitted with the PC95 Application for Plan Change.

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),

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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.

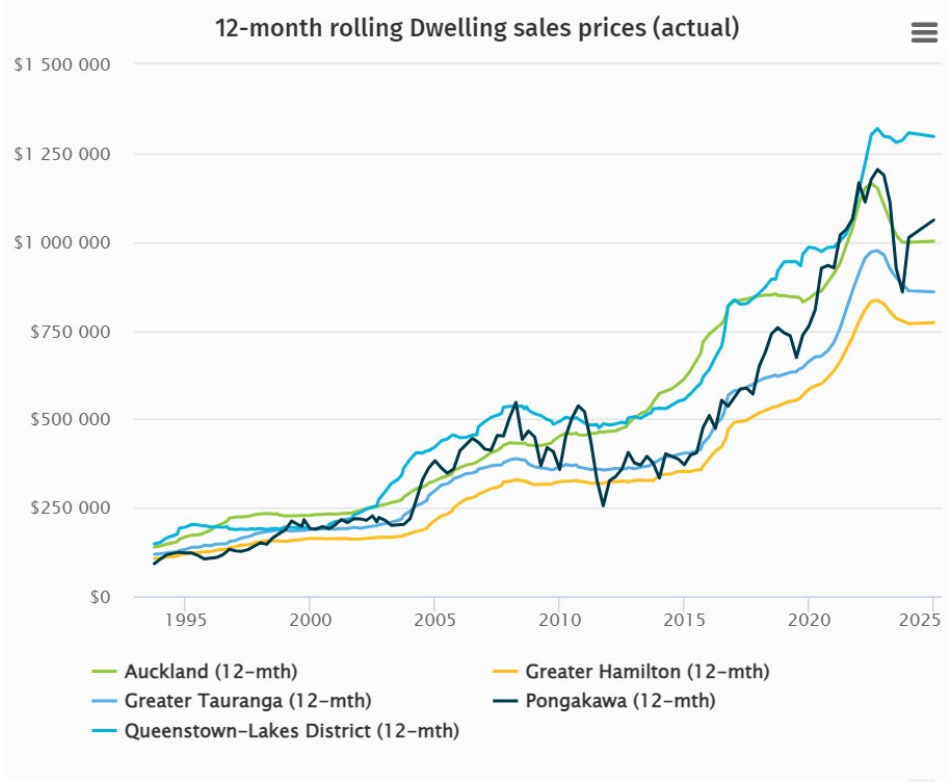
10 Smartgrowth Housing and Business Capacity Assessment 2022 Summary.

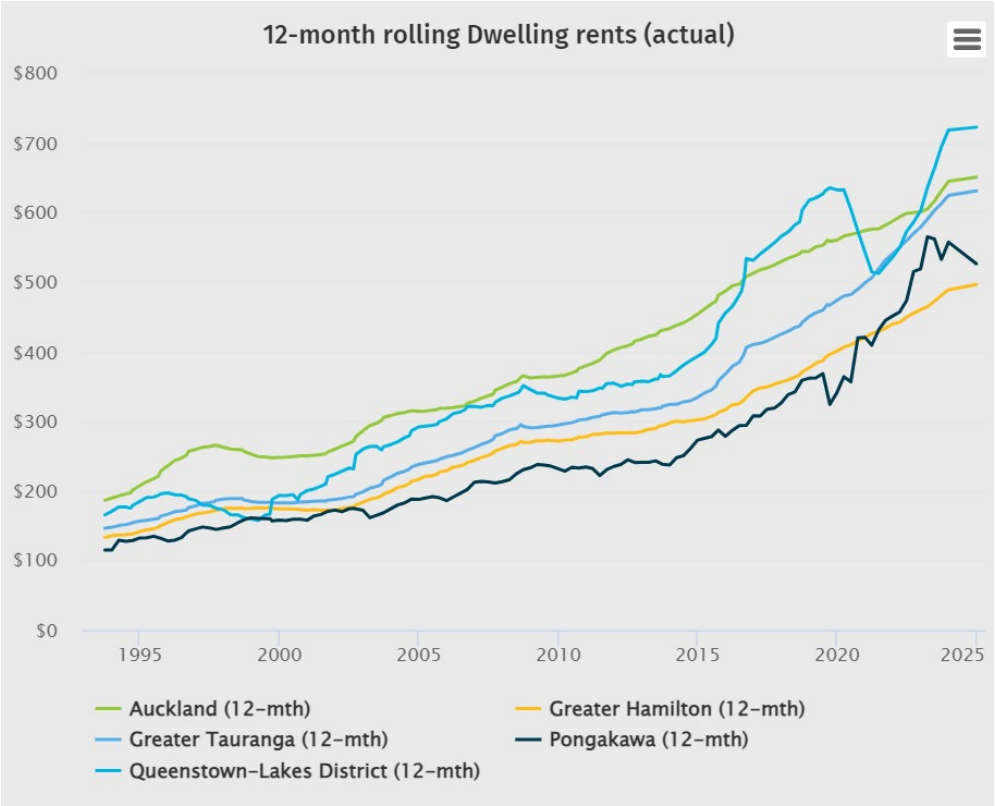
11 Smartgrowth Strategy 2023-2073, Draft for Consultation.

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;

[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.

Chapter 12 – Proposed Amendments

The below are proposed as new rules to be added to Chapter 12, below the most recent Structure Plan introduced to the District Plan (Rule 12.4.23 – Washer Road Business Park Structure Plan). This would therefore be a new section, Rule 12.4.24 – Pencarrow Estate Pongakawa Structure Plan.

12.4.24 Pencarrow Estate Pongakawa Structure Plan

12.4.24.1 General

a. Any subdivision or development (including delivery of stage pre-requisites) of land zoned Residential or Commercial within the Pencarrow Estate Pongakawa Structure Plan shall be undertaken in general accordance with that structure plan as set out in Appendix 7 and in the Pencarrow Estate Pongakawa Structure Plan Stage Prerequisites below.

b. All roofs of buildings constructed in the Pencarrow Estate Pongakawa Structure Plan Area within lots adjoining a Rural Zoned site, or above one storey in height, shall be of a finish with a reflectivity (Light Reflectance Value) of no greater than 37%, measured and determined in accordance with AS/NZ Standard 1580.

12.4.24.2 Staging Details

a. Subdivision or development of land within the Pencarrow Estate Pongakawa Structure Plan shall occur sequentially in that Stage 1 shall be completed prior to, or at the same time, as Stages 2 and 3.

b. Subdivision to create separate lots that reflect the boundaries of the Pencarrow Estate Pongakawa Structure Plan area (in its entirety or of individual stages), including prior to the delivery of any stage pre-requisites, is a Controlled Activity.:

Council shall exercise control over the following:

i) The new lot(s) to be established shall be generally consistent with the boundaries of the structure plan area or individual stages

ii) Provision of legal and physical access to all proposed lots.

12.4.24.3 Pencarrow Estate Pongakawa Structure Plan – Stage Prerequisites

Stage	Prerequisites to subdivision 224 certificate being granted or to land use or building consent activity being established
	The pre-requisites below in part correspond to details on Pencarrow Estate Pongakawa Structure Plan drawings, see Appendix 7, Section 13 of the District Plan.
Stage 1	**Roading and Access**

- Intersection of Arawa Road and State Highway 2 ~~to be upgraded in accordance with the recommendations of the Transportation Assessment Report prepared by Harrison Transportation (reference 496 TA, Rev 3 dated August 2023), or subsequent design prepared by a suitably qualified transportation professional, as approved by Waka Kotahi NZ Transport Agency and Council.~~
- ~~Carriageway of Arawa Road widened or amended in terms of width to have a 6.5m wide carriageway following exit from the SH2/Arawa Road intersection into Arawa Road, in accordance with the Transportation Assessment Report prepared by Harrison Transportation (reference 496 TA, Rev 3 dated August 2023), or subsequent design prepared by a suitably qualified transportation professional, as approved by Council.~~, and Arawa Road carriageway to the vehicle entrance to the plan change site, to be upgraded generally in accordance with the concept 'Pencarrow Estate – Arawa Road/SH2 Intersection Upgrade', refer to preliminary design at Appendix 7, Section 13.5 of the District Plan.
- Footpaths and roads formed within ~~pedestrian access strip between Arawa Road, adjacent to road carriageways and otherwise following 'Pedestrian Connection' routes within~~ Stage 1, in accordance with the Council's Development Code (or successor document) and as approved by Council.
- Footpath to frontage of Commercial Zone to be provided.
- Access to, and ~~B~~bus stop established within, the Commercial Zone meeting design requirements of Council's Development Code (or successor document).

Stormwater, Wastewater and Water Infrastructure

~~Following proposed design recommendations within the Engineering Servicing Report prepared by Lysaght Consultants (reference 225216 Rev 2 dated 1/9/2022):~~

- Stormwater wetland ~~pond~~ installed in in identified reserve location, formed and planted.
- Stormwater conveyance infrastructure within Stage 1 installed.
- Construction of ~~Overland Flow Path 2~~overland flowpaths within Stage 1, formed and planted.
- ~~Roadside swales to all roads within Stage 1.~~
- ~~Stormwater infrastructure planted to follow recommendations at section 11.3 of Wildland's Consultants' report no. 6334 *Assessment of Ecological Effects for the Proposed Pencarrow Structure Plan Area at Pongakawa*.~~
- Preparation of wastewater disposal field and supporting infrastructure of adequate size to service the number of lots within Stage 1.
- Water mains and reservoirs (if necessary) of sufficient pressure and capacity to service all lots within Stage 1 inclusive of firefighting requirements.

Deviation from these requirements shall be in accordance with an engineering design report prepared by a suitably-qualified chartered civil engineer, and as approved by Council.

Landscaping, Reserves

Landscaping mitigation measures within and at the boundary of Stage 1, including in Reserve to Vest, established in general accordance with the structure plan landscaping plan., ~~inclusive of proposed trees. Tree planting to adhere to minimum applicable requirements specified within Pencarrow Estate Structure Plan Drawing No. 004 – Tree Planting.~~

Reverse sensitivity

Prior to Stage 1 being completed, all effluent pond and storage infrastructure within the Pencarrow Estate Pongakawa Structure Plan area shall be relocated so as to be west of the north-western boundary of the structure plan area, and north of the existing milking shed and stock pad.

Commercial Land

The commercially-zoned land shall be established and available for future commercial and community service activities.

Stage 2 **Roading and Access**

- New roads and footpaths within Stage 2 constructed, in accordance with the Council's Development Code (or successor document) and as approved by Council.

- Footpath connection between Arawa Road to internal roads through to 'Village Green' ~~Stage 2 Road and Stage 1 Road to complete the~~established ~~connection to the stormwater pond reserve detailed in the structure plan~~.
- ~~Footpaths following 'Pedestrian Connection' structure plan requirements within Stage 2.~~

Stormwater, Wastewater and Water Infrastructure

~~Following proposed design recommendations within the Engineering Servicing Report prepared by Lysaght Consultants (reference 225216 Rev 2 dated 1/9/2022):~~

- Stormwater conveyance infrastructure within Stage 2 installed.
- Construction of overland flowpaths within Stage 2, formed and planted.
- ~~Roadside swales to all roads within Stage 2, planted to follow recommendations at section 11.3 of Wildlands Consultants' report no. 6334. *Assessment of Ecological Effects for the Proposed Pencarrow Structure Plan Area at Pongakawa*.~~
- Preparation of wastewater disposal field and infrastructure of adequate size to service the number of lots within Stage 2.
- Water mains and reservoirs (if necessary) of sufficient pressure and capacity to service all lots within Stage 2 inclusive of firefighting requirements.

Deviation from these requirements shall be in accordance with an engineering design report prepared by a suitably-qualified chartered civil engineer, and as approved by Council.

Landscaping, Reserves

- Formation of reserve around stormwater ~~attenuation pond~~treatment wetland and adjacent overland flowpath, including 'Village Green' seating area.
- Landscaping mitigation, including planting in Reserve to Vest, within Stage 2 boundaries established in general accordance with the structure plan landscaping plan.

~~**Landscaping**~~

~~Landscaping mitigation measures within and at the boundary of Stage 2 in general accordance with the structure plan. Tree planting to adhere to minimum applicable requirements specified within Pencarrow Estate Structure Plan Drawing No. 004 – Tree Planting.~~

Reverse sensitivity

Dairy cow milking shall cease to occur at the existing milking shed.

Stage 3 **Roading and Access**

- New roads or privateways within Stage 3 constructed, in accordance with the Council's Development Code (or successor document) and as approved by Council.
- ~~Footpaths following 'Pedestrian Connection' structure plan requirements within Stage 3.~~

Stormwater, Wastewater and Water Infrastructure

~~Following proposed design recommendations within the Engineering Servicing Report prepared by Lysaght Consultants (reference 225216 Rev 2 dated 1/9/2022):~~

- Construction of overland flowpath within Stage 3, formed and planted.
- ~~Roadside swales to all roads within Stage 3, planted to follow recommendations at section 11.3 of Wildlands Consultants' report no. 6334. *Assessment of Ecological Effects for the Proposed Pencarrow Structure Plan Area at Pongakawa.*~~
- Stormwater conveyance infrastructure within Stage 3 installed.
- Preparation of wastewater disposal field and infrastructure of adequate size to service the number of lots within Stage 3.
- Water mains and reservoirs (if necessary) of sufficient pressure and capacity to service all lots within Stage 3 inclusive of firefighting requirements.

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.

Landscaping

Landscaping mitigation measures within and at the boundary of Stage 3 in general accordance with the structure plan. ~~Tree planting to adhere to minimum applicable requirements specified within Pencarrow Estate Structure Plan Drawing No. 004 – Tree Planting.~~

Chapter 13 – Proposed Amendments

13.3.2 Controlled Activities

a. More than one *dwelling* per *lot* subject to performance standard 13.4.1.i.

Conventional Residential Areas	Minimum Lot Size
Katikati and Waihi Beach (including Athenree, Bowentown and Pios Beach) and Pencarrow Estate Structure Plan (Density B).	350m^2
Pencarrow Estate Pongakawa Structure Plan (Density A).	350m^2 Maximum average 400m^2
Pencarrow Estate Pongakawa Structure Plan (Density B).	500m^2
Athenree *Structure Plan* area adjoining the Tauranga Harbour or esplanade reserve	2,000m^2
Ōmokoroa Stage 1	400m^2 with a *maximum average* of 800m^2
Ōmokoroa Stage 2	350m^2 with a *maximum average* of 650m^2
Ōmokoroa Existing Village	600m^2
Maketu – greenfield areas connected to a reticulated wastewater supply with a minimum parent *lot* size of 3000m2	Minimum 350m^2 Average 600m^2
All other residential areas	800m^2 subject to compliance with Rule 12.4.6 and 12.4.7.

.....

13.4.1 General

a. Height of buildings/structures
The maximum *height* shall be 8m and retain a maximum two storey character.

Except that:

(i) The maximum height shall be 6m in the Pencarrow Estate Residential Height Restriction Area and retain a maximum one-storey character.

.....

c. Yards

i. Front *Yards* shall be no less than the following:

Residential *Dwellings* (not including garages) 4m
Other *buildings*/*structures* including all garages 5m

ii. Rear and Side *Yards* shall be no less than the following:

All *buildings*/*structures* 1.5m

Except that:
Dwellings and garages on land adjoining the Pencarrow Estate Residential Rear Yard Boundary shall be setback ~~5m~~ 8m from the specified boundary as shown in that Structure Plan. Accessory buildings are permitted within this yard provided that the maximum height shall be 2m and the maximum gross floor area shall be $10m^2$.

(Also see (c)(iv) for *lots* along Two Mile Creek)

Provided that:
A *building/structure* may be located within a side or rear *yard* and up to a side or rear boundary where the written approval of the owner(s) of the immediately adjoining property to a specified lesser distance is obtained.

A dwelling/garage may only be located within the Pencarrow Estate Residential Rear Yard and up to the specified boundary as shown in that structure plan, and an accessory building may exceed the maximum height or gross floor area permitted within this yard, where the written approval of the owner(s) of the immediately adjoining property is obtained.

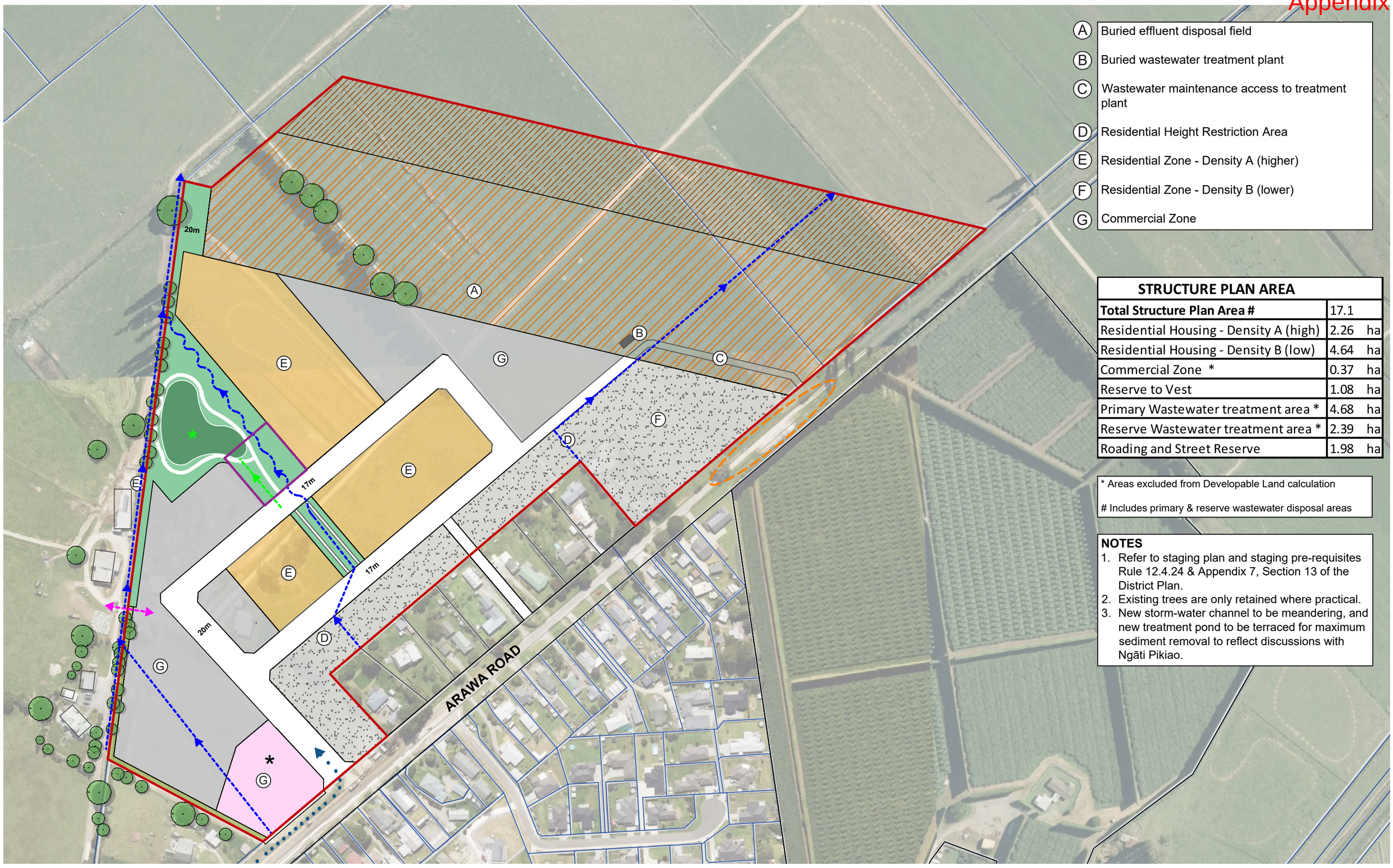
.....

13.4.2 Subdivision and Development (See also Section 12)

a. Minimum net *lot* size:

Conventional Residential Areas	Minimum Lot Size
Katikati and Waihi Beach (including Athenree, Bowentown and Pios Beach) and Pencarrow Estate Structure Plan (Density B).	350m^2
Pencarrow Estate Pongakawa Structure Plan (Density A).	350m^2 Maximum average 400m^2
Pencarrow Estate Pongakawa Structure Plan (Density B).	500m^2
Athenree *Structure Plan* area adjoining the Tauranga Harbour or esplanade reserve	2,000m^2
Ōmokoroa Stage 1	400m^2 with a *maximum average* of 800m^2
Ōmokoroa Stage 2	350m^2 with a *maximum average* of 650m^2
Ōmokoroa Existing Village	600m^2
Maketu – greenfield areas connected to a reticulated wastewater supply with a minimum parent *lot* size of 3000m2	Minimum 350m^2 Average 600m^2
All other residential areas	800m^2 subject to compliance with Rule 12.4.6 and 12.4.7.

Appendix C



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

STRUCTURE PLAN AREA		
Total Structure Plan 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 *	4.68	ha
Reserve Wastewater treatment area *	2.39	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 - Structure Plan - General Layout & Infrastructure

LEGEND

- Higher-Density Housing
- Lower-Density Housing
- Residential Height Restriction Area
- Commercial Zone
- Structure Plan Area
- Village Green
- Maintained Property Access
- Overland Flowpath
- Stormwater
- Water Supply
- * Proposed Playground Area
- * Stormwater Reserve / Infrastructure
- Reserve to Vest - 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

Date: 12.04.2024
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 Development	3.06	ha
Stage 2 Development	5.05	ha
Stage 3 Development	1.51	ha

Note: Wastewater disposal field not included in calculations

20m

STAGE 2

STAGE 3

STAGE 1

STAGE 2

STAGE 1

ARAWA ROAD

COMMERCIAL

RESERVE / PLAYGROUND

Pencarrow Estate Pongakawa - Staging Plans

LEGEND

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

Date: 12.04.2024
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

RURAL ZONE

RESIDENTIAL ZONE

Height restriction

Height restriction

ARAWA ROAD

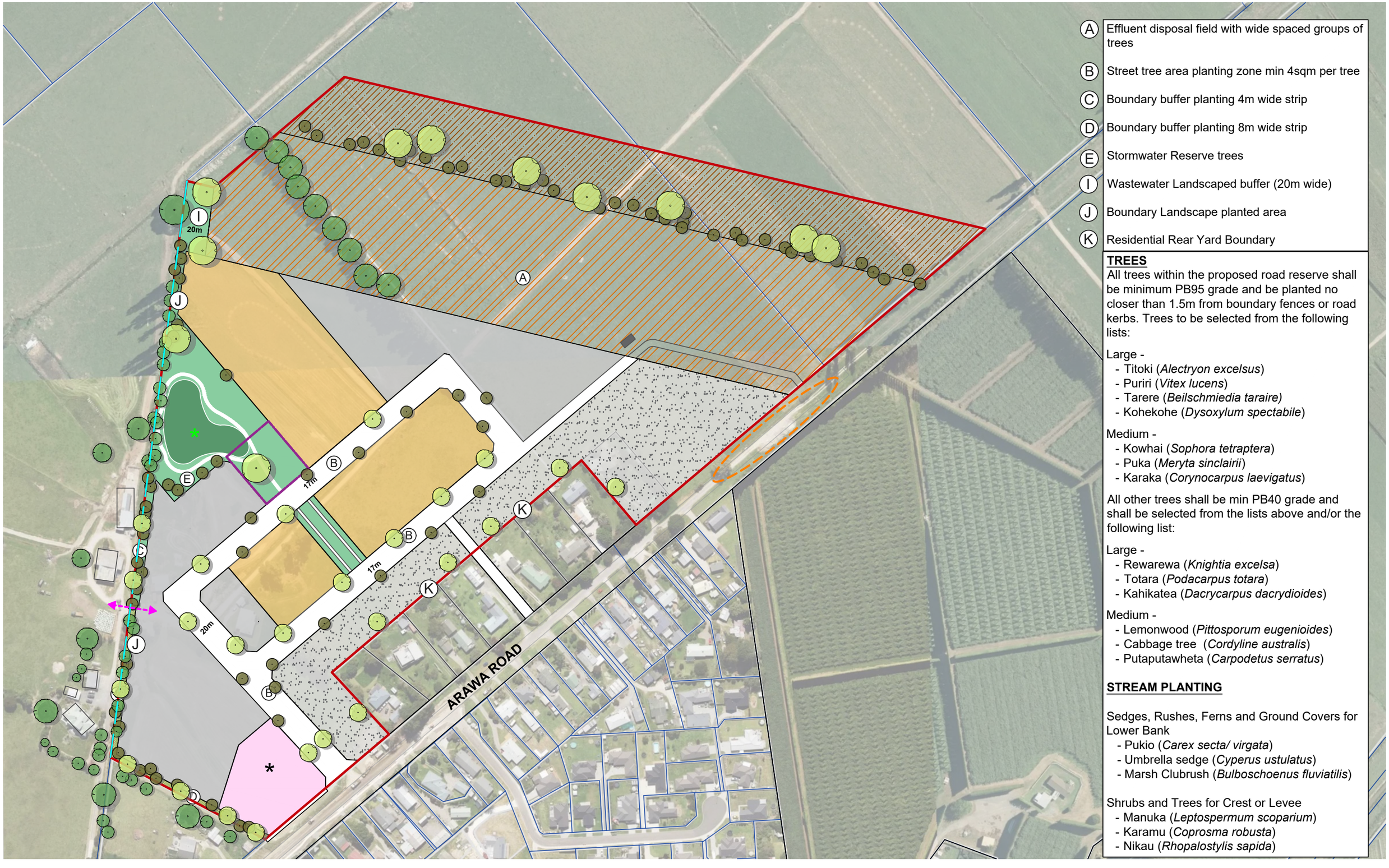
COMMERCIAL ZONE

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: 12.04.2024
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
D	Boundary buffer planting 8m wide strip
E	Stormwater Reserve trees
I	Wastewater Landscaped buffer (20m wide)
J	Boundary Landscape planted area
K	Residential Rear Yard Boundary

TREES

All trees within the proposed road reserve shall be minimum PB95 grade and be planted no closer than 1.5m from boundary fences or road kerbs. Trees to be selected from the following lists:

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

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

All other trees shall be min PB40 grade and shall be selected from the lists above and/or the following list:

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

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

STREAM PLANTING

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

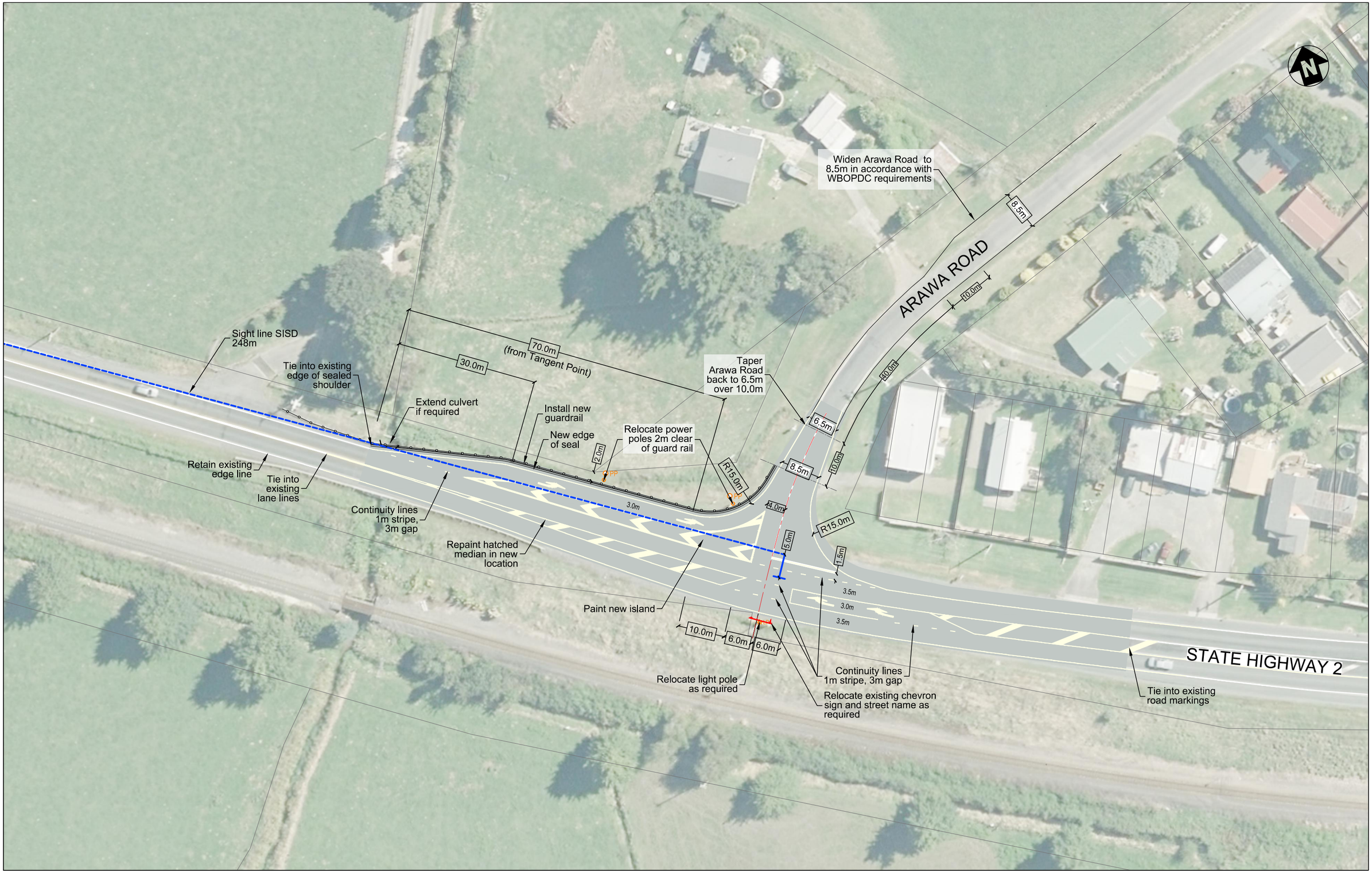
Shrubs and Trees for Crest or Levee
- Manuka (*Leptospermum scoparium*)
- Karamu (*Coprosma robusta*)
- Nikau (*Rhopalostylis sapida*)

Pencarrow Estate Pongakawa - Landscaping Plan

LEGEND

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

Date: 12.04.2024
Drawing : **004**
Reference: Pencarrow Estate Pongakawa
Scale: 1:2500 at A3
Drawn: PT
Reviewed: VM



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A	ARAWA ROAD WIDTH REVISED	15/03/24	BH

KA & AD MARSH
ARAWA ROAD PONGAKAWA
INTERSECTION RECONFIGURATION WITH OFFSET LEFT TURN LANE

Harrison Transportation
PO Box 11557, Papamoa 3151
Phone: 07 576 6737
Mobile: 027 221 6926
Email: bruce@harrisontransportation.co.nz

Design	BH	Job No.	
Drawn	DJ	496	CAD File 22–205
Checked	BH		Plot Date 15/03/24
Date	09/08/23	Drawing No.	Rev.No.
Drawing	1 of 1	496-03	A

DRAWING No **03**

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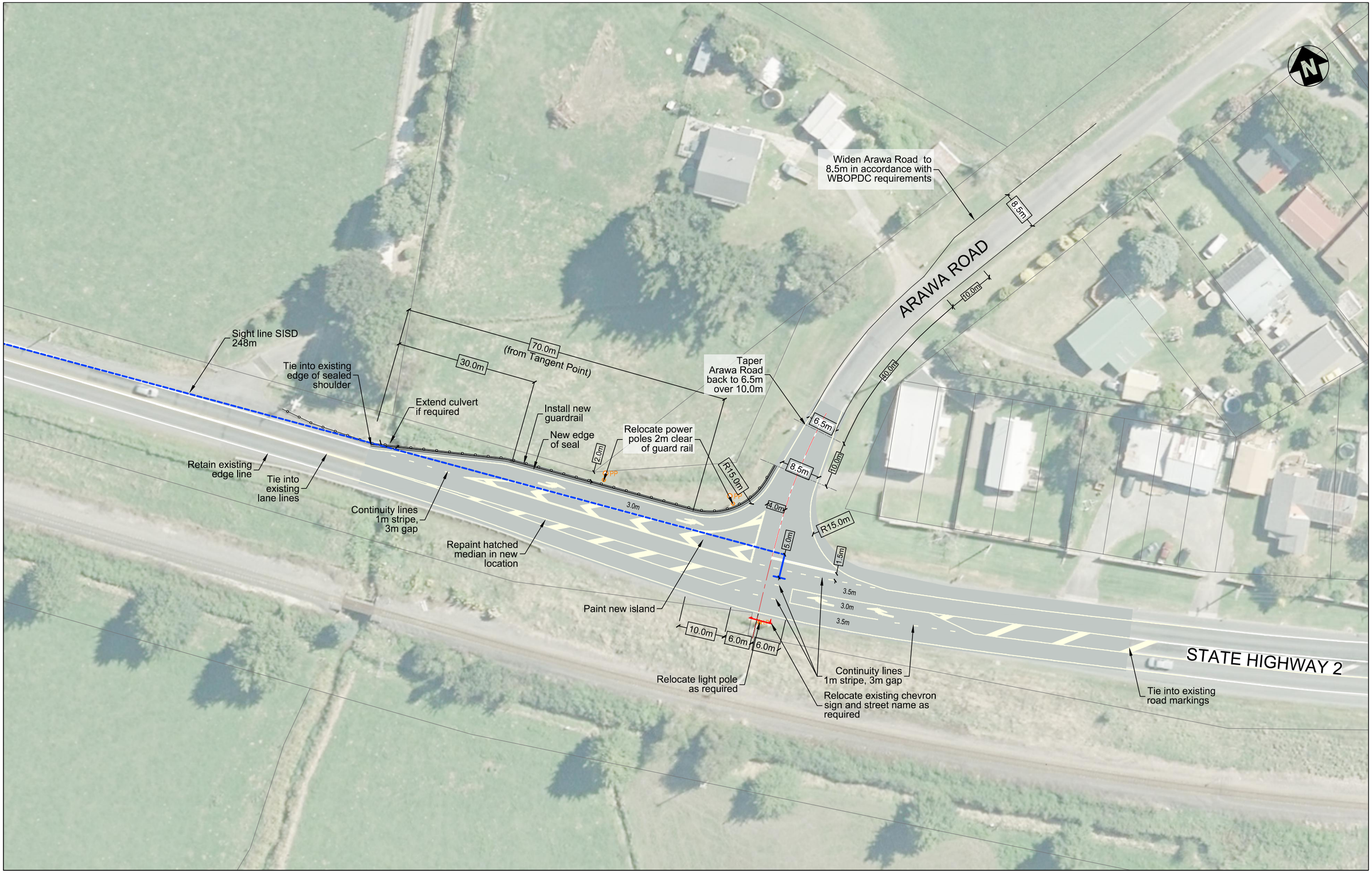

No	DESCRIPTION	DATE	CHK
A	ARAWA ROAD WIDTH REVISED	15/03/24	BH

KA & AD MARSH

ARAWA ROAD PONGAKAWA

INTERSECTION RECONFIGURATION WITH OFFSET LEFT TURN LANE

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Design	BH	Job No.	
Drawn	DJ	496	CAD File 22–205
Checked	BH		Plot Date 15/03/24
Date	09/08/23	Drawing No.	Rev.No.
Drawing	1 of 1	496-03	A

DRAWING No 03

SCALE 1:750 @A3

Appendix E

LYSAGHT

Our Ref: 225216

05/04/2024

Western Bay of Plenty Regional Council
Private Bag 12803
Tauranga Mail Centre
3143

To whom it may concern,

ADDENDUM TO ENGINEERING SERVICE REPORT – PENCARROW ESTATE, REVISION 5 (LYSAGHT REF: 225216)

This addendum letter is to be read in conjunction with the newly revised Pencarrow Estate Private Plan Change Engineering Servicing Report (revision 6), and summarises the changes made to that report in response to:

- Bay of Plenty Regional Council's ("BOPRC") submission on Plan Change 95, dated 8th December 2023.
- Western Bay of Plenty District Council's ("WBOPDC") servicing concerns, as captured in the Momentum Planning and Design ("MPAD") Meeting Record, dated 29th February 2024.

Below, each of the relevant issues raised in those two documents are listed in italics, with responses to each provided accordingly.

BOPRC SUBMISSION

Strategic Matters

No strategic matters raised by BOPRC are addressed in this addendum or in the revised report, as they are understood to have been addressed by others.

Technical Matters

"Reference: Puanene Stream classification: …" (Page 8)

Addressed by others.

"Reference: Puanene Stream mitigation: …" (Page 9)

Addressed by others.

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"Subject: Stormwater Management (Page 11)

Reason: Regional Council recommends a stormwater management plan is provided for this plan change area to ensure the issues identified in the following submission points about stormwater are addressed in an integrated manner, as required by section 30(1)(a) of the Resource Management Act 1991, RPS Objective 11 and RPS Policy IR 3B.

Land use and development decisions are closely connected to the health and wellbeing of water and the risks of water-related natural hazards to communities, and so catchment planning is needed at the land use decision stage. It is not appropriate to consider stormwater matters after the structure plan has been drafted – integrating land use and water planning is essential to protecting and enhancing the life supporting capacity of the region's waters and te mana o te wai.

The stormwater discharge consent process under the regional plan is not the appropriate mechanism to manage stormwater effects of large developments for two main reasons:

1. *If the permanent stormwater discharge consent is applied for after the development is completed, there is little or no ability to consider alternative stormwater management options or ability to improve stormwater quality.*
2. *It is difficult or impossible to consider catchment-wide cumulative effects from stormwater discharges under a resource consent process. Stormwater effects need to be considered collectively on a catchment or sub-catchment basis to enable cumulative effects to be assessed at the structure planning stage and implemented via provisions in the district/city plan.*

Relief Sought: Provide a stormwater management plan (SMP), which sets out the stormwater management for the proposed structure plan area. The SMP should:

1. *Set out the objectives for stormwater management and the receiving environment for the proposed structure plan area.*
2. *Demonstrate how the proposed stormwater management is the best practicable option (BPO), taking into account the existing site features.*
3. *Set out how stormwater quality and quantity will be managed in an integrated way.*
4. *Outline draft planning provisions to manage stormwater in the structure plan area, to be incorporated into the plan change."*

The reasons given to explain why a discharge consent is not the appropriate mechanism are disputed. The first reason given assumes that a discharge consent will be applied for after the development is completed, which is inaccurate. Any developer of the land will be required to obtain a discharge consent prior to discharging any runoff, and therefore prior to starting works. BOPRC would therefore have the opportunity to address the effects of the discharge and to consider alternatives prior to the development being commenced. The second reason provided states that it is difficult or impossible to consider catchment wide cumulative effects from

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stormwater discharges under a resource consent process. Again, that isn't necessarily an accurate statement, and there is no apparent reason why those cumulative effects can't be considered as part of a discharge consent application.

The request for a stormwater management plan ("SMP") to be provided isn't in itself unreasonable, but the proposed timing (as part of the plan change application) is unusual, and the reasons given for requiring that are tenuous.

"Subject: Stormwater management (Page 11)

Reason: Regional Council supports onsite soakage to discharge stormwater from individual lot areas (roofs, paved areas, driveways) where possible. However, based on the Geotechnical Investigation Report (CMW Geosciences, 11/02/2022, TGA2021-0096AC Rev 0), a high groundwater table may preclude the use of soakage in the lower lying areas.

Relief Sought: The conceptual stormwater design should check there is sufficient capacity in the stormwater pond/wetland to provide treatment and attenuation of stormwater from those areas (if needed)."

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 1: 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

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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.

"Subject: Stormwater Management (Page 11)

Reason: The Engineering Servicing Report (Lysaght, 12/12/2022, Revision 5) states that stormwater from roads will be collected in catchpits and piped to the stormwater detention pond. The structure plan states that roadside swales will drain the roads.

Relief Sought: Clarify at structure plan stage if swales or pipes will be used to drain the roads. Regional Council supports grassed swales to provide water quality treatment before discharging to the receiving environment. If swales are proposed, they must be appropriately sized and designed."

Both swales and pipes are proposed. It is envisaged that catchpits and pipes will collect runoff from the road and reticulate that runoff to a central swale, as explained with more clarity in the appended revised servicing report.

"Subject: Stormwater quality (Page 12)

Reason: The Assessment of Ecological Effects (Wildlands, May 2022, Contract Report No. 6334) recommends the stormwater detention area is planted with wetland plants. The Engineering Servicing Report (Lysaght, 12/12/2022, Revision 5) and proposed planning map (Private Plan Change 95 Pencarrow Estate – Pongakawa, proposed Planning Map) refer mainly to a stormwater pond.

Relief Sought: Clarify if a stormwater wetland or stormwater pond will be used.

Regional Council's Stormwater Management Guidelines (page 161) favour constructed wetlands over ponds because they provide better filtration of contaminants, including dissolved contaminants, due to densities of wetland plants, incorporation of contaminants in soils, adsorption, plant uptake, and biological microbial decomposition. In addition, wetlands, being shallow water bodies, do not have the safety issues associated with deeper ponds. Constructed wetlands must have a spillway to carry the 1% AEP flood with a minimum of 0.5 metre embankment freeboard."

The proposed stormwater device will function as a wetland for all storms up to and including the 10-year primary storm event, providing the standard treatment function expected of a

wetland. In that event, no attenuation functionality is required, as the prevalence of soakage systems serving all of the lot areas within the site mean that the discharge from the site in primary storm events is inherently lower than in the pre-development scenario. In larger and infrequent secondary storms, the wetland will be inundated, and provide sufficient attenuation to ensure that pre-development discharge rates are not exceeded. This will be achieved by way of careful discharge structure design. Typically, wetlands do not perform their intended treatment function in secondary storms, as the emergency spillway is activated and runoff flows freely across the wetland without the necessary residence time for nutrient removal to occur. This device will be similar, except with an attenuation volume provided for above the regular wetland top water level.

"Subject: Stormwater quality and quantity (Page 12)

Reason: The design and sizing of the stormwater pond is based on using a 10mm/hr rainfall intensity. This approach is taken from GD01 in Auckland which is not the appropriate guideline to use in the Bay of Plenty. The 10mm/hr was based on continuous simulation of Auckland rainfall to determine appropriate rainfall intensity criteria for sizing flow based on proprietary treatment devices such as stormfilters or upflo filters. Using the10mm/hr rainfall intensity depth is likely to lead to the device being undersized.

Relief Sought: Use the Stormwater Management Guidelines for the Bay of Plenty region (Bay of Plenty Regional Council Guidelines 2012/01) to determine water quality and detention volumes based on the 90th percentile rainfall event, and the volumes needed to attenuate the relevant larger storms, such as the 2, 10 and 100 year ARI event). Feasibility for spacing requirements for the stormwater detention area should be redone based on BOPRC guidelines, not Auckland guidelines."

The appended report has been amended to be in accordance with the BOPRC guidelines. The stormwater device has not changed in scale as a result.

"Subject: Stormwater quality (Page 12)

Reason: The stormwater treatment pond does not appear to achieve the correct length to width ratio to meet the treatment requirements in the Stormwater Management Guidelines for the Bay of Plenty Region (Bay of Plenty Regional Council Guideline 2012/01).

Relief Sought: Provide size calculations that meet the Stormwater Management Guidelines for the Bay of Plenty Region (Bay of Plenty Regional Council Guideline 2012/01)."

The MPAD scheme plan has been amended to better allow a correctly proportioned wetland to be formed within the treatment area.

"Subject: Stormwater Quality: water sensitive design (Page 13)

Reason: The Puanene Stream on the northwest boundary of the site is a stream, not a drain. As such, extended detention is required for all impervious areas (except those discharging via soakage) that drain to the stream.
Holding water back (detention) and releasing it slowly helps to reduce erosion. Ensuring that impervious surfaces do not flow directly into streams can clean dirty stormwater and better manage instream erosion, for example by using water sensitive design such as rain gardens and swales and providing extended stormwater detention.

Water sensitive design (WSD) should be used for all developments five hectares or larger. WSD is consistent with the Stormwater Management Guidelines for the Bay of Plenty region and the NPS-FM.

The most effective WSD method is a treatment train approach, which is a series of sequential stormwater treatments to maximise pollutant removal. This ensures that all stormwater runoff is treated at source or as close to the source as possible to maintain or improve stormwater quality post-development. This includes runoff from all roads, car parks, houses, and commercial areas.

Relief Sought: Revise the stormwater plans to include extended detention, including a treatment train approach, for all impervious areas draining to the treatment wetland/pond."

The appended report has been amended to better comply with this request. In short, runoff from the road corridors (the only areas that drain to the pond) is collected by kerb and channel and catchpits, then reticulated to a swale. The swale then conveys the runoff to the stormwater treatment/attenuation wetland/pond. Additionally, extended detention has been incorporated into the design of the pond. The wetland/pond has not change in scale as a result (the previous iteration of the design was based on some high level assumptions that have now been considerably refined.

"Subject: Stormwater Discharge (Page 13)

Reason: The proposal states that stormwater attenuation will be provided. However, the Engineering Services Report (page 10) notes that the watercourse will need to be upgraded where the pond discharges to prevent erosion of the watercourse banks in large storm events.

More stormwater flowing into streams as a result of residential development can cause erosion and destabilise stream channels and the ground. Holding water back (detention) and releasing it slowly helps to reduce erosion.

Relief Sought: Clarify if post-development Puanene Stream flows will be erosive, or if this refers to localised erosion at the outlet which requires erosion protection.

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Avoiding the requirement for new erosion protection structures in rivers and streams as a result of increased flows from the development is consistent with Objective 1 and Policies 1, 3, and 7 of the NPS-FM.

Stormwater discharges and any associated structures must be designed to avoid accelerated stream channel erosion and scour of any river/stream.

Erosion protection of outlets, streams, channels and overland flowpaths must be consistent with the Stormwater Management Guidelines for the Bay of Plenty region (Bay of Plenty Regional Council Guideline 2012/01)."

The reference in the report to upgrading the watercourse regards only the armouring of the discharge point itself. Given the use of soakage to dispose of primary runoff from the lots, and the provision of a pond to attenuate secondary flows, there will be no increase to the flow rates within the stream as a result of the development, and therefore no increase in risk of erosion within the watercourse downstream of the site.

"Subject: Effects of privately owned drainage scheme (Page 14)

Reason: The plan change area drains into an area currently managed by a privately owned drainage system (Little Waihī Drainage Scheme), which relies on conveyance through modified water courses (including drains, channels and pump stations). An increase in impervious areas will result in:

- *more stormwater discharging to the drainage scheme,*
- *more stormwater volume pumped during storm events, and*
- *associated increase in operational cost.*

The proposal fails to address the effect of increase in stormwater volume in relation to the drainage scheme design scenarios.

Relief Sought: Clarify the appropriate stormwater volume mitigation and effects on the Little Waihī Drainage Scheme."

The appended report has been amended to provide improved clarity around this issue. In short, the use of soakage to serve all private lots means that the volume of water discharged from the site will in fact be reduced from pre-development. The Little Waihi Drainage Scheme will therefore not be compromised.

"Subject: Stormwater soakage ability (Page 14)

Reason: The proposal indicates that 50% of the site's stormwater runoff (e.g. from buildings and driveways) will be discharged via ground soakage for the 10 year 10 minute storm and as such assumes that peak flow rates will not increase.

The geotechnical investigation was undertaken during summer after a year of low flow conditions. The report identified groundwater at depths ranging from 1.0m to 4.3m below ground level and concludes that shallow groundwater below the more low-lying areas and swales may preclude the use of ground soakage in these areas. In addition, it is expected that during prolonged phases of rain and following rain events beyond the design levels of the drainage scheme, these groundwater levels will be elevated, and soakage will become less effective.

For the secondary events up to 1% AEP 2130, a stormwater pond is proposed to manage peak flows. The report provides for a pond volume but fails to indicate the required area; the likely shallow groundwater in this area will limit the available pond depth. Visually the area seems to be around 2000m2, which would require the pond to be around 2m deep.

Relief Sought: Clarify the required size of the stormwater pond/wetland. This information should be worked out at structure plan stage as the stormwater wetland/pond size may affect the structure plan layout."

As per the table above, groundwater generally wasn't encountered in the 4m deep test pits dug in the elevated development area on which the pond will be built. Therefore, constructing a pond as deep as two metres isn't expected to be an issue at the proposed location.

Subject: Overland Flow Paths (Page 15)

Reason: The proposal identifies three overland flow paths and proposes to maintain their capacity. Calculations were based on a 1% AEP 2040 climate change. To avoid an increase in upstream flood risk, the capacity must be based on 1% AEP RCP8.5 to 2130.

The structure plan dated October 2023 does not show one of the overland flow paths (OLFP3). This is inconsistent with the Engineering Services Report.

Relief Sought: Revise the calculations of the overland flow paths based on 1% AEP RCP8.5 to 2130.

Revise the structure plan to show all overland flowpaths."

The calculation of overland flowpath capacities has been revised accordingly, and the structure plan has been amended to show all overland flow paths.

"Subject: Flooding: Wharere Canal Catchment (Page 15)

Reason: Regional Council does not have a flood model for this catchment (the Wharere Canal catchment). However, flood modelling results from WBOPDC's rural settlement model indicate that the Puanene Stream capacity is limited. In addition, the bridges underneath State Highway 2 and the Kiwirail embankment appear to be undersized, resulting in ponding and overtopping in the 1% AEP RCP8.5 2130 climate change adjusted event. To avoid failures of this nationally important infrastructure, these assets may need to be upgraded in the future, which could result in increased flood flows downstream through the plan change area."

No relief is sought in association with this issue, however it would appear unreasonable for this development to account for potential increased flood flows from works that may or may not be undertaken on upstream properties. The effects of those potential works should be assessed by the parties undertaking those works and mitigated as necessary.

"Subject: Flooding: Wharere Canal Catchment (Page 15)

Reason: The proposal estimates some flood displacement for the 1% AEP through infilling, although this is not based on flood modelling. The applicant identifies this effect as negligible. However, the proposal fails to identify this effect as part of a cumulative effects assessment including increased stormwater volumes due to land use change. Flood modelling is recommended to identify cumulative effects for a variety of events (flood risk and system performance).

Relief Sought: Assess cumulative effects of floodplain filling and land-use change, identify appropriate mitigation measures and revise the proposal accordingly."

The assessment of the effects of the proposed infilling and land use change is considered appropriate for a development of this scale. The flooded areas within the site that may be infilled are effectively overland flow paths (and not clearly contiguous with the wider floodplain north of the site), the functionality of which will be maintained by the construction of appropriately sized swales through the site.

"Subject: Wastewater discharge: flow calculation (Page 16)

Reason: The high level calculations and designs of the wastewater treatment system must be revised to ensure the discharge area is appropriately sized. If the wastewater discharge area is undersized, wastewater may contaminate groundwater and/or surface water. This should be correctly calculated and designed at the structure plan stage because if the discharge area is undersized, the layout of the proposed development may need to change.

Correct standard to use in the Bay of Plenty

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The Engineering Services Report uses the Auckland Design Manual Wastewater code of practice to estimate the commercial design flow. This is the incorrect standard to calculate flows to the wastewater treatment system for the Bay of Plenty. The Bay of Plenty On-Site Effluent Treatment Regional Plan (OSET Plan) requires the Australian/New Zealand Standard 1547:2012 On-site domestic wastewater management to be used for on-site wastewater discharges in the Bay of Plenty.

The Engineering Services Report (Lysaght, 12/12/2022, Revision 5) has calculated the residential flow incorrectly and should be revised to ensure the discharge area is sized correctly. This must be corrected at the structure plan stage because it is likely to affect the layout of the proposed development.

The Engineering Services Report uses municipal methods to calculate the flows to the wastewater treatment system, which appears to have led to a significant underestimate of the discharge area required to service the proposed development. Decentralised on-site wastewater design is not subject to the same occupancy and per capita flow assessment methods.

Relief Sought: Revise the wastewater flow calculation using the Australian/New Zealand Standard 1547:2012 (AS/NZ1547:2012) On-site domestic wastewater management.

Revise the residential flow calculation based on AS/NZ1547:2012 methodology for on-site wastewater treatment systems (rather than centralised municipal systems). Provide references for the residential flow calculation.

Based on the revised/corrected wastewater flow calculation, revise and redesign the wastewater discharge area."

The methodology for deriving the wastewater discharge rate has been amended in the appended report.

"Subject: Wastewater discharge: occupancy allowance for correct flow calculation (Page 17)

Reason: The Engineering Services Report incorrectly calculates the occupancy allowance of the proposed development. In the Bay of Plenty, Schedule 6 of the OSET Plan sets out the correct way to calculate the occupancy allowances. Average occupancy cannot be used for on-site systems because they must be designed for peak flows.

Relief Sought: Revise the occupancy allowance – it should be calculated correctly using Schedule 6 of the Bay of Plenty Regional OSET Plan. The maximum occupancy, not the average, is relevant for onsite wastewater treatment systems."

The methodology for deriving the wastewater discharge rate has been amended in the appended report.

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"Subject: Wastewater discharge: flow calculation (Page 17)

Reason: A 130 lot residential subdivision comprising 4 bedroom dwellings, occupied by 6 people each would equate to a population of 780 people. Using a per capita flow allowance of 200 litres/person/day (in accordance with AS/NZ1547:2012) equates to a residential design flow of 156,000 l/day (or 156 m3/day) for the full development (rather than the estimated residential flow of 85.8m3/day).

Relief Sought: Revise the size of the discharge area using the correct wastewater flow calculations."

The methodology for deriving the wastewater discharge rate has been amended in the appended report, and the disposal field has been amended accordingly.

"Subject: Wastewater discharge: flow calculation (Page 17)

Reason: Commercial wastewater production is very specific to the business involved and is difficult to estimate, but the applicant should at least estimate the total daily flow allowances. It appears that the preferred wastewater treatment system suppliers were not aware of the commercial component of the proposal and so have not included this in the high level design and the discharge area is likely to be undersized.

Relief Sought: Revise the size of the discharge area using the correct wastewater flow calculations."

An allowance has been made for the commercial zone in the appended report.

All remaining technical matters (pages 18-20) regarding the treatment of wastewater have been addressed by others.

WBOPDC SERVICING CONCERNS

The following issues are lifted from the appended MPAD meeting minutes, summarising the meeting held with WBOPDC staff on the 29th of February, 2024.

"5. Water Supply – Pipe upgrade from reservoir on Maniatutu Road is Council's preferred option. MPAD to remove from Structure Plan Stage Pre-Requisites the potential for the reservoir option unless Marsh's want to maintain flexibility. Discuss with Marsh's."

Both water supply options remain in the Lysaght servicing report. It is however noted that the watermain upgrade is WBOPDC's preferred option.

"6. Water Supply – some uncertainty on firefighting requirements being met. Lysaghts to confirm for applicant. Paul Van Den Berg suggested 3 hydrants required within plan change area are needed."

The actual number and location of fire hydrants within the site has not been determined at this stage. That will be confirmed as part of the detailed design phase. It is understood that the meeting also covered the fire hazard category ("FHC") that the buildings within the commercial zone would fall under, and whether or not the proposed network could provide the necessary coverage for a fire water classification three ("FW3") building. Such a building requires 25 litres per second to be delivered simultaneously from two different hydrants. Modelling of the network suggests that that can't be achieved in either water supply scenario (watermain upgrade and reservoir/pump). Therefore, any proposed building that qualified as FW3 would need to be provided with its own firefighting system (sprinklers, storage, etc.), to be designed by a suitably qualified fire engineer.

"7. Water Supply – WBOPDC expect firefighting capacity to be provided by the pipe upgrade to service Penelope Place development. MPAD to consider and come back to WBOPDC on. This is a positive consequential outcome for the Pongakawa community. Firefighting storage at Penelope can be removed once capacity has improved as it will then be redundant."

If the preferred watermain upgrade solution were pursued, then the reservoir and pump in Penelope Place could conceivably be removed. To do so would also require the upgrading of the mains within Arawa Road, which are only 75mm and 50mm PE pipes, respectively.

"15. MPAD to investigate potential risks to Little Waihi Drainage Scheme. WBOPDC state it is irrefutable that SW volumes downstream are going to be increased owing to impervious surface increase and point-source discharge. Whilst pre-development flows per second might be met, the excess water will be discharged over a protected time. More water through the Little Waihi Drainage Scheme infrastructure. Risk needs to be investigated further. MPAD to discuss with Lysaghts and confirm effects less than minor due to downstream catchment area, discharge energy dissipation."

The appended report has been amended to provide improved clarity around this issue. In short, the use of soakage to serve all private lots means that the volume of water discharged from the site will in fact be reduced from pre-development. The Little Waihi Drainage Scheme will therefore not be compromised.

"16. Lysaghts to ensure correct rainfall event being used – RCP 8.5."

The appended report has been amended, with stormwater calculations now in terms of RCP 8.5, climate change adjusted to 2130.

"17. Lysaghts to change terminology to refer to BOPRC SW Management Guidelines rather than Auckland guidelines. James Abraham agreed with Lysaghts they are just a re-incarnation of the guidelines referred to by Lysaghts, however relates to BOPRC being able to utilize revised BOP-specific guidelines in the future."

The appended revised report is now in terms of the BOPRC stormwater management guidelines.

Kind Regards

Daniel Hight
Partner | Engineering Team Leader (BE(Hons), CPEng, CMEngNZ)
LYSAGHT

LYSAGHT

MOMENTUM PLANNING AND DESIGN
PROPOSED PRIVATE PLAN CHANGE
ENGINEERING SERVICING REPORT
PENCARROW ESTATE
1491 STATE HIGHWAY 2
PONGAKAWA
REVISION 5

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 10/04/2024

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

TABLE OF CONTENTS

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.

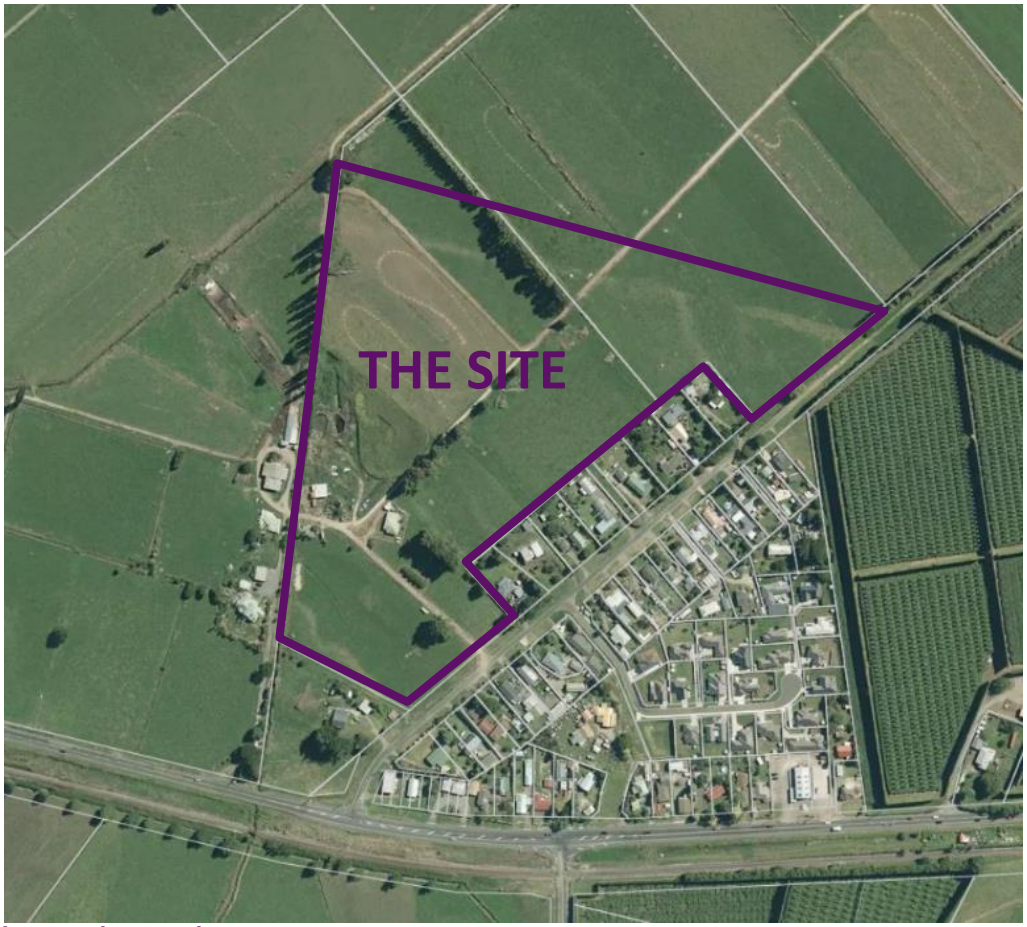


Figure 1: Site Location

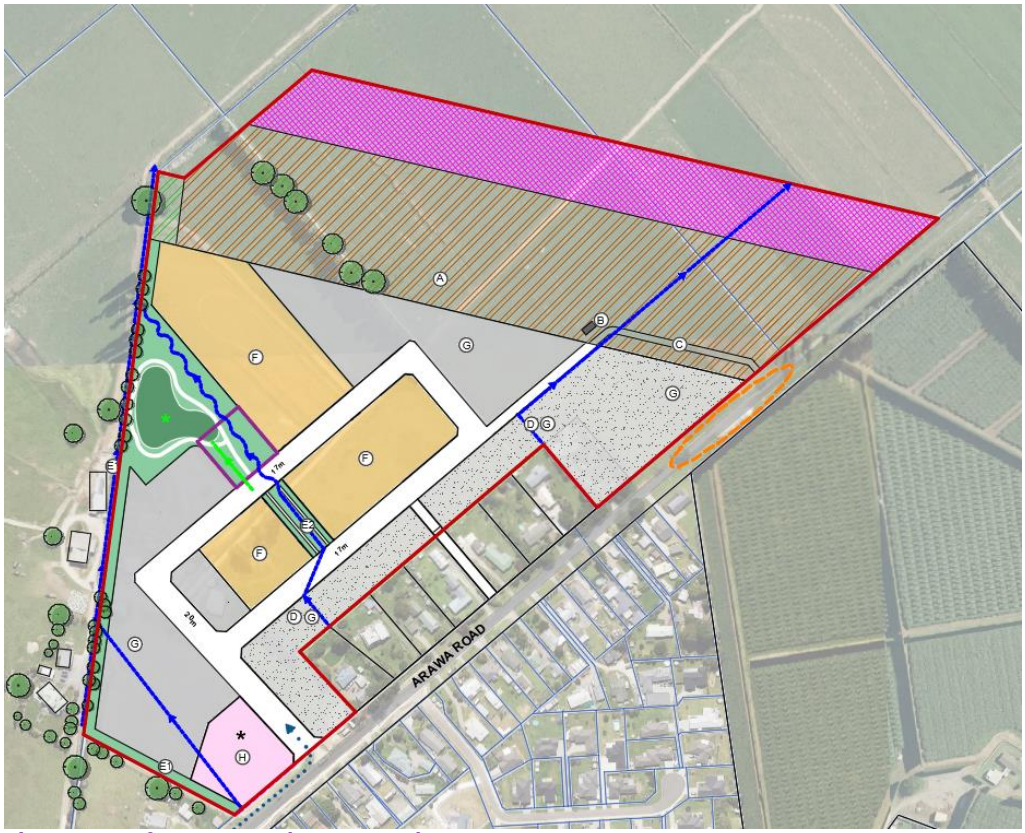


Figure 2: Draft structure plan proposal

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 3 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 4. 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 3: Flood mapping on site (from WBOPDC Maps)

Figure 4: Flood mapping in the wider area

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	0.56mm

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 in Figure 5 below. It is expected that in significant storm events this pond overtops, and stormwater flows across the adjacent properties, as WBOPDC flood mapping indicates.

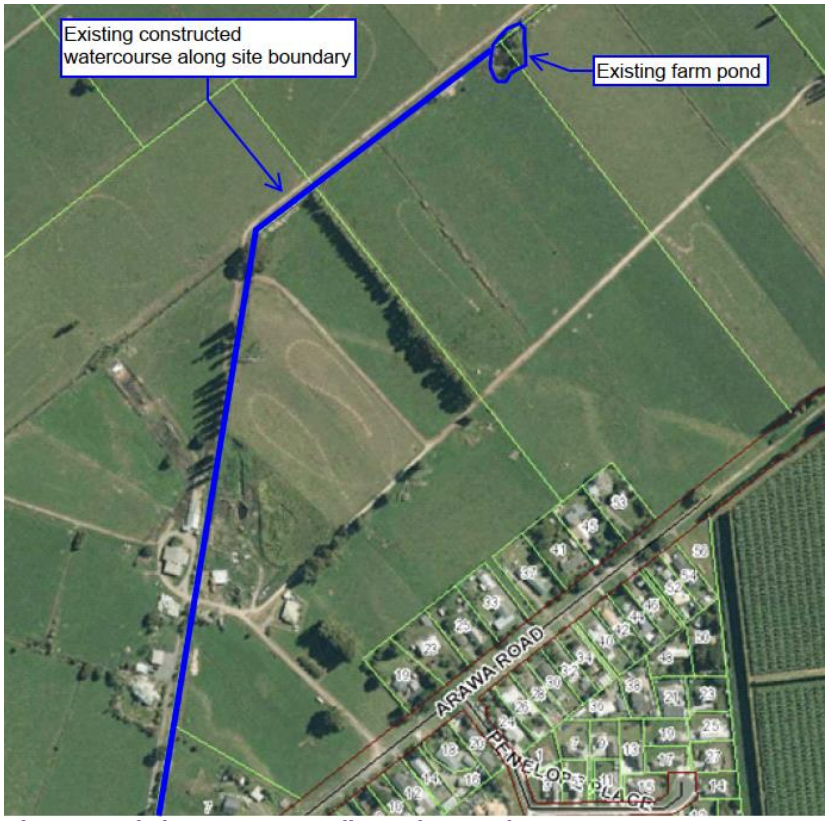


Figure 5: Existing stormwater disposal network

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	
Soakage Rate	100mm/hr
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

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 Figure 2. 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 Figure 2 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%	**1.31m³/s**	Off-site overland
Buildings and driveways	8.01Ha	70%	1.90m³/s	Soakage
			0.00m³/s	To pond
Roads and Yards	1.96Ha	55%	0.40m³/s	To pond
Pond Discharge	N/A	N/A	0.09m³/s	Off-site overland
		Change in peak flow off site	**-1.22m³/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%	**5.33m³/s**	Off-site overland
Buildings and driveways	8.01Ha	70%	2.20m³/s	Soakage
			3.15m³/s	To pond
Roads and Yards	1.96Ha	55%	1.18m³/s	To pond
Pond Discharge	N/A	N/A	4.02m³/s	Off-site overland
		Change in peak flow off site	**-1.31m³/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.

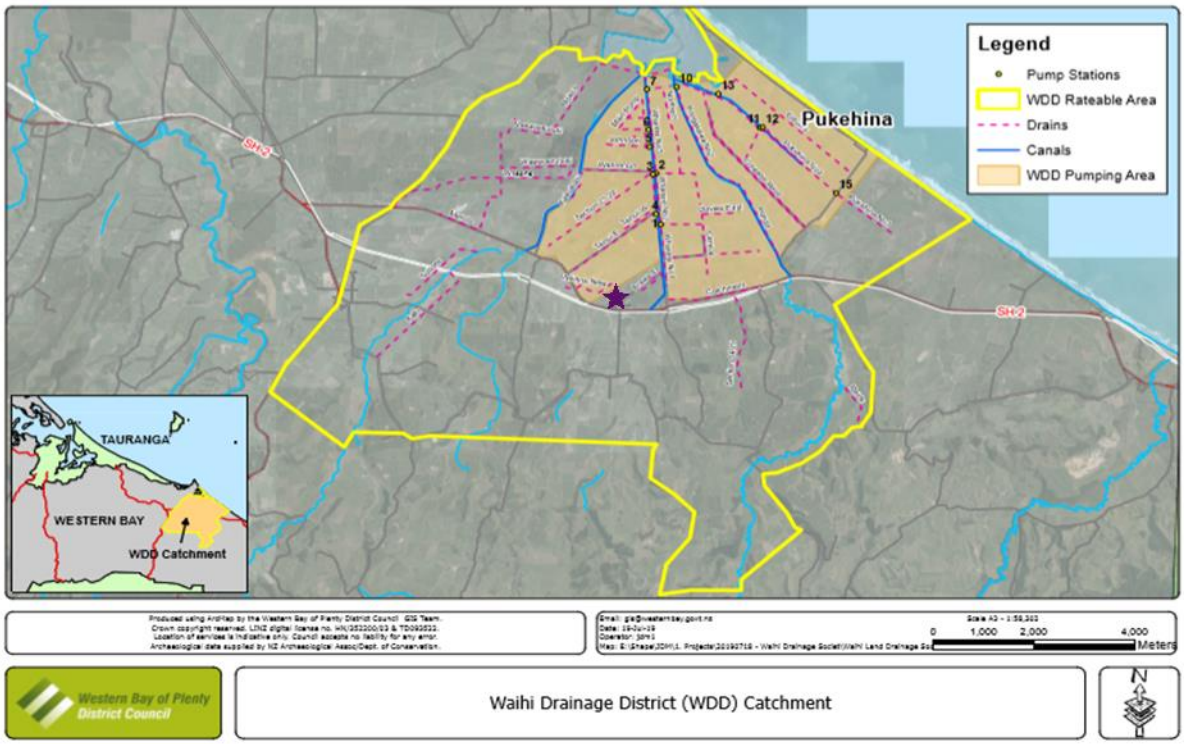


Figure 6: WBOPDC drawing depicting the area downstream of the site served by the Little Waihi Drainage Scheme (Provided by WBOPDC). The purple star represents the approximate site location.

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.

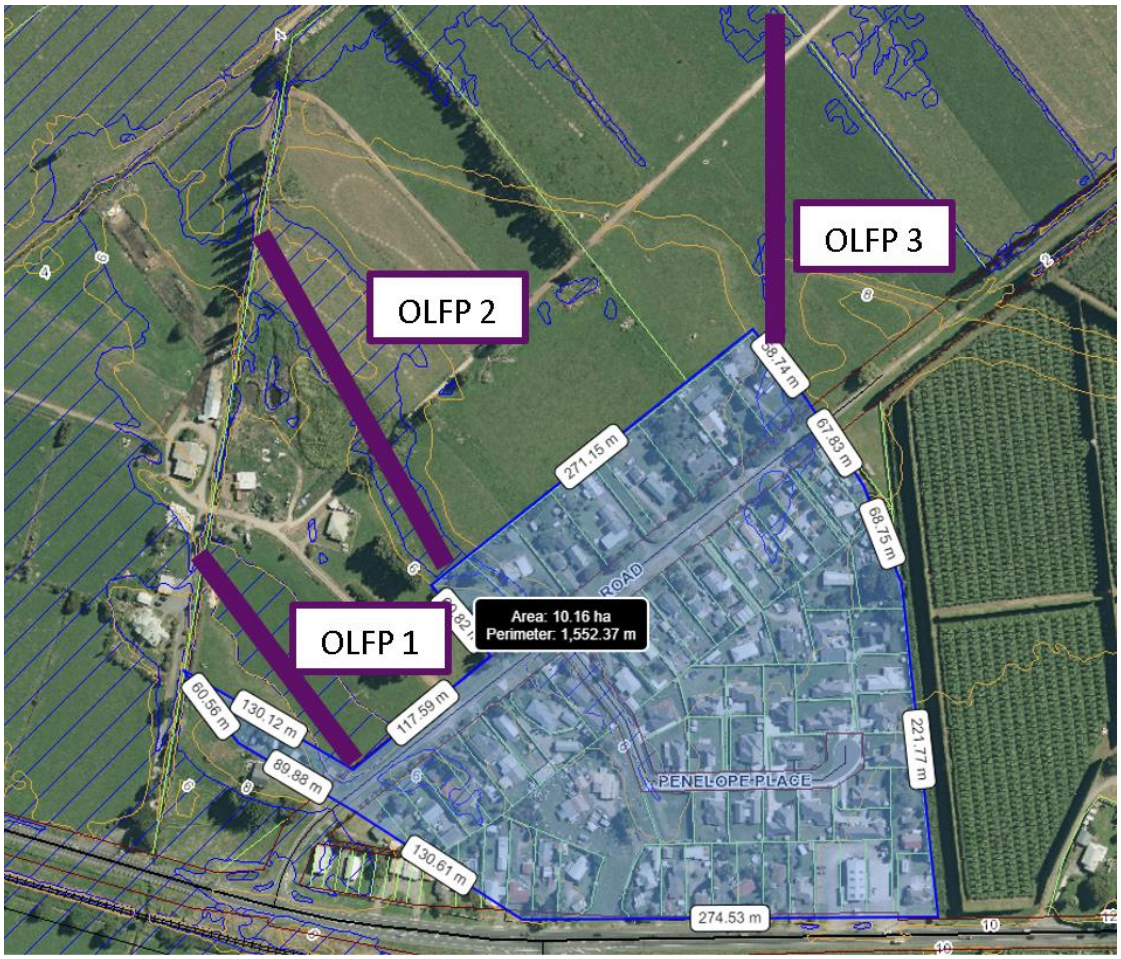


Figure 7: Additional catchment from neighbouring properties and OLFP diversions

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.

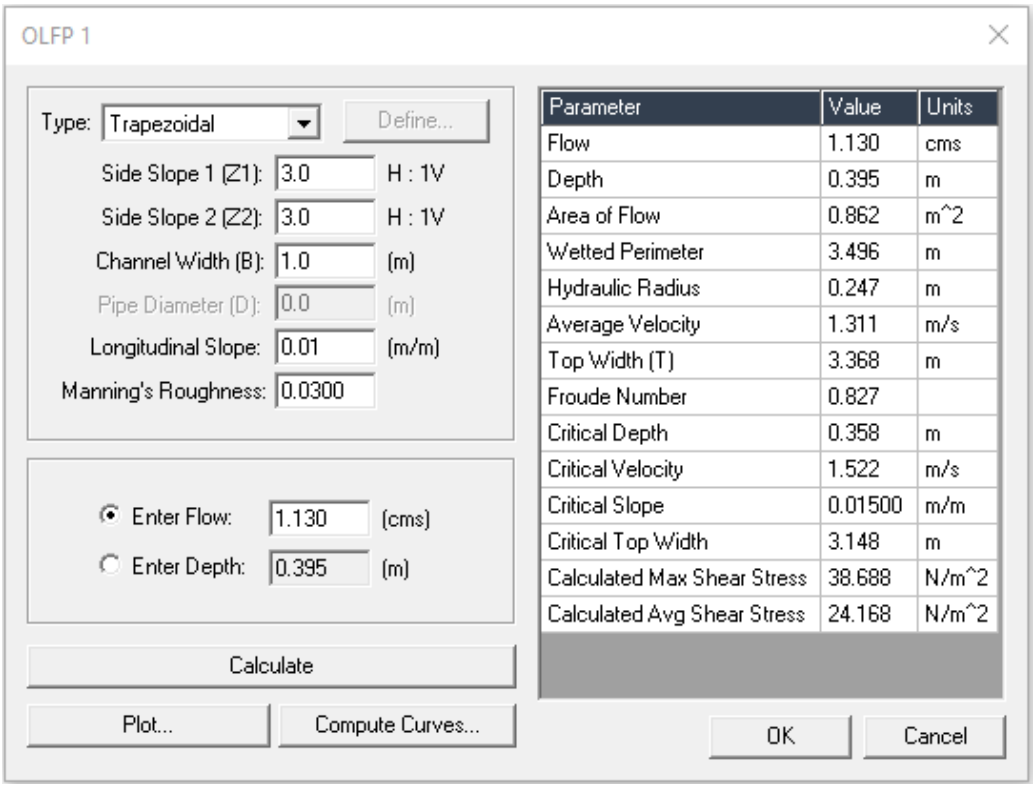
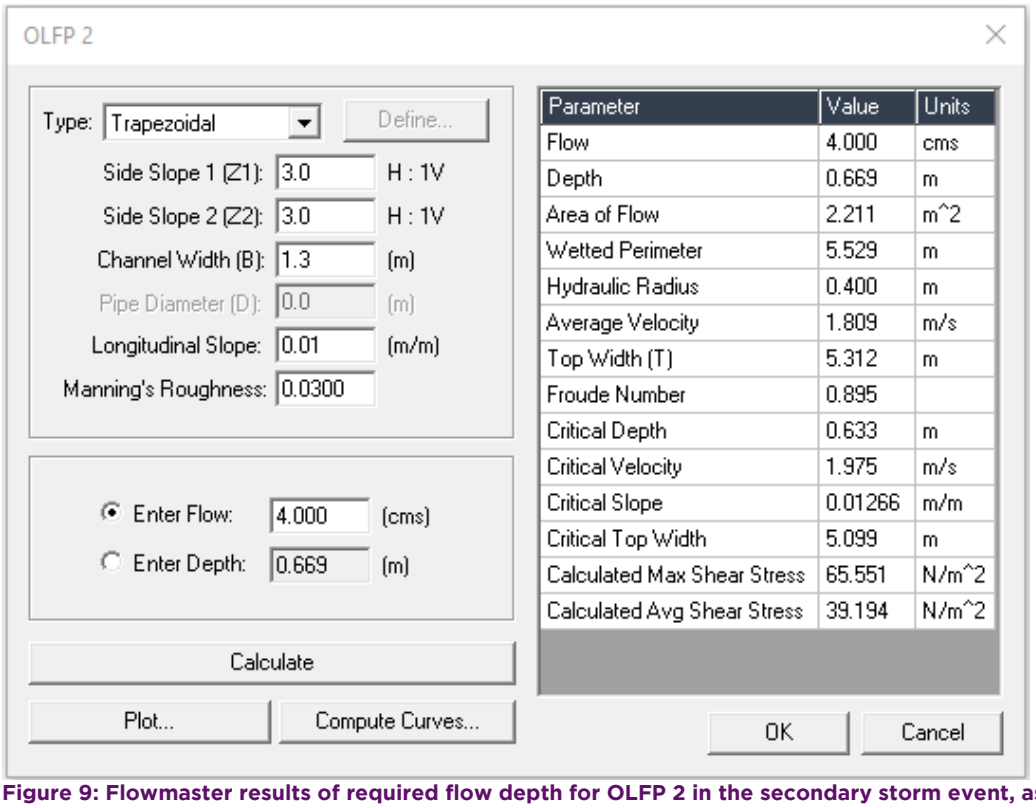
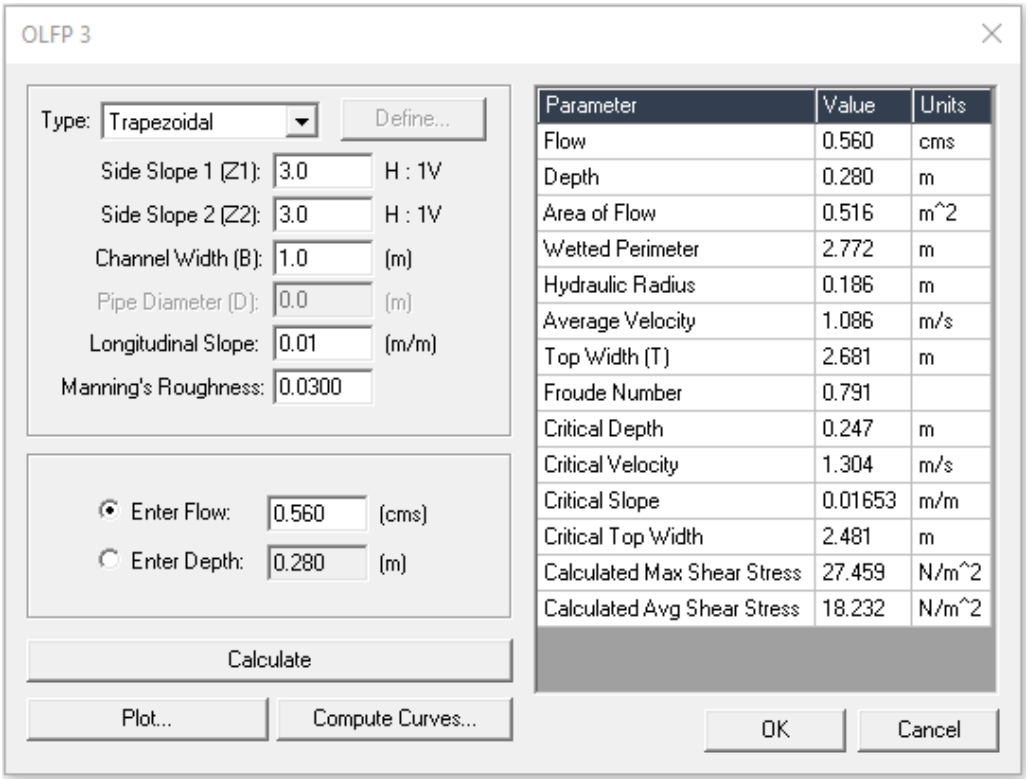


Figure 8: Hydraulic Toolbox results of required flow depth for OLFP 1 in the secondary storm event, assuming a 1% channel grade trapezoidal channel.



Parameter	Value	Units
Flow	4.000	cms
Depth	0.669	m
Area of Flow	2.211	m^2
Wetted Perimeter	5.529	m
Hydraulic Radius	0.400	m
Average Velocity	1.809	m/s
Top Width (T)	5.312	m
Froude Number	0.895	
Critical Depth	0.633	m
Critical Velocity	1.975	m/s
Critical Slope	0.01266	m/m
Critical Top Width	5.099	m
Calculated Max Shear Stress	65.551	N/m^2
Calculated Avg Shear Stress	39.194	N/m^2

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



Parameter	Value	Units
Flow	0.560	cms
Depth	0.280	m
Area of Flow	0.516	m^2
Wetted Perimeter	2.772	m
Hydraulic Radius	0.186	m
Average Velocity	1.086	m/s
Top Width (T)	2.681	m
Froude Number	0.791	
Critical Depth	0.247	m
Critical Velocity	1.304	m/s
Critical Slope	0.01653	m/m
Critical Top Width	2.481	m
Calculated Max Shear Stress	27.459	N/m^2
Calculated Avg Shear Stress	18.232	N/m^2

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)

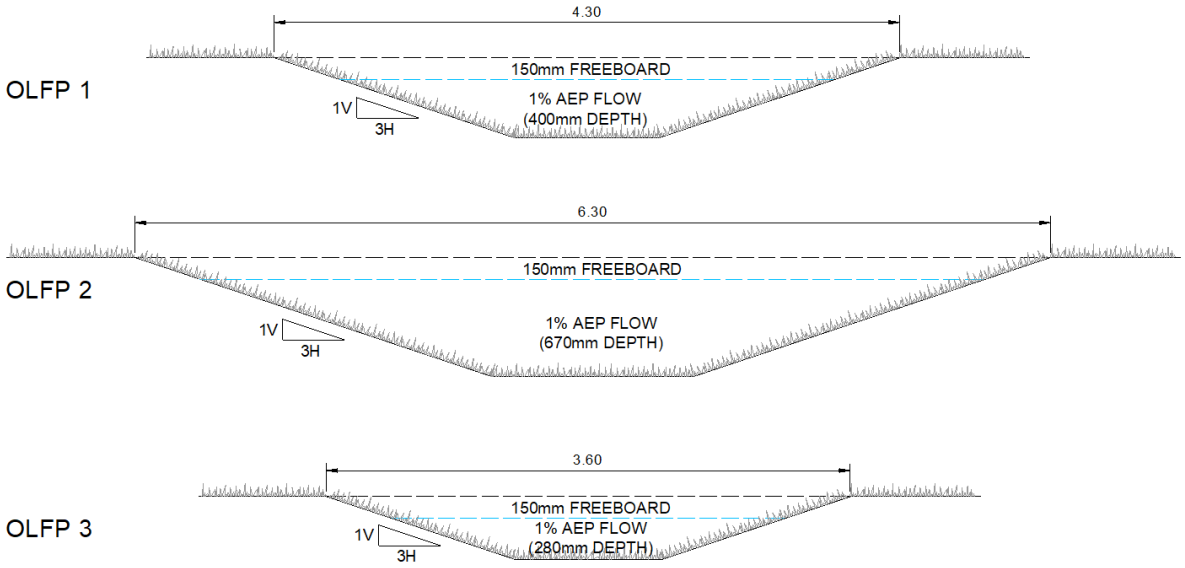


Figure 11: Sketches of overland flow paths 1-3

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 orange in Figure 2 above.

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 12 below.

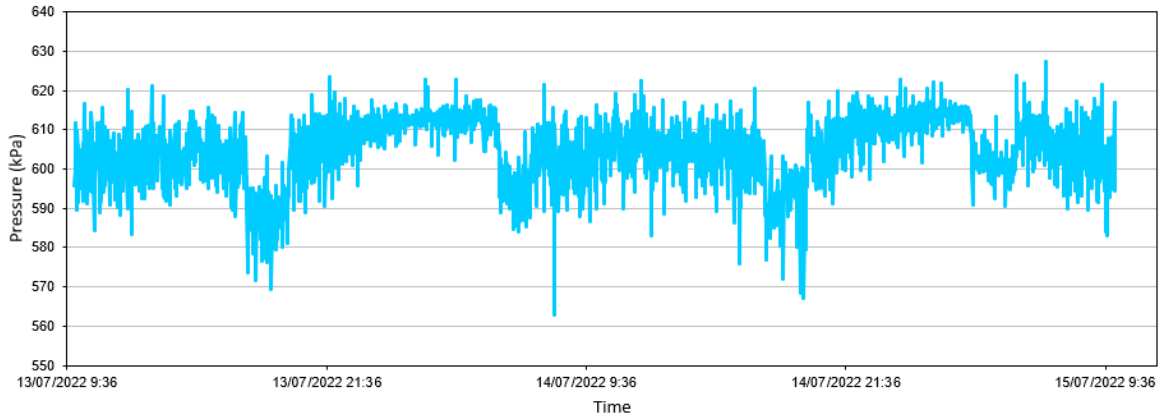


Figure 12: Pressure monitoring results, provided by Alec Coory of Rolec. Monitoring was undertaken at the air valve on the pipe bridge 90m west of the SH2/Arawa Road intersection.

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 13 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.

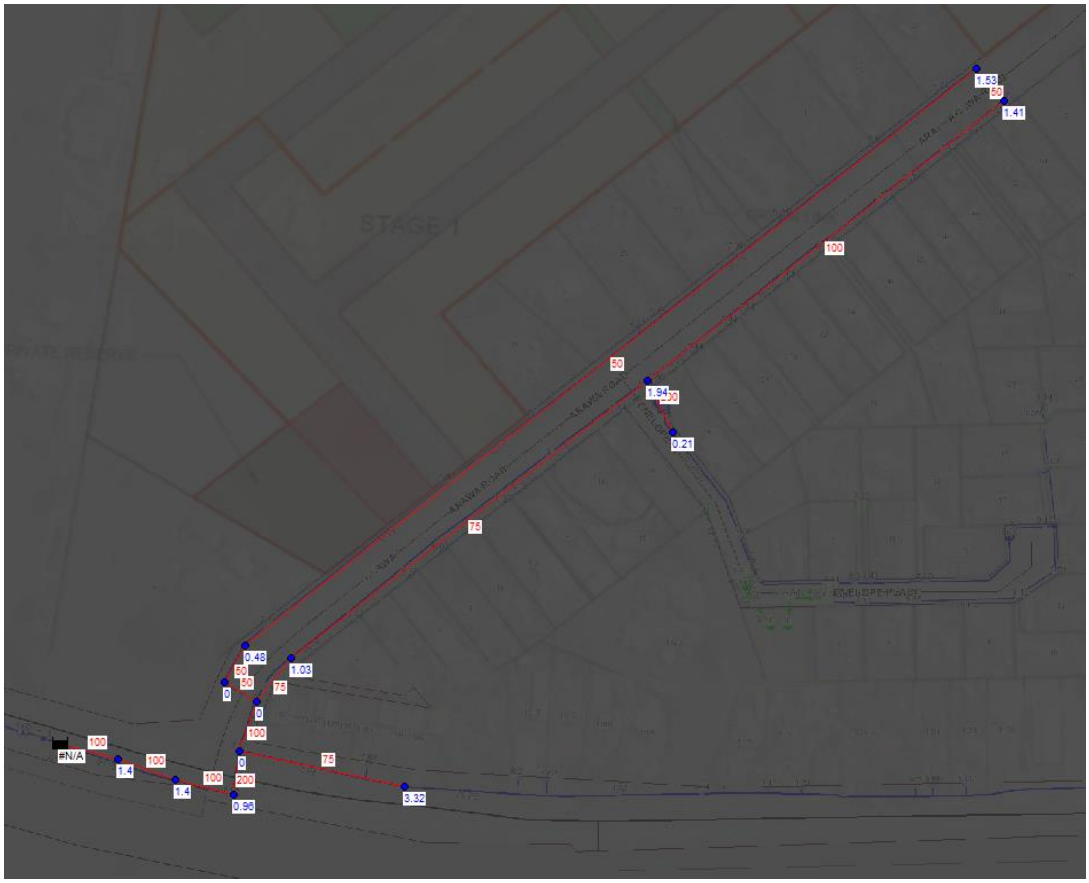


Figure 13: Screenshot of the EPANet water pressure model for the existing network. Red lines/text denote pipes and their respective diameters (in mm), blue dots/text represent nodes in the network and their estimated demand (in l/s). The green reservoir at bottom left represents the 100mm main in SH2, 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.

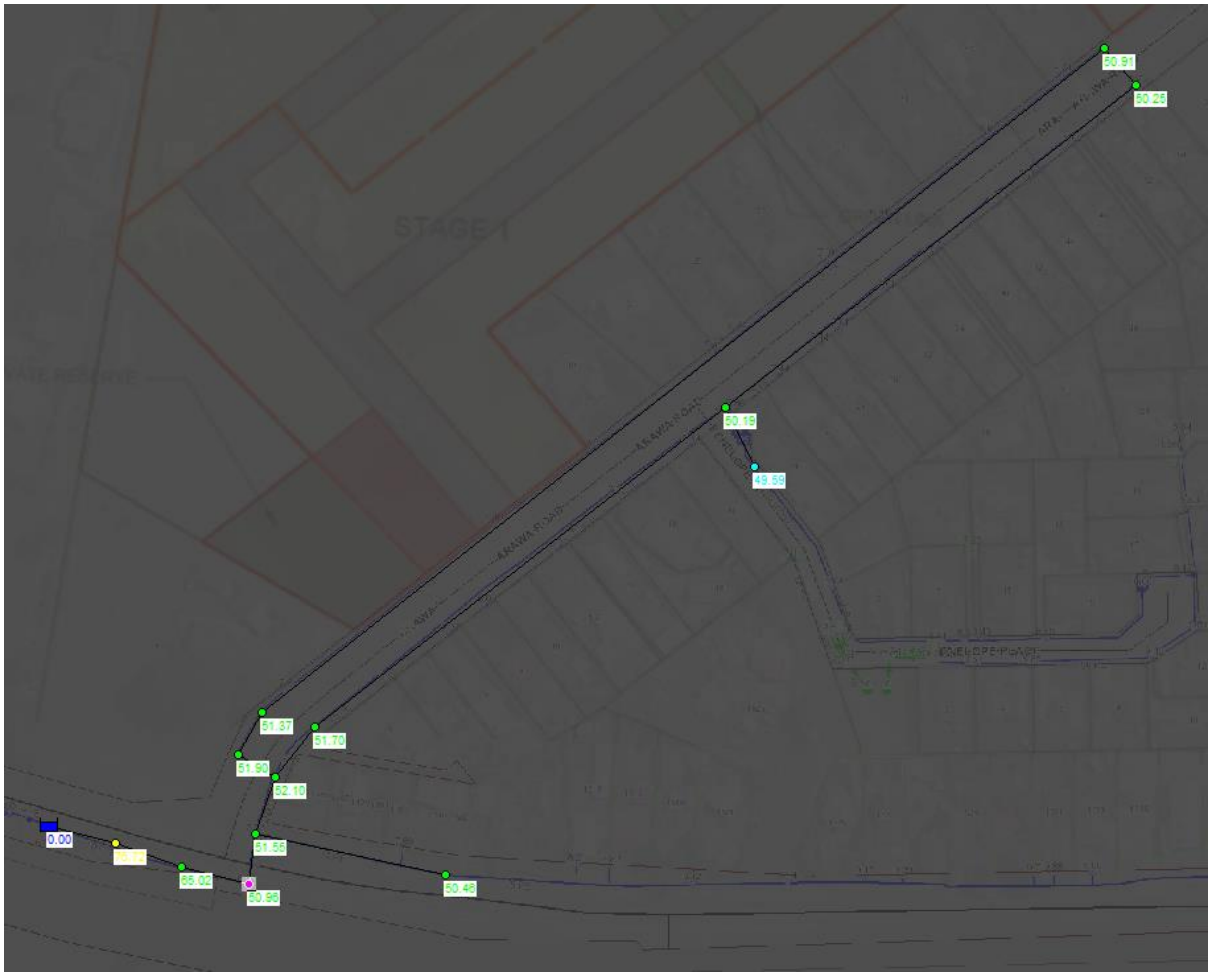


Figure 14: Screenshot of the EPANet water pressure model for the existing network. Black lines denote pipes green dots/text represent nodes in the network and their modelled pressure (in metres head).

7.3 Option 1 – State Highway 2 Watermain Upgrade

Figure 15 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 15: 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 16 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.

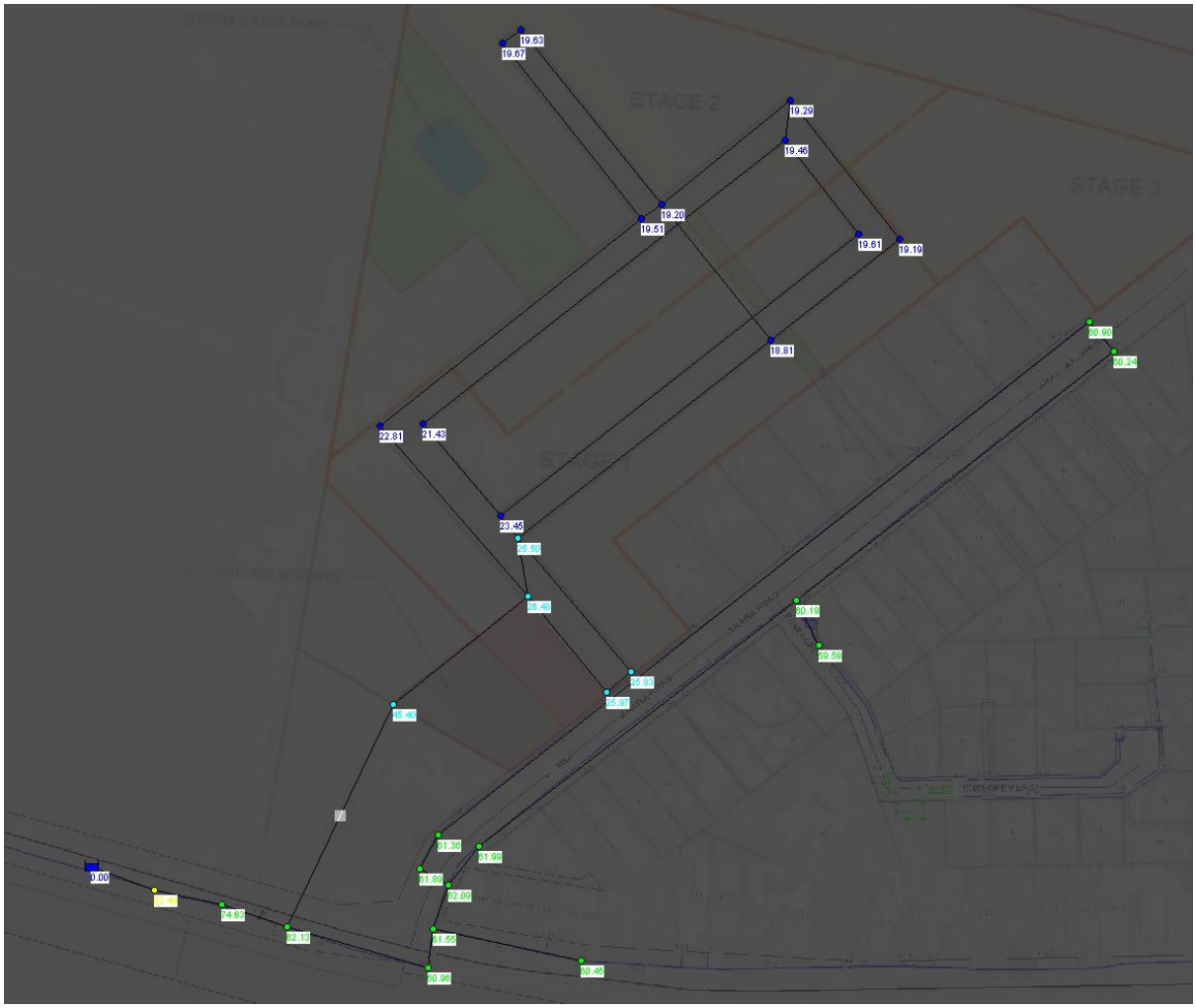


Figure 16: Screenshot of the EPANet water pressure model for Option 1. Blue and Green dots/text represent nodes in the network and their modelled residual pressures when two fire hydrants are each drawing 12.5l/s within the proposed plan change area.

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 17 below is a diagrammatic representation of how that might be achieved.

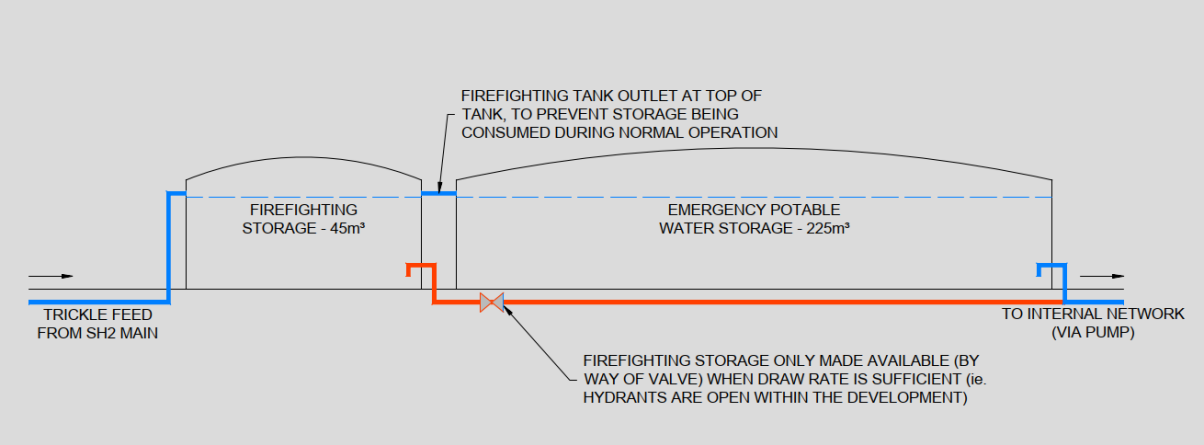


Figure 17: Diagrammatic representation of a potential conceptual reservoir arrangement at the site entrance.

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 18 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.

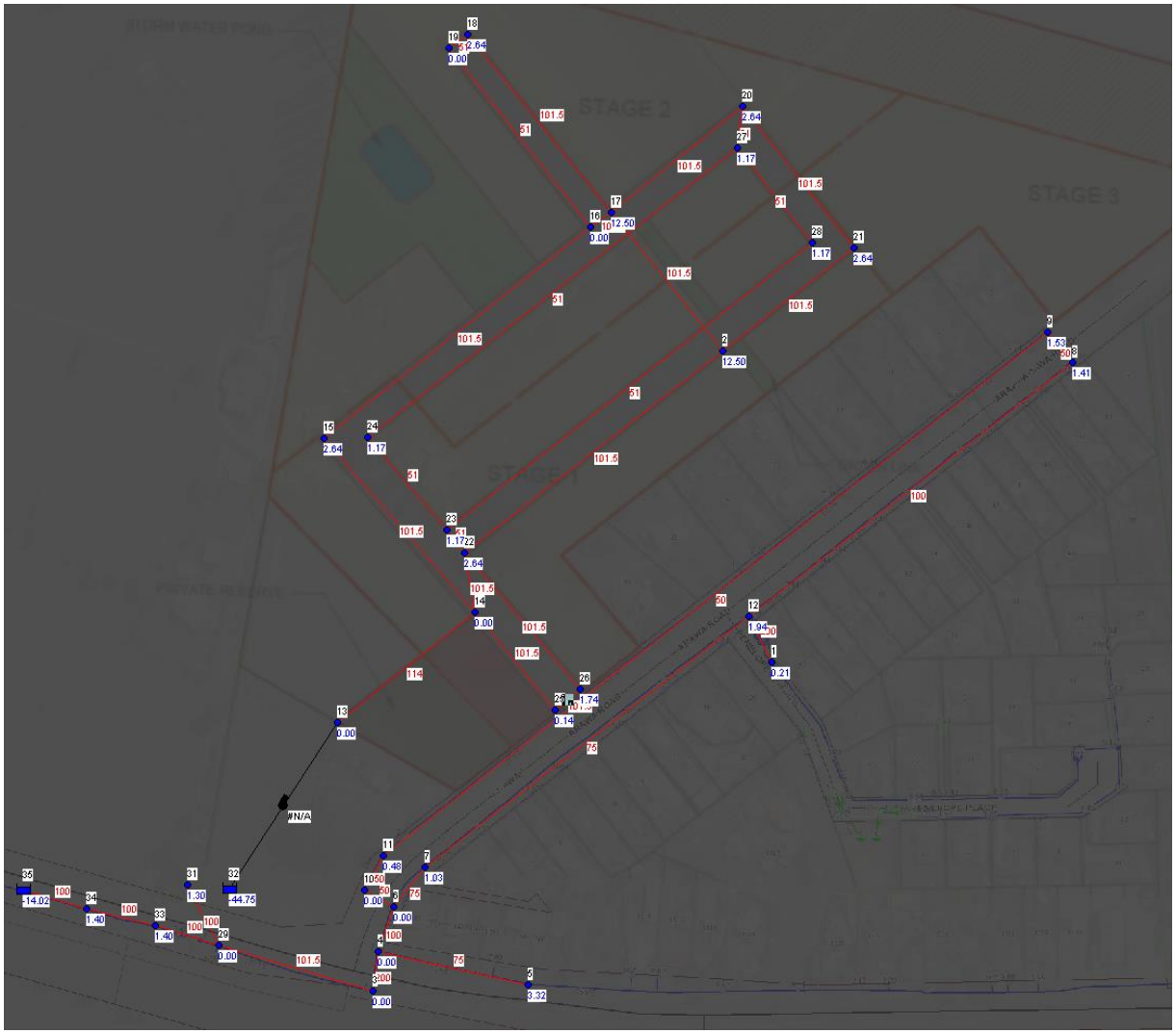


Figure 18: Screenshot of the EPANet water pressure model for Option 2. Red lines/text denote pipes and their respective diameters (in mm), blue dots/text represent nodes in the network and their estimated demand (in l/s). The black reservoirs at bottom left represents the 100mm main in SH2, with 100m 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 19 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).

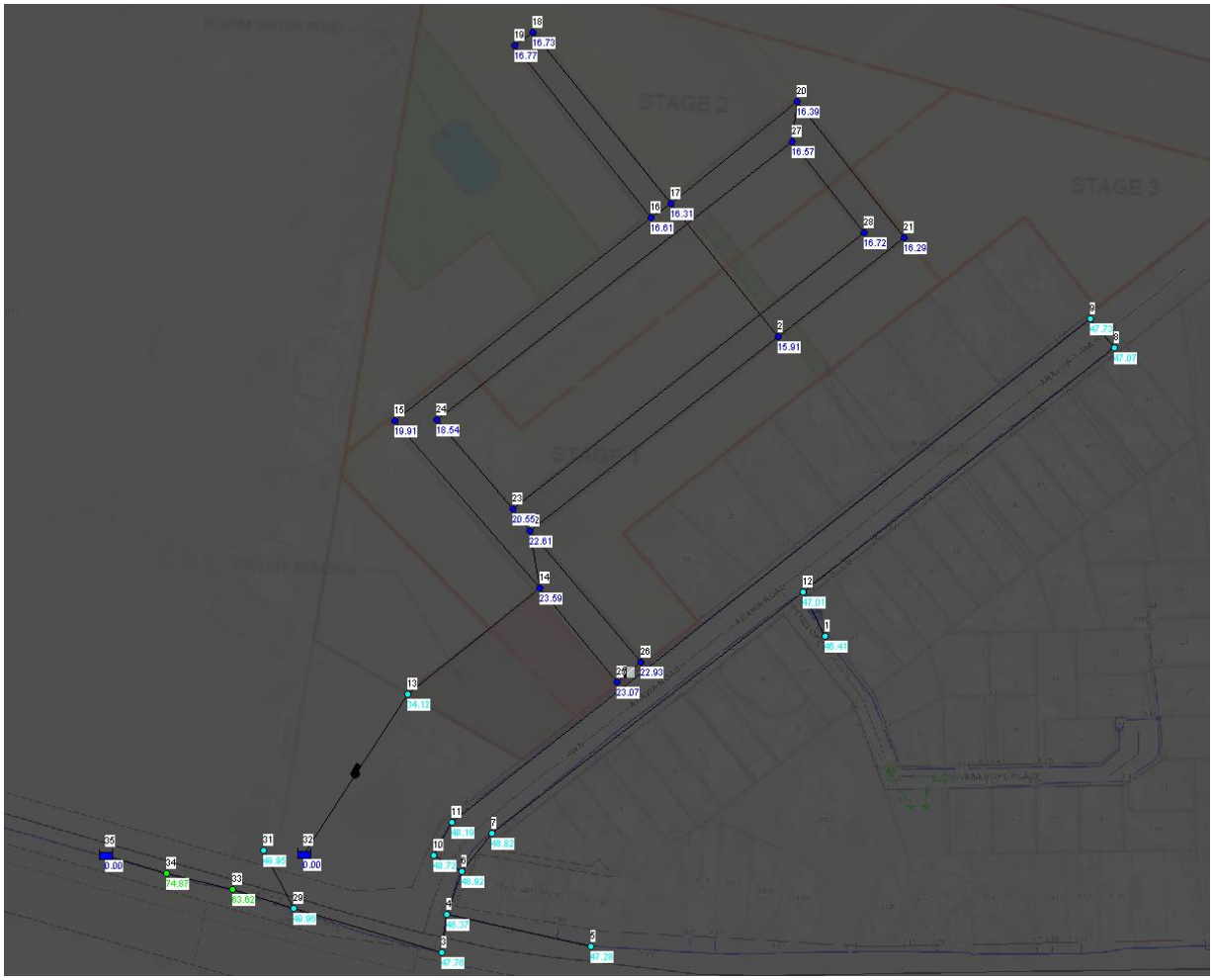


Figure 19: Screenshot of the EPANet water pressure model for Option 2. Blue and Green dots/text represent nodes in the network and their modelled residual pressures when two fire hydrants are each drawing 12.5l/s within the proposed plan change area.

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).

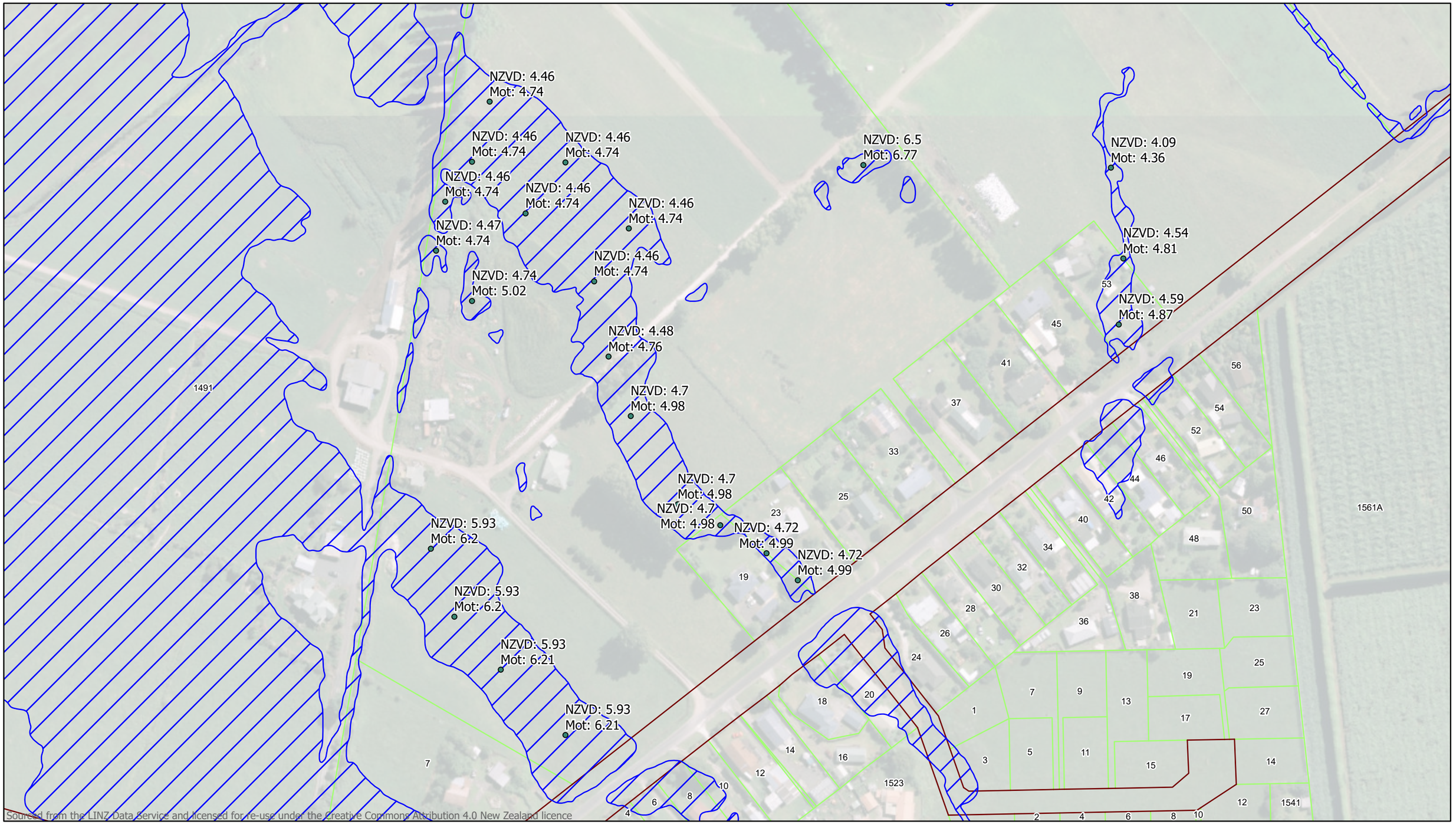
Sensitivity analysis was carried out on the existing network, and whilst the proposed development theoretically needs only a 1.3l/s trickle feed to operate, as much as 3.7l/s could be taken from the existing network at the point of supply without the pressure in the existing mains dropping below 30m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

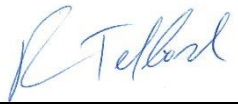
1491 STATE HIGHWAY 2, PONGAKAWA

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.

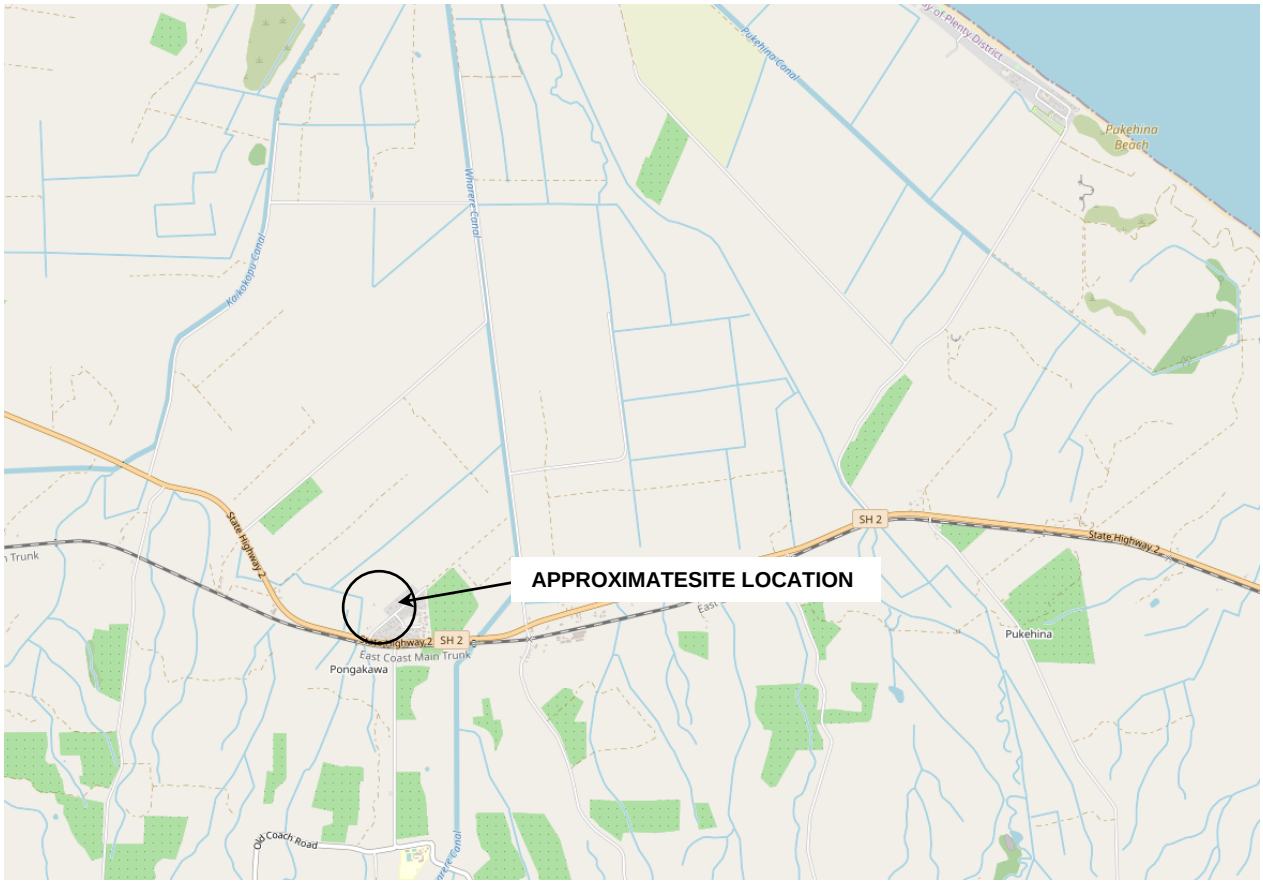


Figure 1: Site Location Plan (openstreetmaps.org)

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.

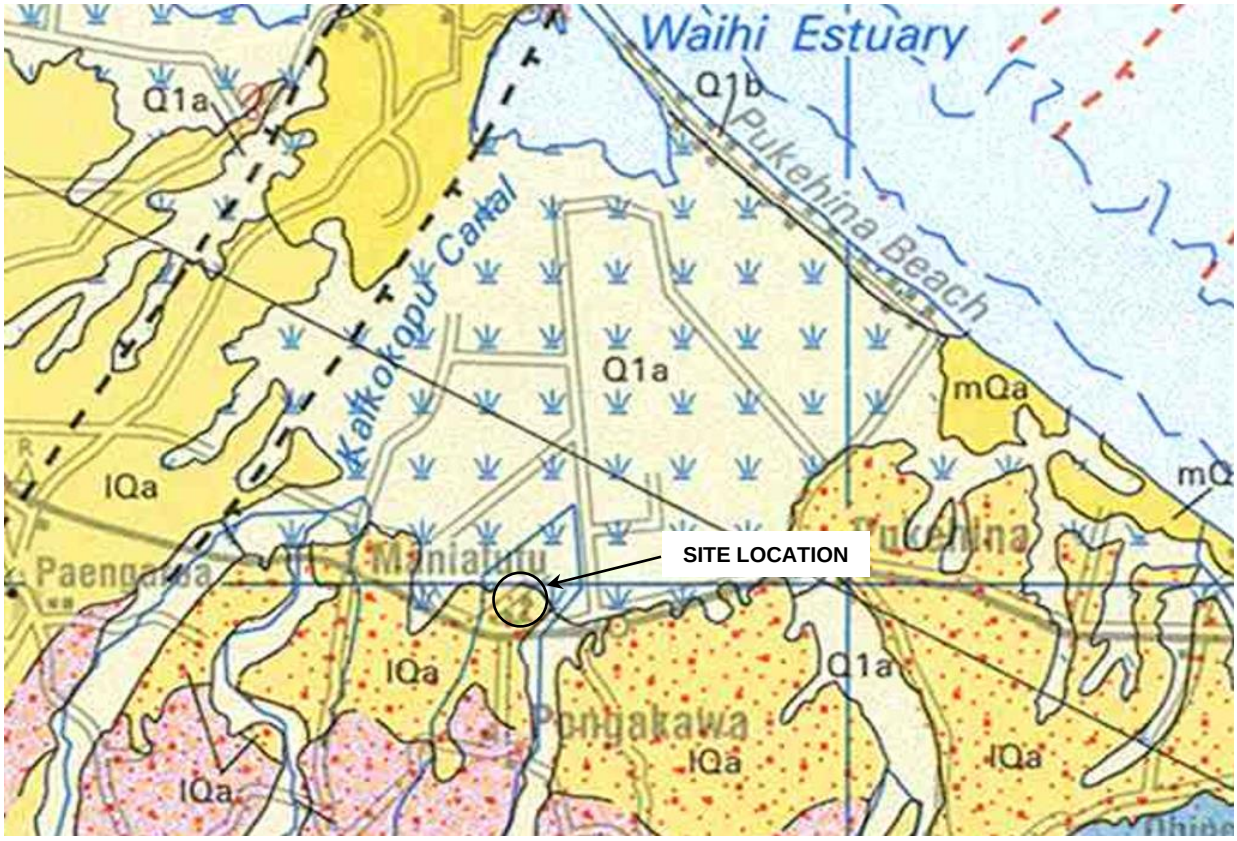


Figure 2: Regional Geology (Leonard and Begg 2010)

[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***.

[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.

[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.

[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:

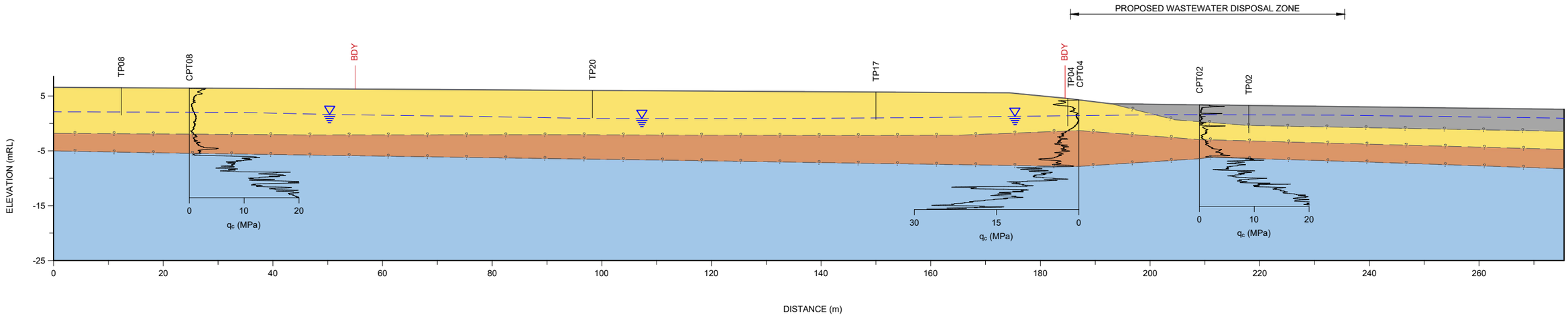
1. BASE PLAN ADAPTED FROM WESTERN BAY OF PLENTY DISTRICT COUNCIL MAPI.
2. CONTOURS ARE IN 1.0m INTERVALS AND ARE IN TERMS OF MOTURIKI DATUM.
3. TEST LOCATIONS ARE APPROXIMATE ONLY.

1:3000 0 30 60 90 120 150 m

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

Legend

- Plan Change Boundary
- Flood effected area*
- Existing Building
- Contours with site area
- Open drains

* Flood data sourced from WBOPDC, flood data is modeled for a 1% flood event, adjusted for climate change and 1.25m sea level rise.

Notes

Total Area:	97722m²
Flood effected Area:	19471m²
Unconstrained Land:	78250m²
Lot Yield:	106*

* Lot yield has been calculated assuming 25% of unconstrained land will be used for roads and reserves.
Allow for 75% of land to be allocated to lots.
Lot sized assumed to be 550m².
Lot yield indicative and may change.

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

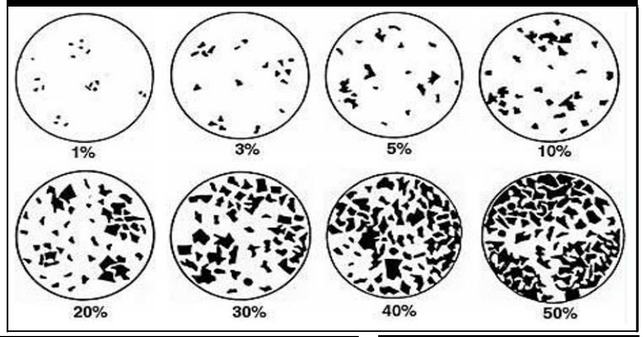
BEHAVIOURAL SOIL CLASSIFICATION SYSTEM

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			Sand				Silt	Clay	Organic Soil
			coarse	medium	fine	coarse	medium	fine				
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

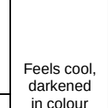
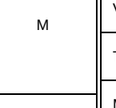
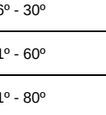
SOIL STRUCTURE

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

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

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

Revision 2 April 2018

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	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
						OL: Organic SILT: with trace sand; dark brownish black. No plasticity; sand, fine. (Topsoil)			5 10 15 20	Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks
						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)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
						OL: Organic SILT: with trace sand; dark brownish black. No plasticity; sand, fine. (Topsoil)			5 10 15 20	Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks
						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)				
				1			W			
▼	1.4	Peak = 29kPa Residual = 20kPa								
	2.0	Peak = 58kPa Residual = 26kPa		2				F		
	2.6	Peak = 41kPa Residual = 20kPa					S			
				3						
	3.2	Peak = 32kPa Residual = 14kPa								
	3.6	Peak = 89kPa Residual = 30kPa				ML: SILT: with minor clay; light brownish grey mottled orange brown. Low plasticity, moderately sensitive (Pleistocene Alluvium)		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 - 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	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			
						SP: Fine SAND: light brownish grey. Uniformly graded. (Alluvial Sands)				
	0.6	Peak = 46kPa Residual = 17kPa				Pt: PEAT: dark brownish black. Low plasticity, moderately sensitive, organic, fibrous, tree stumps. (Peat)	W			
▼	1.1	Peak = 41kPa Residual = 17kPa		1				F		
	1.6	Peak = 46kPa Residual = 14kPa					S			
	2.0	Peak = 72kPa Residual = 43kPa		2				St		
	2.5	Peak = 69kPa Residual = 41kPa								
				3		SP: Fine to medium SAND: brownish grey. Poorly graded, interbedded with sandy SILT. (Pleistocene Alluvium)		L to MD	2 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)	Graphic Log	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			
						SP: Fine SAND: light brownish grey. Uniformly graded. (Pleistocene Alluvium)				
						ML: Silty fine to medium SAND : light greyish yellow. Poorly graded. (Pleistocene Alluvium)				
	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)		VSt		
	1.3	Peak = 156kPa Residual = 35kPa								
				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		
	2.5	Peak = 75kPa Residual = 29kPa								
	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)		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)	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)
				0		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	
	1.0	Peak = 75kPa Residual = 20kPa		1		ML: Sandy SILT: light brownish grey mottled orange brown. Low plasticity, moderately sensitive; sand fine to medium. (Pleistocene Alluvium)				
	2.0	Peak = 119kPa Residual = 20kPa		2		... at 2.20m, becoming clayey SILT	M	VSt to St		
	2.5	Peak = 87kPa Residual = 32kPa								
	3.0	Peak = 84kPa Residual = 32kPa		3						
				4		SM: Silty Fine to coarse SAND: with minor gravel and clay; light yellowish white. Well graded; gravel, fine to medium, weathered. (Pleistocene Alluvium)				
						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	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)			5 10 15 20	Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks
						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		
	0.7	Peak = 46kPa Residual = 17kPa		1		ML: SILT: orange. Low plasticity, moderately sensitive. (Pleistocene Alluvium)				
	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			M			
	2.5	Peak = 107kPa Residual = 35kPa						VSt to St		
	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	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)			5 10 15 20	Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks
						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	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
						OL: Organic SILT: brown. No plasticity. (Topsoil)			5 10 15 20	Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks
						SP: Fine SAND: light brownish grey. Poorly graded. (Pleistocene Alluvium)				
						ML: SILT: with some sand; orange. Low plasticity, insensitive; sand, fine to medium. (Pleistocene Alluvium)				
	0.5	Peak = 64kPa Residual = 23kPa						St		
						MH: Clayey SILT: with minor sand; light grey streaked orange brown. Low plasticity, moderately sensitive; sand, medium. (Pleistocene Alluvium)				
	1.0	Peak = 104kPa Residual = 29kPa		1						
	1.5	Peak = 142kPa Residual = 38kPa								
	2.0	Peak = 90kPa Residual = 26kPa		2			M			
	2.5	Peak = 107kPa Residual = 29kPa						St to VSt		
	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)				
				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	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
						OL: Organic SILT: dark brownish black. Non-plastic; sand, fine. (Topsoil)	M		5 10 15 20	Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks
						SP: Fine SAND: light brownish grey. poorly graded. (Alluvial Sands)		LP		
	0.8	Peak = 43kPa Residual = 20kPa		1		Pt: PEAT: dark brownish black. Low plasticity, , moderately sensitive, organic, fibrous, tree stumps. (Peat)	W			
	1.5	Peak = 46kPa Residual = 17kPa								
	2.0	Peak = 38kPa Residual = 17kPa		2			W to S	F		
	2.5	Peak = 43kPa Residual = 20kPa								
				3		ML: SILT: light brownish grey. Low plasticity. (Pleistocene Alluvium)				
	3.6	Peak = 104kPa Residual = 29kPa						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	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
	0.5	Peak = 77kPa Residual = 30kPa				OL: Organic SILT: with trace sand; dark brownish black. Non-plastic; sand, fine. (Topsoil) ML: SILT: with some sand; orange. Low plasticity, moderately sensitive; sand, fine to medium. (Pleistocene Alluvium)		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)				
	1.5	Peak = 107kPa Residual = 27kPa					M			
	2.0	Peak = 119kPa Residual = 30kPa		2				VSt		
	2.5	Peak = 137kPa Residual = 45kPa								
	3.0	Peak = 131kPa Residual = 42kPa		3						
	3.5	Peak = 140kPa Residual = 45kPa								
				4		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			
						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	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)			5 10 15 20	Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks
						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						
						MH: Clayey SILT: with minor sand; light grey streaked orange brown. Low plasticity, moderately sensitive to sensitive; sand, medium. (Pleistocene Alluvium)				
	1.5	Peak = 78kPa Residual = 29kPa						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 | Pit Dimensions: m by m
Datum: Moturiki | Survey Source: pLog tablet

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	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)			5 10 15 20	
						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)				
				1			W			
	1.2	Peak = 38kPa Residual = 14kPa								
▼	1.7	Peak = 43kPa Residual = 20kPa						F		
				2						
	2.4	Peak = 43kPa Residual = 23kPa					W to S			
	2.9	Peak = 32kPa Residual = 14kPa								
				3						
	3.5	Peak = 75kPa Residual = 29kPa				ML: Sandy SILT: greyish brown streaked orange brown. Low plasticity, moderately sensitive; sand, fine to coarse. (Pleistocene Alluvium)		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

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
						OL: Organic SILT: dark brownish black. Non-plastic; sand, fine. (Topsoil)	D to M			
						SP: Fine SAND: light brownish grey. Poorly graded. (Alluvial Sands)				
	0.8	Peak = 49kPa Residual = 14kPa		1		Pt: PEAT : dark brownish black. Low plasticity; moderately sensitive, organic, fibrous, tree stumps. (Peat)	M to W			
▼	1.3	Peak = 43kPa Residual = 14kPa								
	1.8	Peak = 43kPa Residual = 17kPa		2				F		
	2.4	Peak = 46kPa Residual = 17kPa					W to S			
	2.9	Peak = 46kPa Residual = 12kPa		3						
						SP: Fine to medium SAND: brownish grey. Poorly graded, interbedded with sandy SILT. (Pleistocene Alluvium)		L to MD	2 3 1 1	
				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 - 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)	Graphic Log	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	LP		
						SP: Fine SAND: light brownish grey. Poorly graded. (Alluvial Sands)				
	0.5	Peak = 43kPa Residual = 14kPa				Pt: PEAT : dark brownish black. Low plasticity, moderately sensitive, organic, fibrous, tree stumps (Peat)		F		
	1.0	Peak = 41kPa Residual = 20kPa		1			M to W			
						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)		F		
				2		SW: Fine to coarse SAND: grey. Well graded, pumiceous. (Pleistocene Alluvium)	W to S	L to MD	2 3 4 2 3 4 4 2 3 2 4	
				3					4 3 3 3 4	
						Test pit terminated at 3.50 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 - 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	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	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		5 10 15 20	Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks
	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								
▼						SW: Fine to coarse SAND: with trace gravel; light grey. Well graded, pumiceous. (Alluvial Sands)				
				2		*... 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)	Graphic Log	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			
						SP: Fine SAND: light brownish grey. Uniformly graded. (Pleistocene Alluvium)			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
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)	Graphic Log	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.	D to M			
						(Topsoil)				
						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)				
				1			M	F to St		
	1.2	Peak = 75kPa Residual = 41kPa								
	1.8	Peak = 75kPa Residual = 20kPa								
▼				2		MH: Clayey SILT: with minor sand; light grey. Low plasticity; sand, fine to medium. (Matua Subgroup)				
						... *at 2.20m, Interbedded with thin sand layers*				
	2.5	Peak = 119kPa Residual = 46kPa					W to S	VSt		
	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	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)				
	0.4	Peak = 43kPa Residual = 26kPa				ML: SILT: orange. Low plasticity, moderately sensitive to sensitive. (Pleistocene Alluvium)	D to M	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)				
	2.0	Peak = 142kPa Residual = 29kPa		2						
	2.5	Peak = 119kPa Residual = 29kPa					M	VSt		
	3.0	Peak = 142kPa Residual = 38kPa		3		... at 2.90m, contains minor sand				
	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	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			
	0.5	Peak = 104kPa Residual = 35kPa				ML: SILT: with some sand; orange. Low plasticity, moderately sensitive; sand, fine. (Pleistocene Alluvium)				
	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			M	VSt		
	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						

Dynamic Cone Penetrometer (Blows/100mm): 5 10 15 20

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.

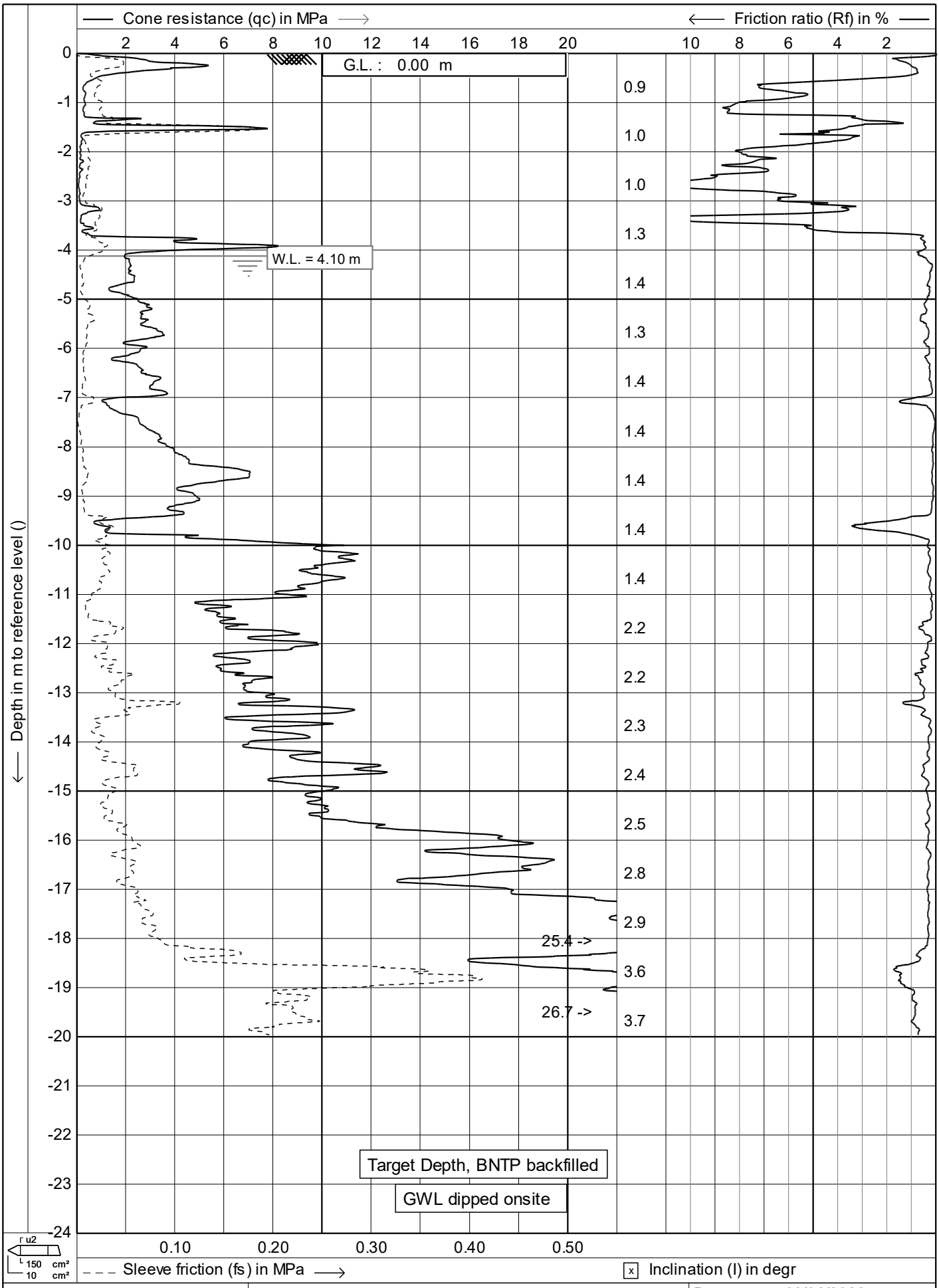
TEST PIT LOG - TP21

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	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			
						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)				
	1.0	Peak = 87kPa Residual = 23kPa		1			M to W	St		
	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.



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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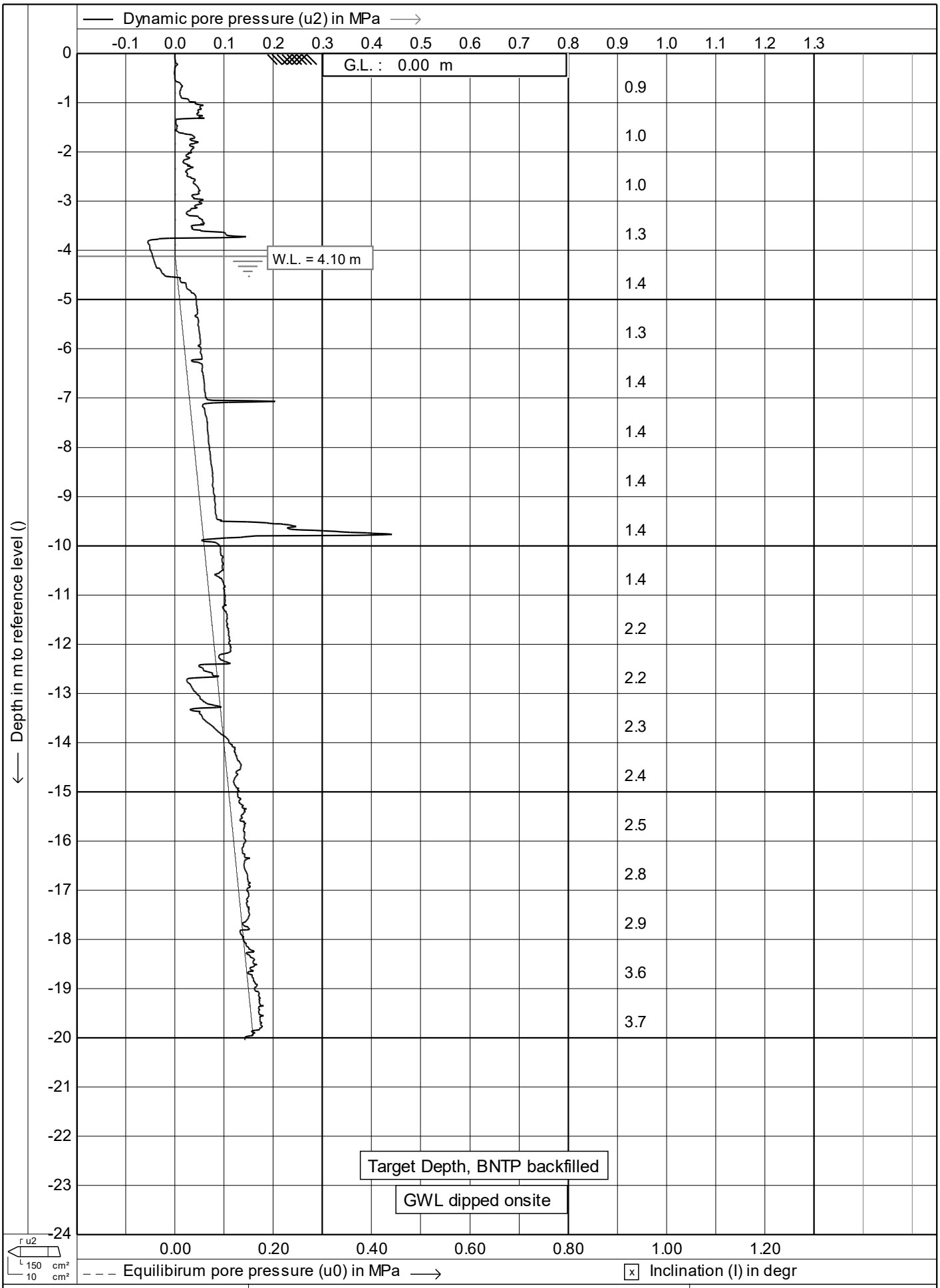

PERRY GEOTECH

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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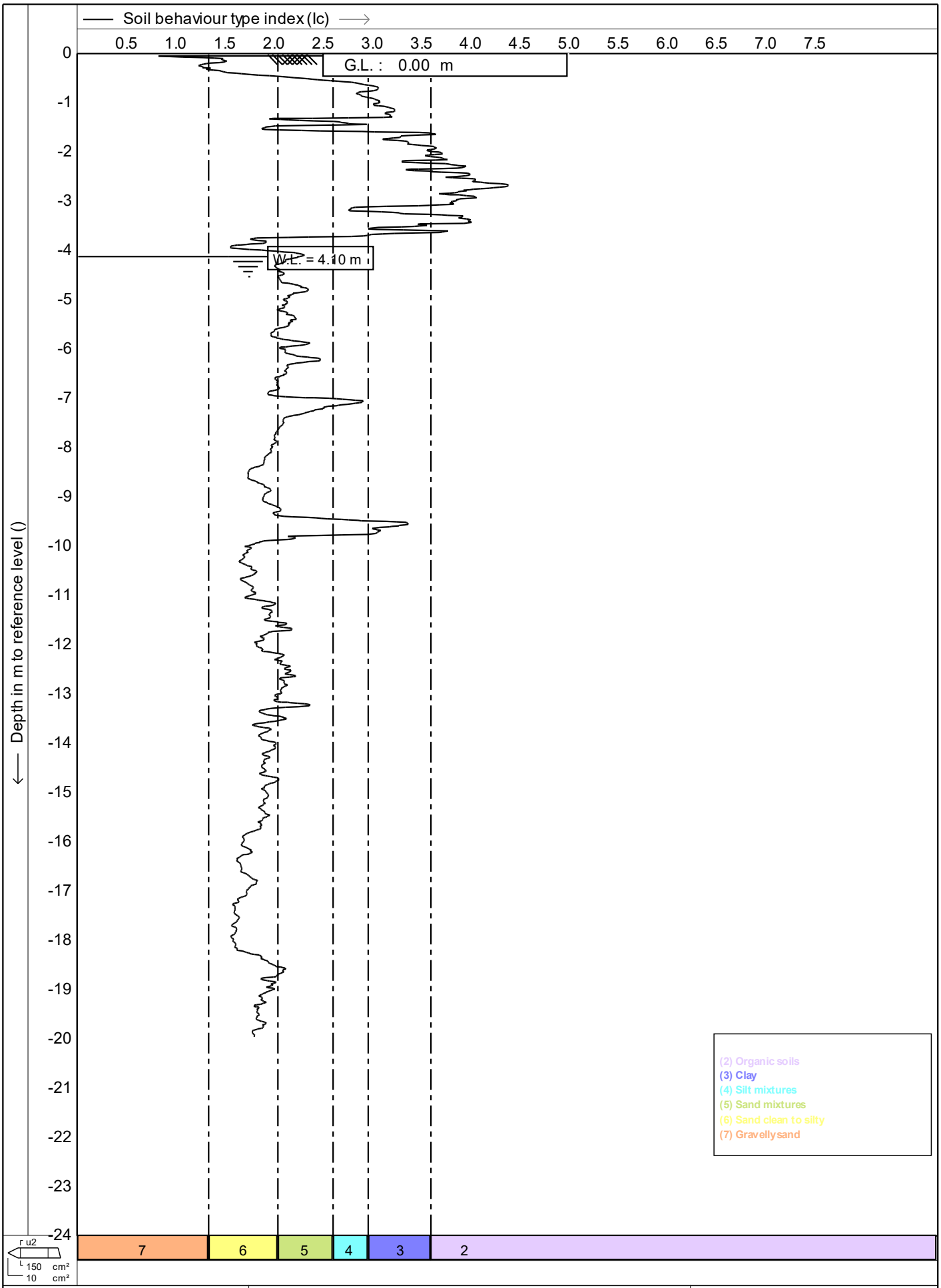

PERRY GEOTECH

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** **9/14**

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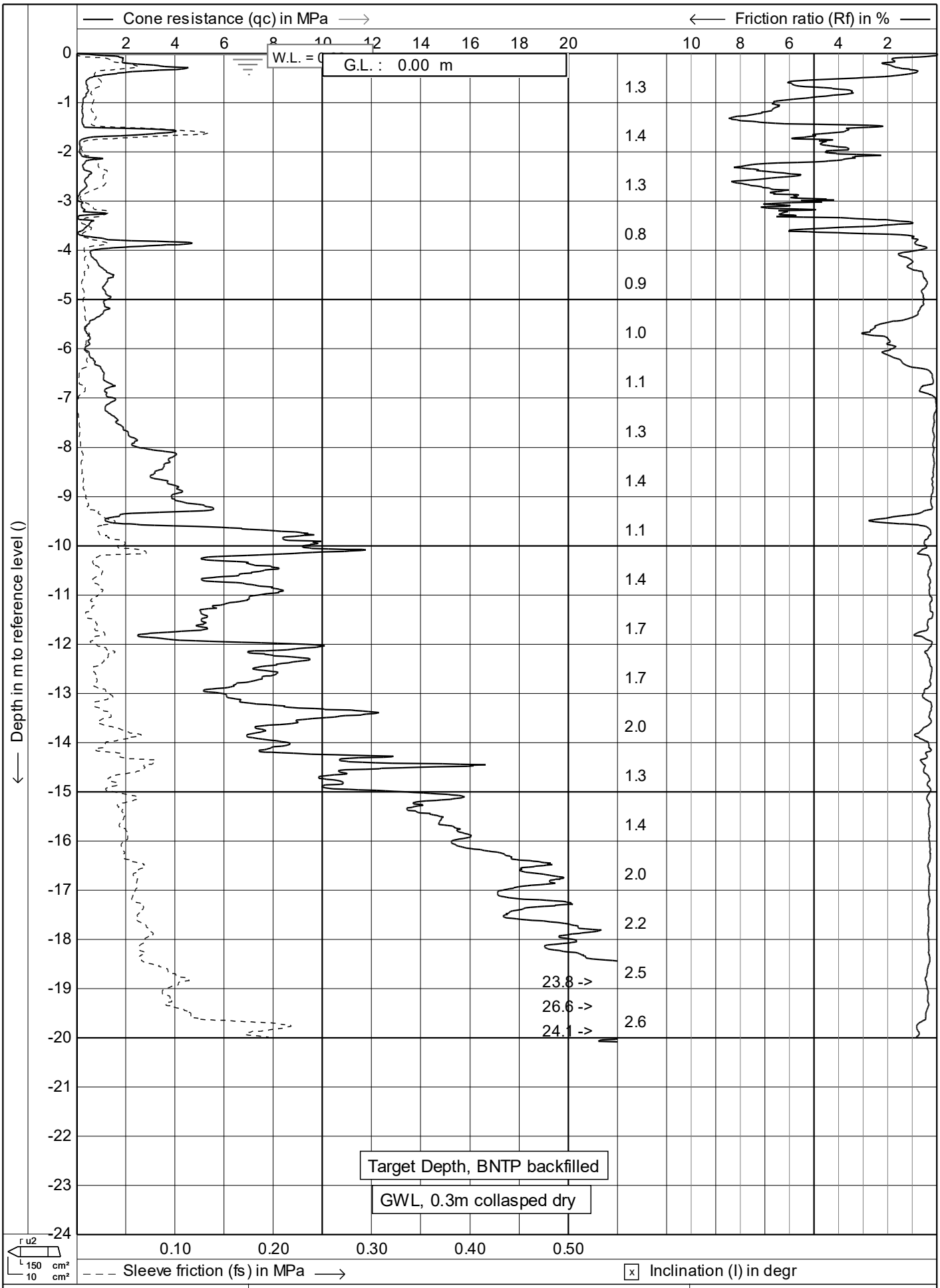

PERRY GEOTECH

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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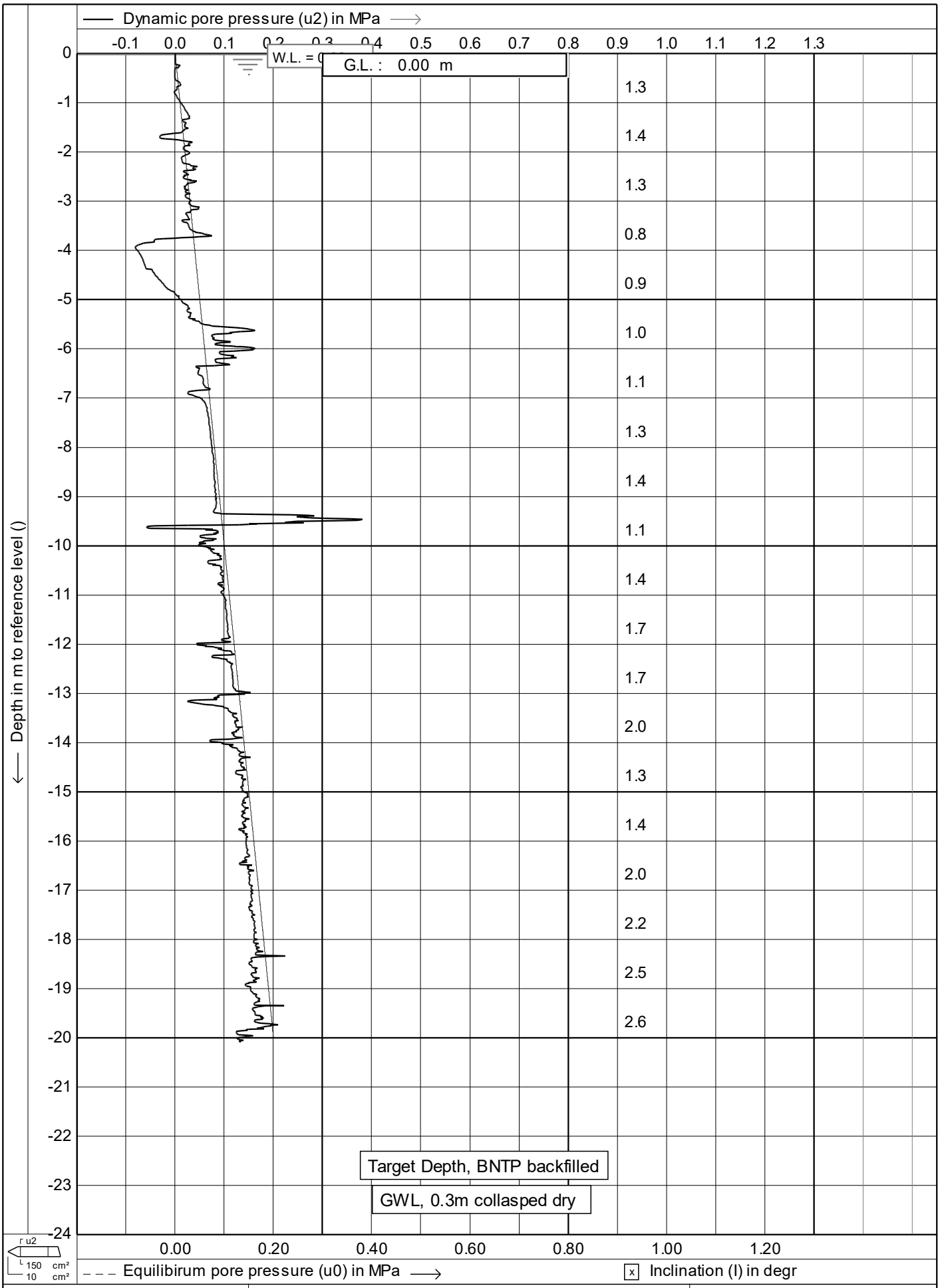

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Test according A.S.T.M Standard D 5778-12

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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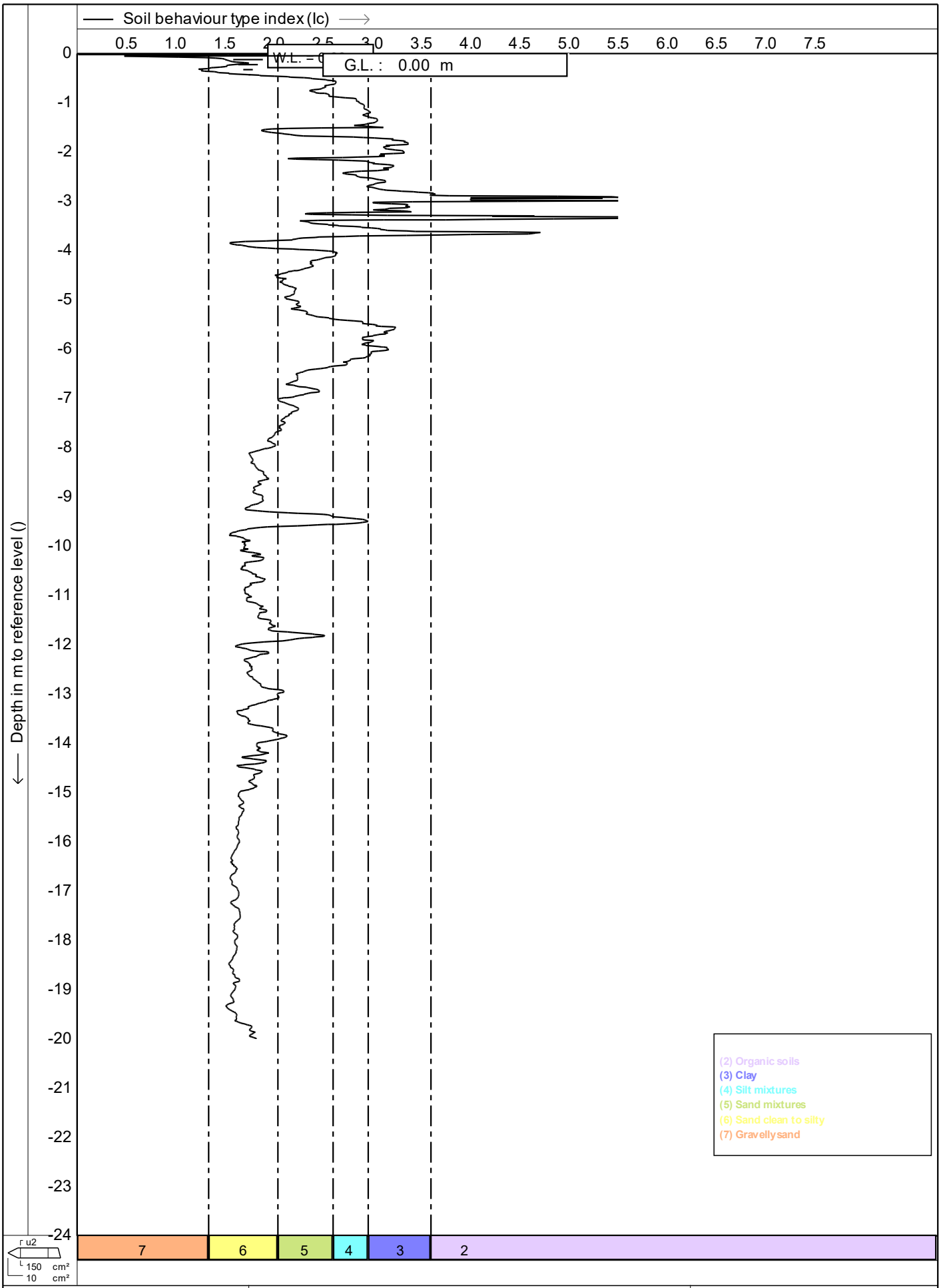

PERRY GEOTECH

Test according A.S.T.M Standard D 5778-12

Project : **Site Investigations**

Location: **1491 Arawa Rd Pongakawa**

Position: **0, 0**

Date : **19/01/2022**

Cone no. : **C10CFIIP.C17803**

Project no. : **05CMW099**

CPT no. : **02** **9/14**

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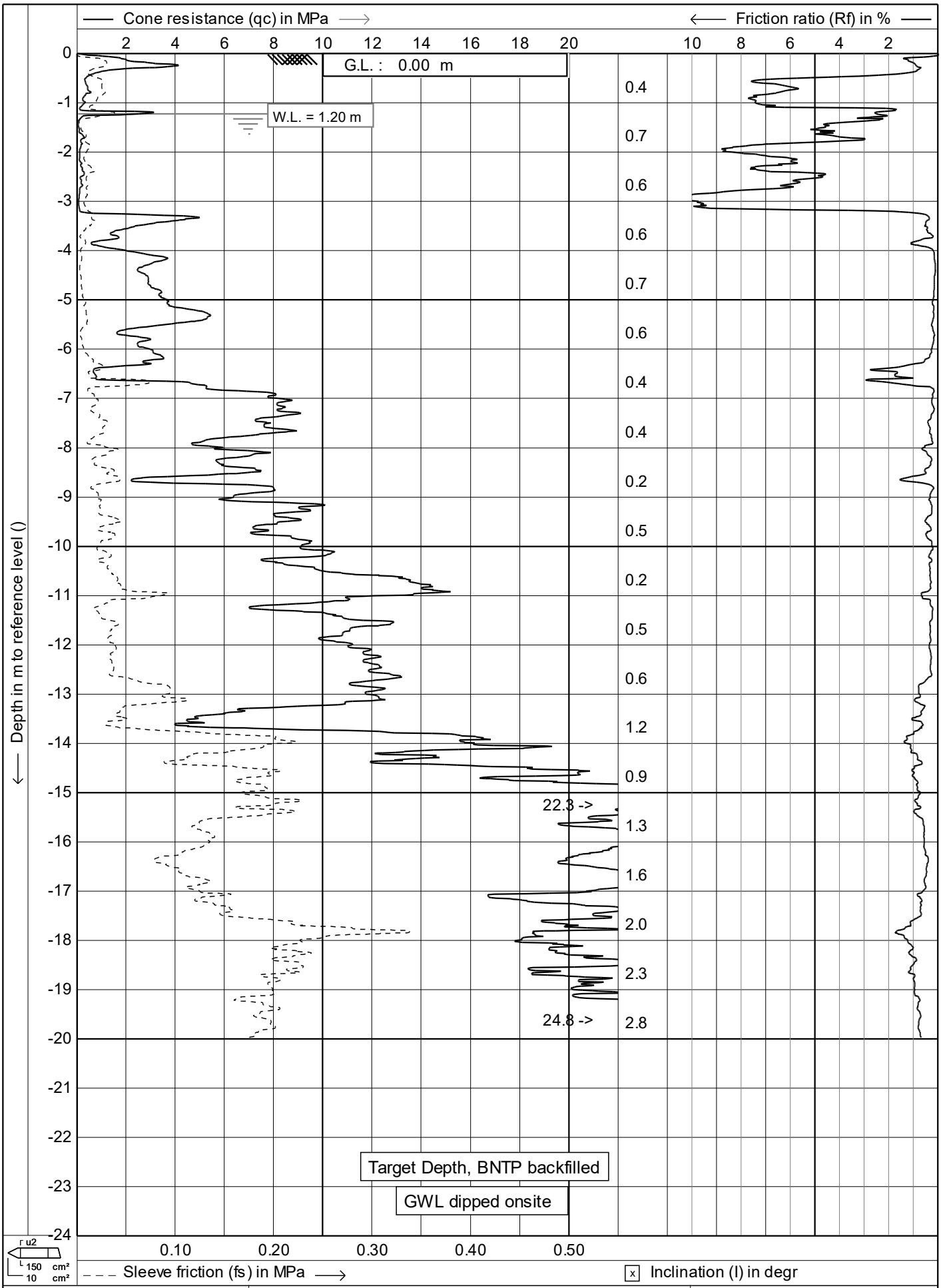

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Test according A.S.T.M Standard D 5778-12

Project : **Site Investigations**

Location: **1491 Arawa Rd Pongakawa**

Position: **0, 0**

Date : **19/01/2022**

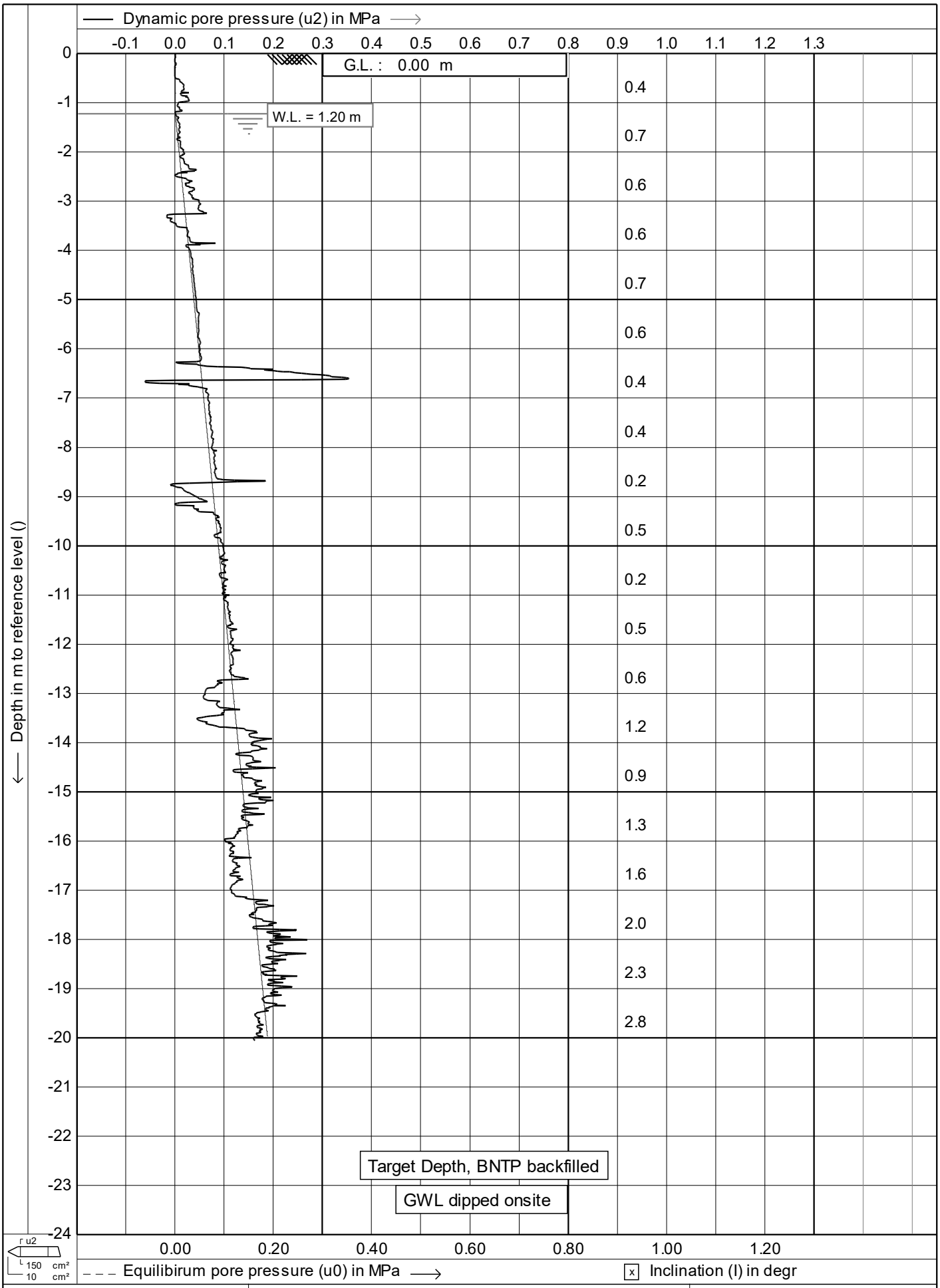
Cone no. : **C10CFIIP.C17803**

Project no. : **05CMW099**

CPT no. : **03**

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**

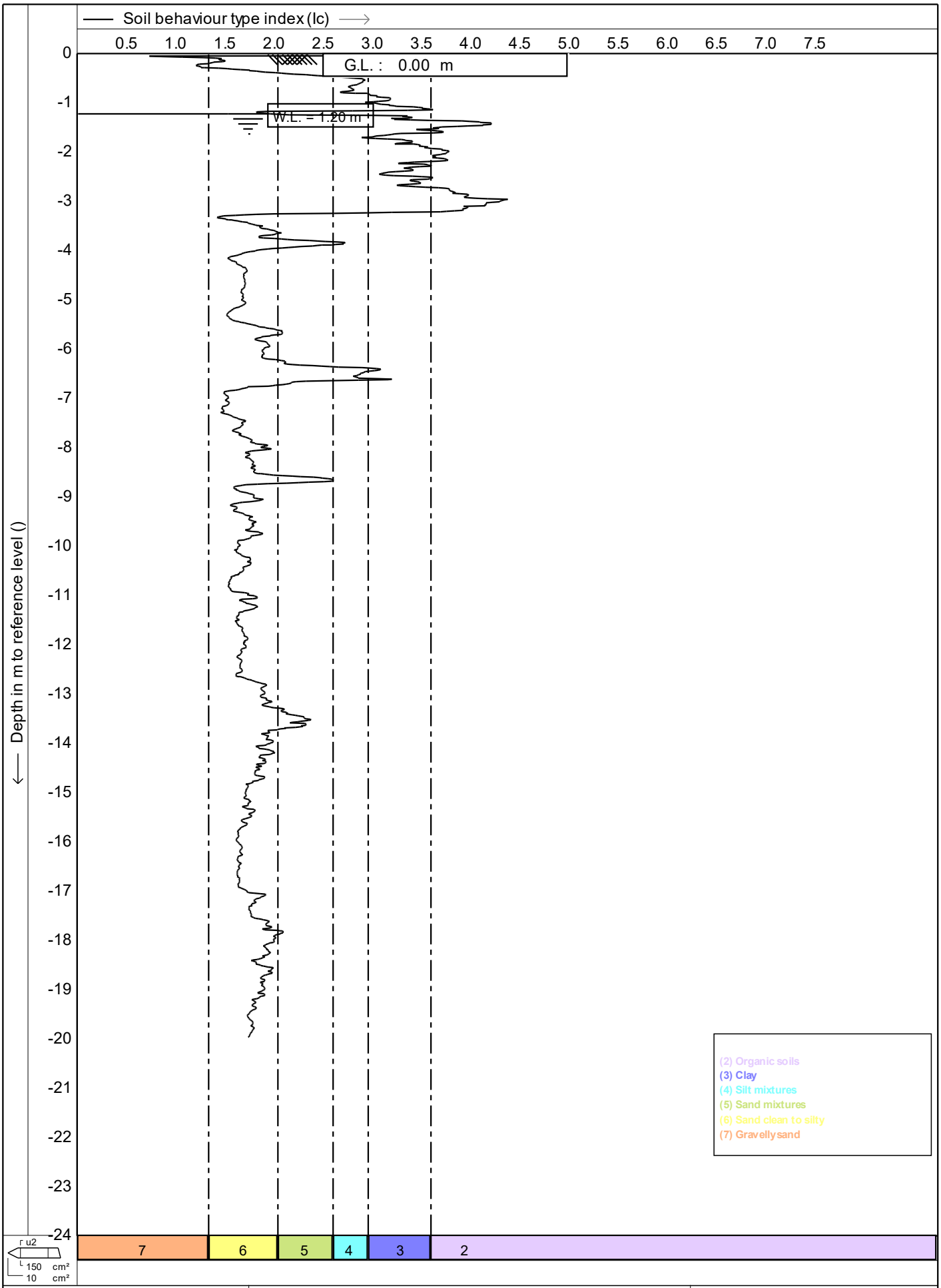
Date : **19/01/2022**

Cone no. : **C10CFIIP.C17803**

Project no. : **05CMW099**

CPT no. : **03**

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**

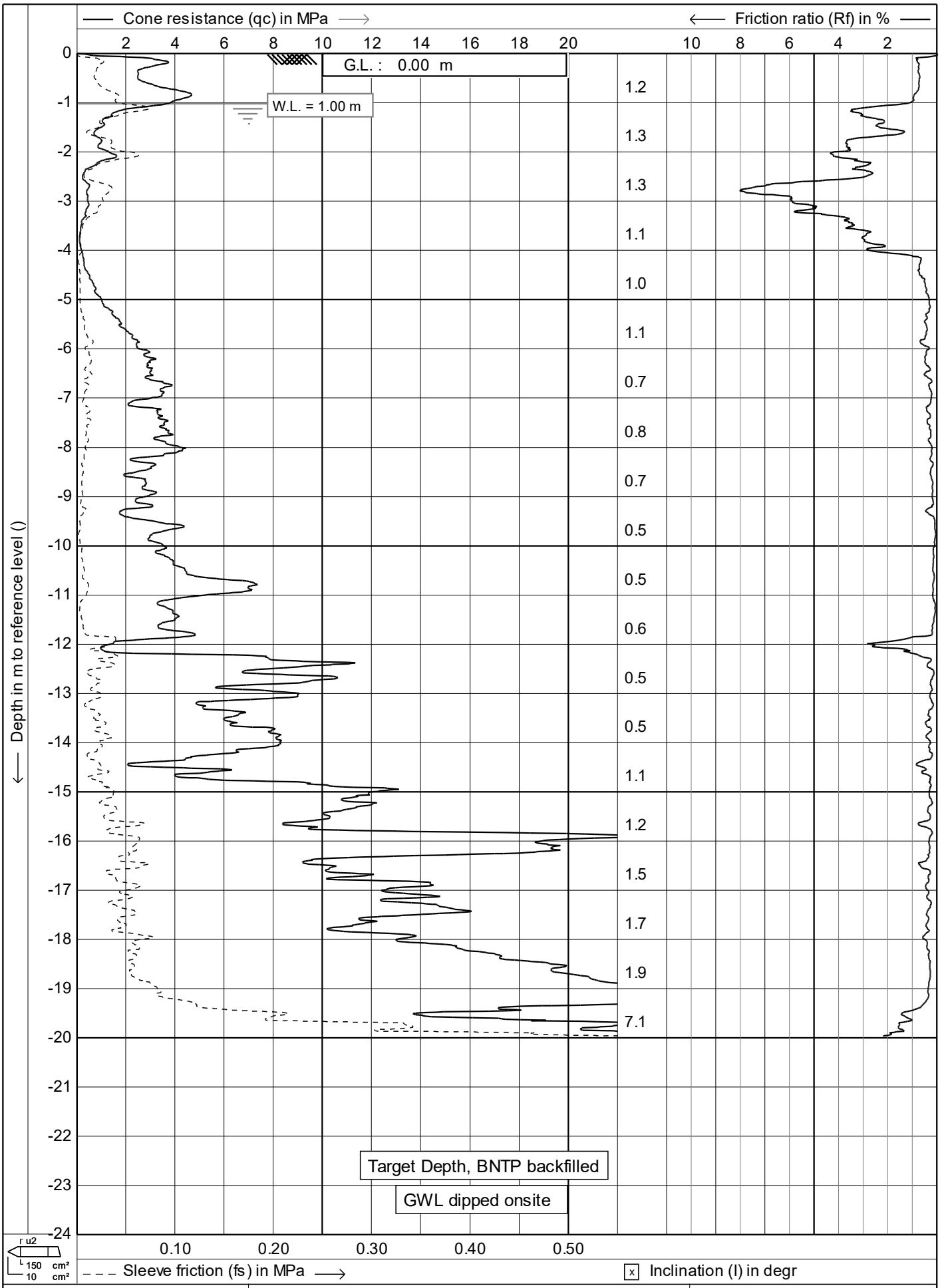
Date : **19/01/2022**

Cone no. : **C10CFIIP.C17803**

Project no. : **05CMW099**

CPT no. : **03** **9/14**

1.48



PERRY GEOTECH

Test according A.S.T.M Standard D 5778-12

Project : **Site Investigations**

Location: **1491 Arawa Rd Pongakawa**

Position: **0, 0**

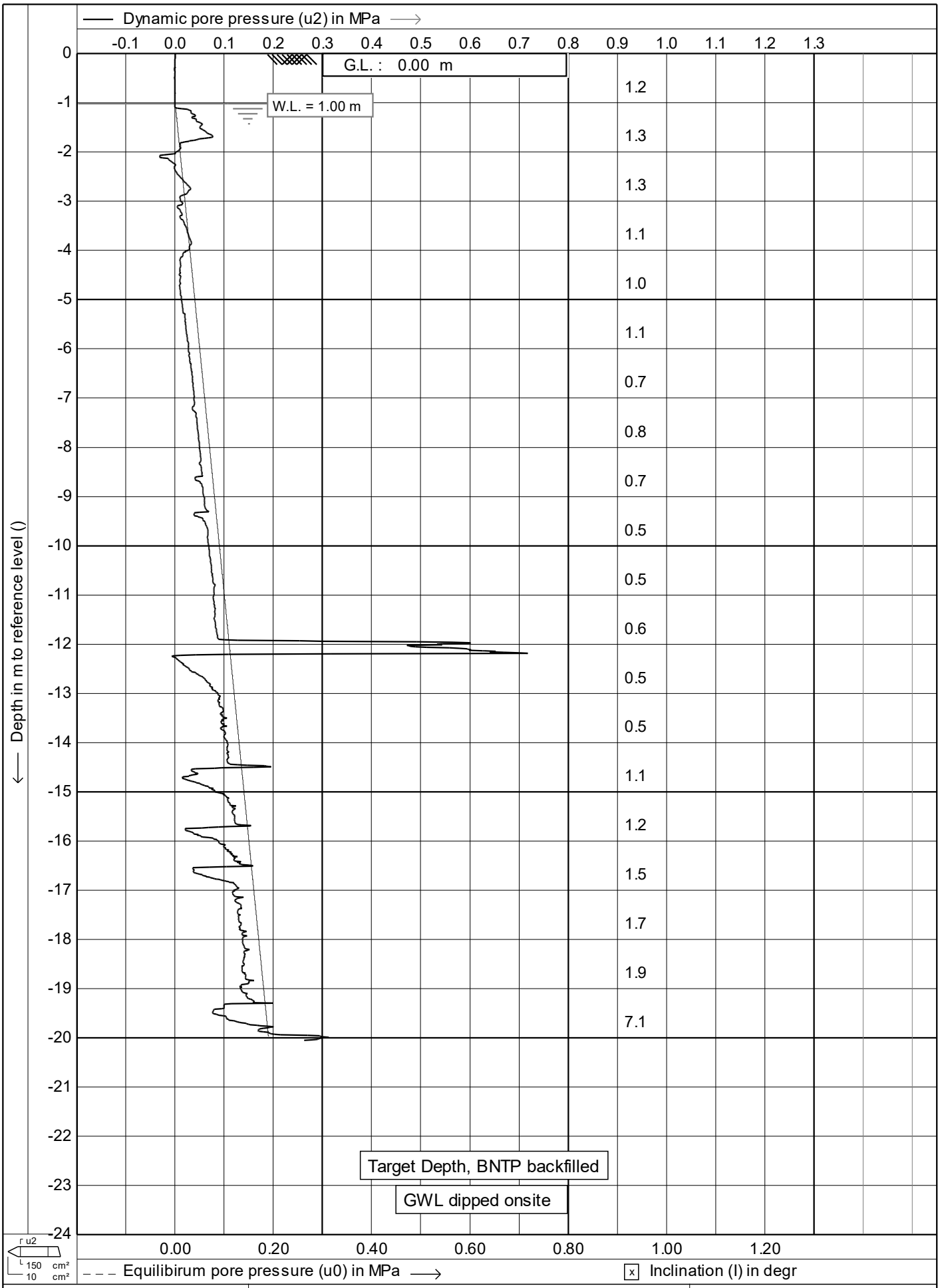
Date : **18/01/2022**

Cone no. : **C10CFIIP.C17803**

Project no. : **05CMW099**

CPT no. : **04**

1.48



PERRY GEOTECH

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**

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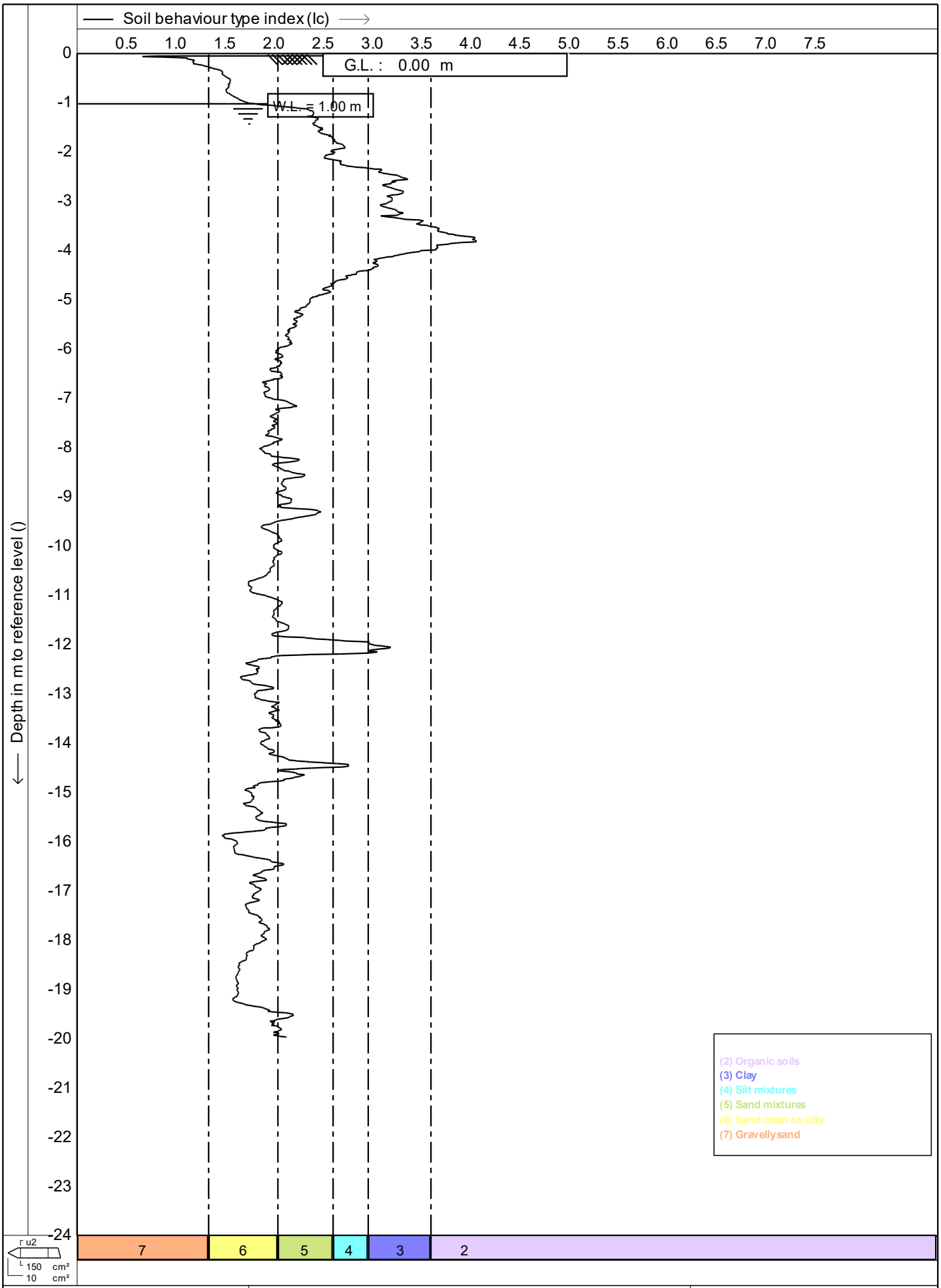

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Test according A.S.T.M Standard D 5778-12

Project : **Site Investigations**

Location: **1491 Arawa Rd Pongakawa**

Position: **0, 0**

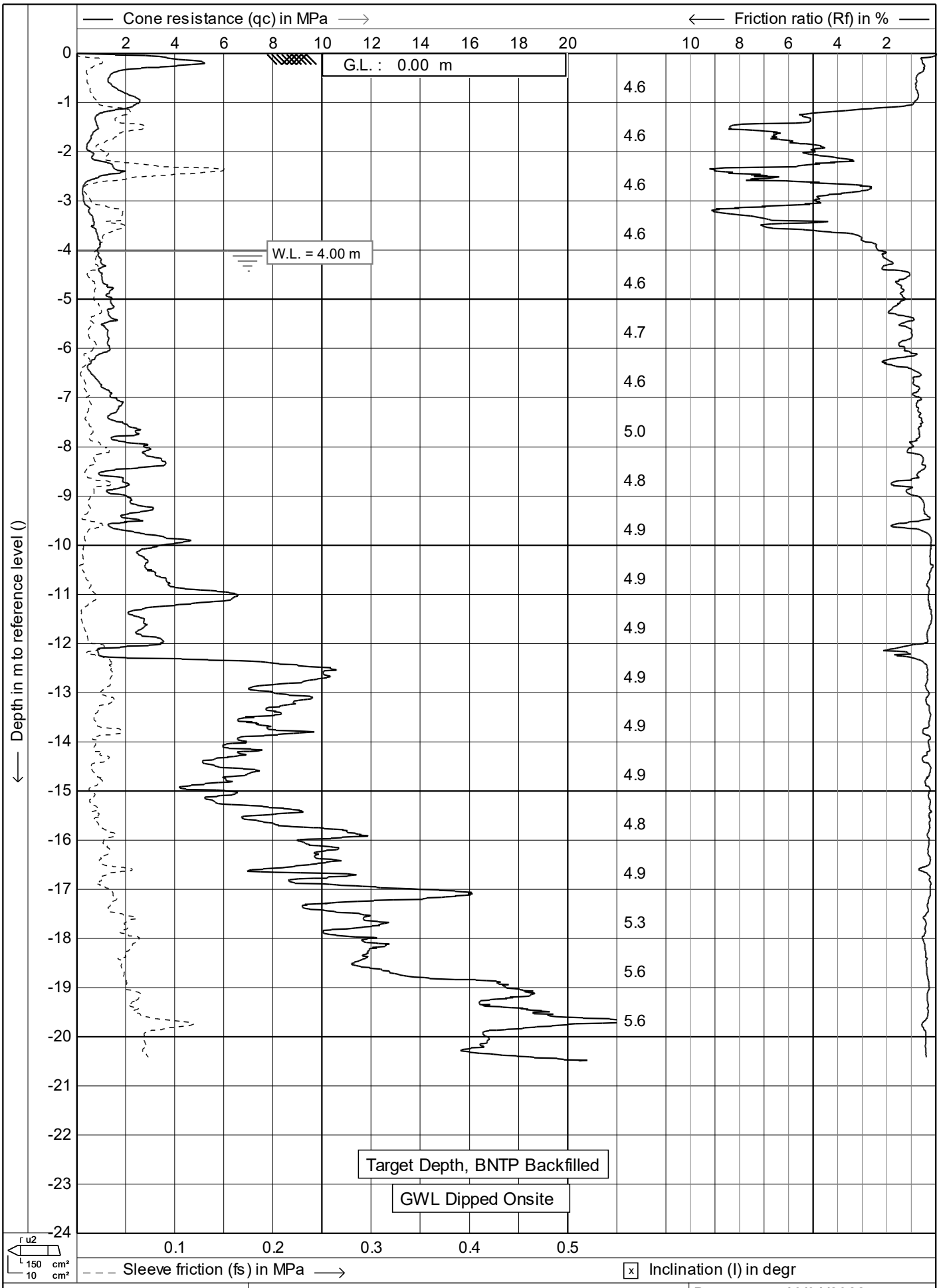
Date : **18/01/2022**

Cone no. : **C10CFIIP.C17803**

Project no. : **05CMW099**

CPT no. : **04** **9/14**

1.48



PERRY GEOTECH

A.S.T.M D5778-12

Project : **Site Investigations**

Location: **Arawa Rd - Pongakawa**

Position: **0, 0**

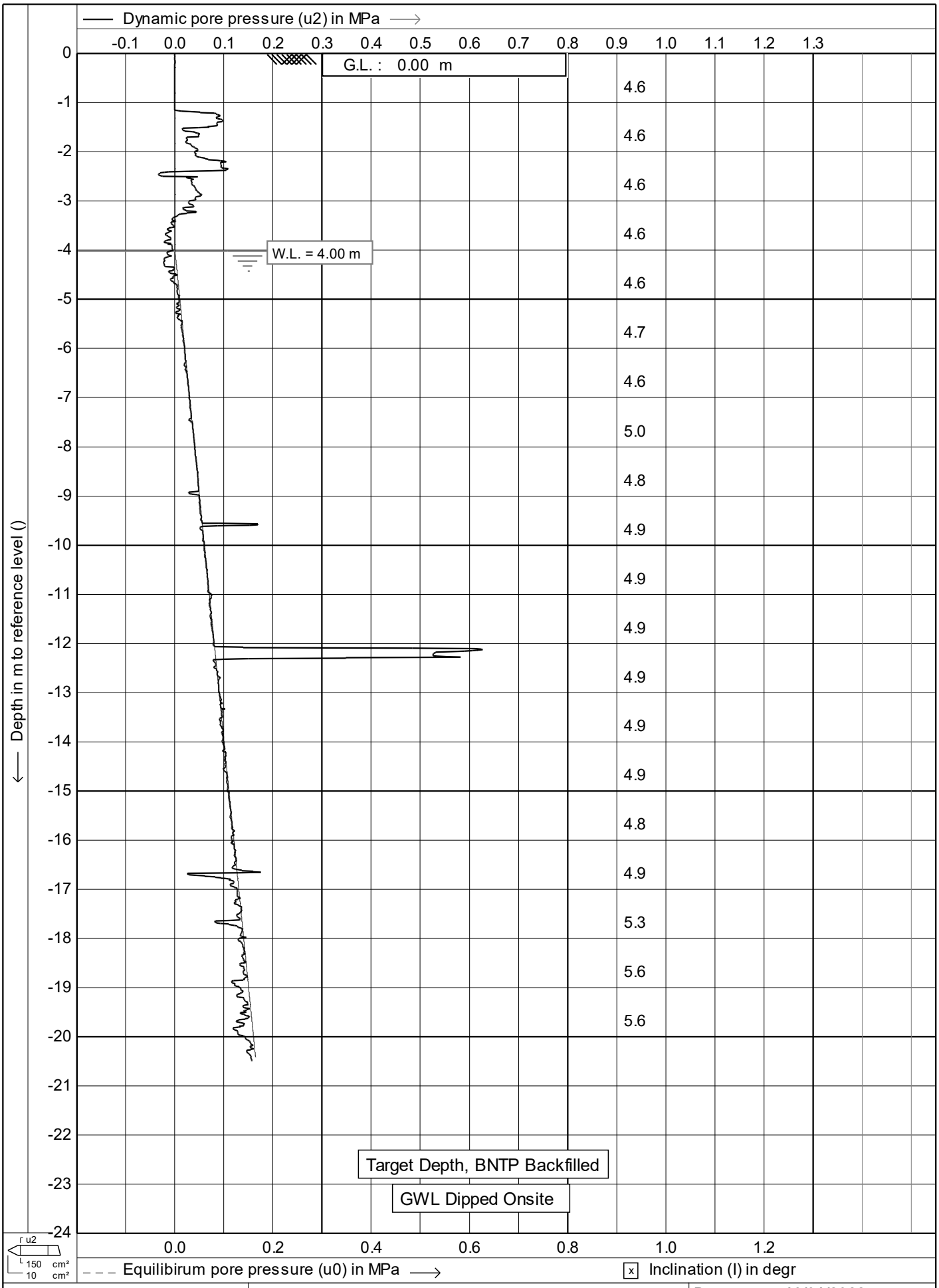
Date : **19/01/2022**

Cone no. : **C10CFIIP.C15212**

Project no. : **02CMW099**

CPT no. : **SCPT05** **1/14**

1.49



A.S.T.M D5778-12

PERRY GEOTECH

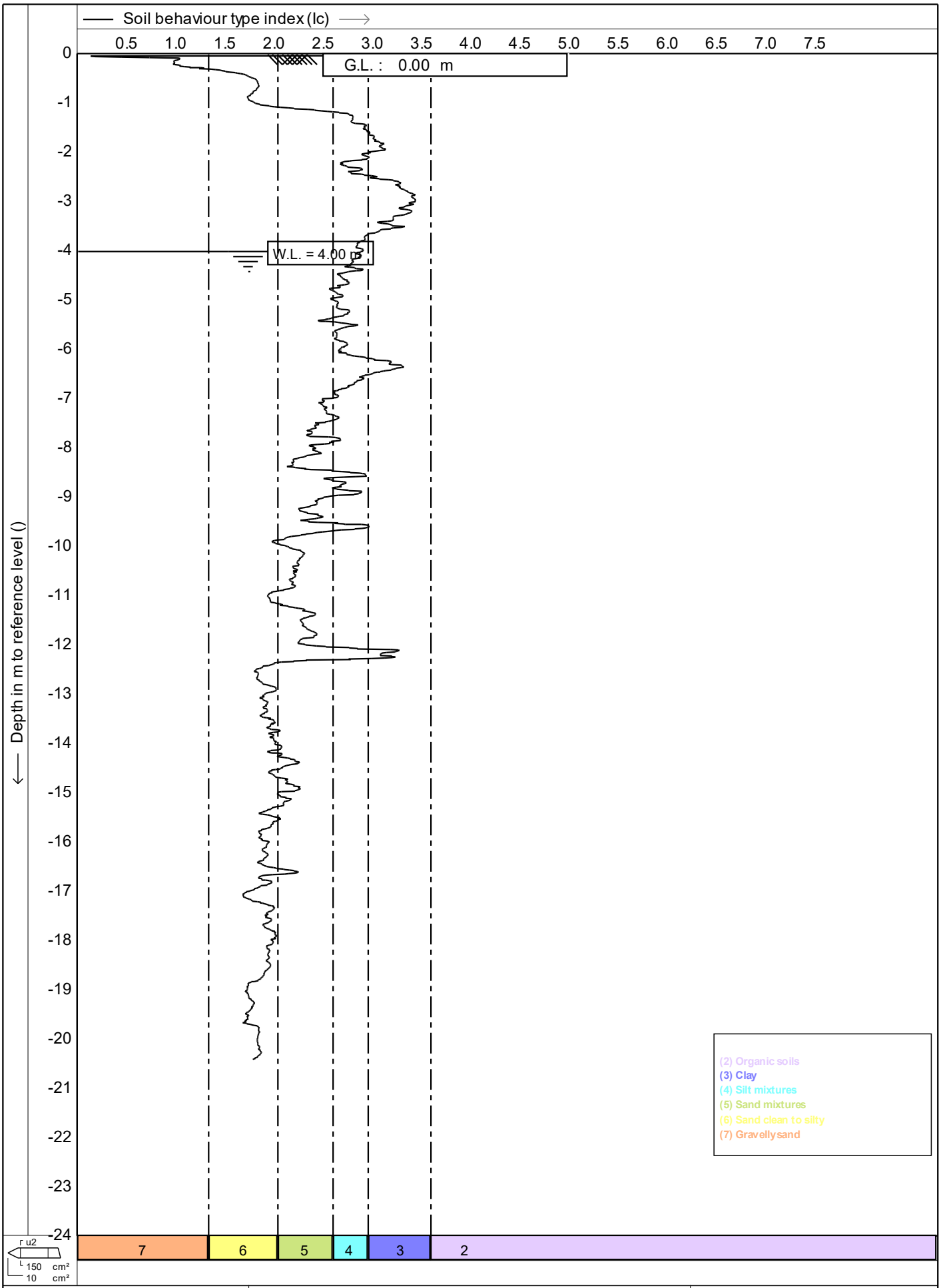
Project : **Site Investigations**

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

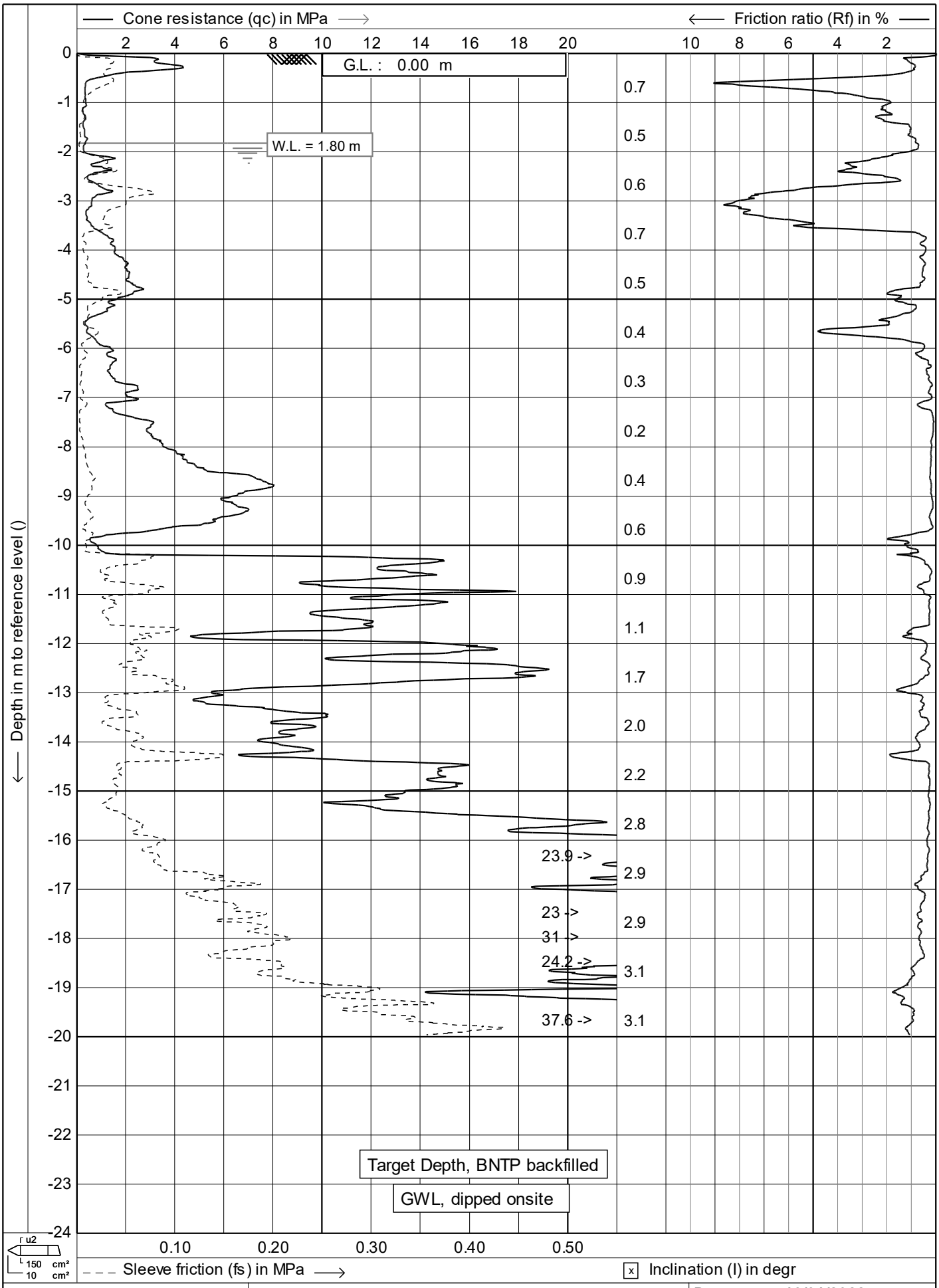
Project : **Site Investigations**

Location: **Arawa Rd - Pongakawa**

Position: **0, 0**

Date	: **19/01/2022**
Cone no.	: **C10CFIIP.C15212**
Project no.	: **02CMW099**
CPT no.	: **SCPT05** **9/14**

1.49



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**

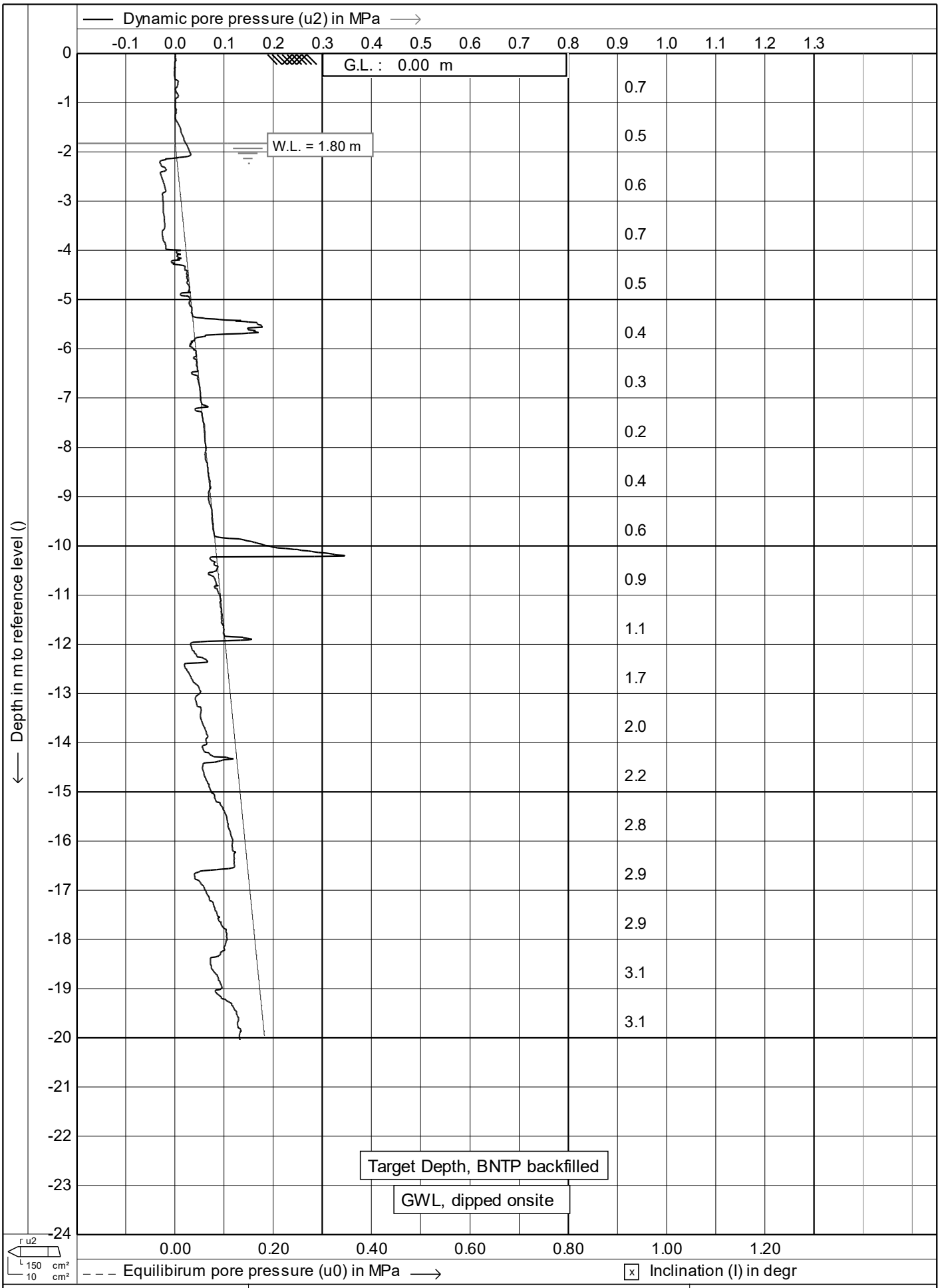
Cone no. : **C10CFIIP.C17803**

Project no. : **05CMW099**

CPT no. : **06**

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**

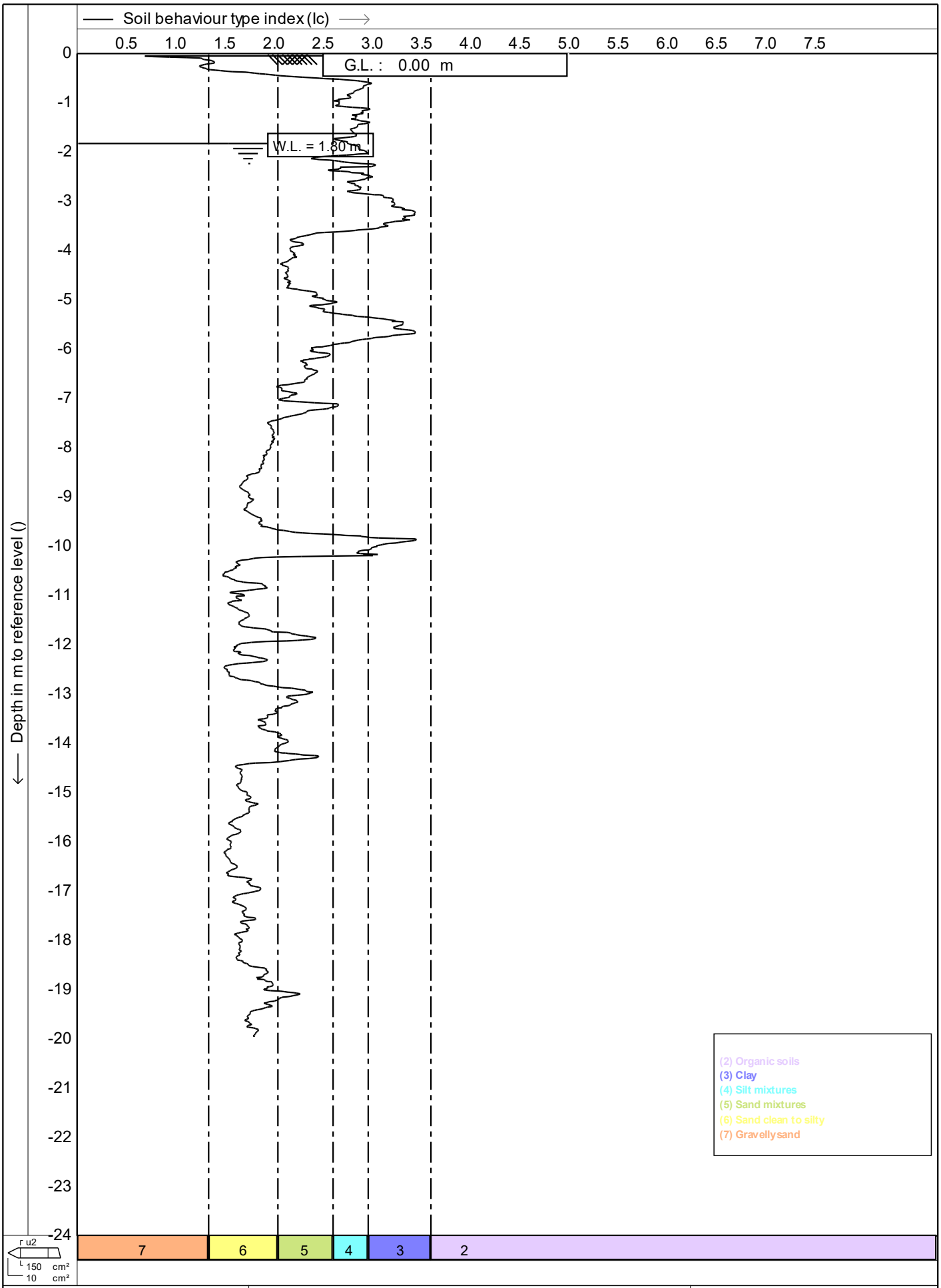
Date : **19/01/2022**

Cone no. : **C10CFIIP.C17803**

Project no. : **05CMW099**

CPT no. : **06**

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**

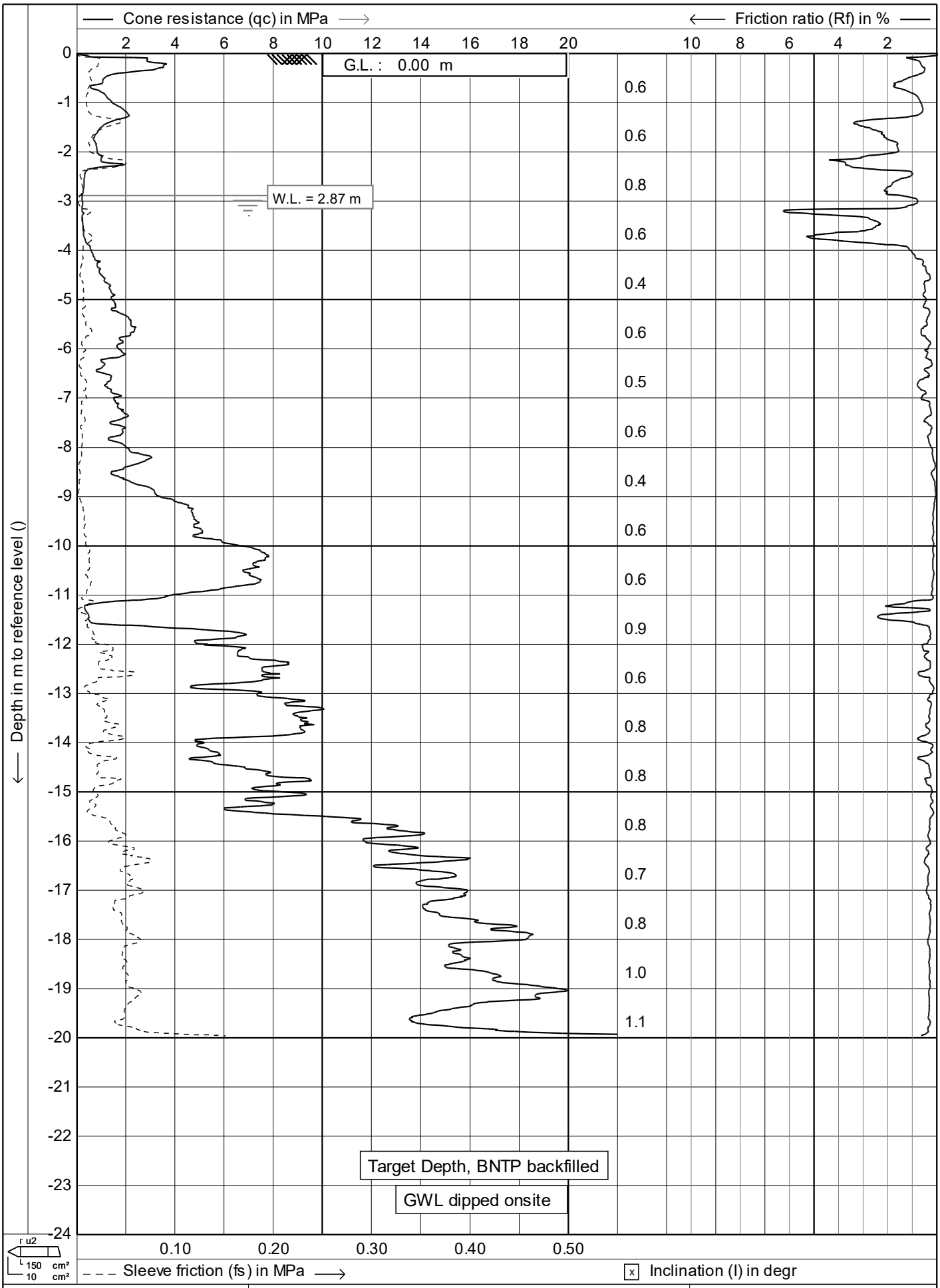
Date : **19/01/2022**

Cone no. : **C10CFIIP.C17803**

Project no. : **05CMW099**

CPT no. : **06** **9/14**

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**

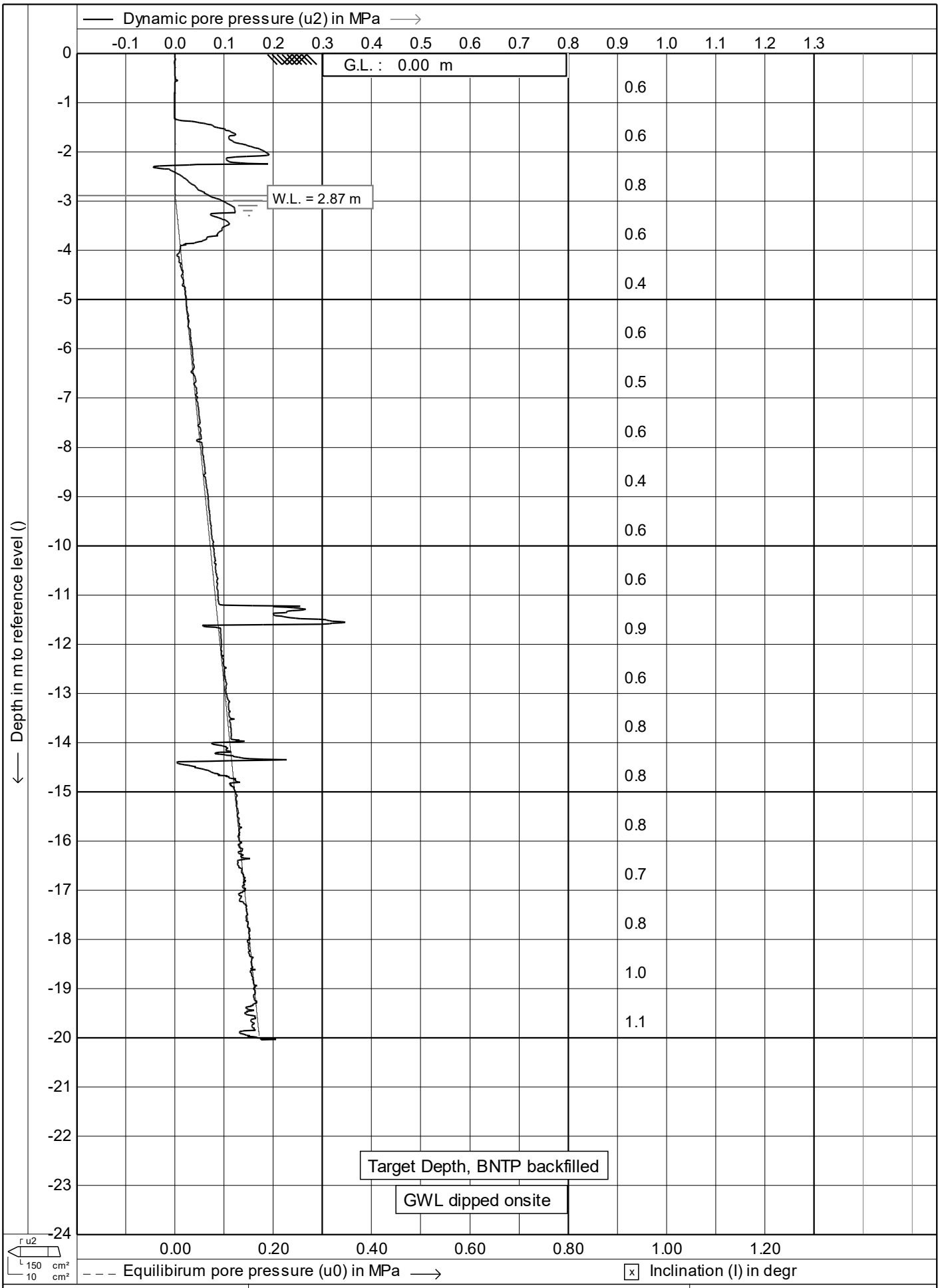
Date : **18/01/2022**

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**

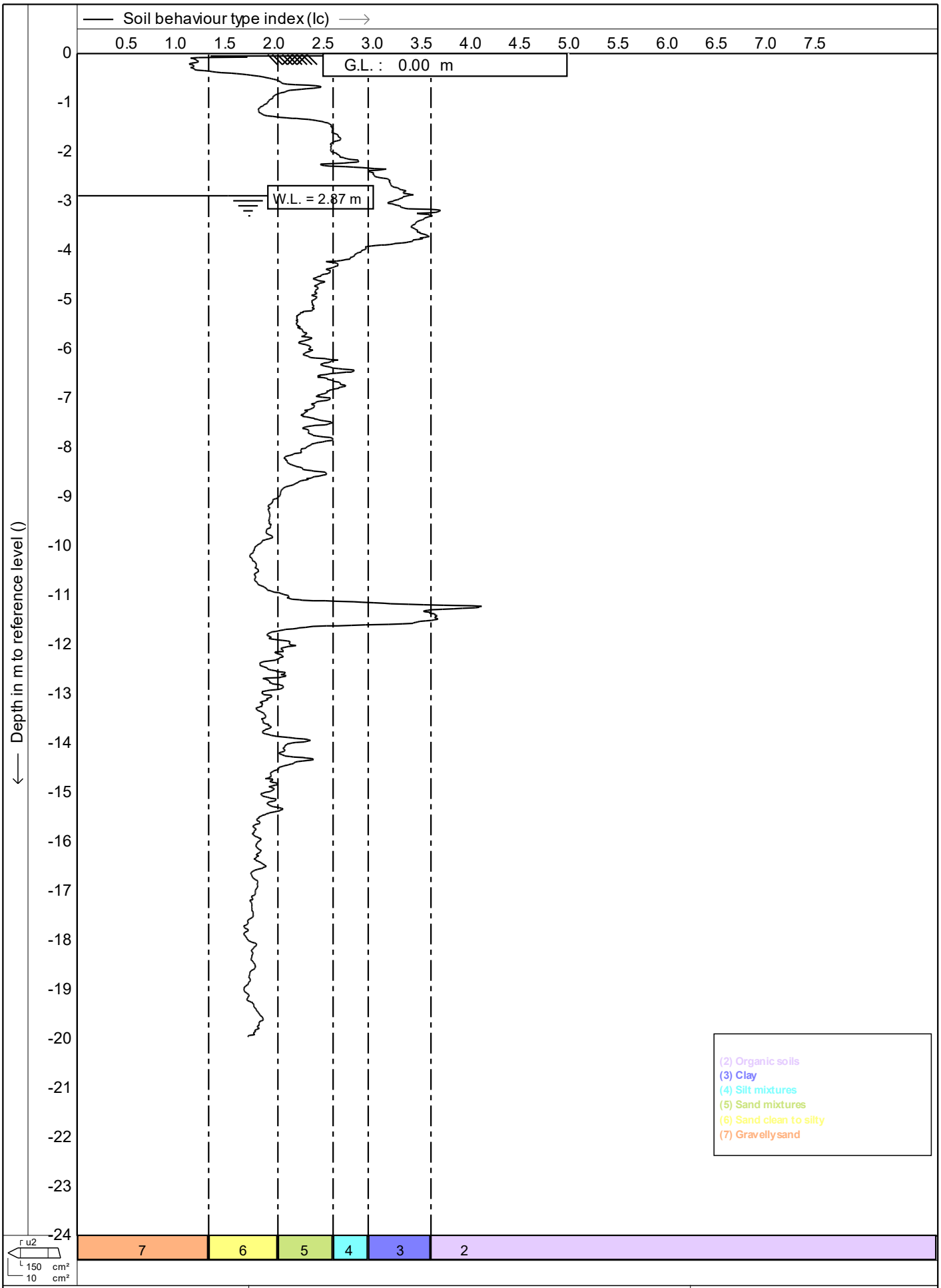
Date : **18/01/2022**

Cone no. : **C10CFIIP.C17803**

Project no. : **05CMW099**

CPT no. : **07**

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**

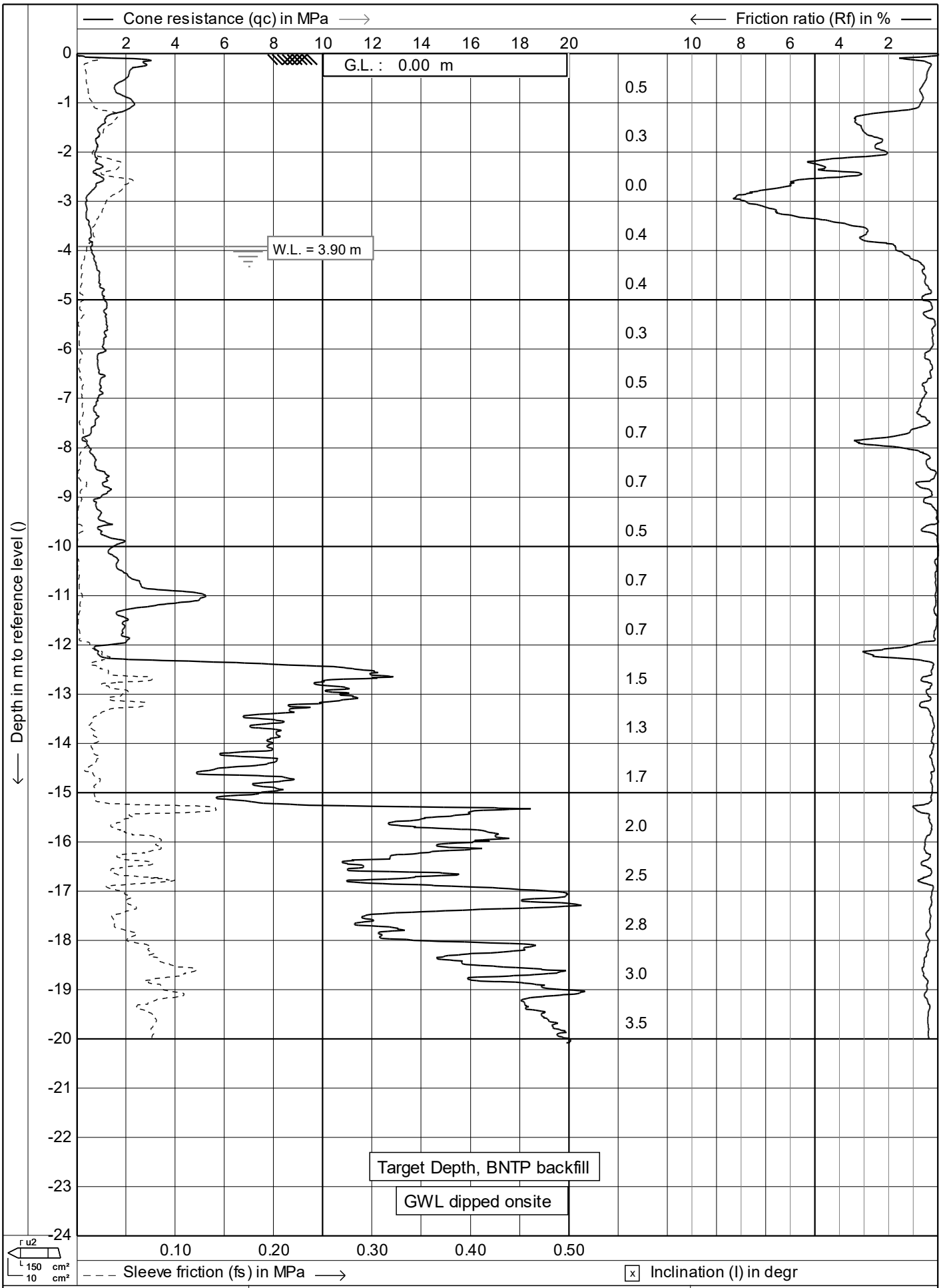
Date : **18/01/2022**

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

Project : **Site Investigations**

Location: **1491 Arawa Rd Pongakawa**

Position: **0, 0**

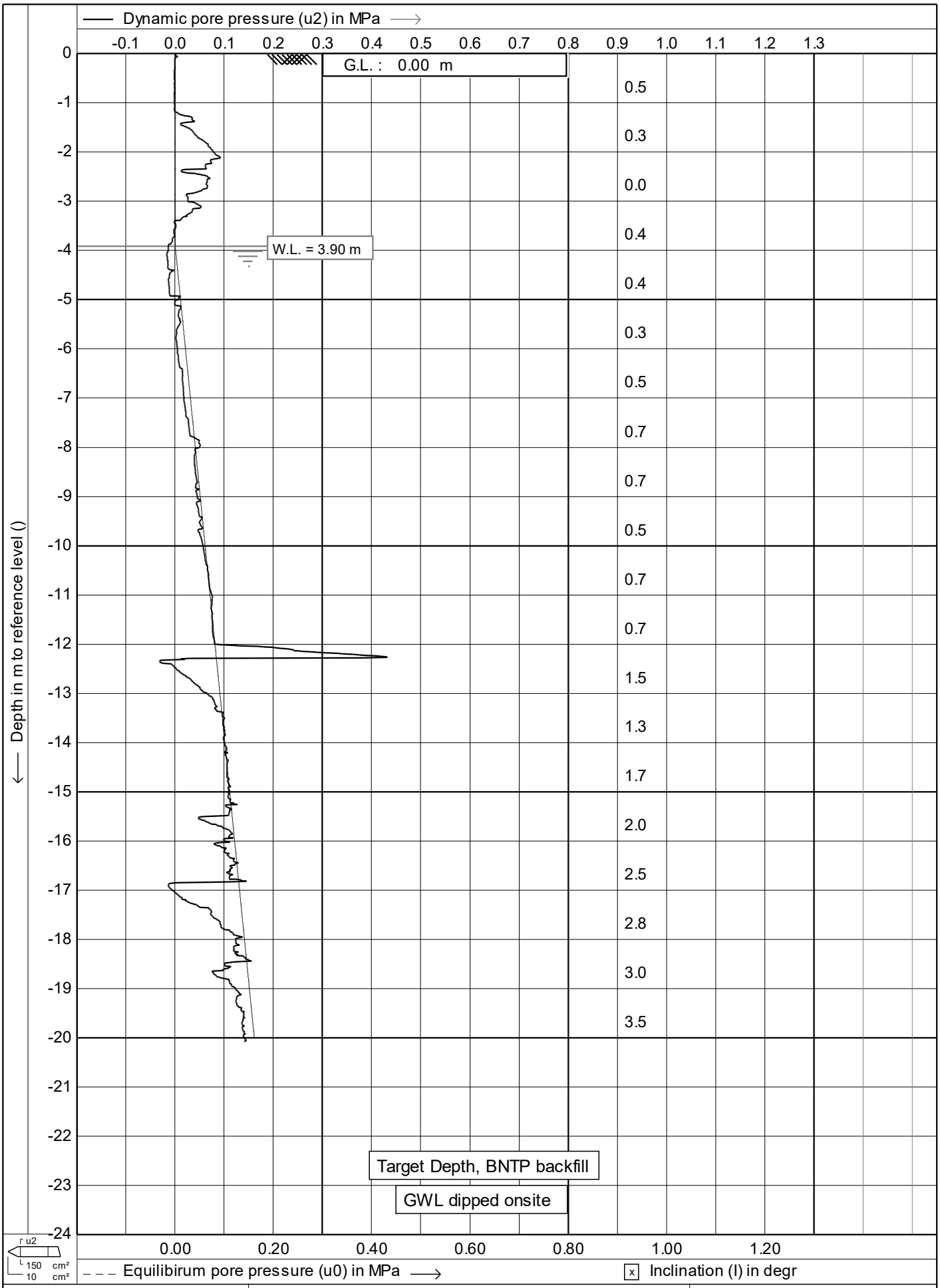
Date : **18/01/2022**

Cone no. : **C10CFIIP.C17803**

Project no. : **05CMW099**

CPT no. : **08**

1.48



PERRY GEOTECH

Test according A.S.T.M Standard D 5778-12

Project : **Site Investigations**

Location: **1491 Arawa Rd Pongakawa**

Position: **0, 0**

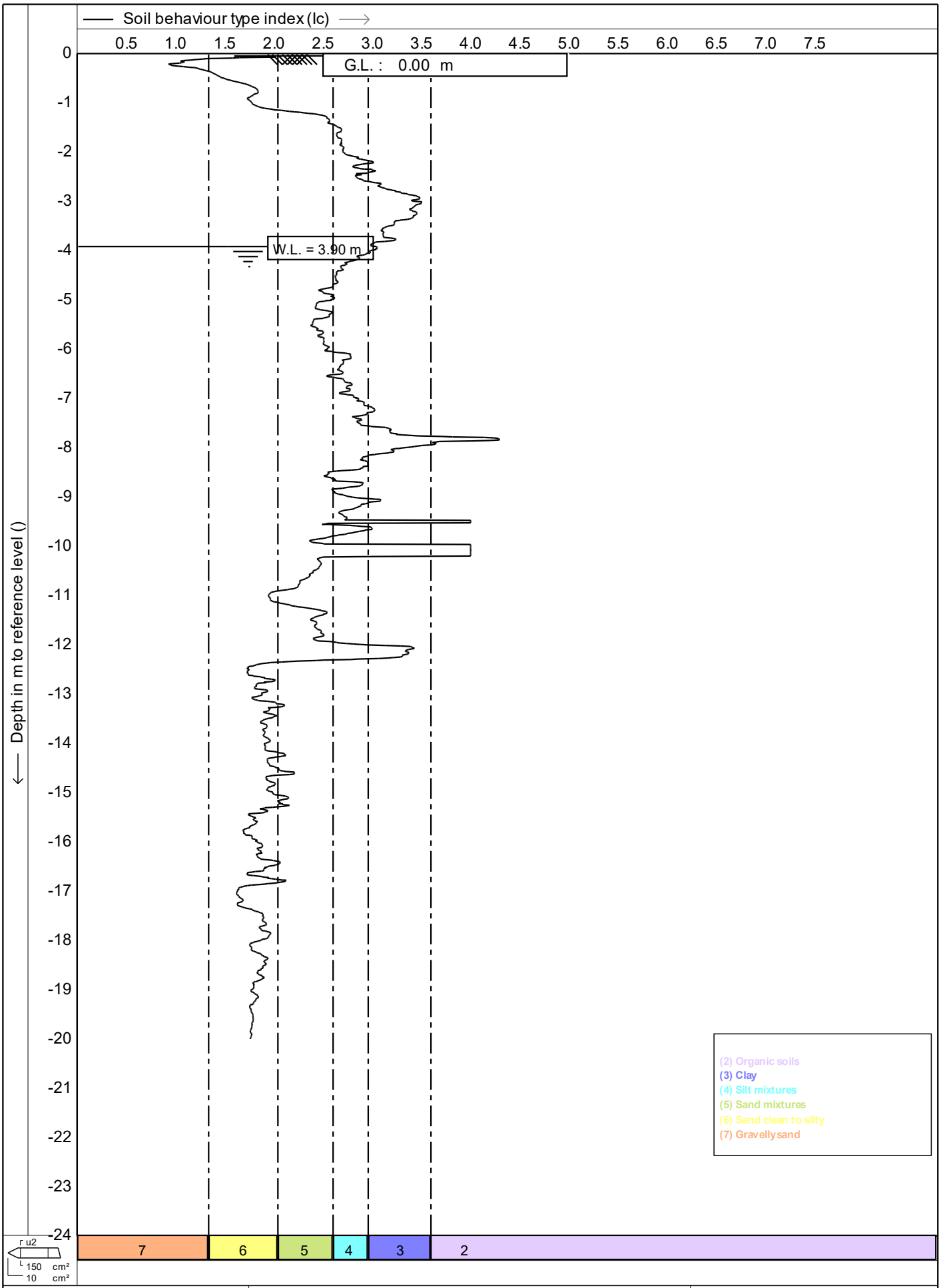
Date : **18/01/2022**

Cone no. : **C10CFIIP.C17803**

Project no. : **05CMW099**

CPT no. : **08**

1.48



PERRY GEOTECH

Test according A.S.T.M Standard D 5778-12

Project : **Site Investigations**

Location: **1491 Arawa Rd Pongakawa**

Position: **0, 0**

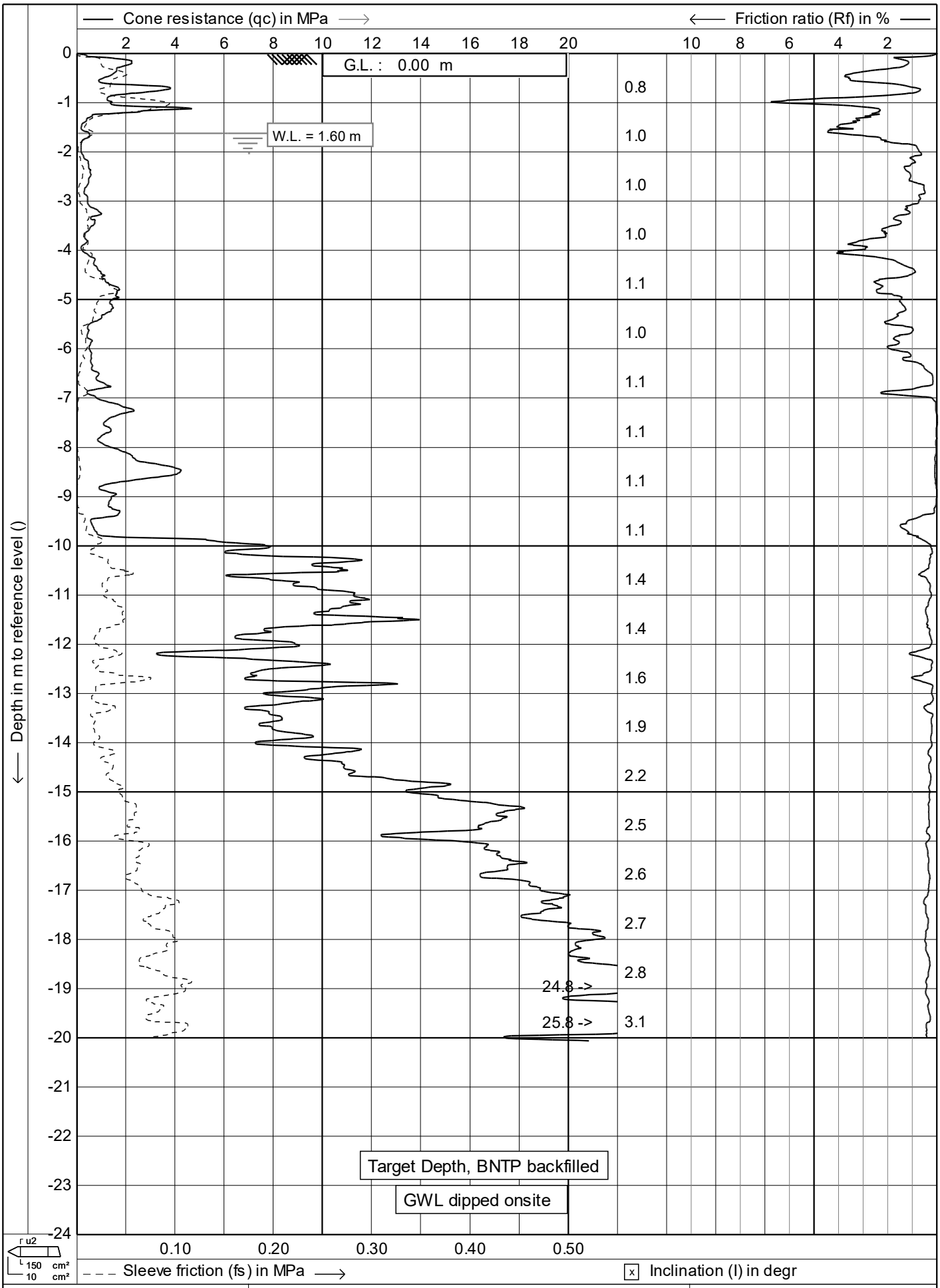
Date : **18/01/2022**

Cone no. : **C10CFIIP.C17803**

Project no. : **05CMW099**

CPT no. : **08** **9/14**

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**

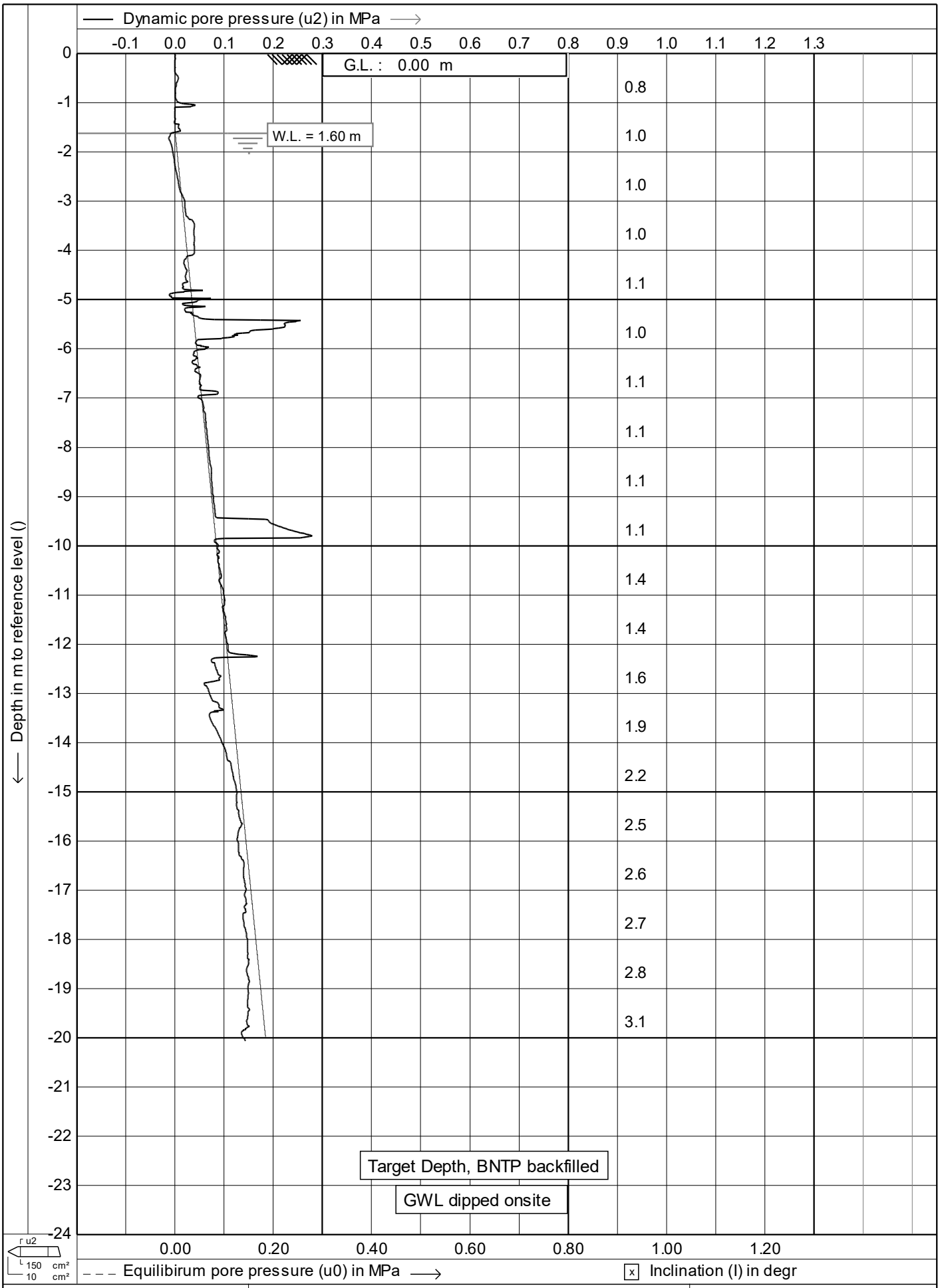
Cone no. : **C10CFIIP.C17803**

Project no. : **05CMW099**

CPT no. : **10**

1/14

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**

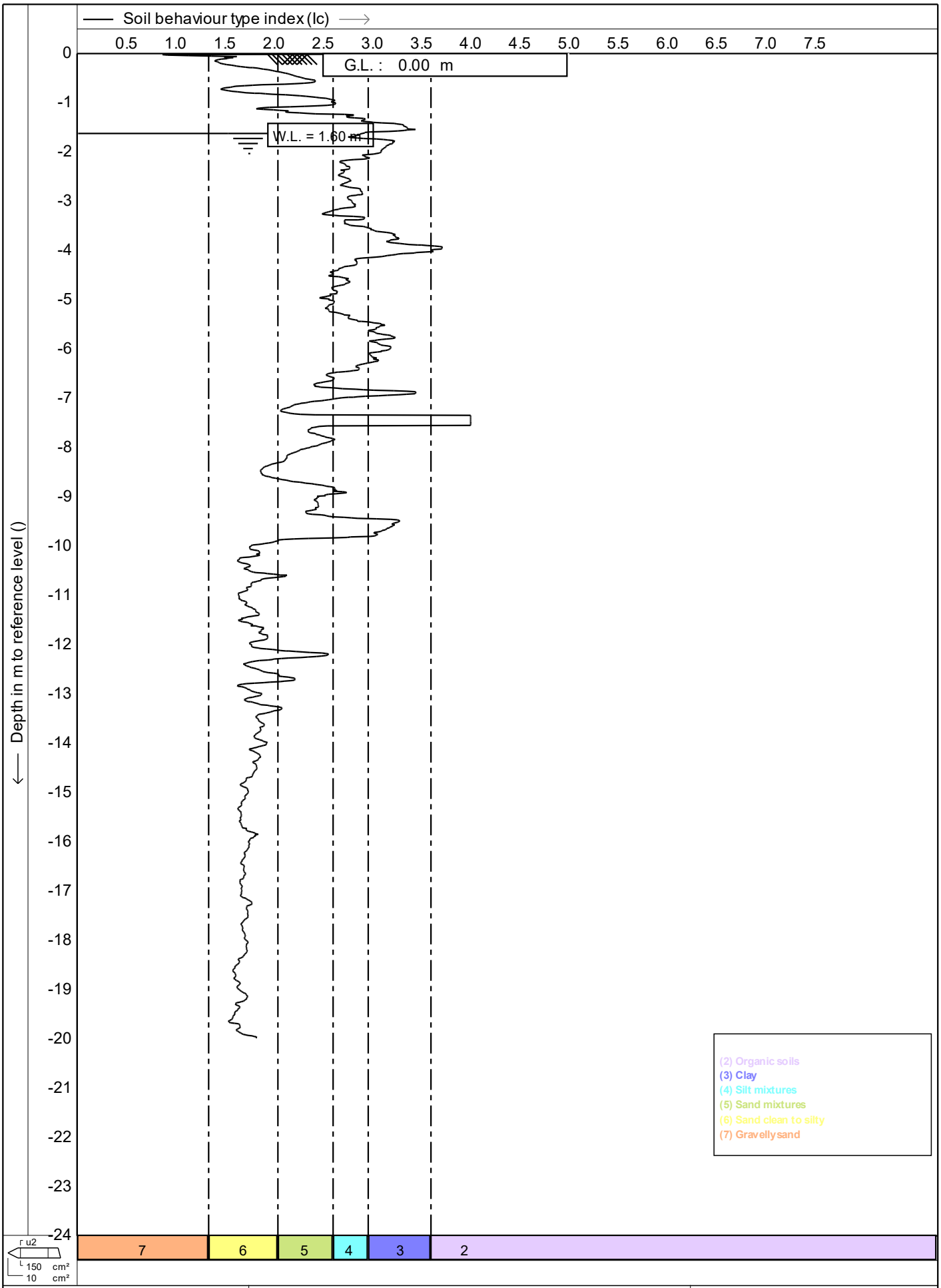
Date : **18/01/2022**

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**

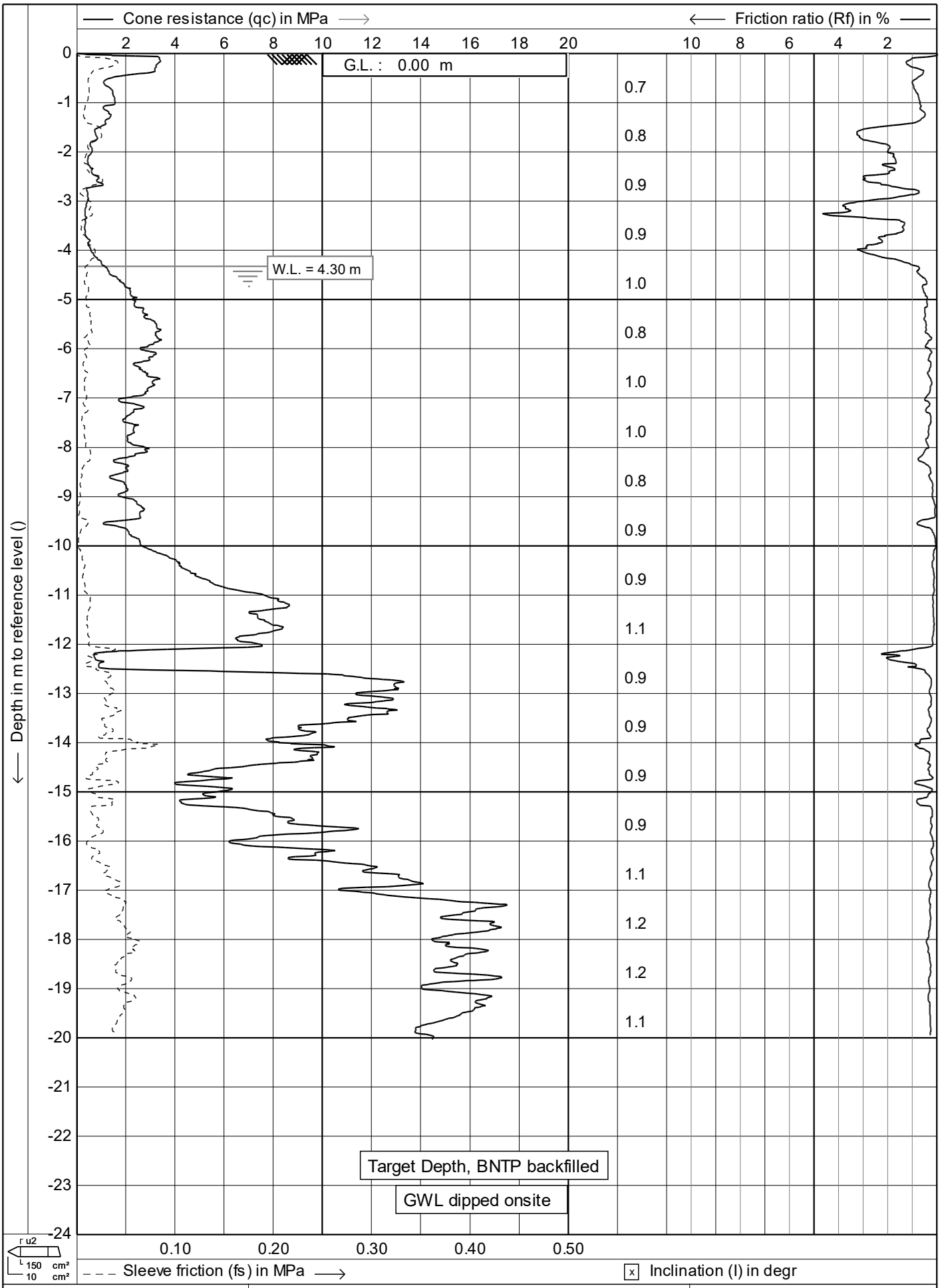
Date : **18/01/2022**

Cone no. : **C10CFIIP.C17803**

Project no. : **05CMW099**

CPT no. : **10** **9/14**

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**

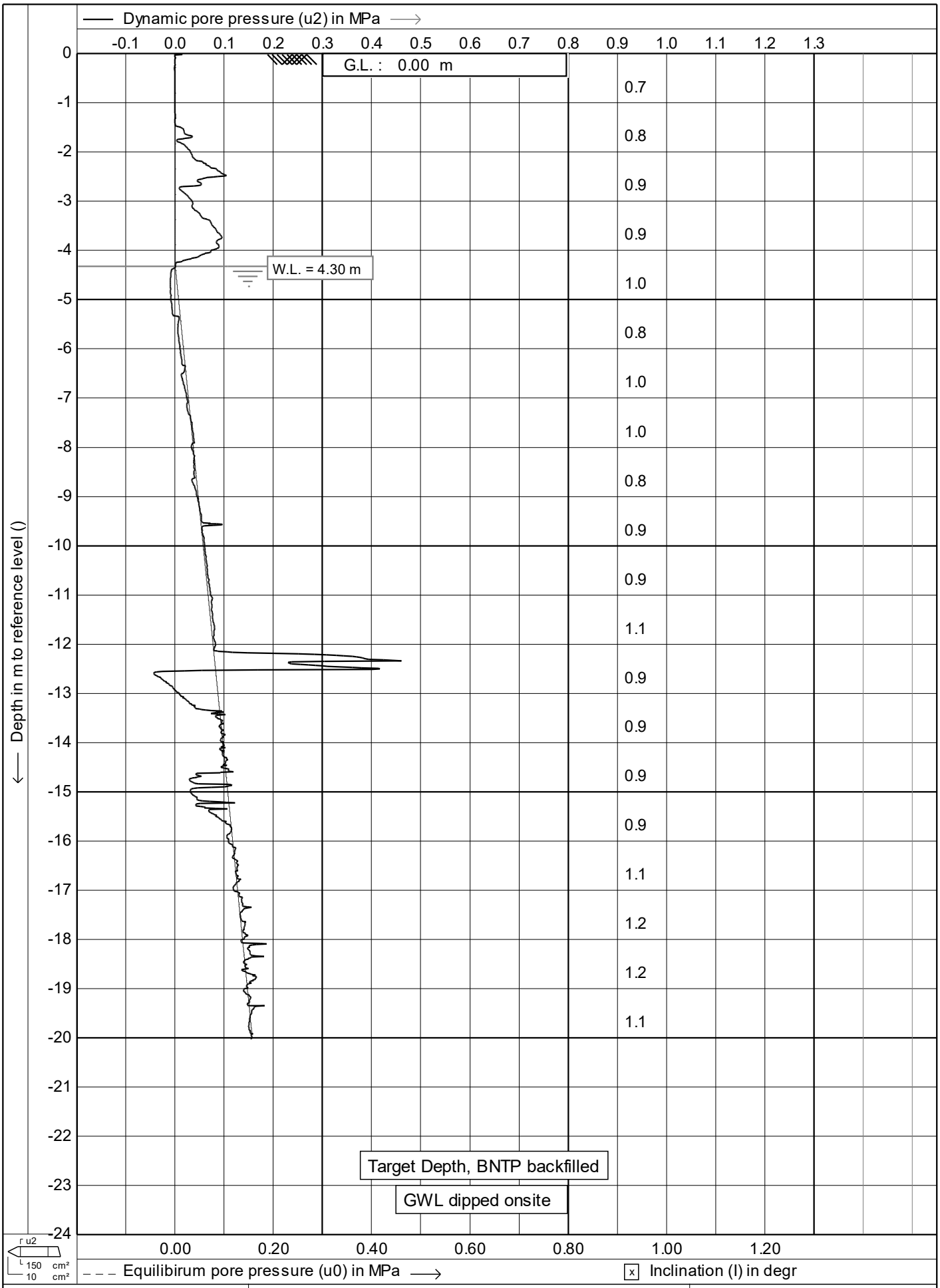
Cone no. : **C10CFIIP.C17803**

Project no. : **05CMW099**

CPT no. : **11**

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**

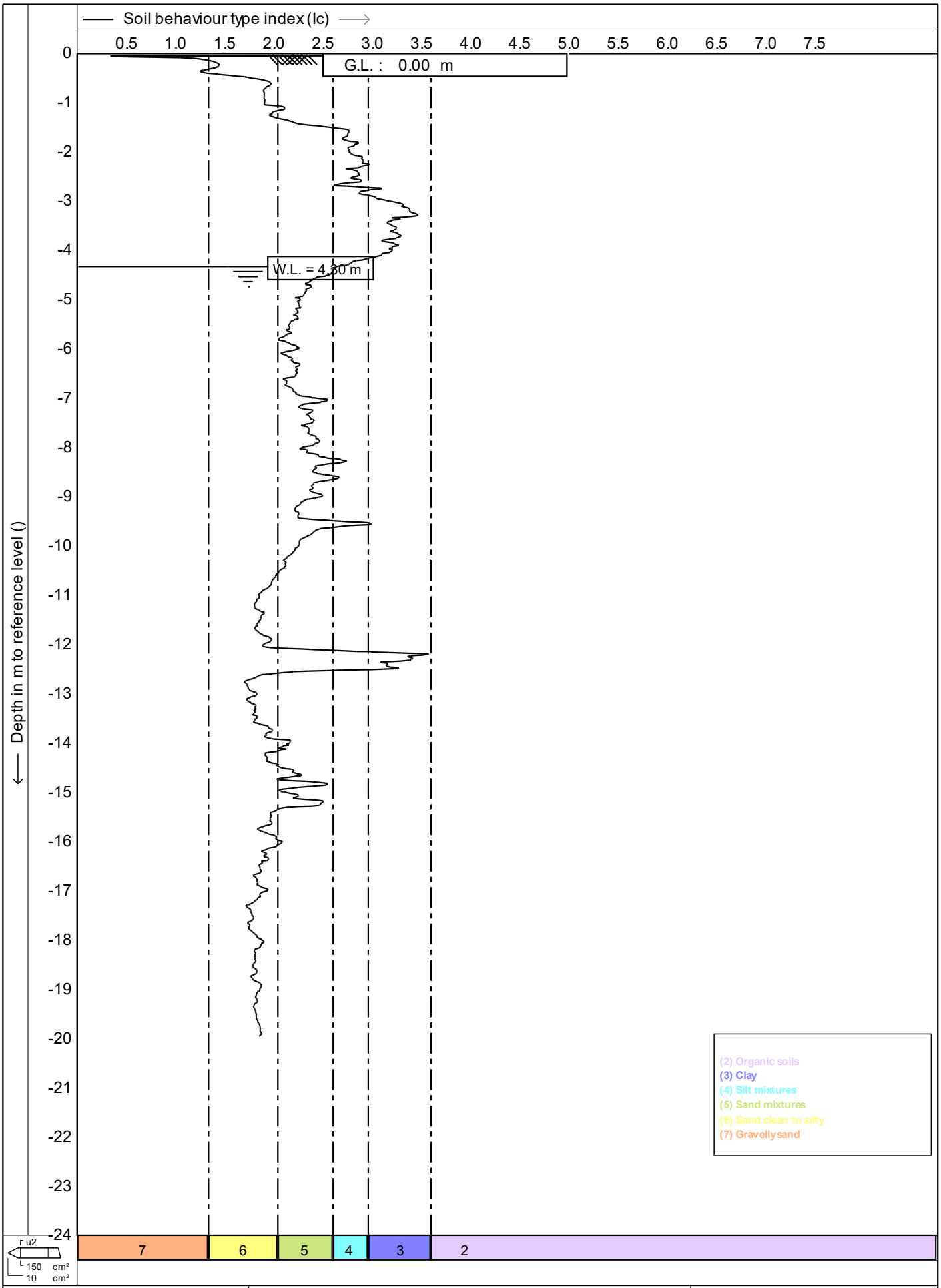
Date : **18/01/2022**

Cone no. : **C10CFIIP.C17803**

Project no. : **05CMW099**

CPT no. : **11**

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**

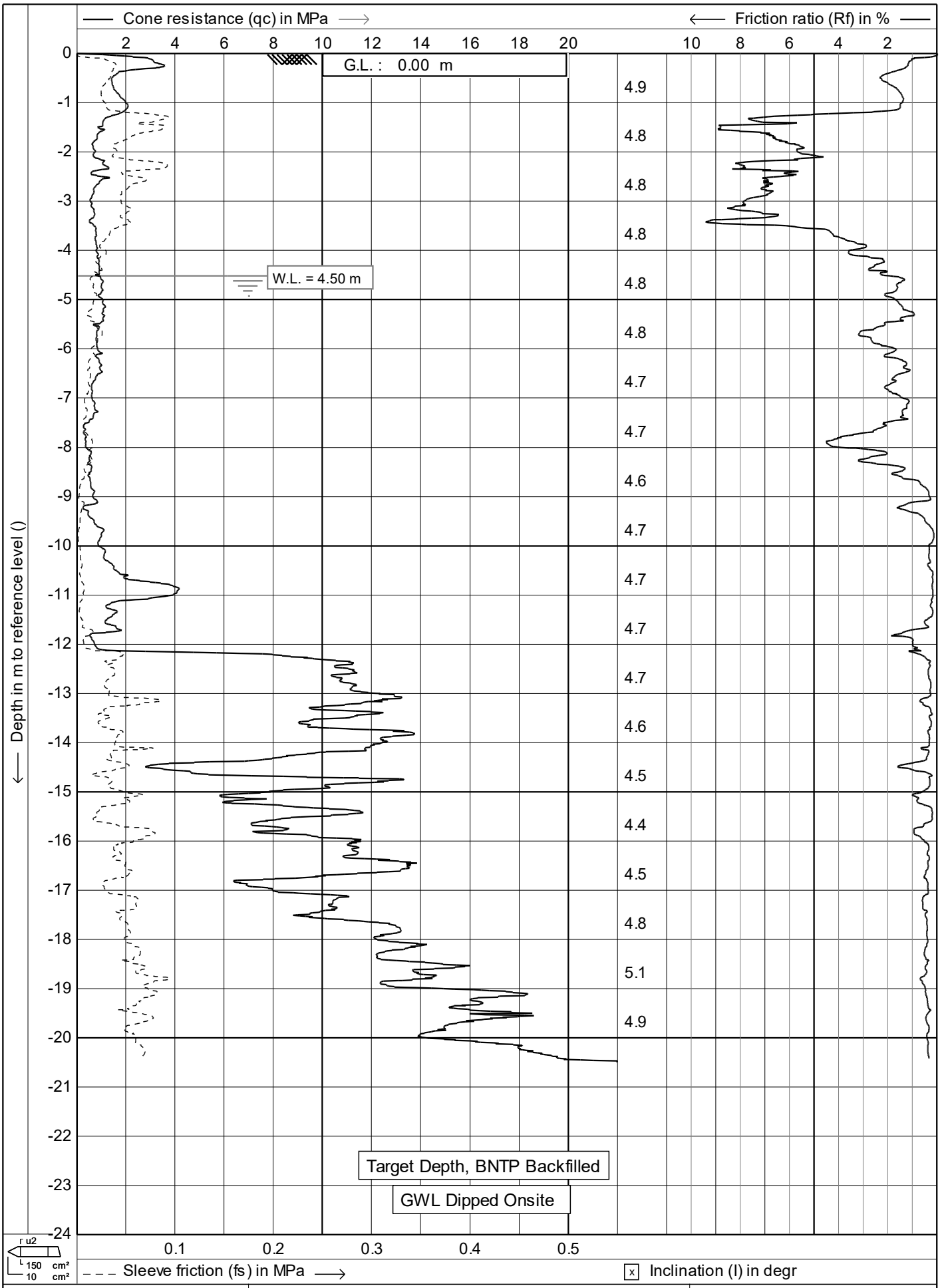
Date : **18/01/2022**

Cone no. : **C10CFIIP.C17803**

Project no. : **05CMW099**

CPT no. : **11** **9/14**

1.48



PERRY GEOTECH

A.S.T.M D5778-12

Project : **Site Investigations**

Location: **Arawa Rd - Pongakawa**

Position: **0, 0**

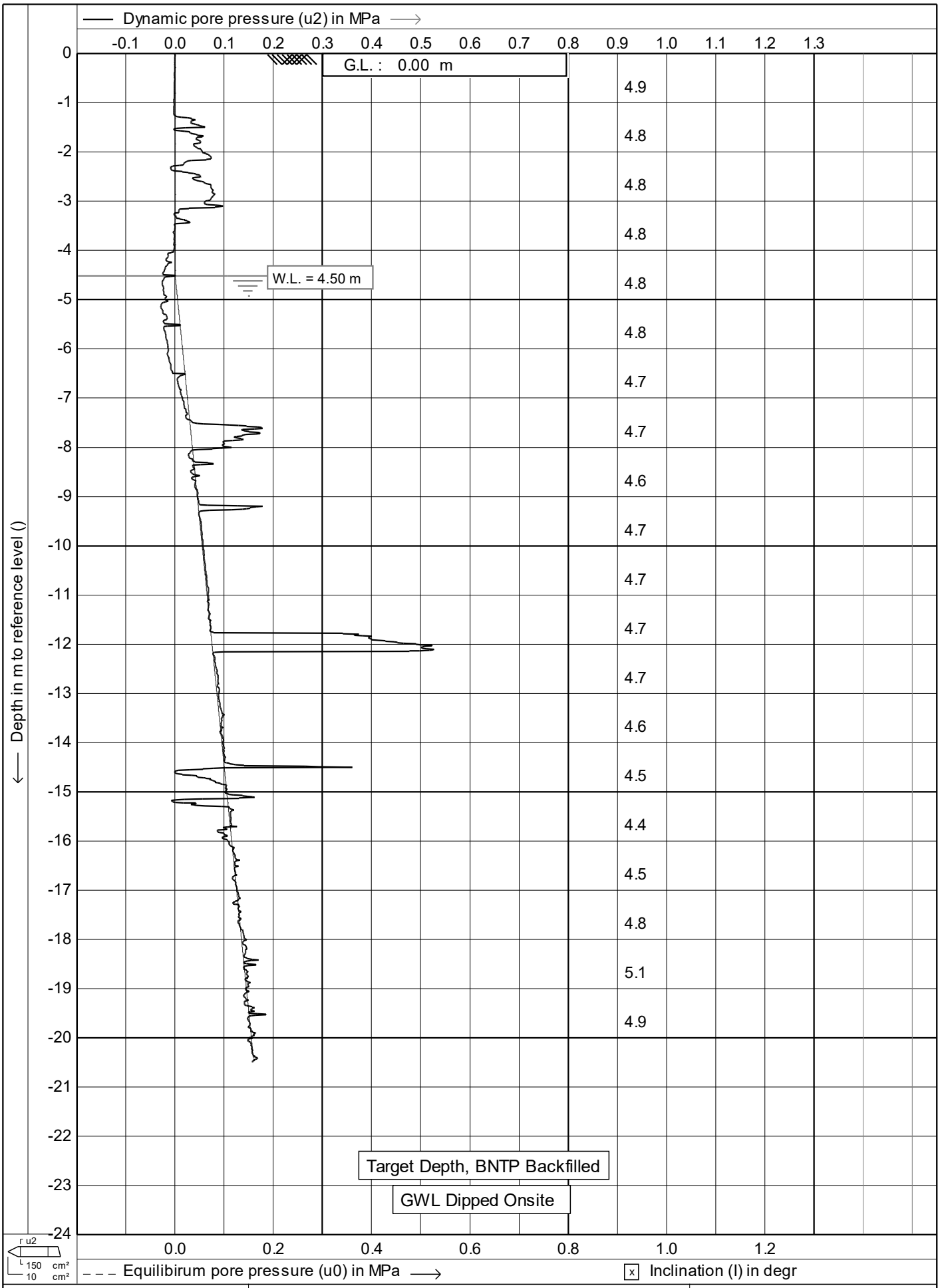
Date : **19/01/2022**

Cone no. : **C10CFIIP.C15212**

Project no. : **02CMW099**

CPT no. : **SCPT12** **1/14**

1.49



PERRY GEOTECH

A.S.T.M D5778-12

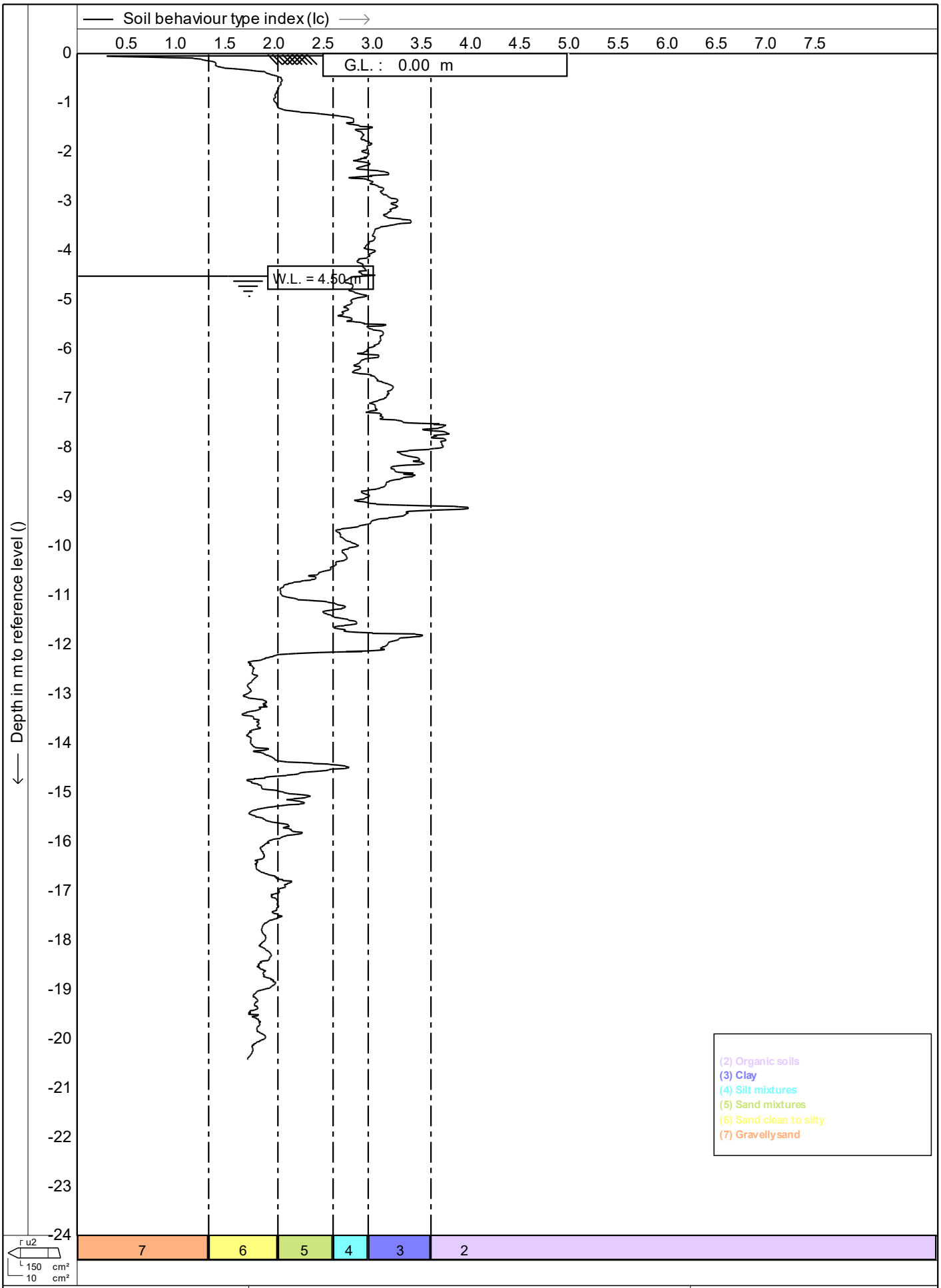
Project : **Site Investigations**

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



PERRY GEOTECH

A.S.T.M D5778-12

Project : **Site Investigations**

Location: **Arawa Rd - Pongakawa**

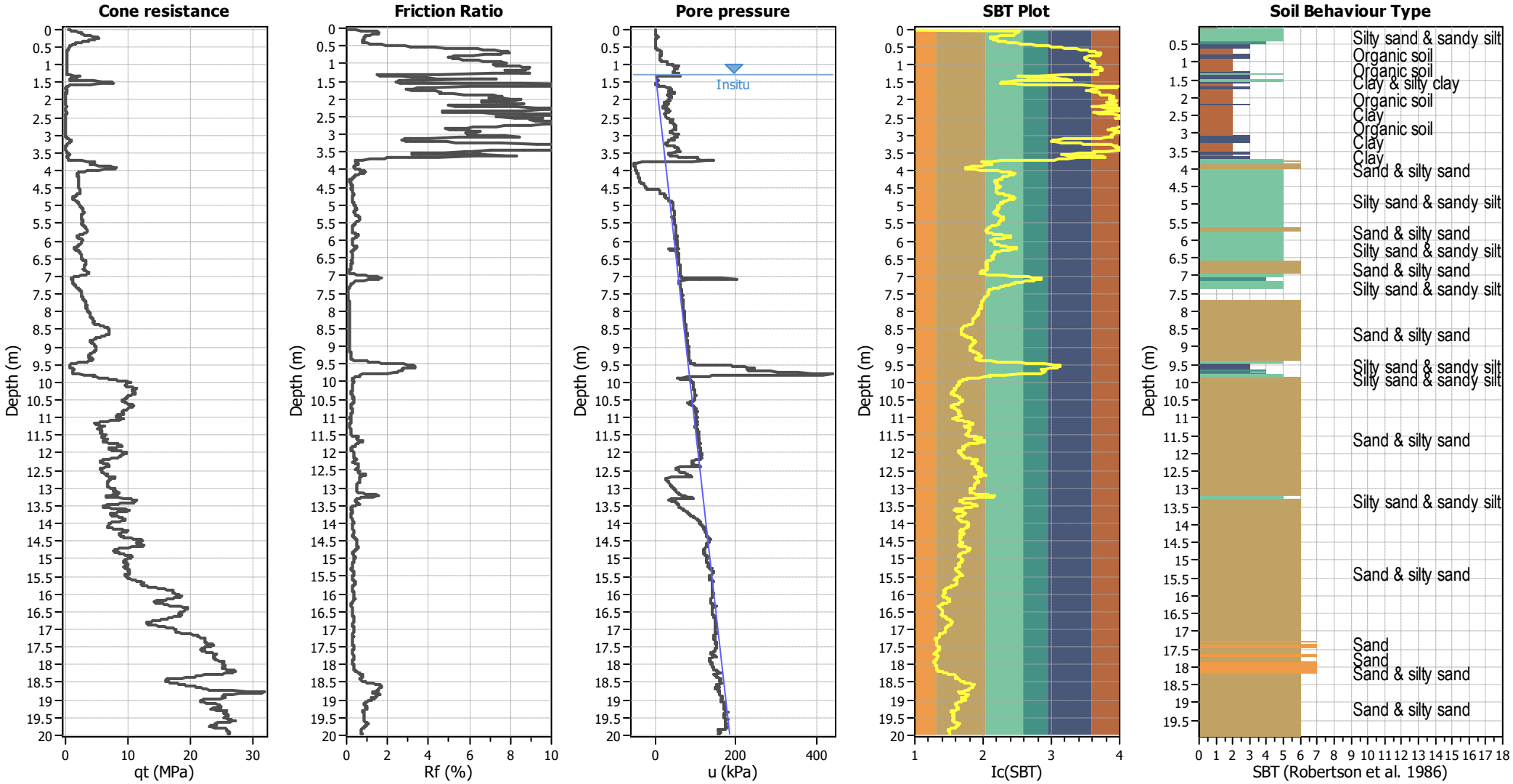
Position: **0, 0**

Date	: **19/01/2022**
Cone no.	: **C10CFIIP.C15212**
Project no.	: **02CMW099**
CPT no.	: **SCPT12** **9/14**

1.49

Appendix D: Liquefaction Analyses

CPT basic interpretation plots



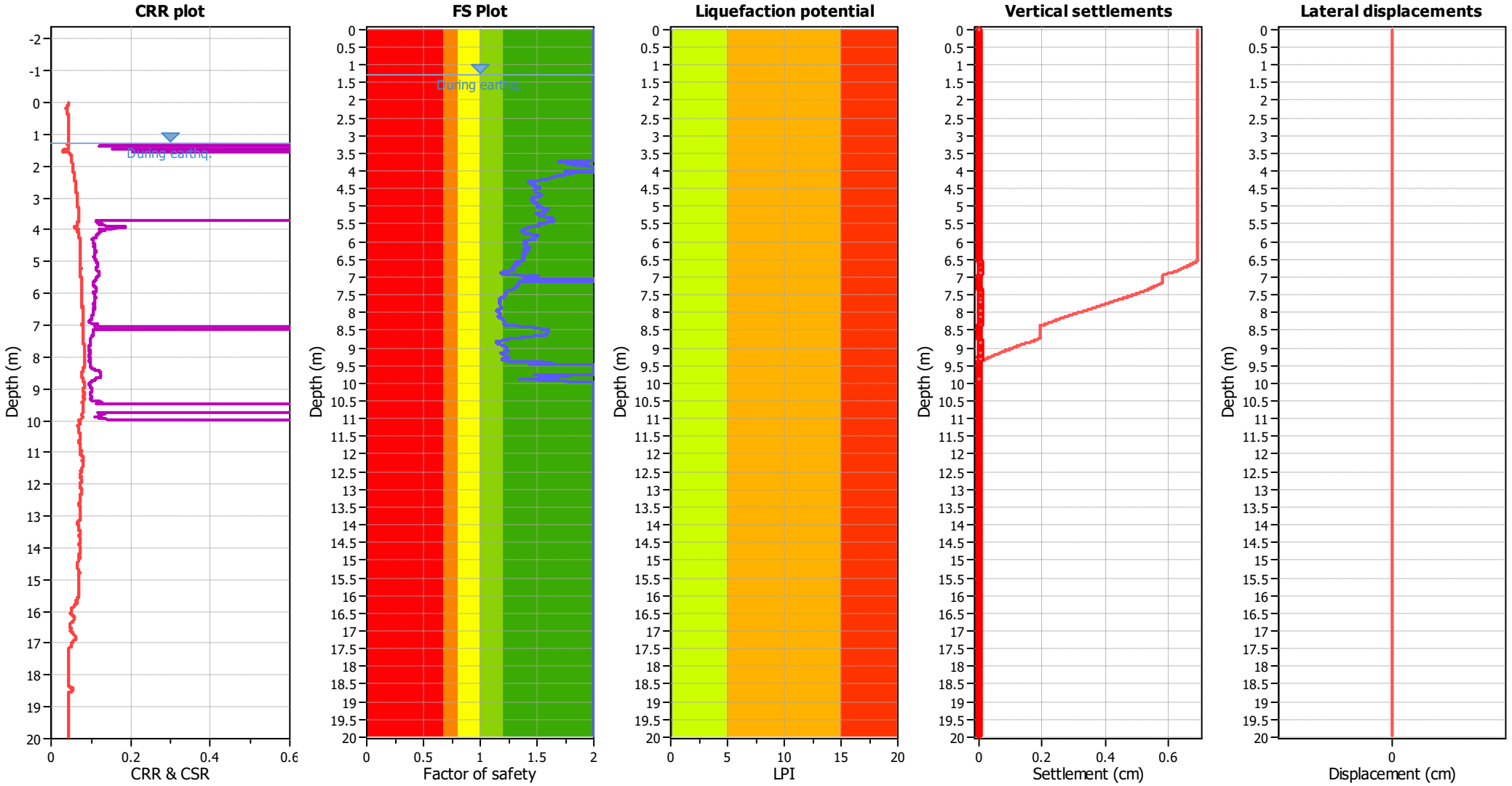
Input parameters and analysis data

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

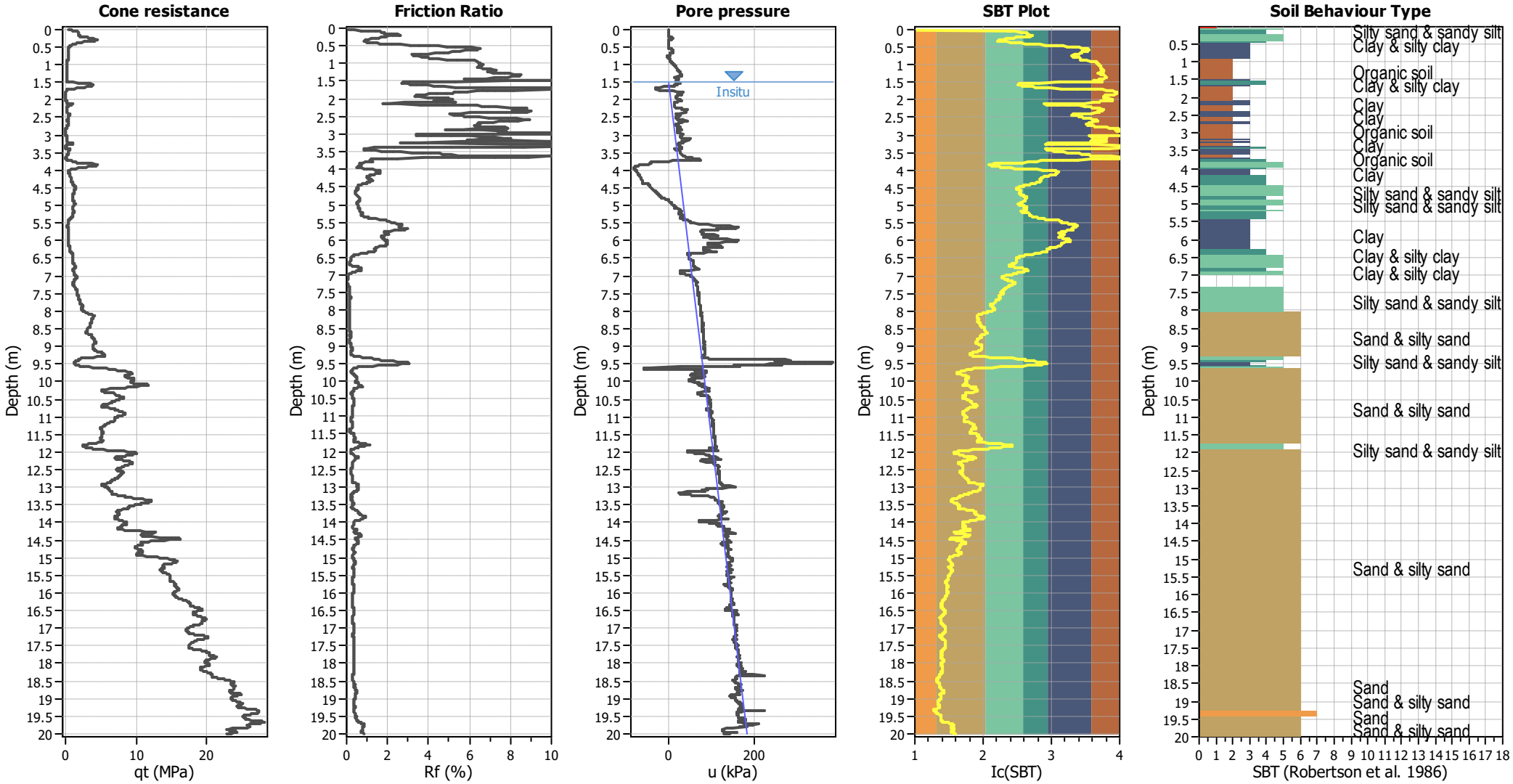
F.S. color scheme

- 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



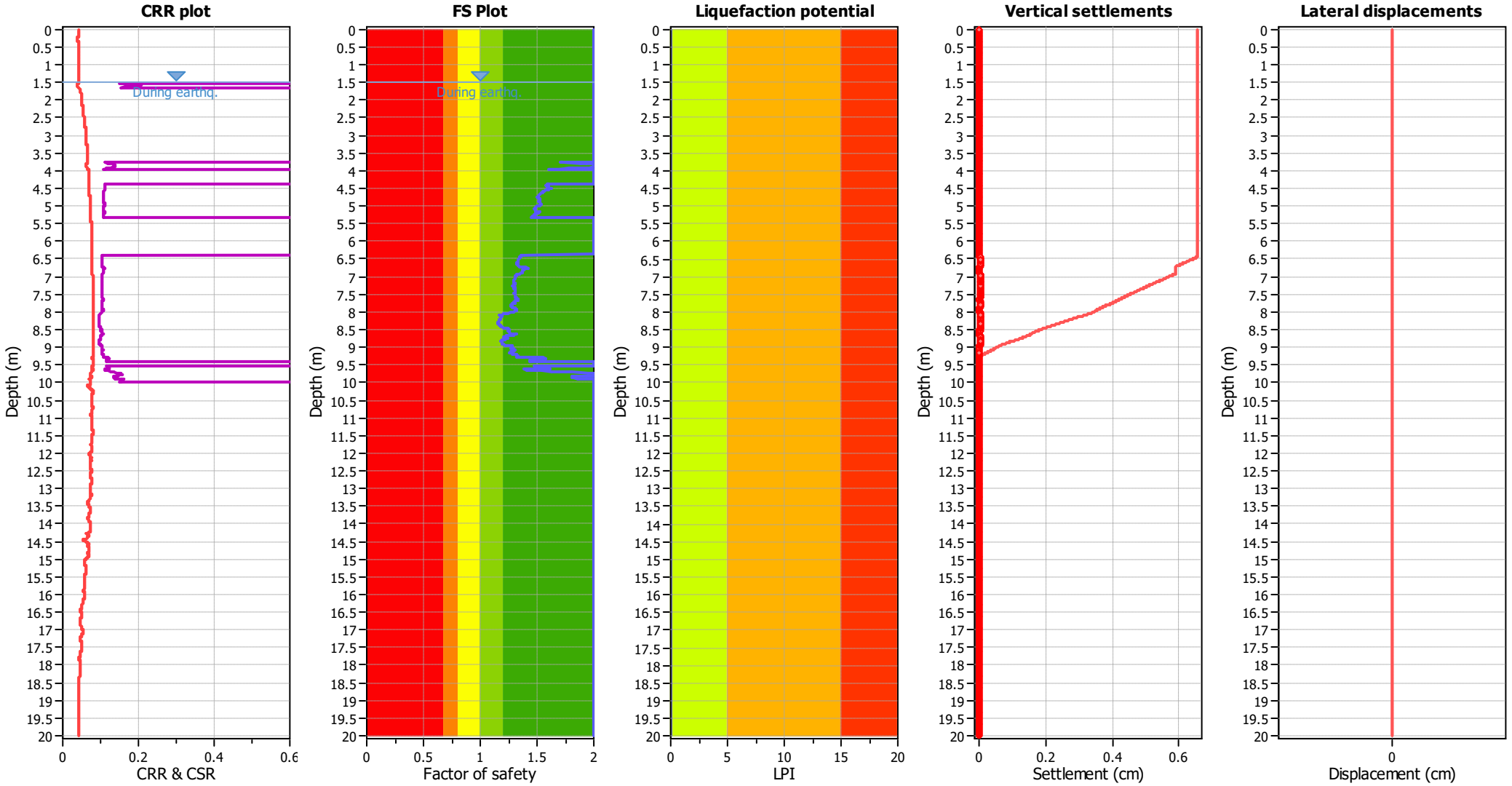
Input parameters and analysis data

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
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:	0.08	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.50 m	Fill height:	N/A	Limit depth:	10.00 m

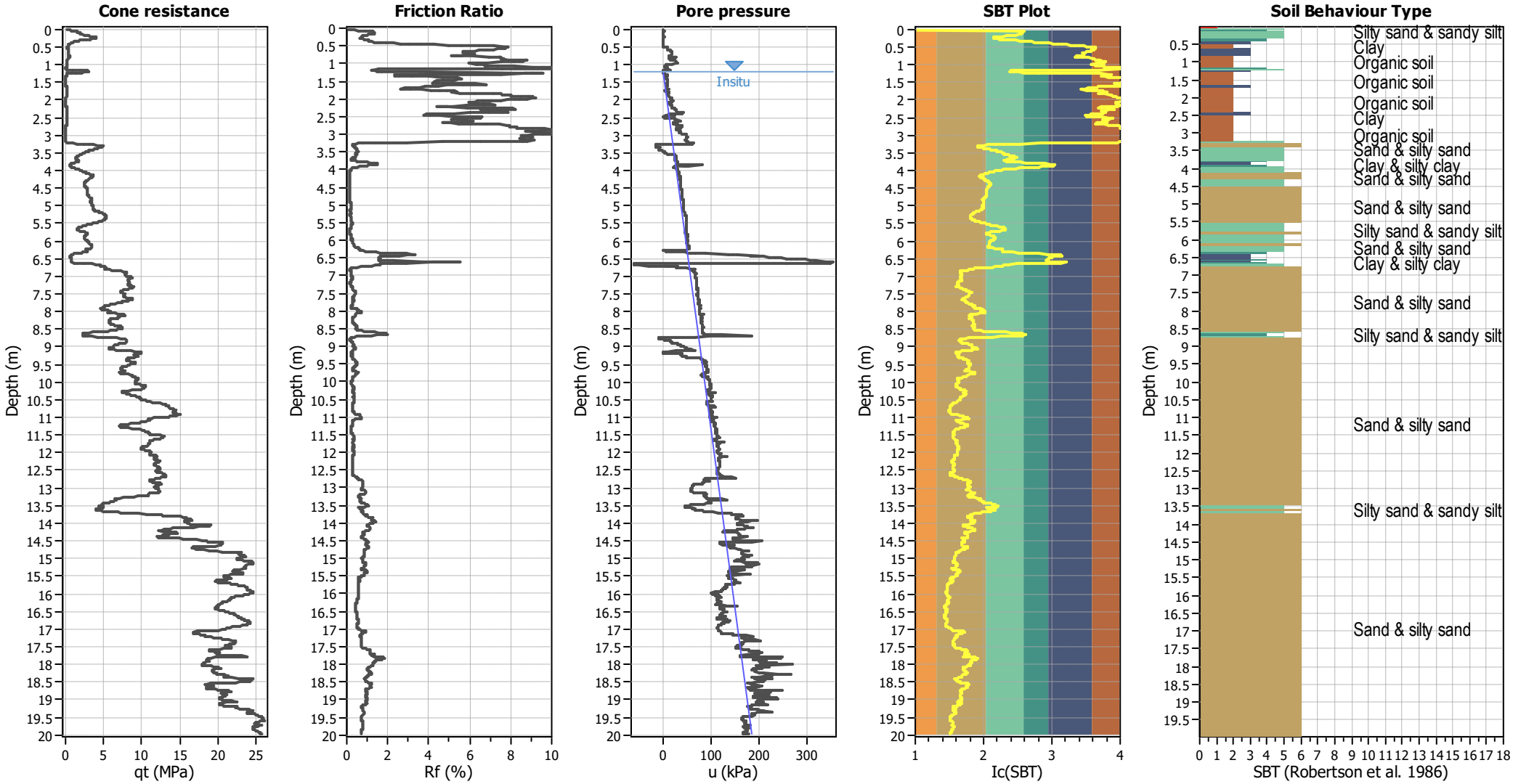
F.S. color scheme

- 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



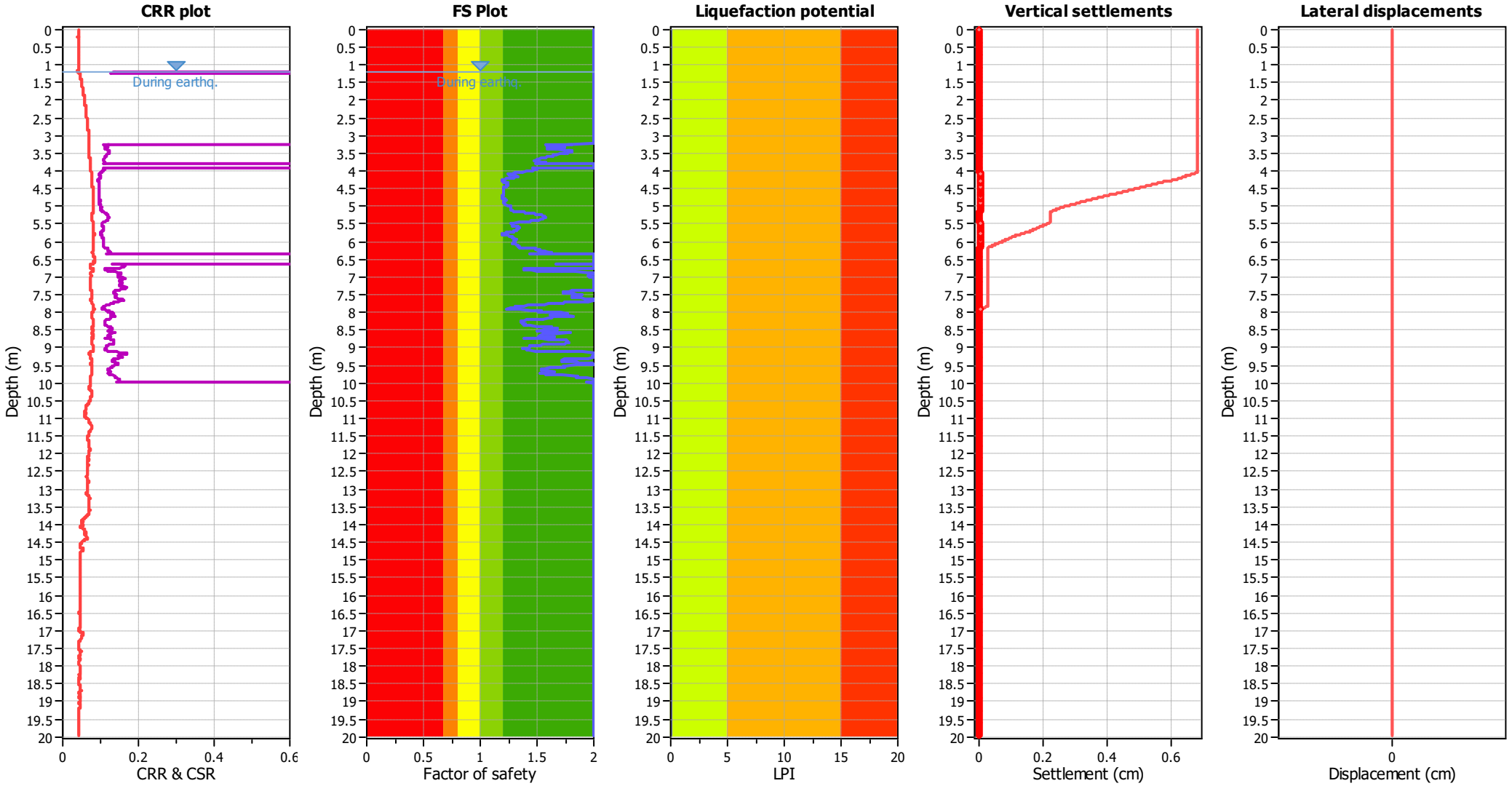
Input parameters and analysis data

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

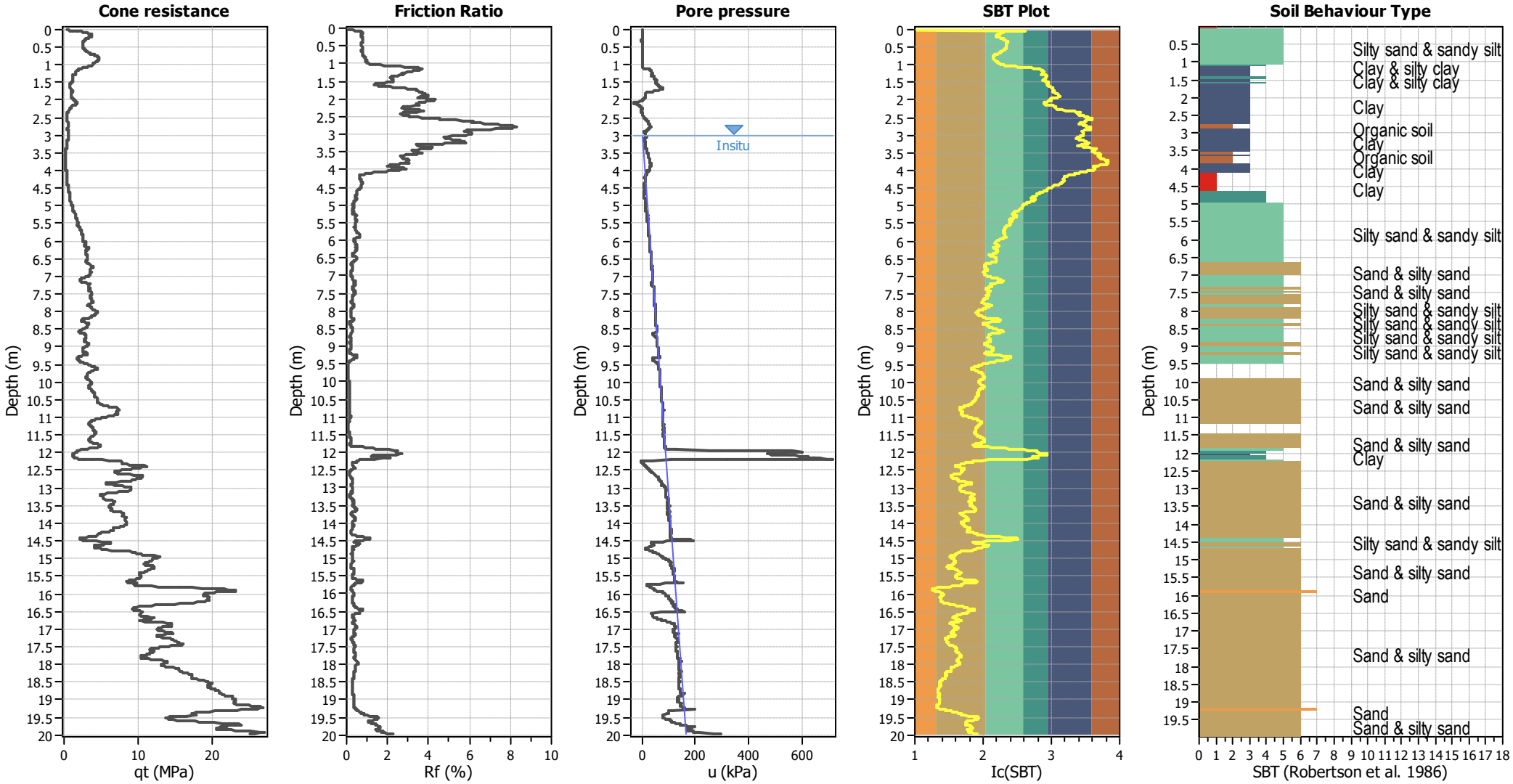
F.S. color scheme

- 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



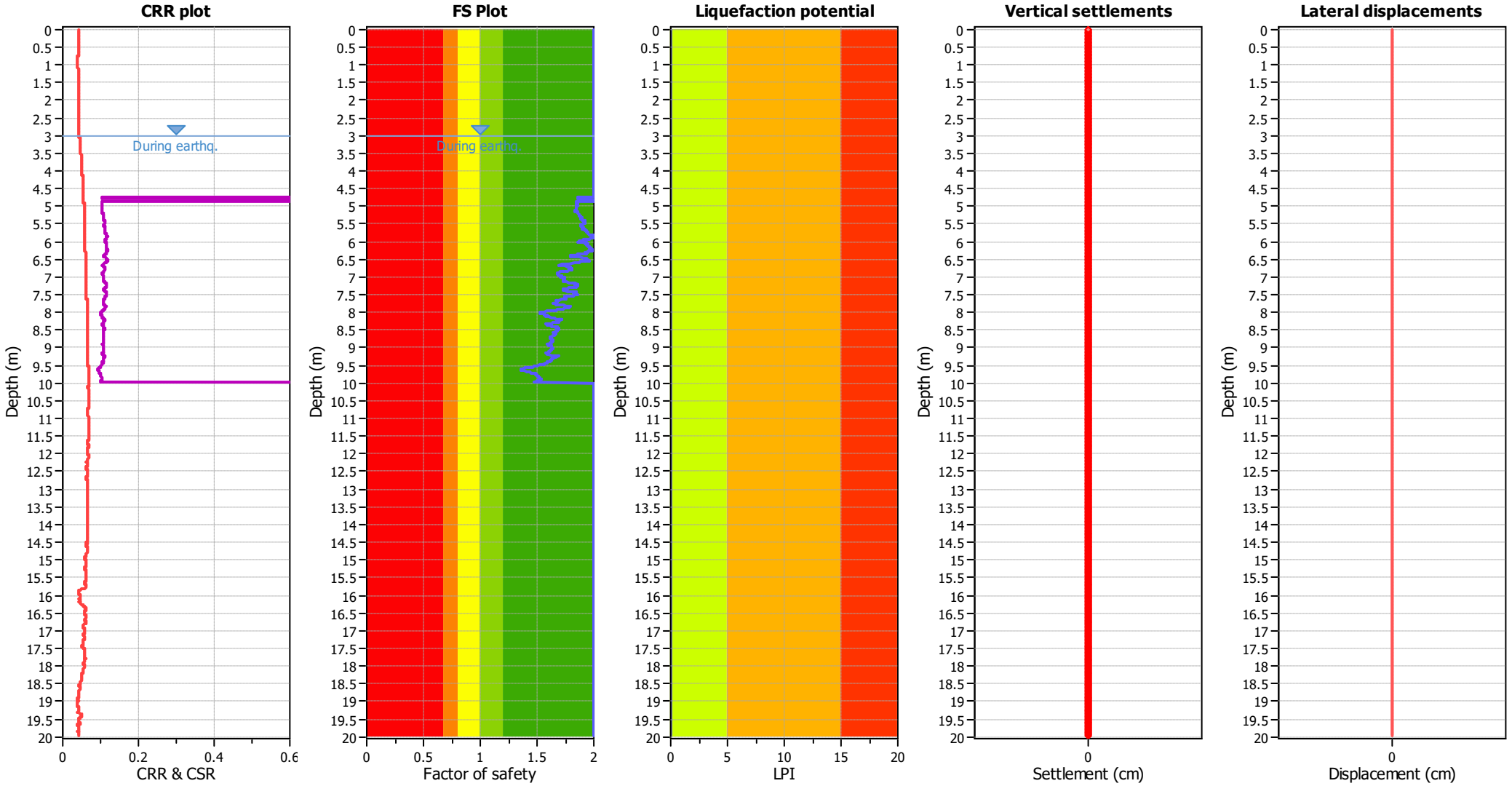
Input parameters and analysis data

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

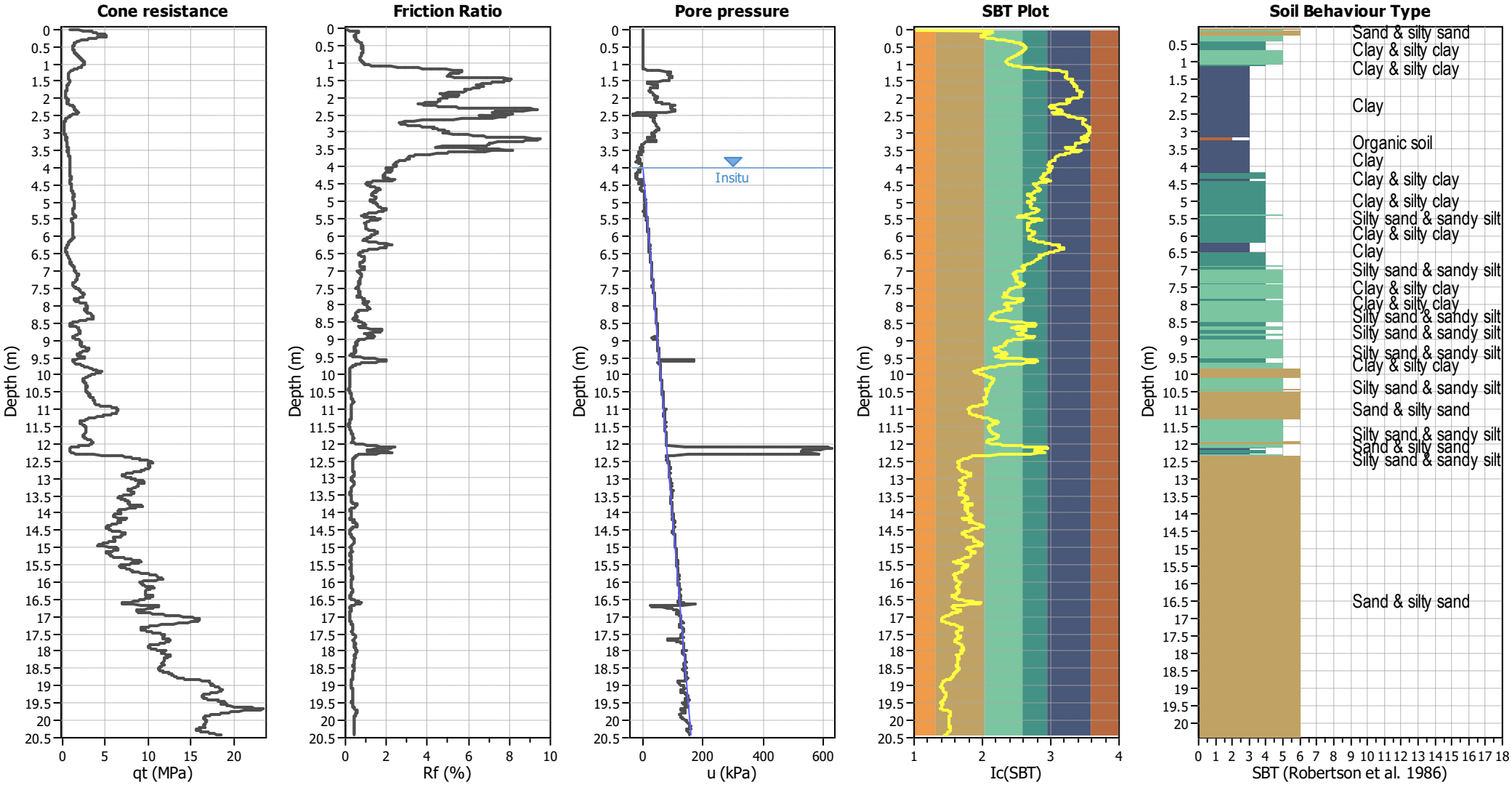
F.S. color scheme

- 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



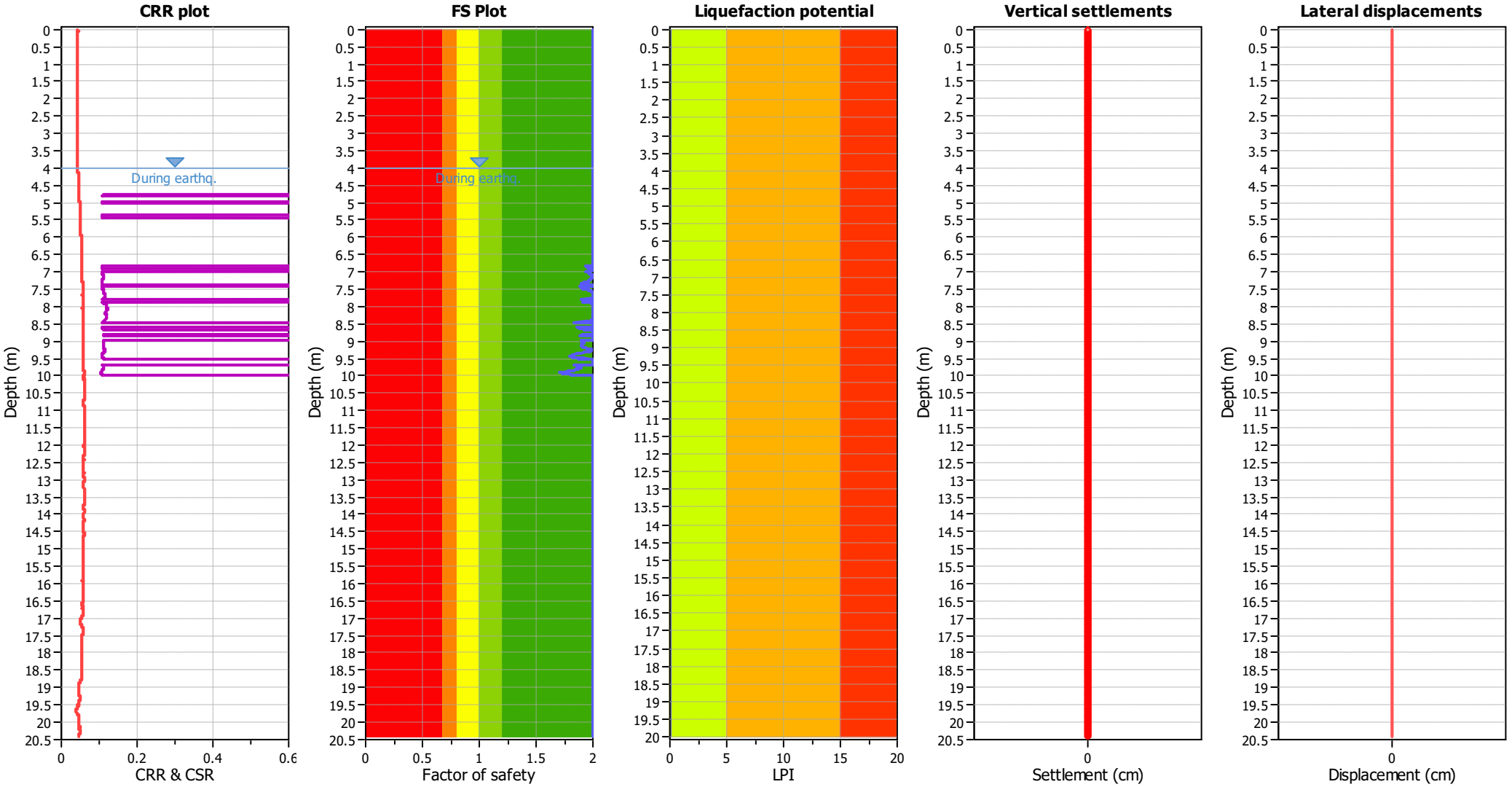
Input parameters and analysis data

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

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:	0.08	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	4.00 m	Fill height:	N/A	Limit depth:	10.00 m

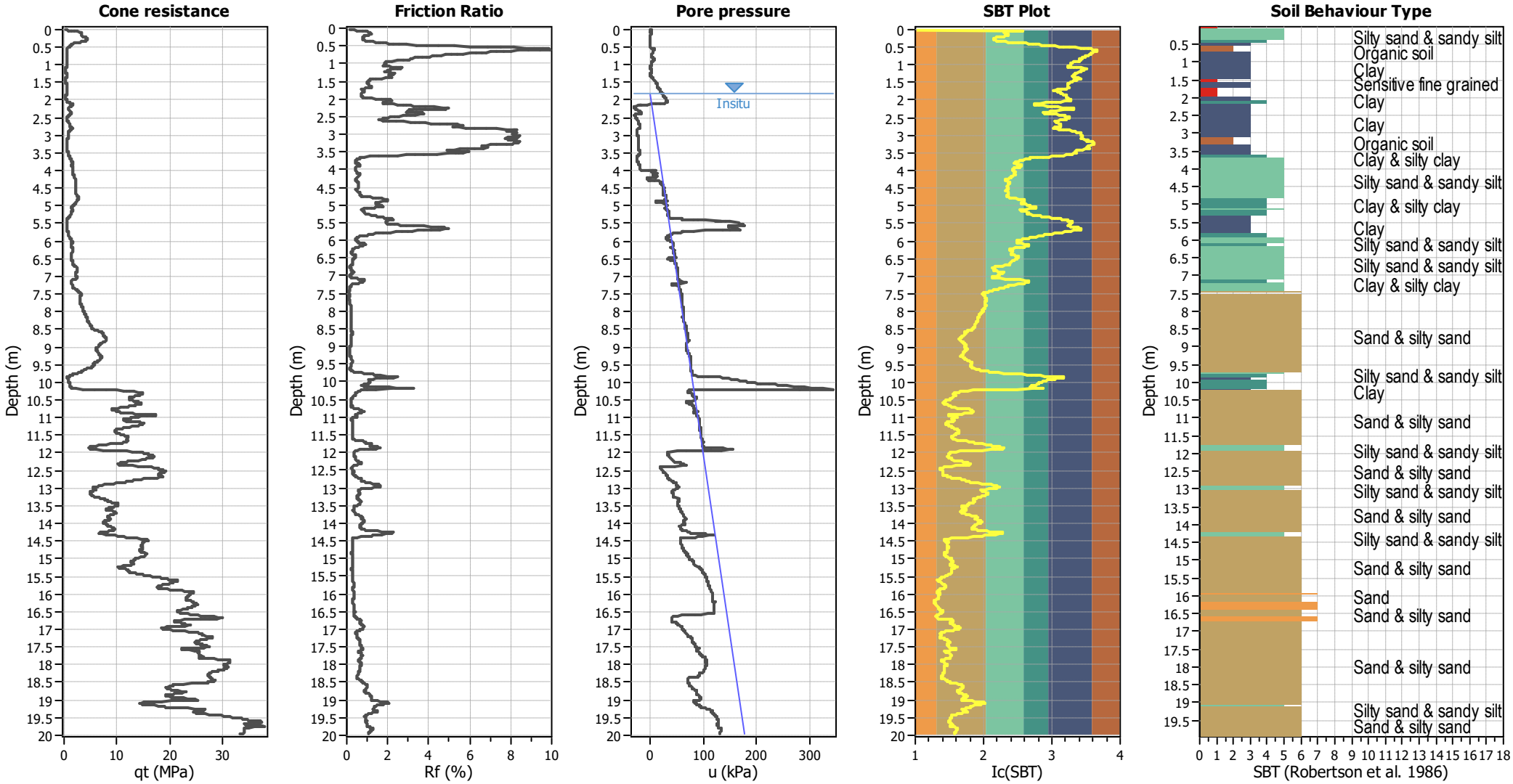
F.S. color scheme

- 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



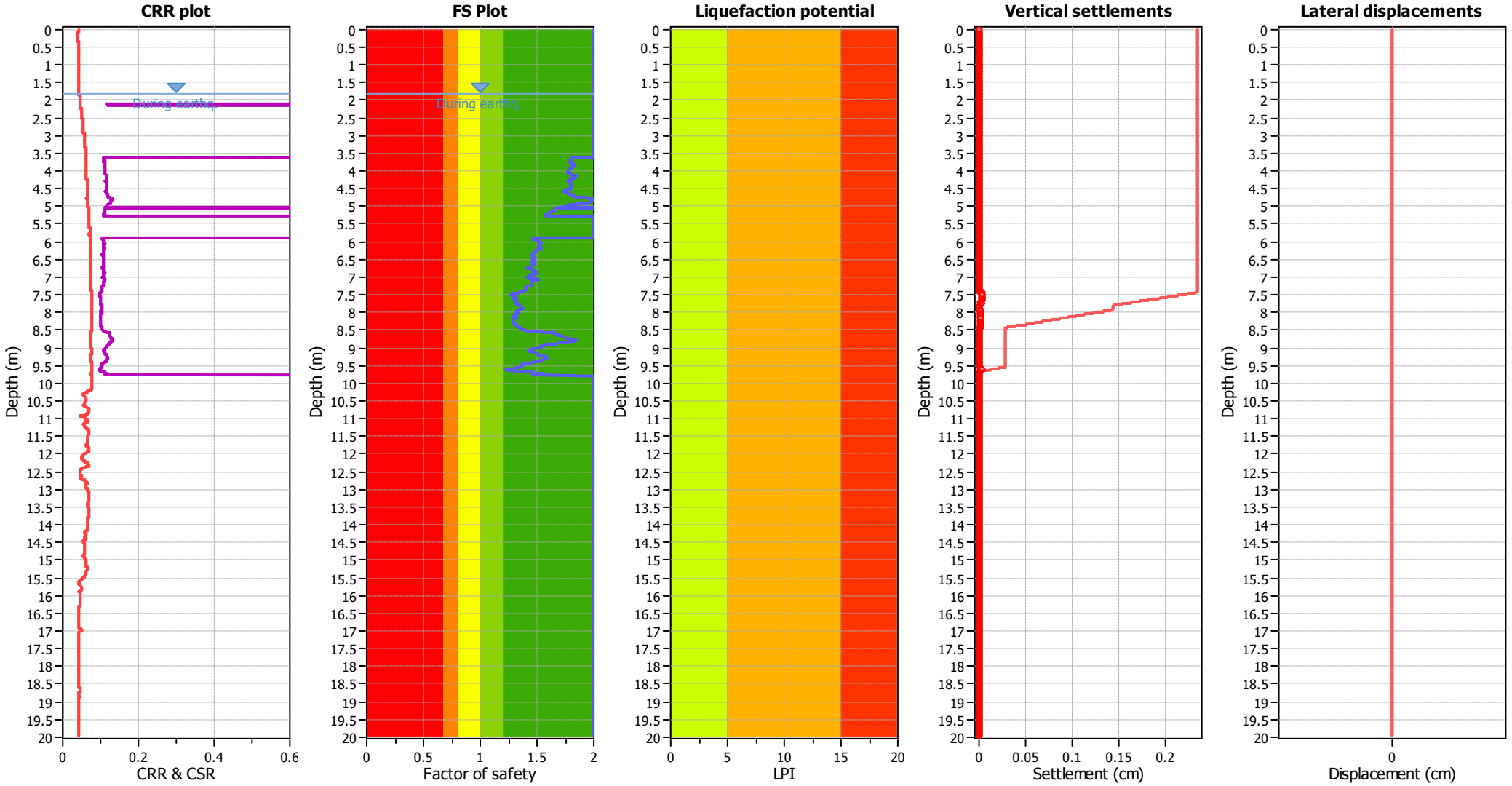
Input parameters and analysis data

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
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:	0.08	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

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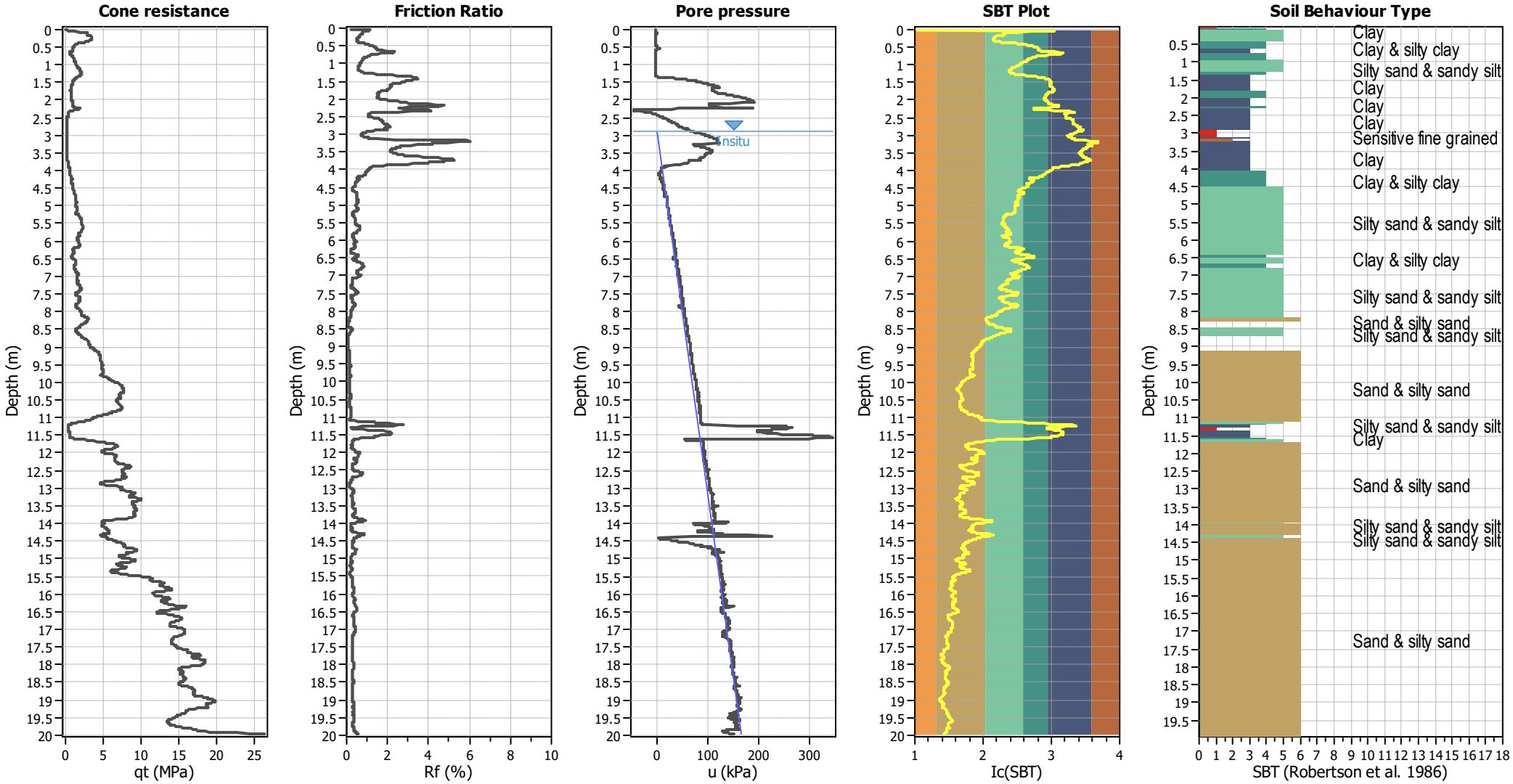
LPI color scheme

- Very high risk
- High risk
- Low risk

CPT basic interpretation plots



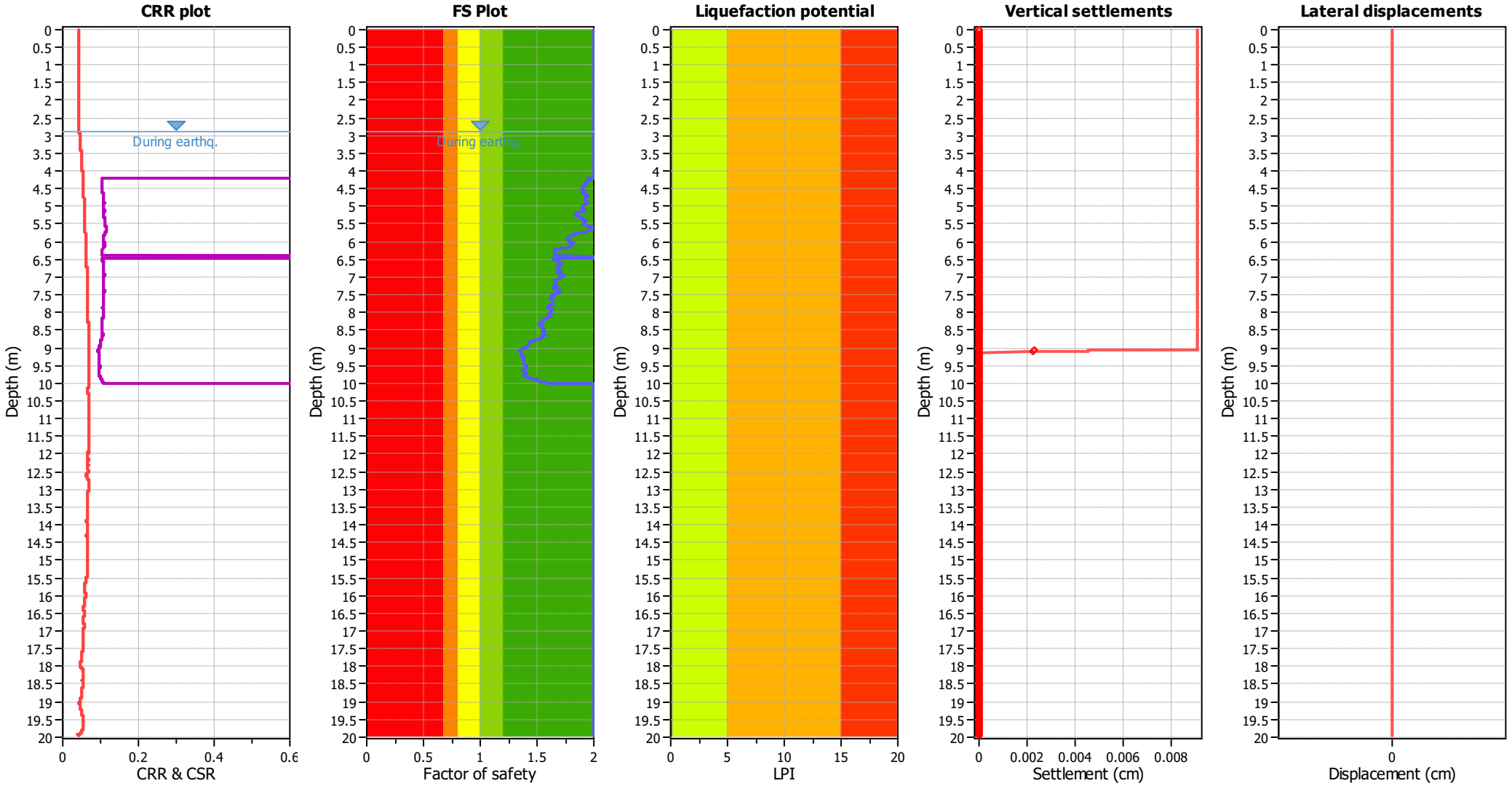
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	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

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LPI color scheme

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- High risk
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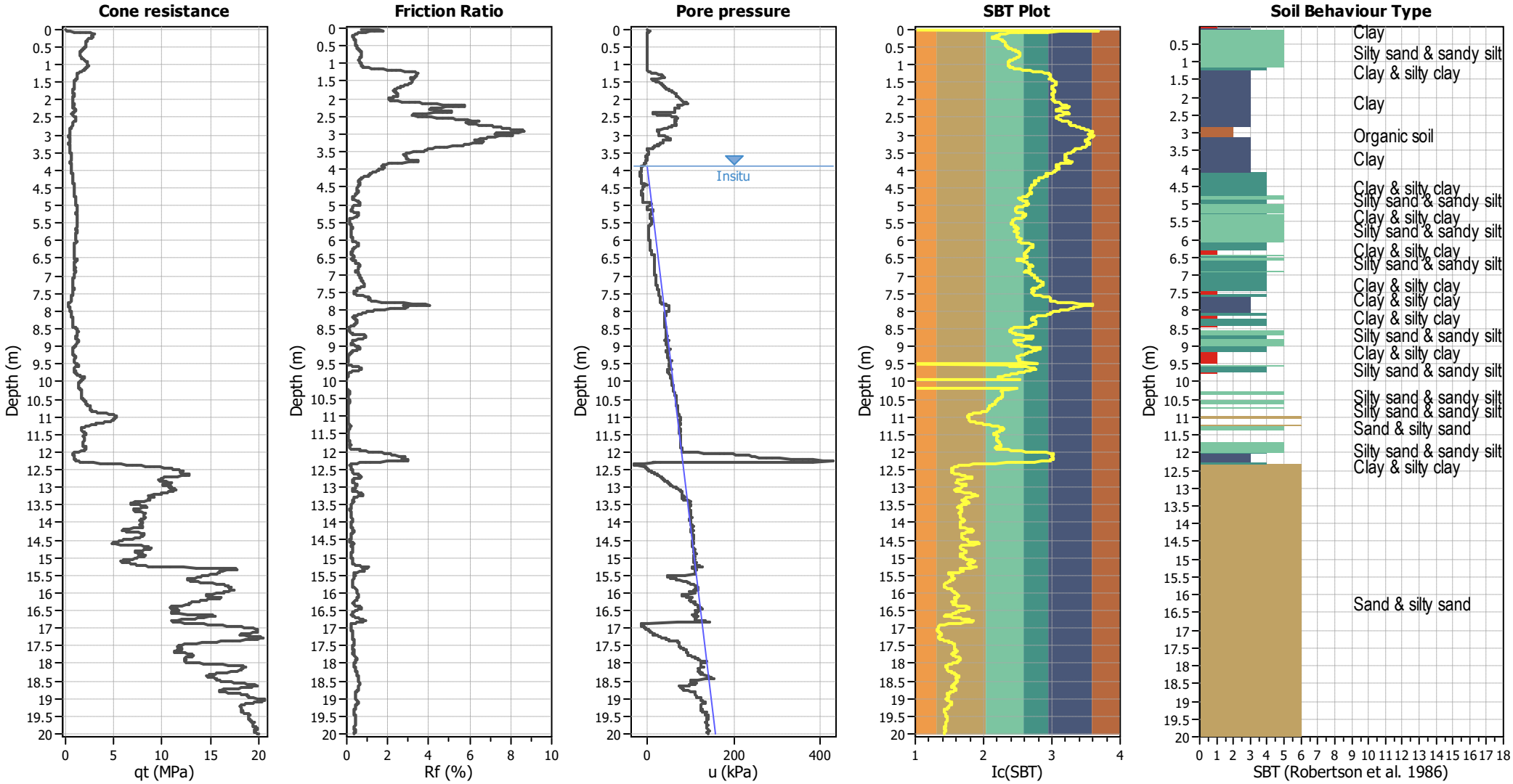
CPT basic interpretation plots



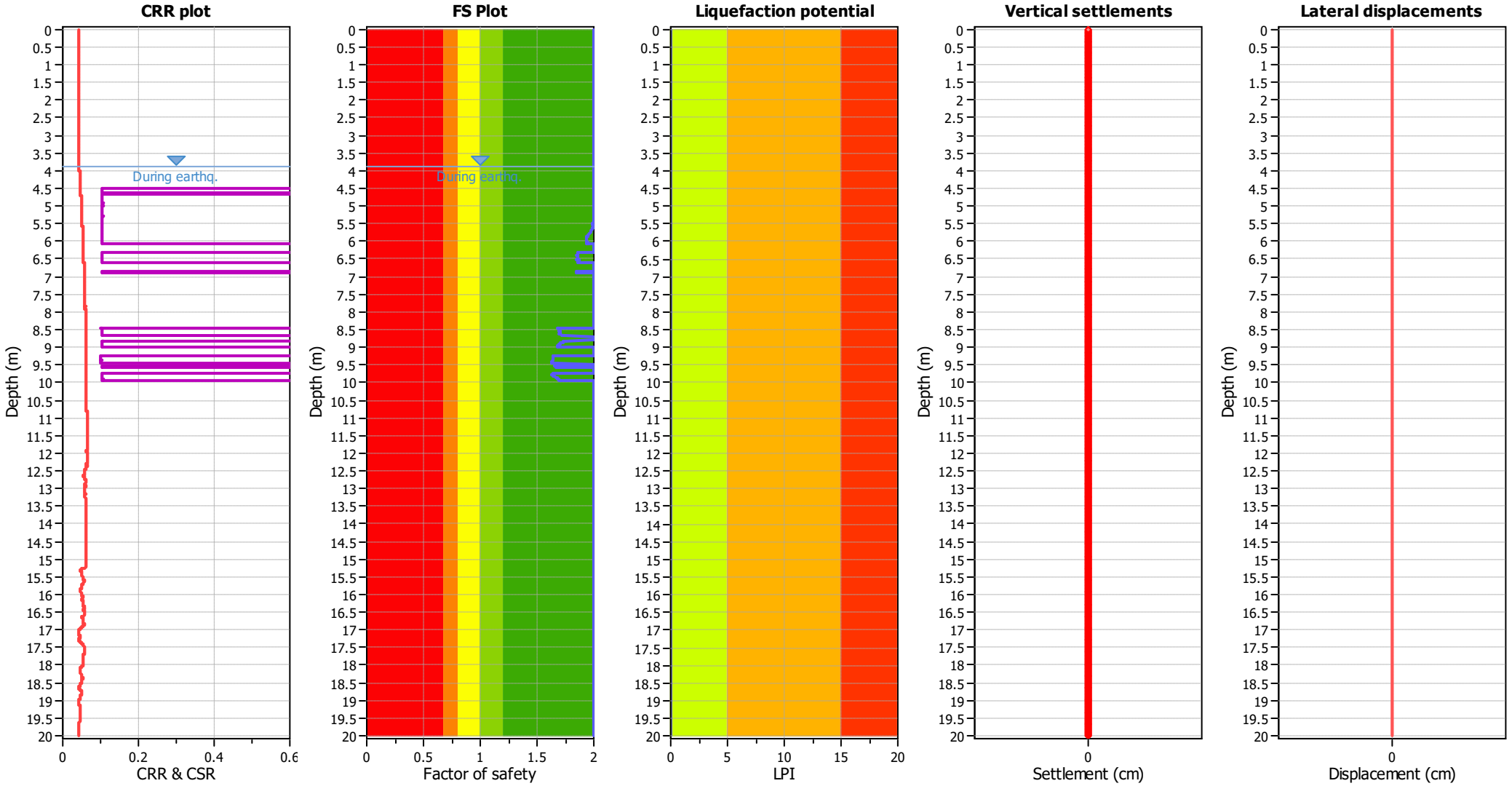
Input parameters and analysis data

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
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.):	3.90 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

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LPI color scheme

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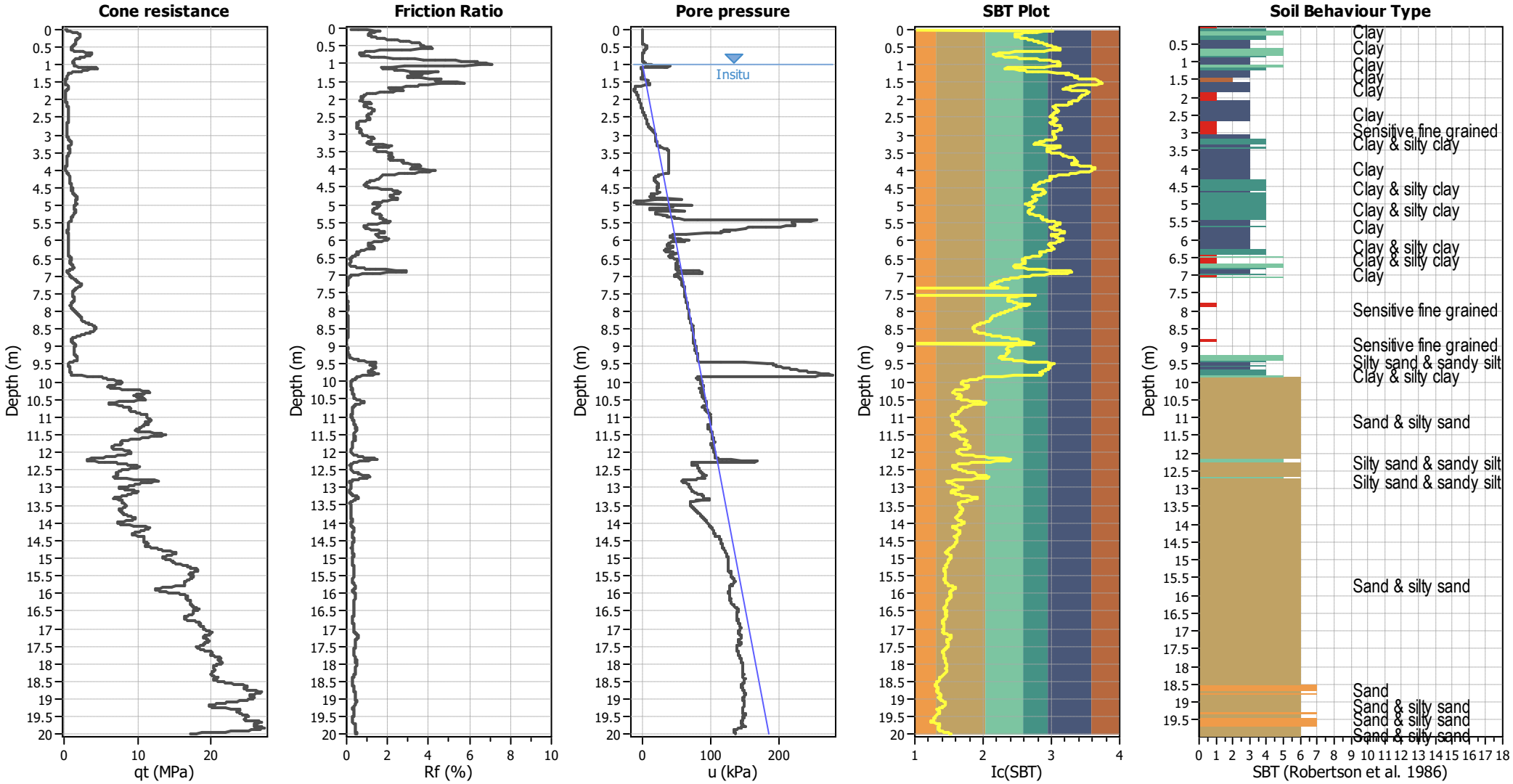
CPT basic interpretation plots



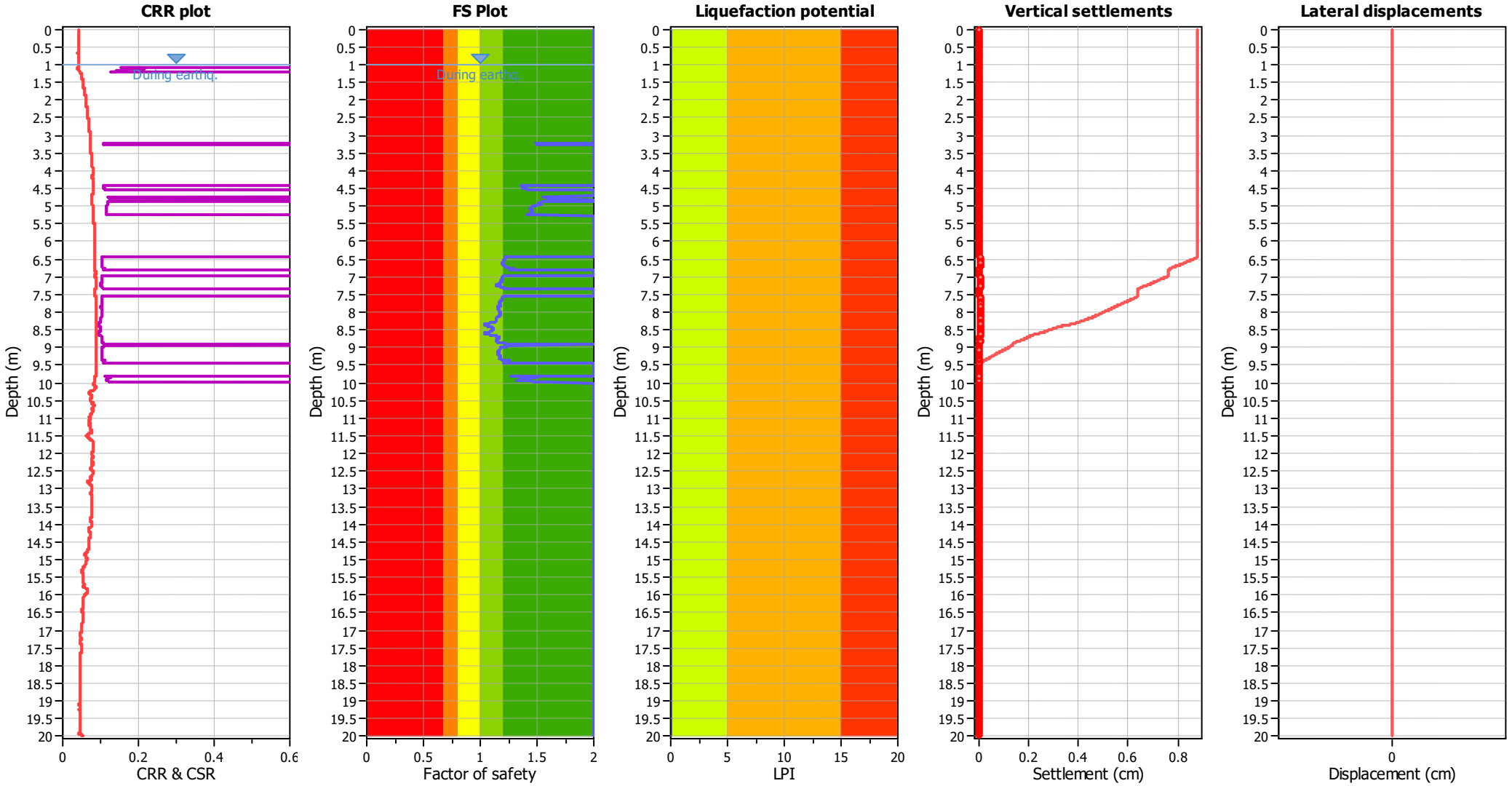
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	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

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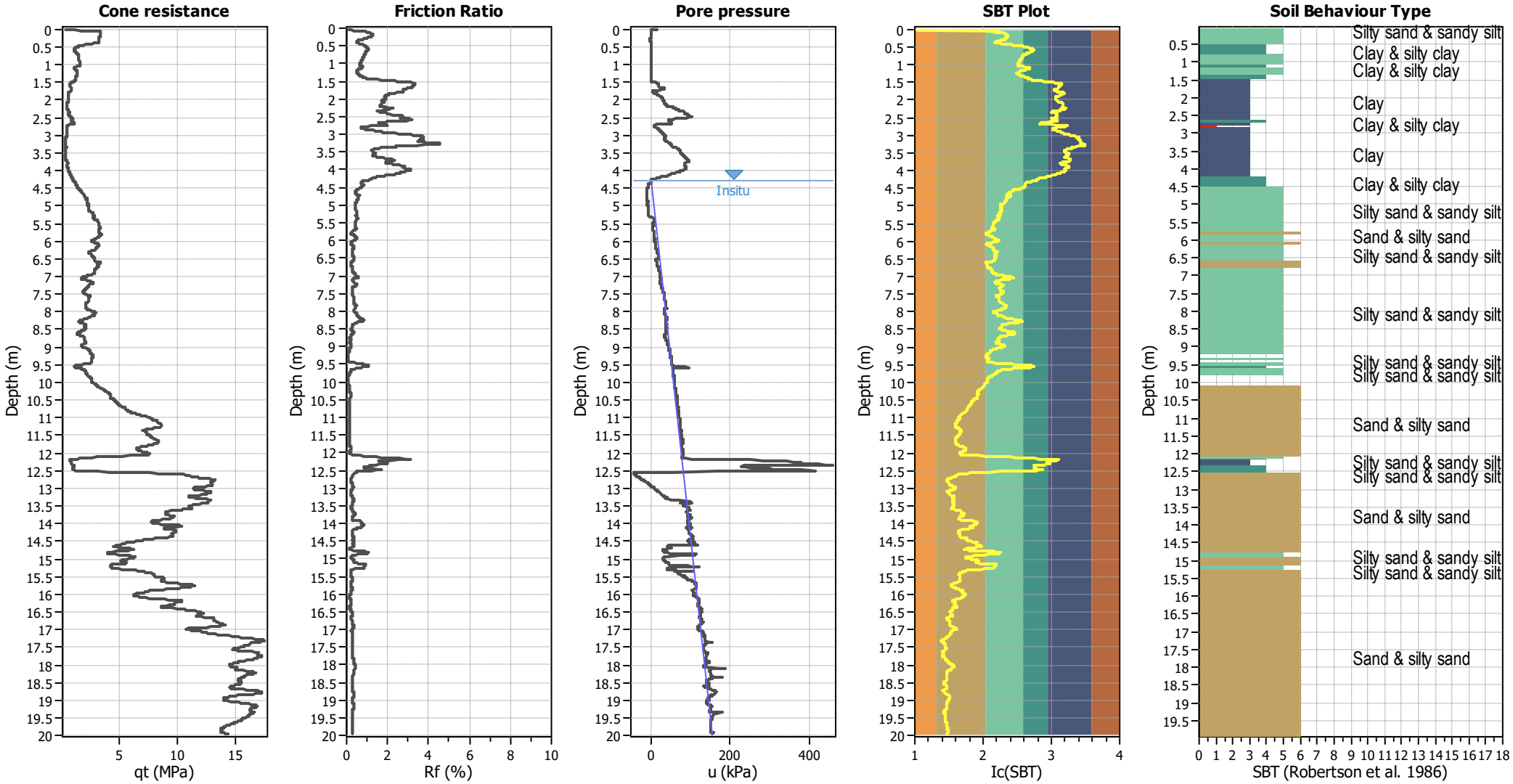
LPI color scheme

- Very high risk
- High risk
- Low risk

CPT basic interpretation plots



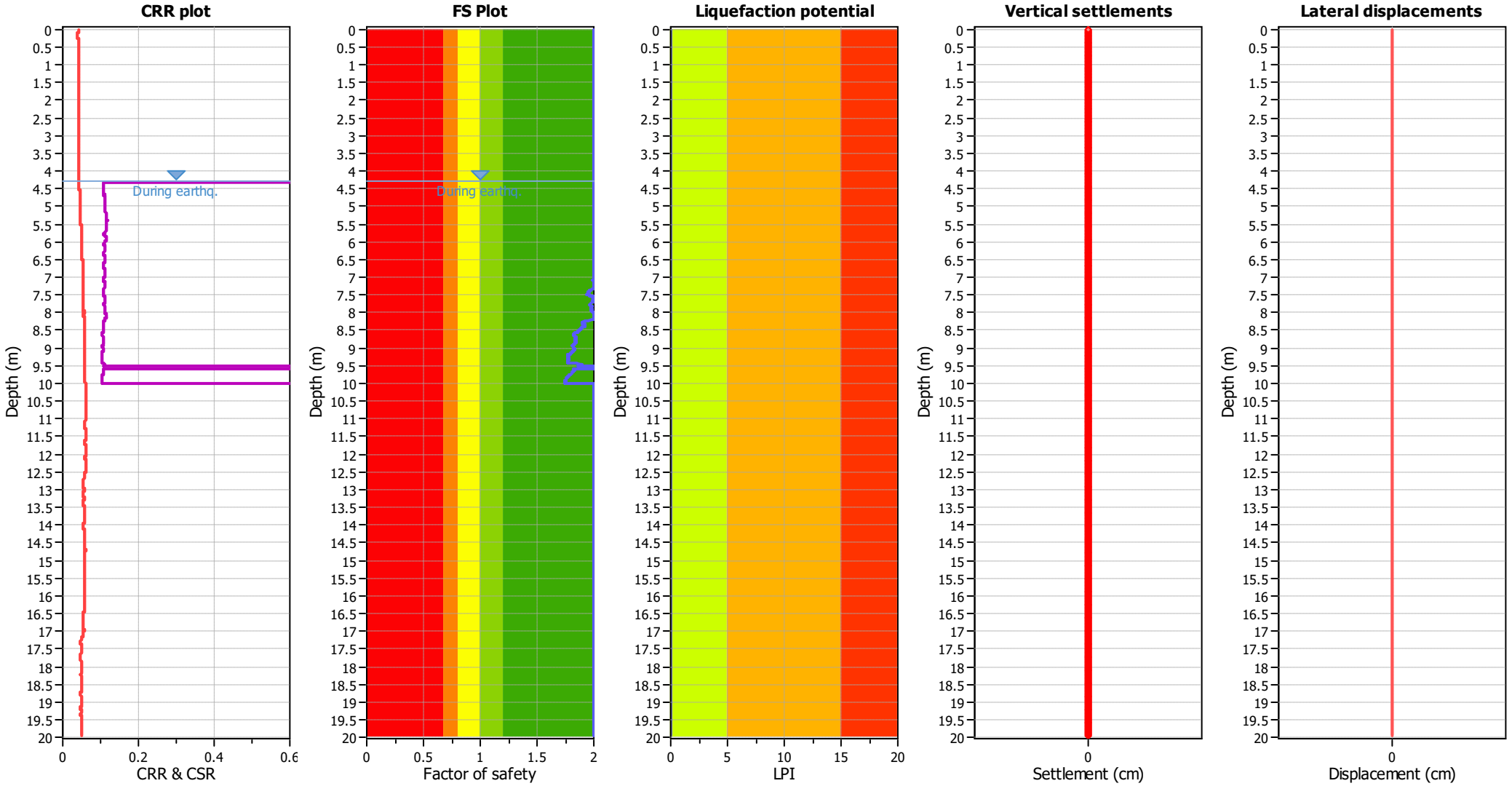
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.30 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
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.):	4.30 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

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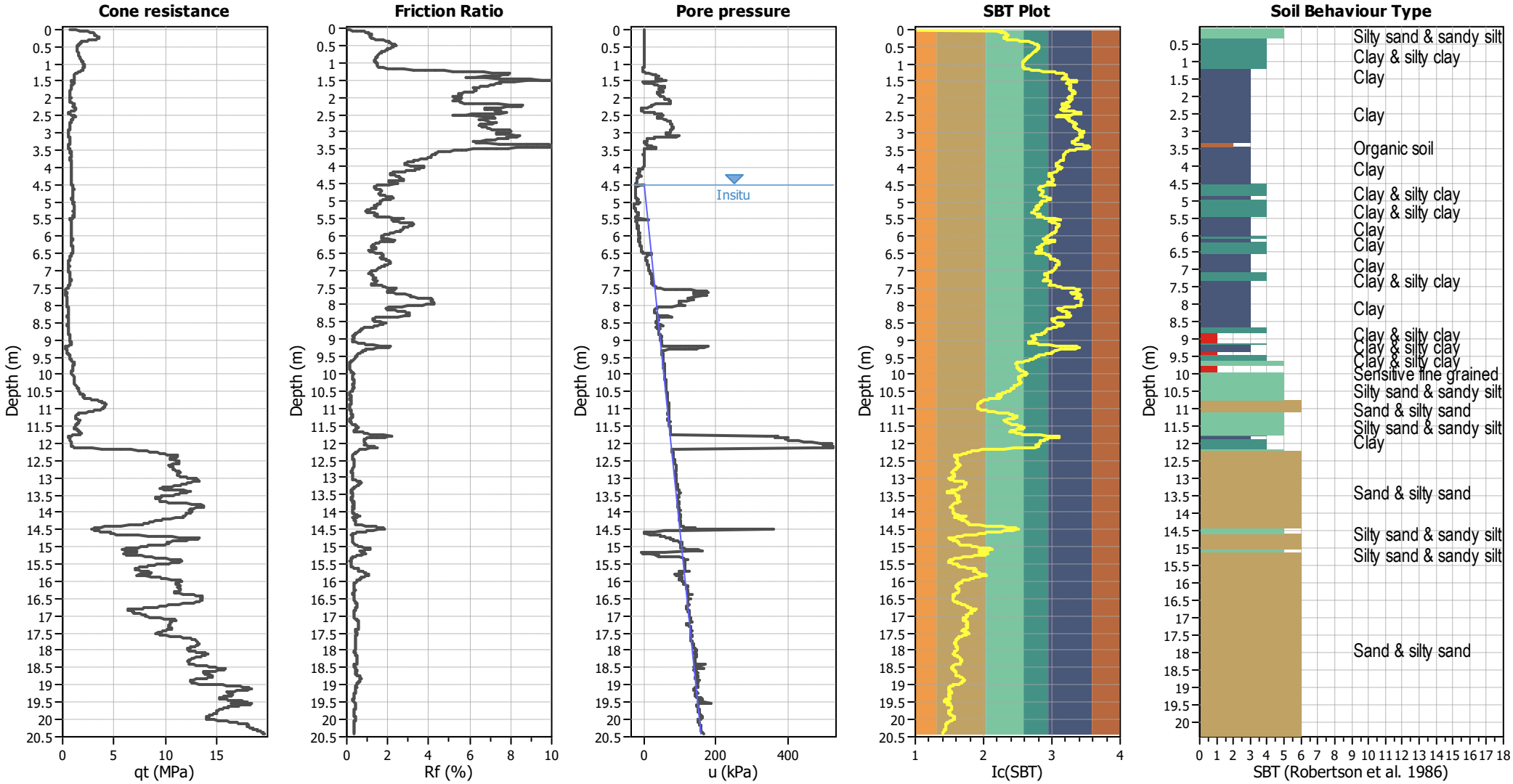
LPI color scheme

- Very high risk
- High risk
- Low risk

CPT basic interpretation plots



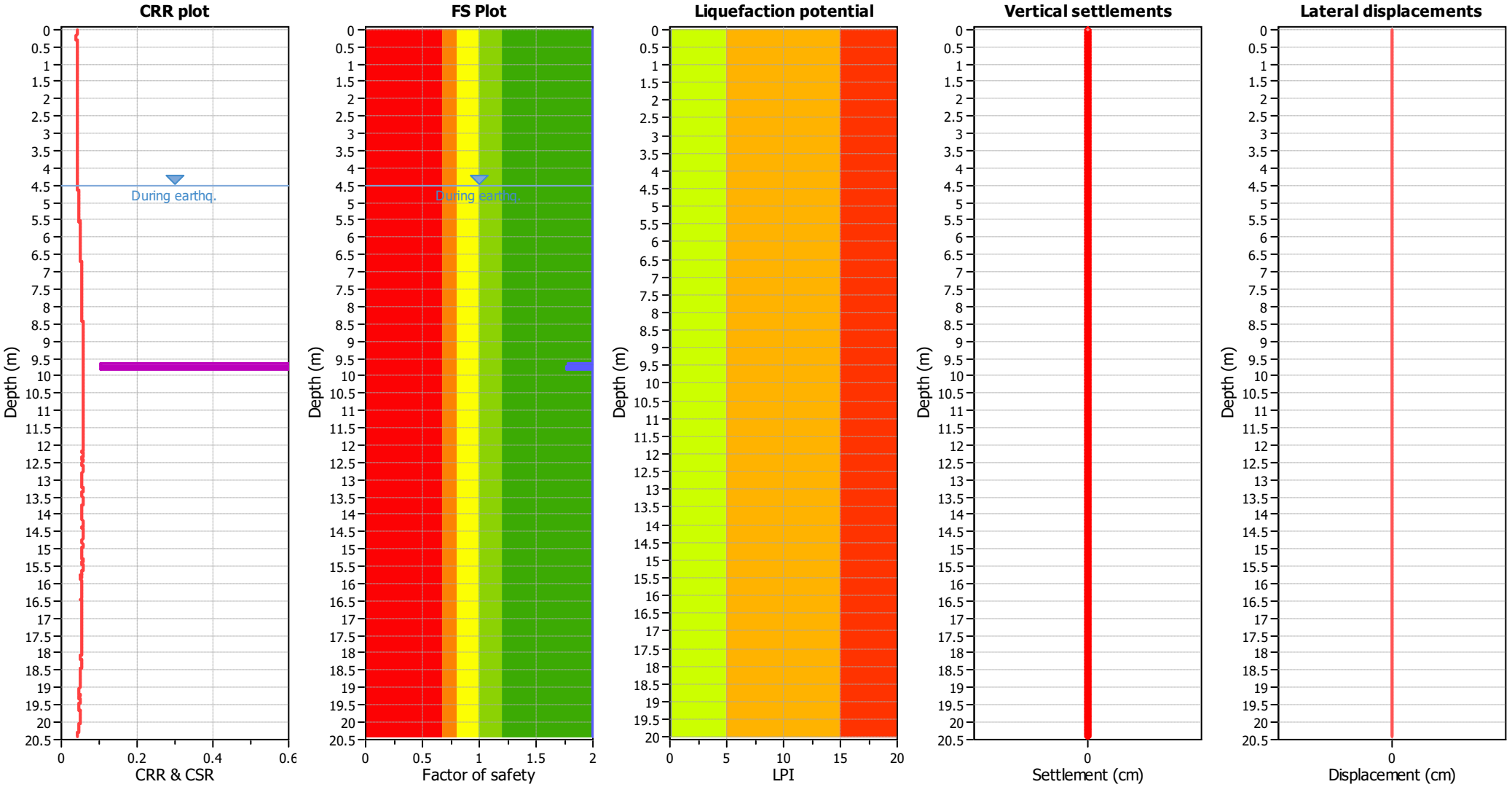
Input parameters and analysis data

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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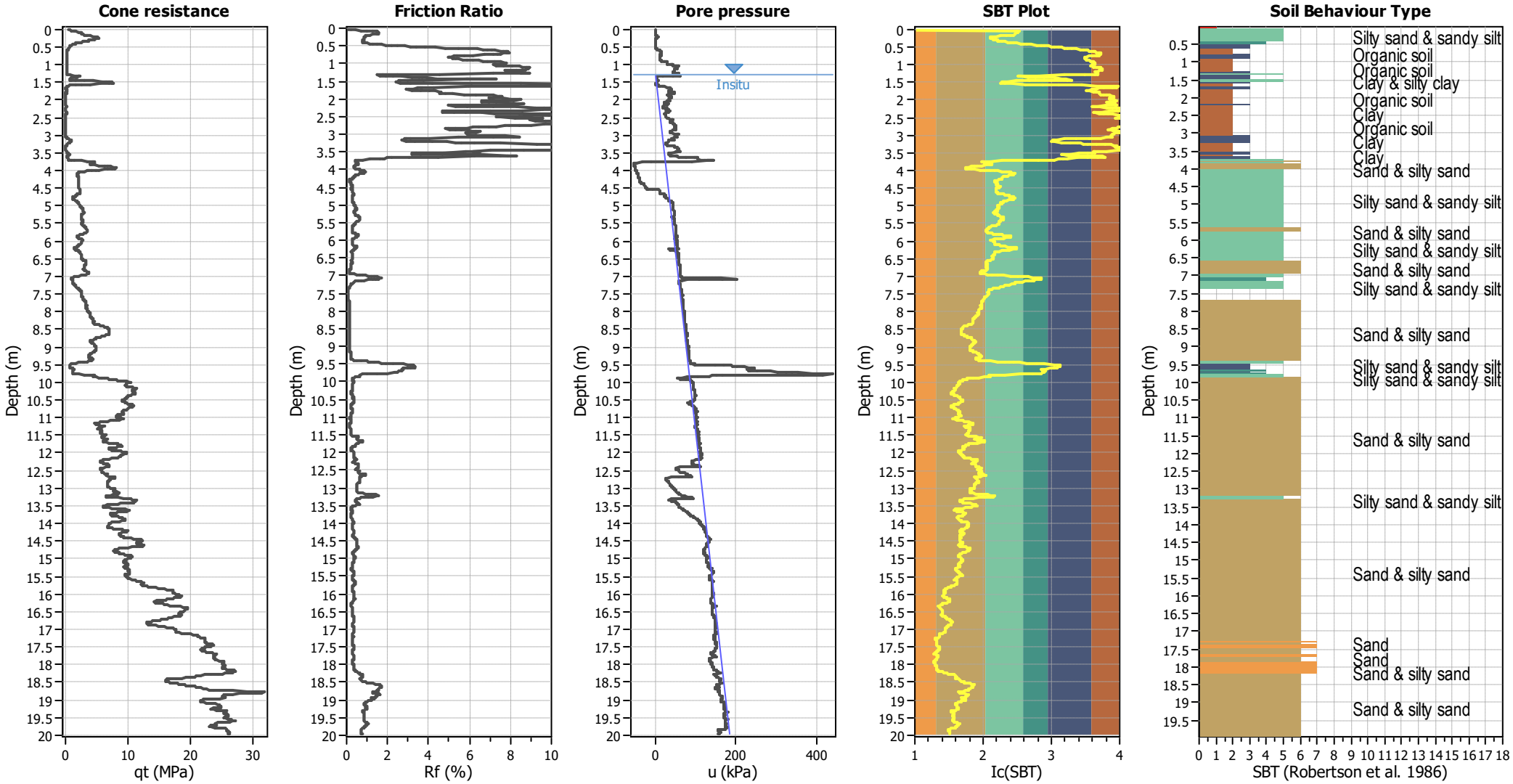
LPI color scheme

- Very high risk
- High risk
- Low risk

CPT basic interpretation plots



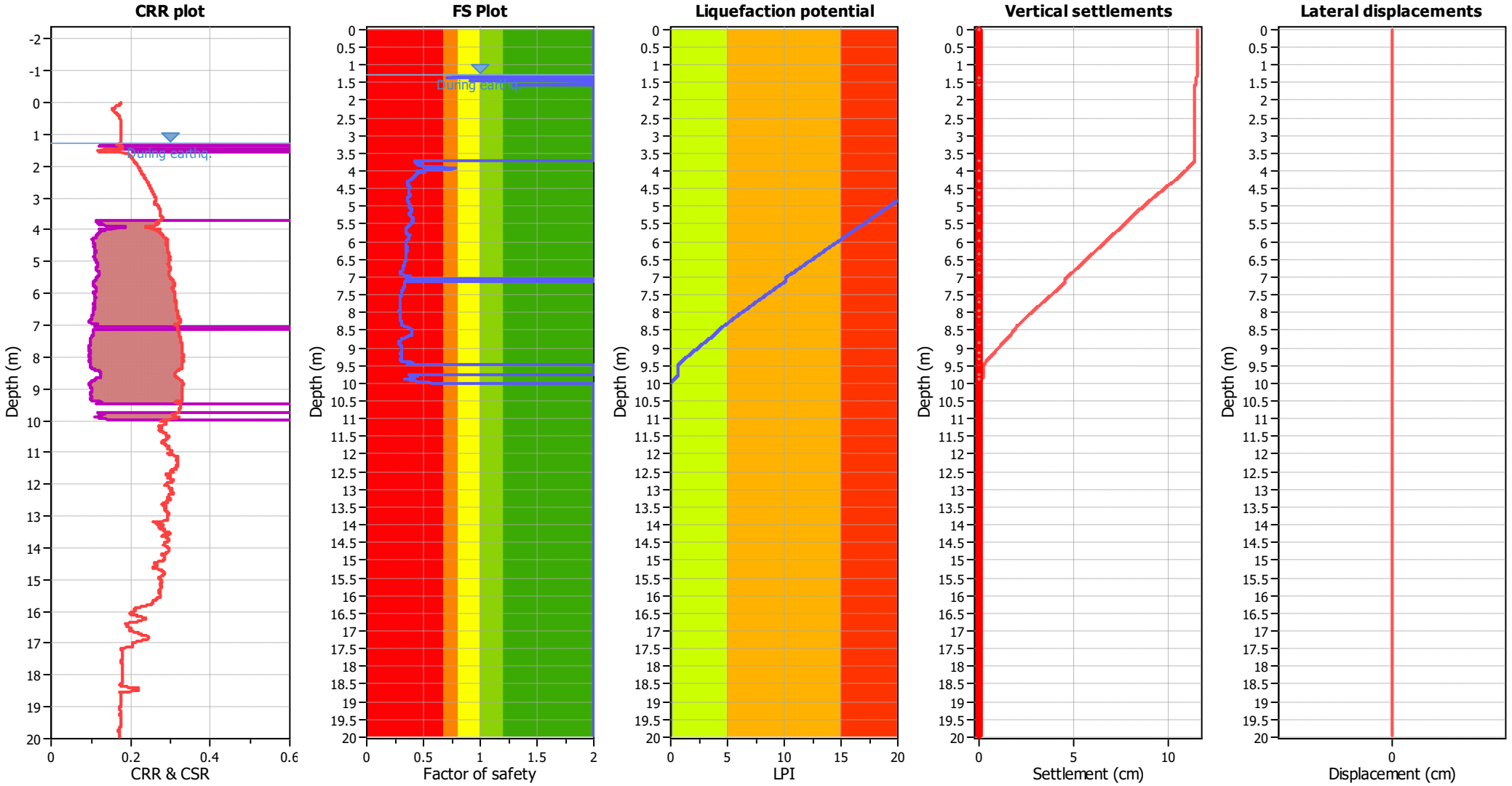
Input parameters and analysis data

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
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:	0.32	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.30 m	Fill height:	N/A	Limit depth:	10.00 m

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LPI color scheme

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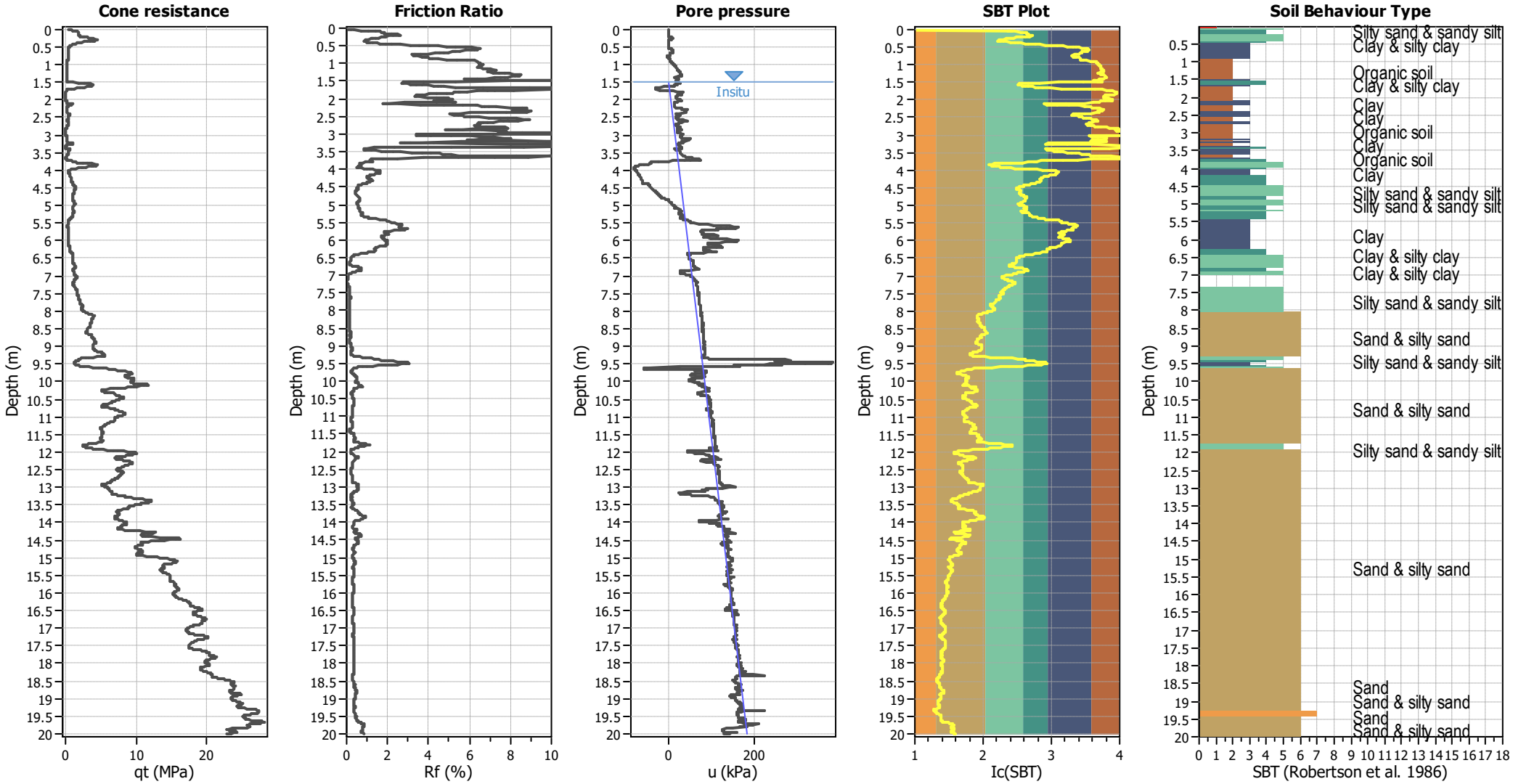
CPT basic interpretation plots



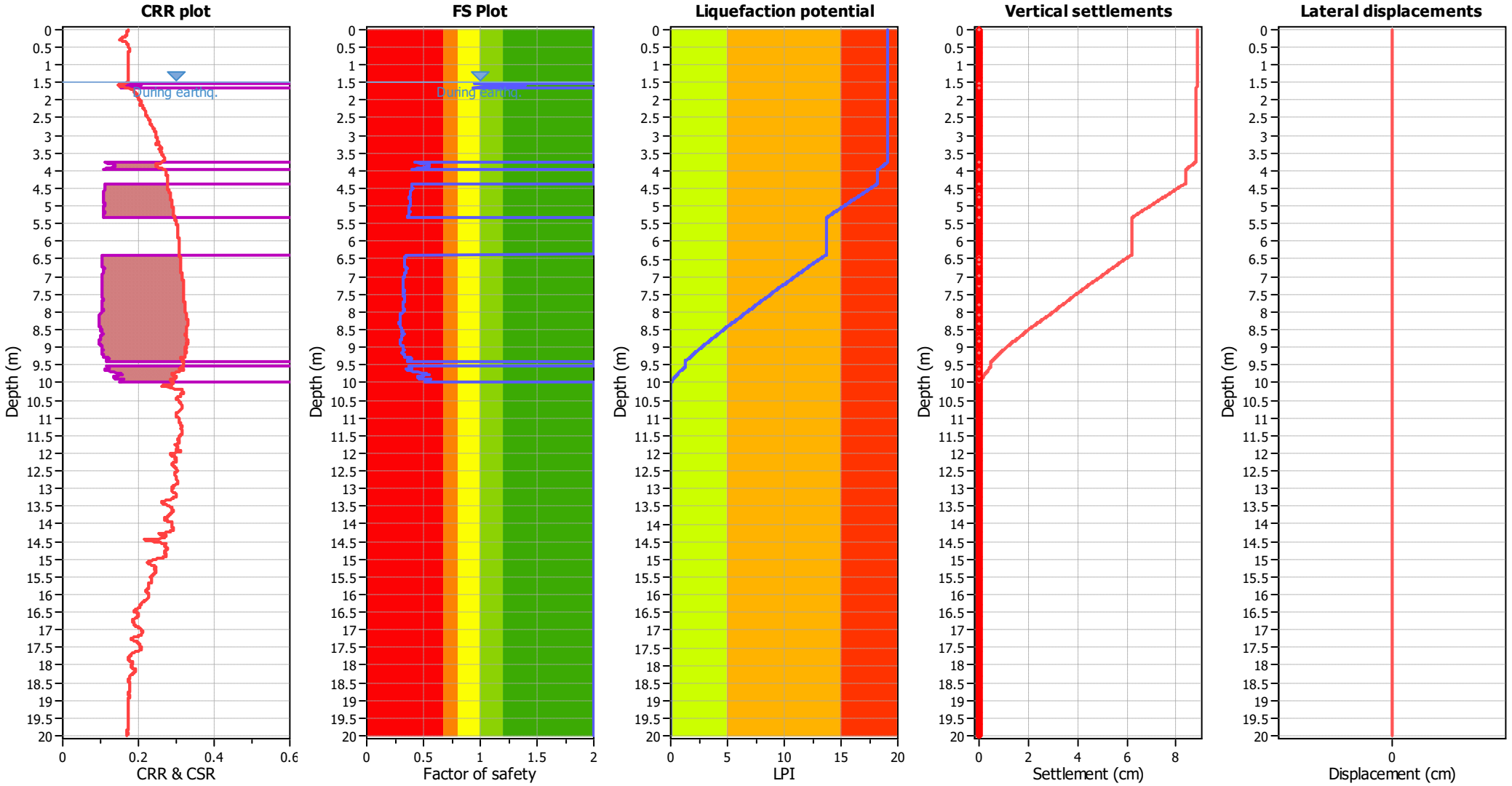
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	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

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LPI color scheme

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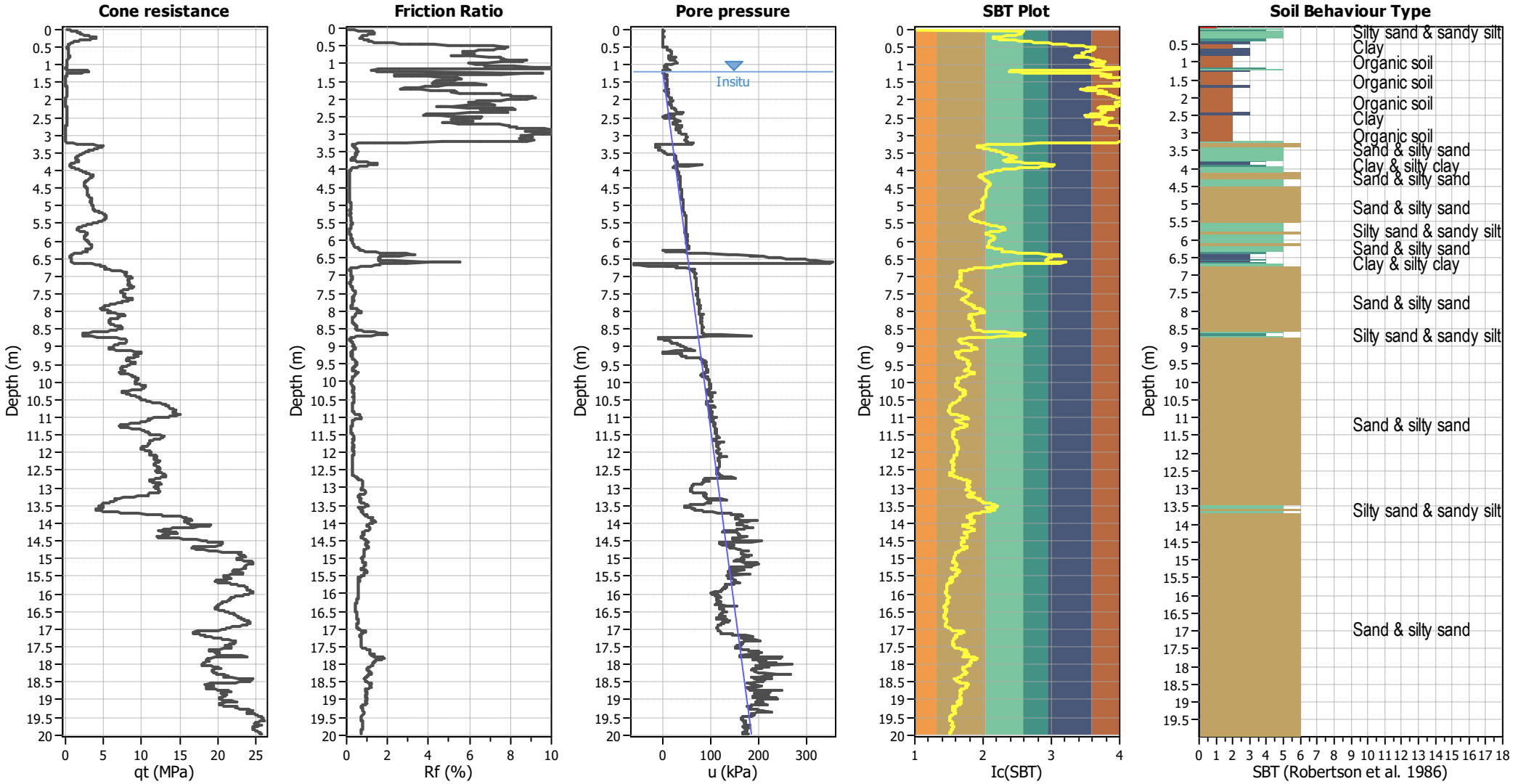
CPT basic interpretation plots



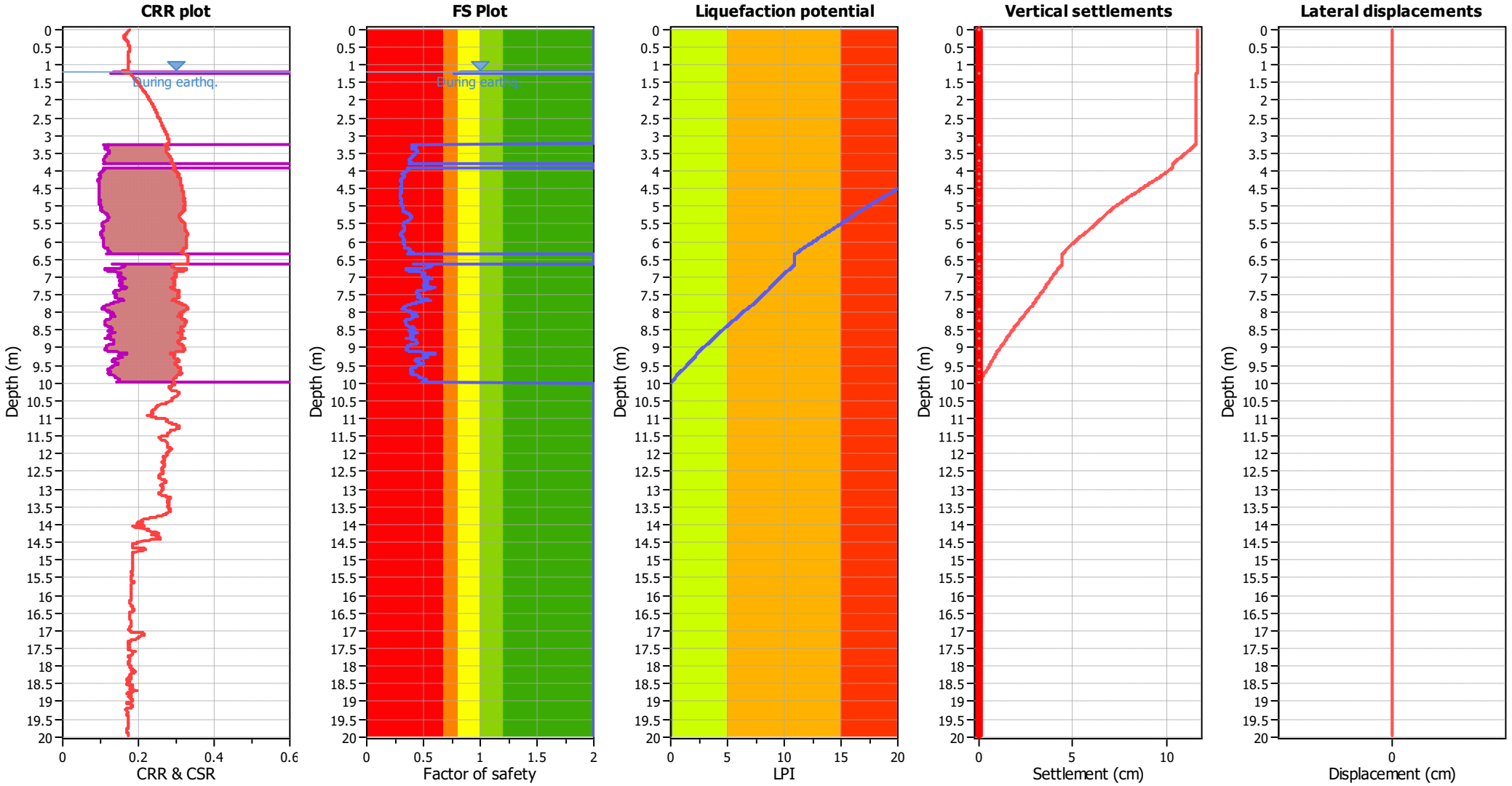
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	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

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LPI color scheme

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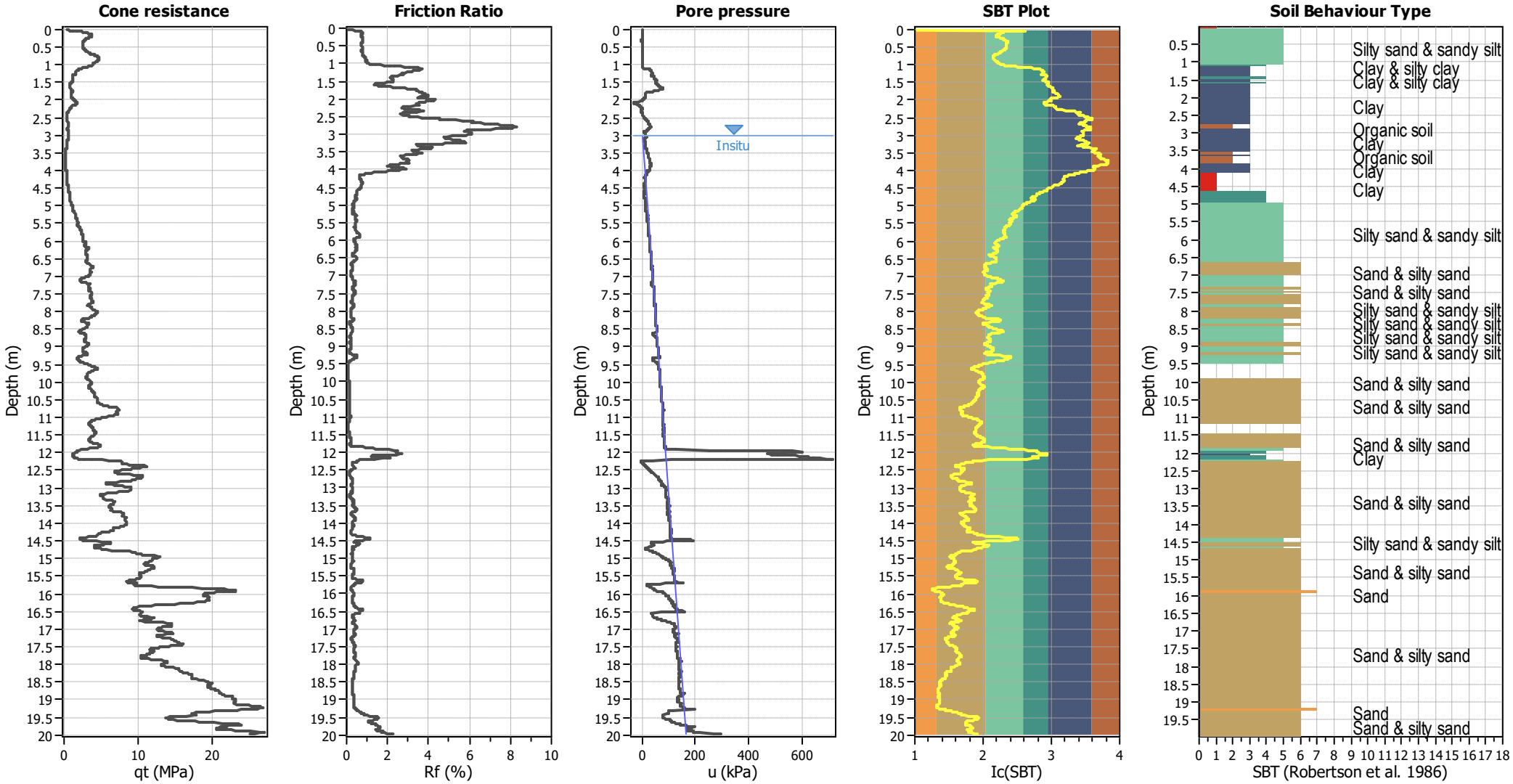
CPT basic interpretation plots



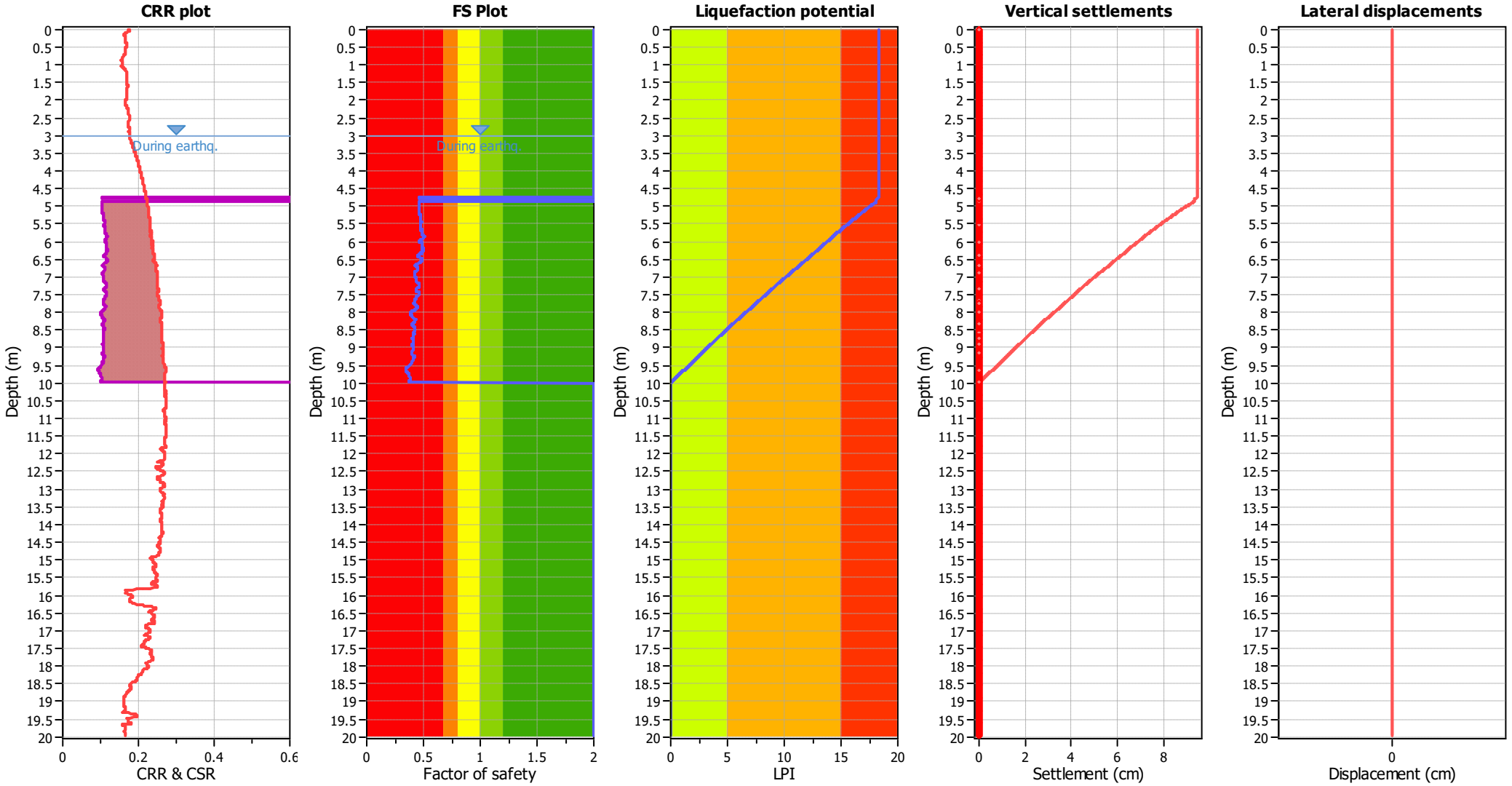
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	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

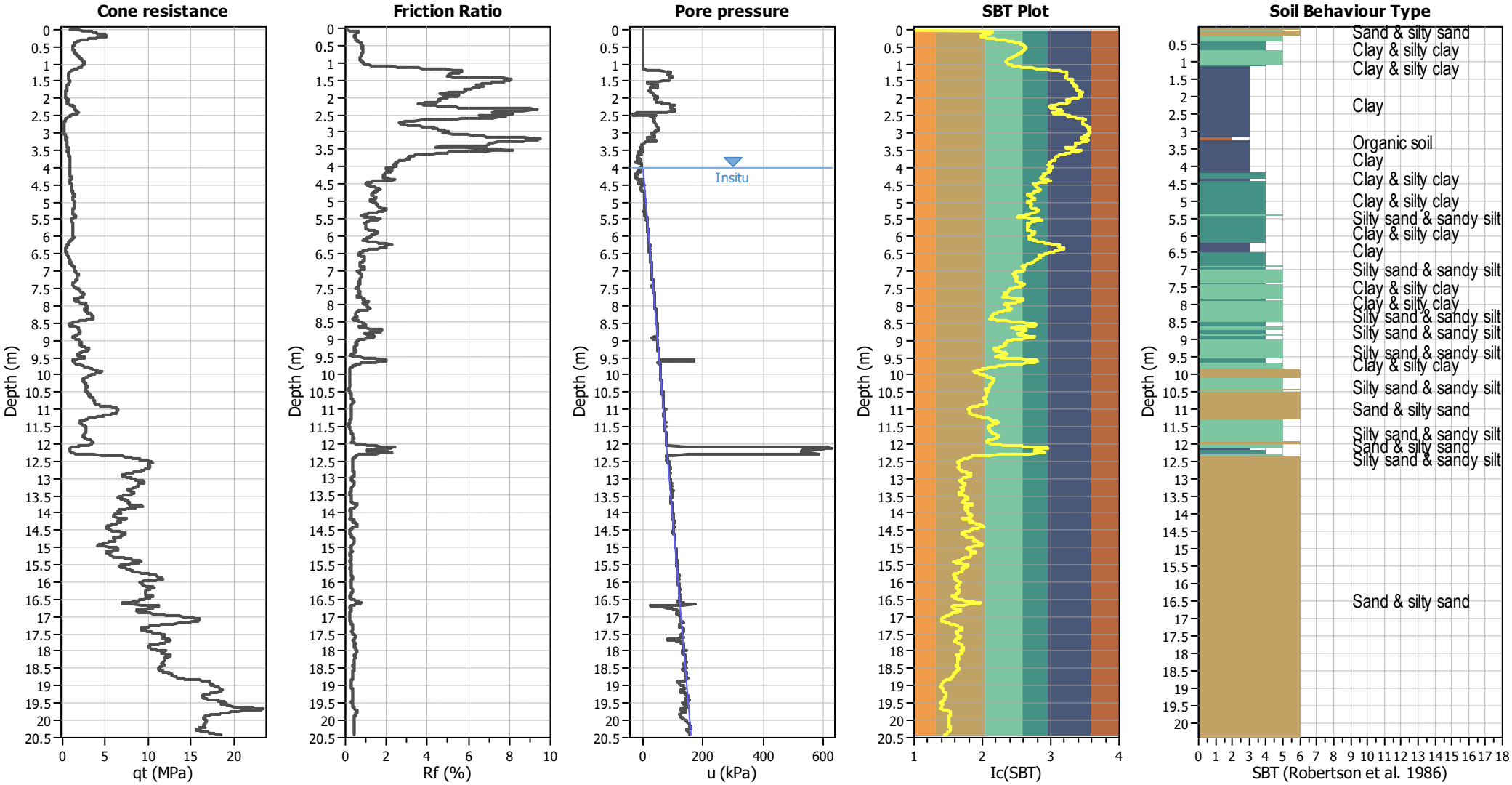
F.S. color scheme

- 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



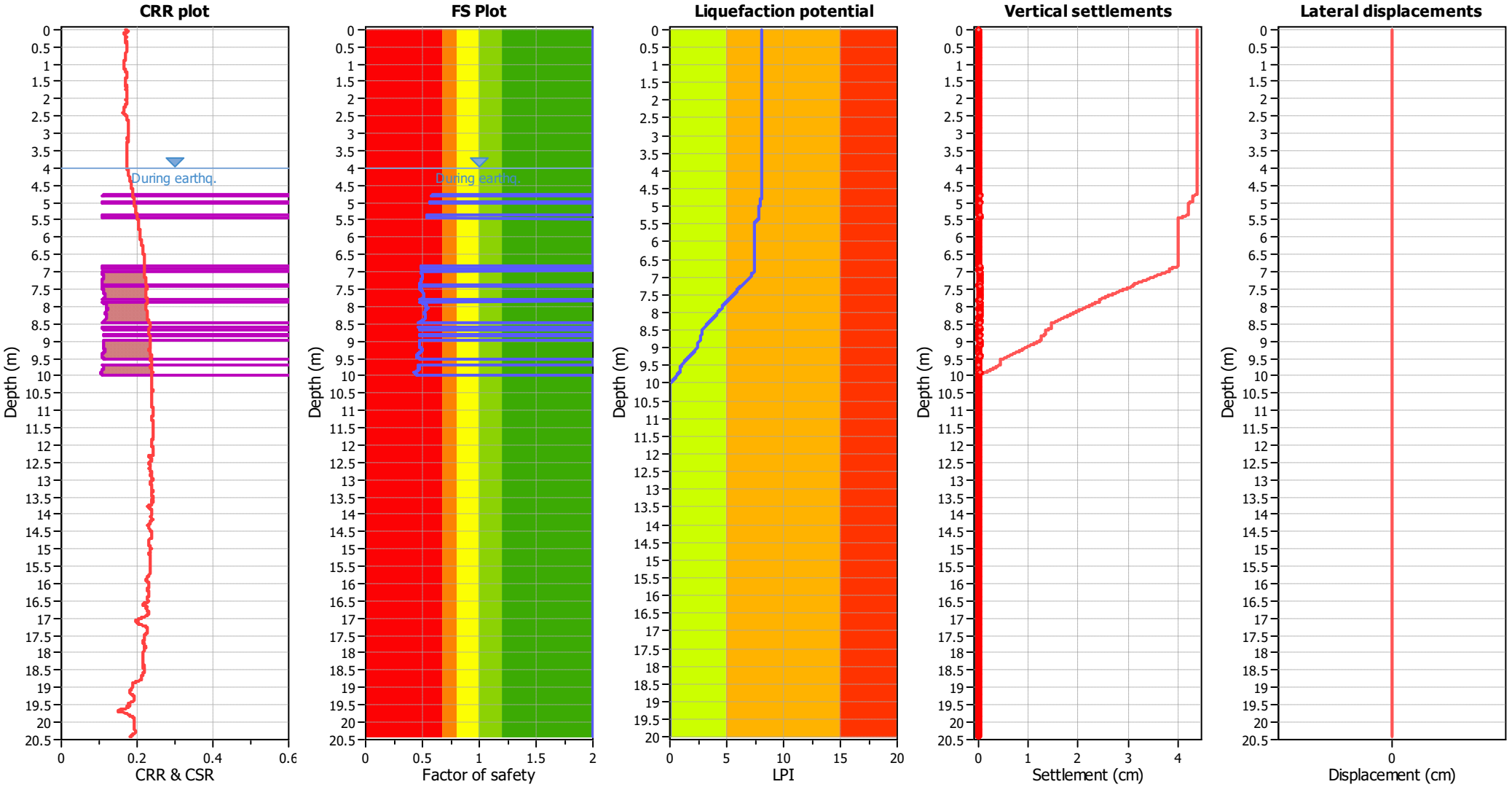
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.00 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

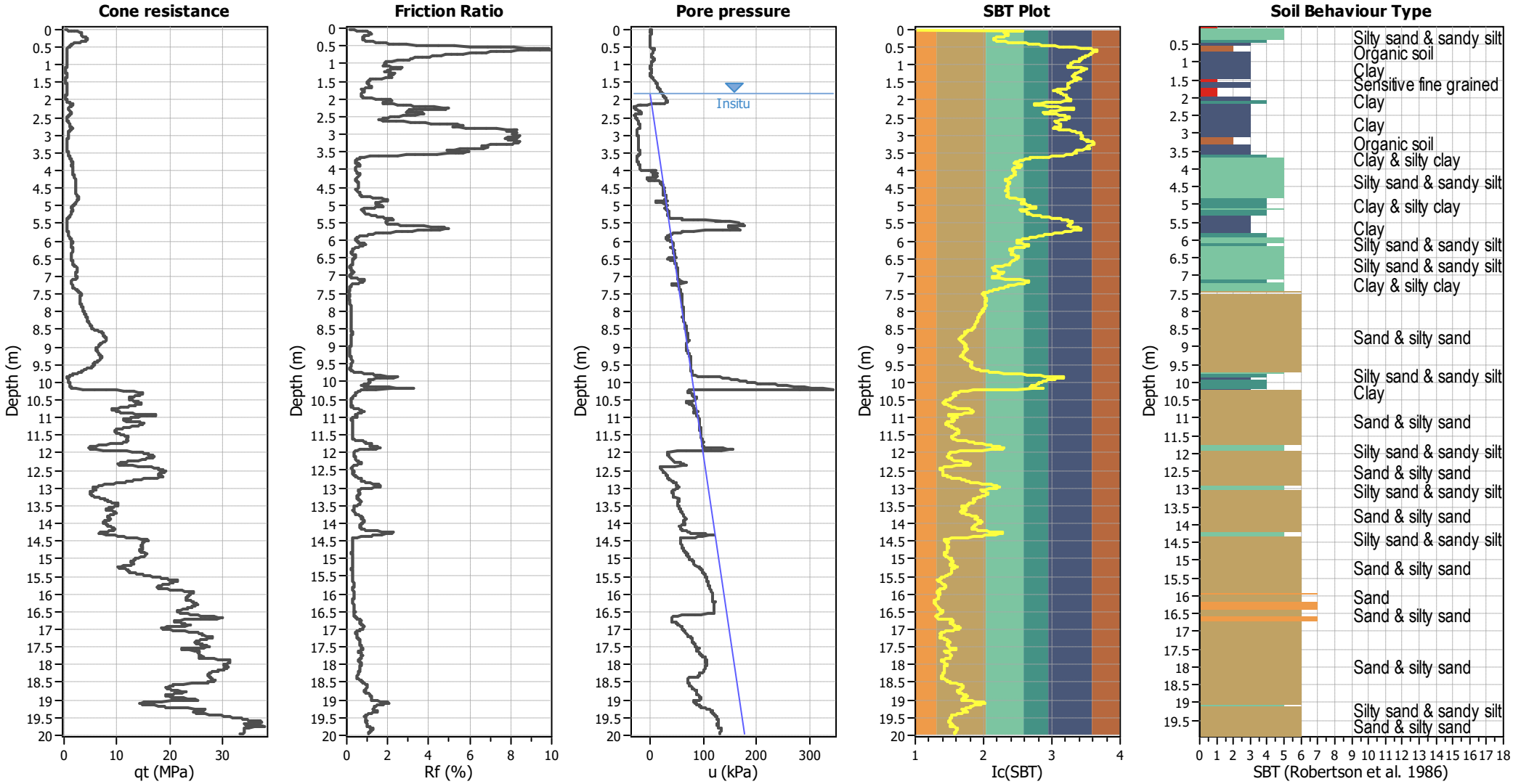
F.S. color scheme

- 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



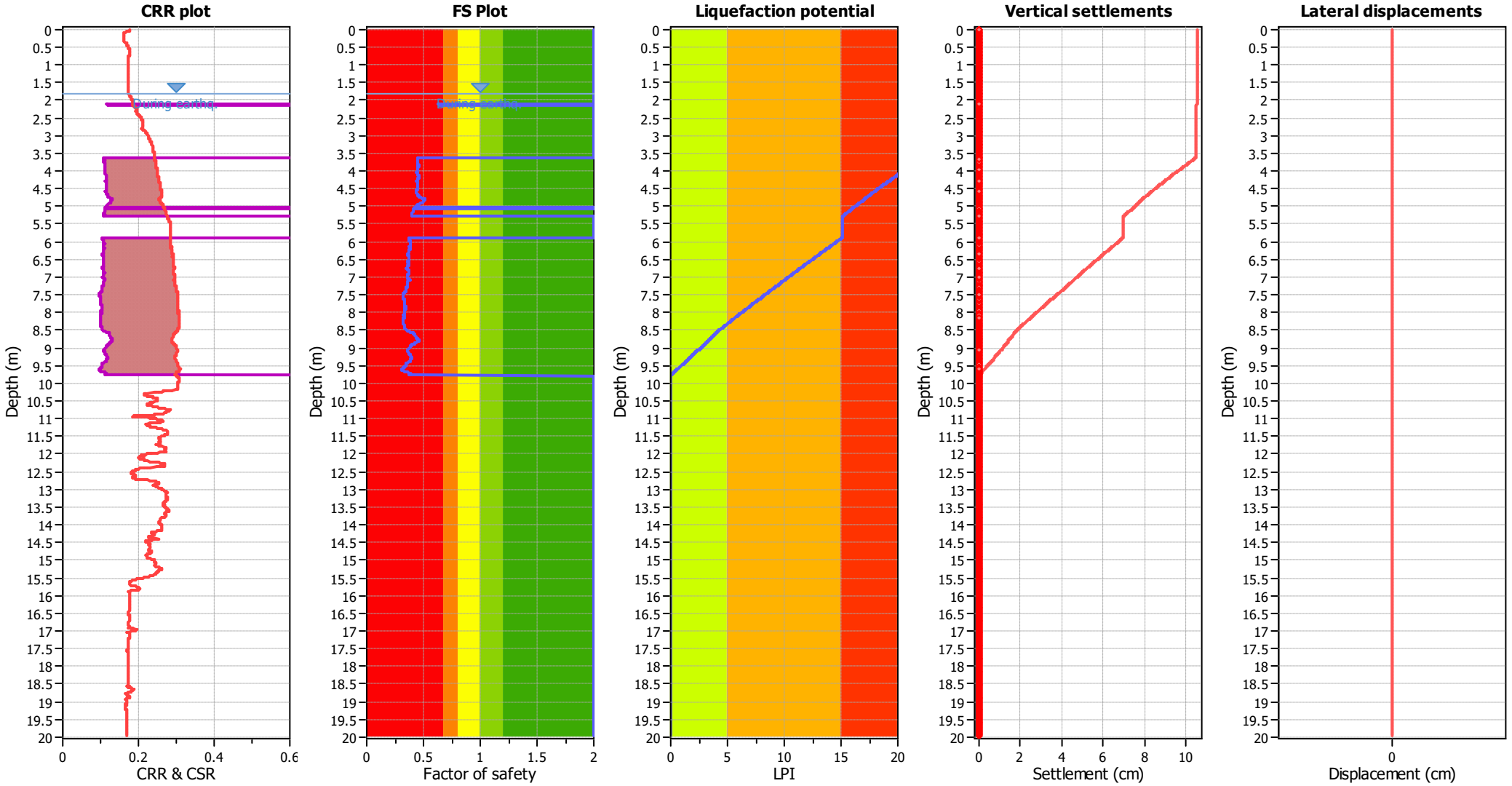
Input parameters and analysis data

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:	0.32	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

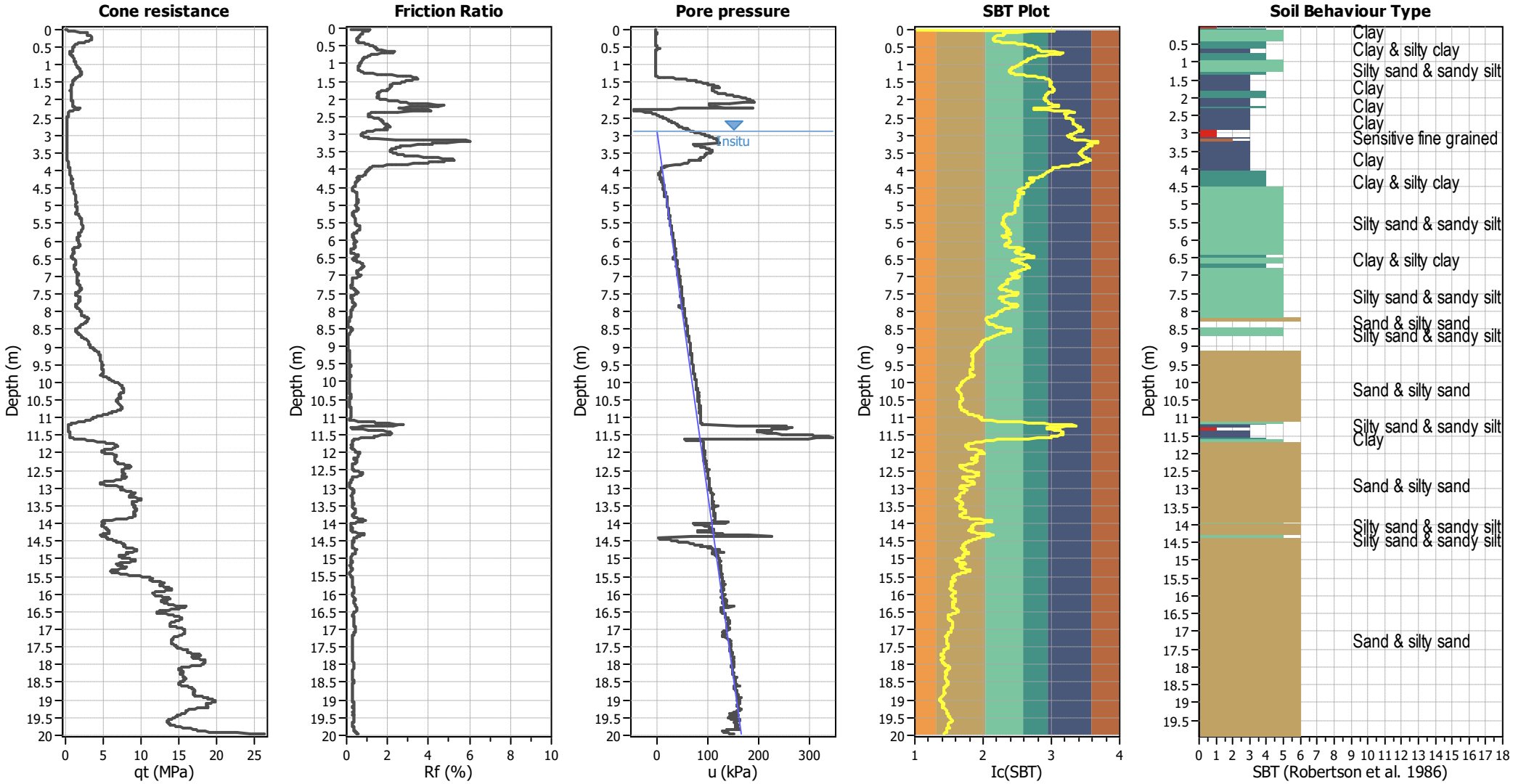
F.S. color scheme

- 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



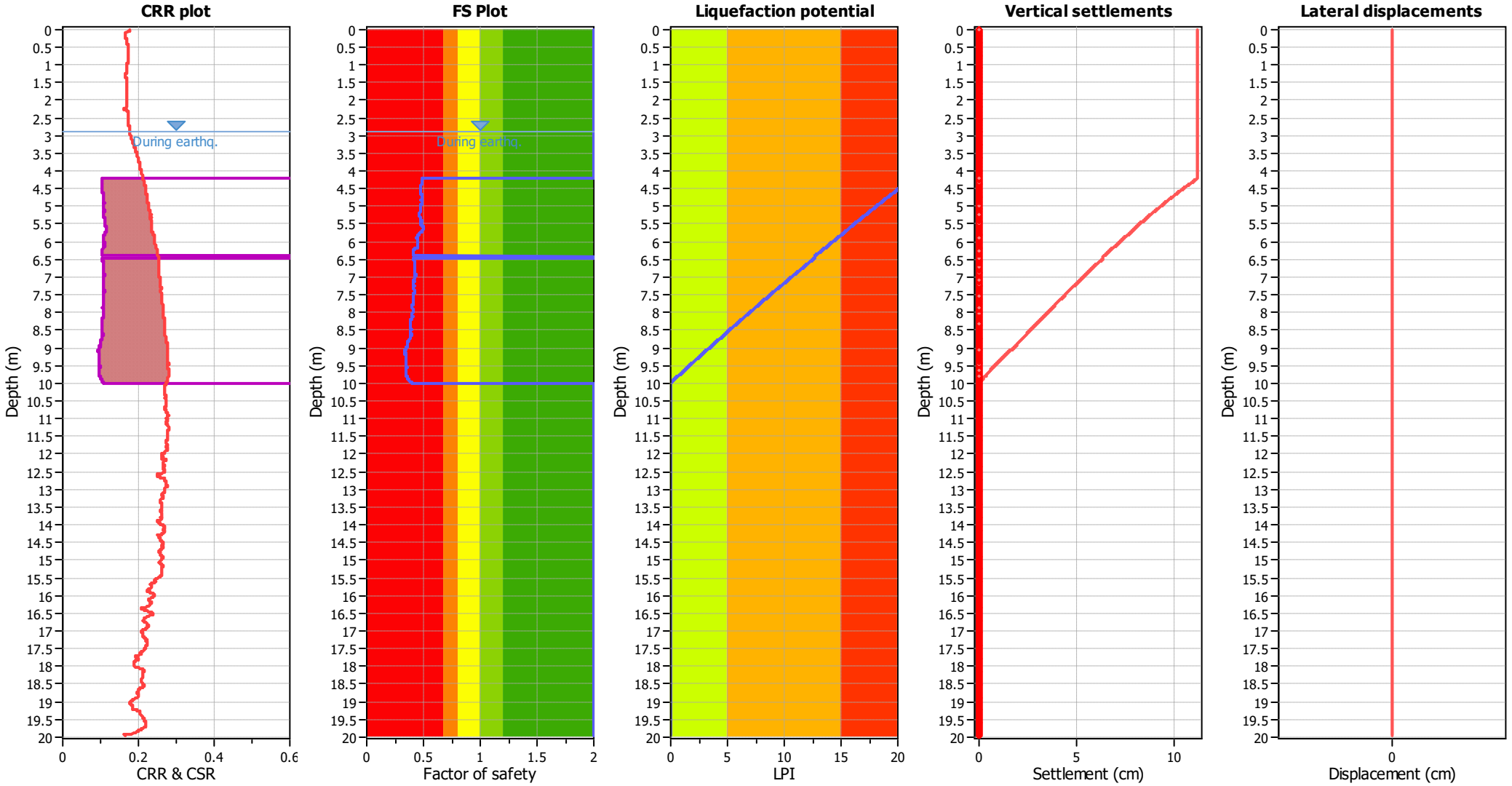
Input parameters and analysis data

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:	0.32	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	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:	0.32	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.90 m	Fill height:	N/A	Limit depth:	10.00 m

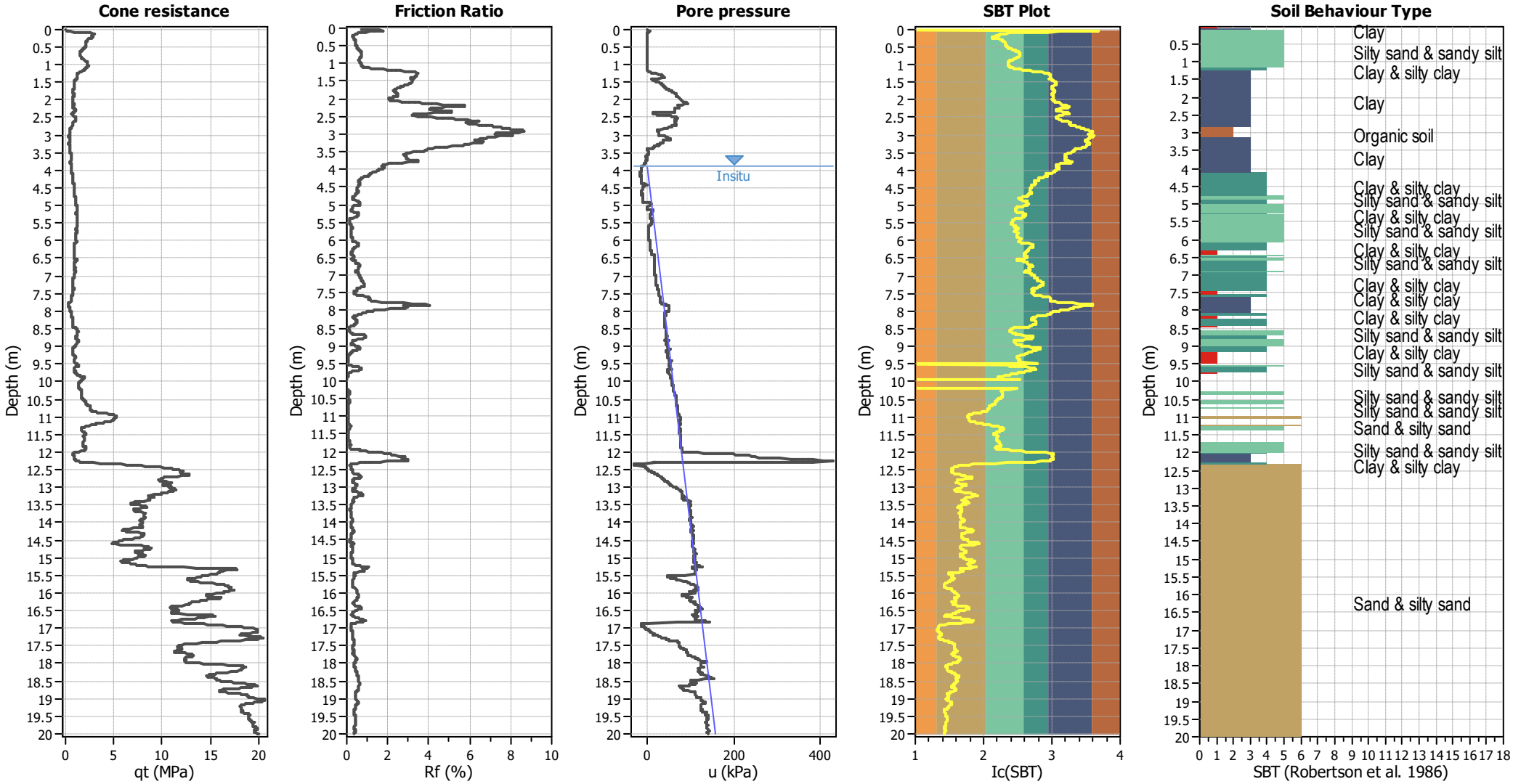
F.S. color scheme

- 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



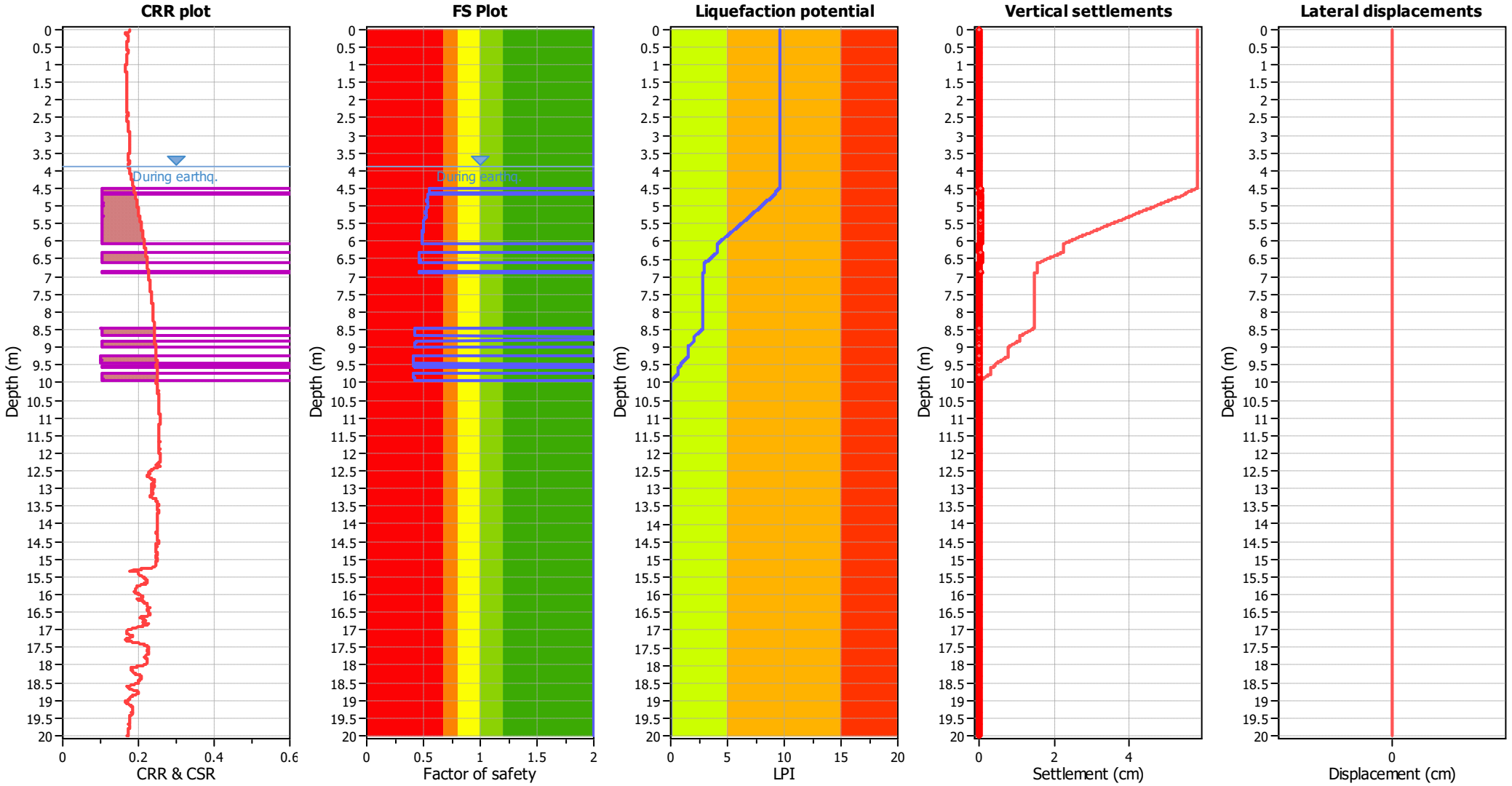
Input parameters and analysis data

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:	0.32	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
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.):	3.90 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

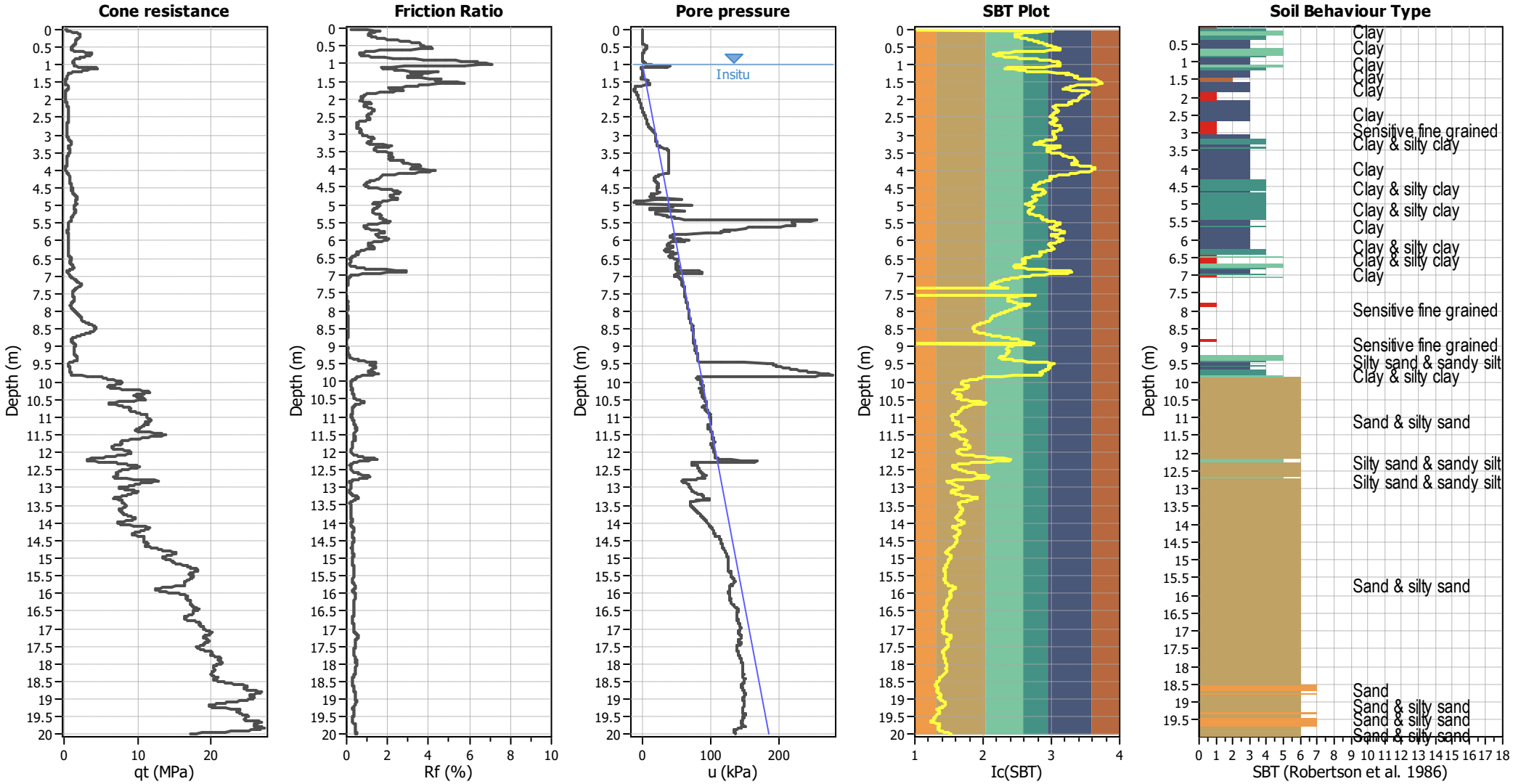
F.S. color scheme

- 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



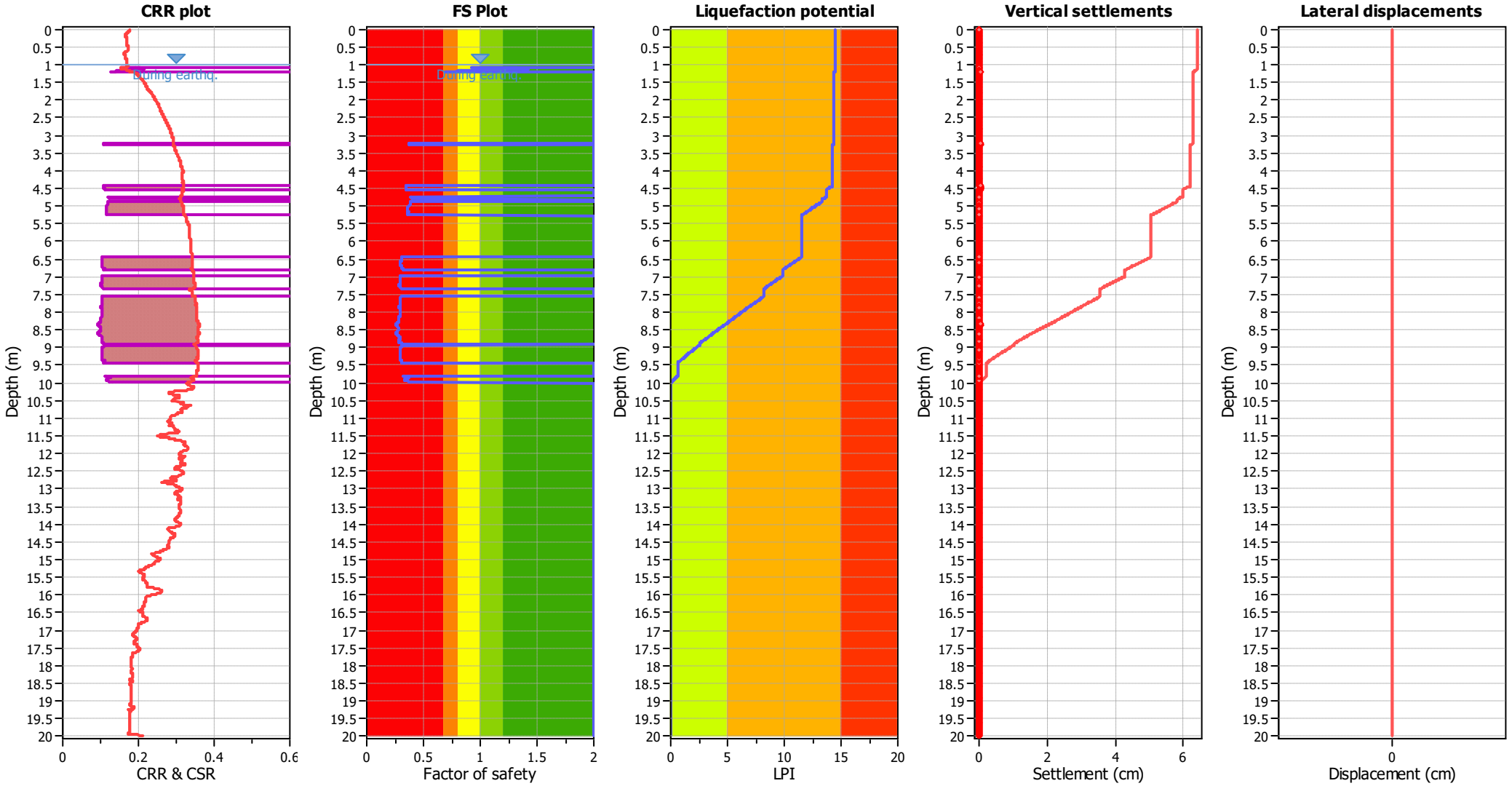
Input parameters and analysis data

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

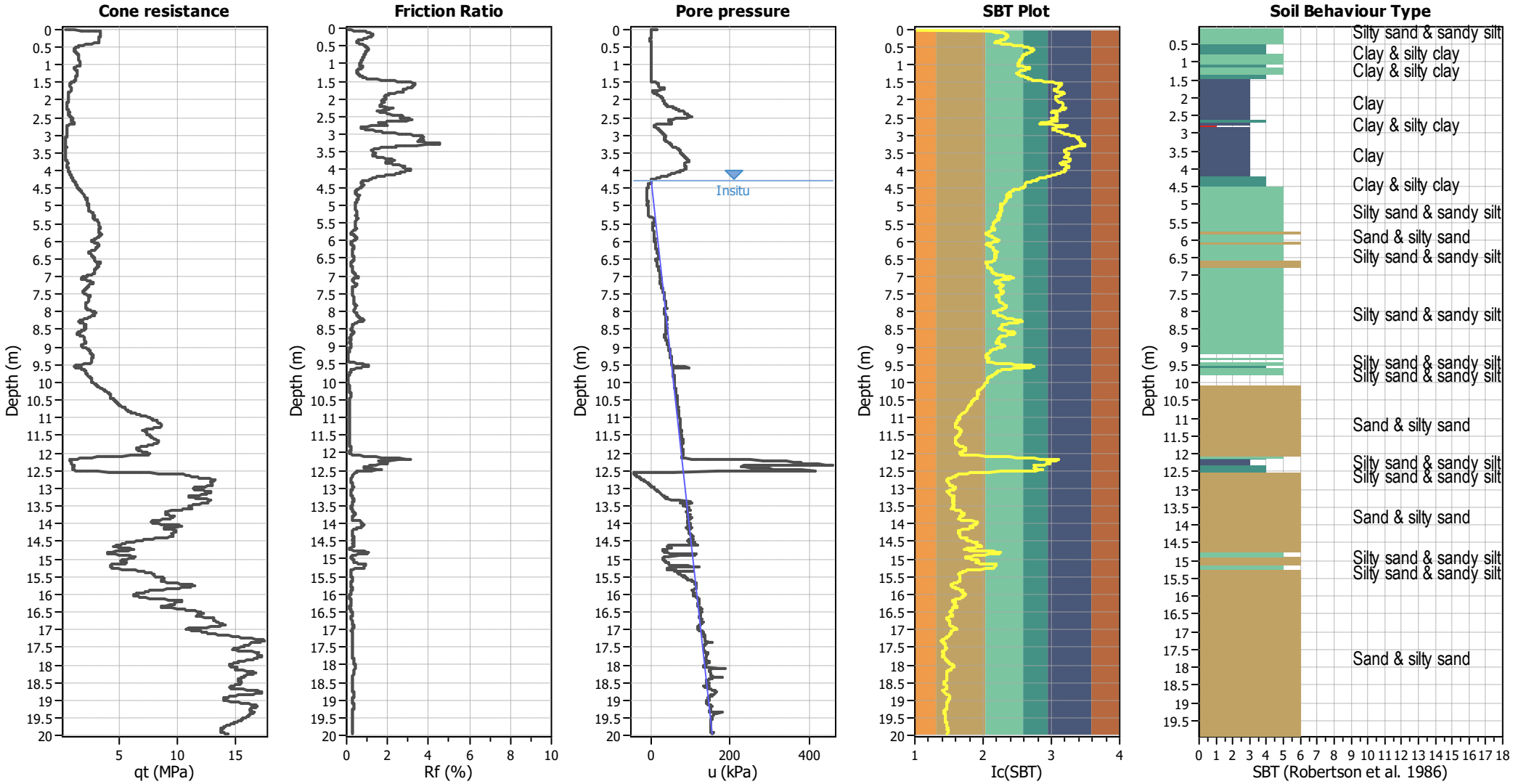
F.S. color scheme

- 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



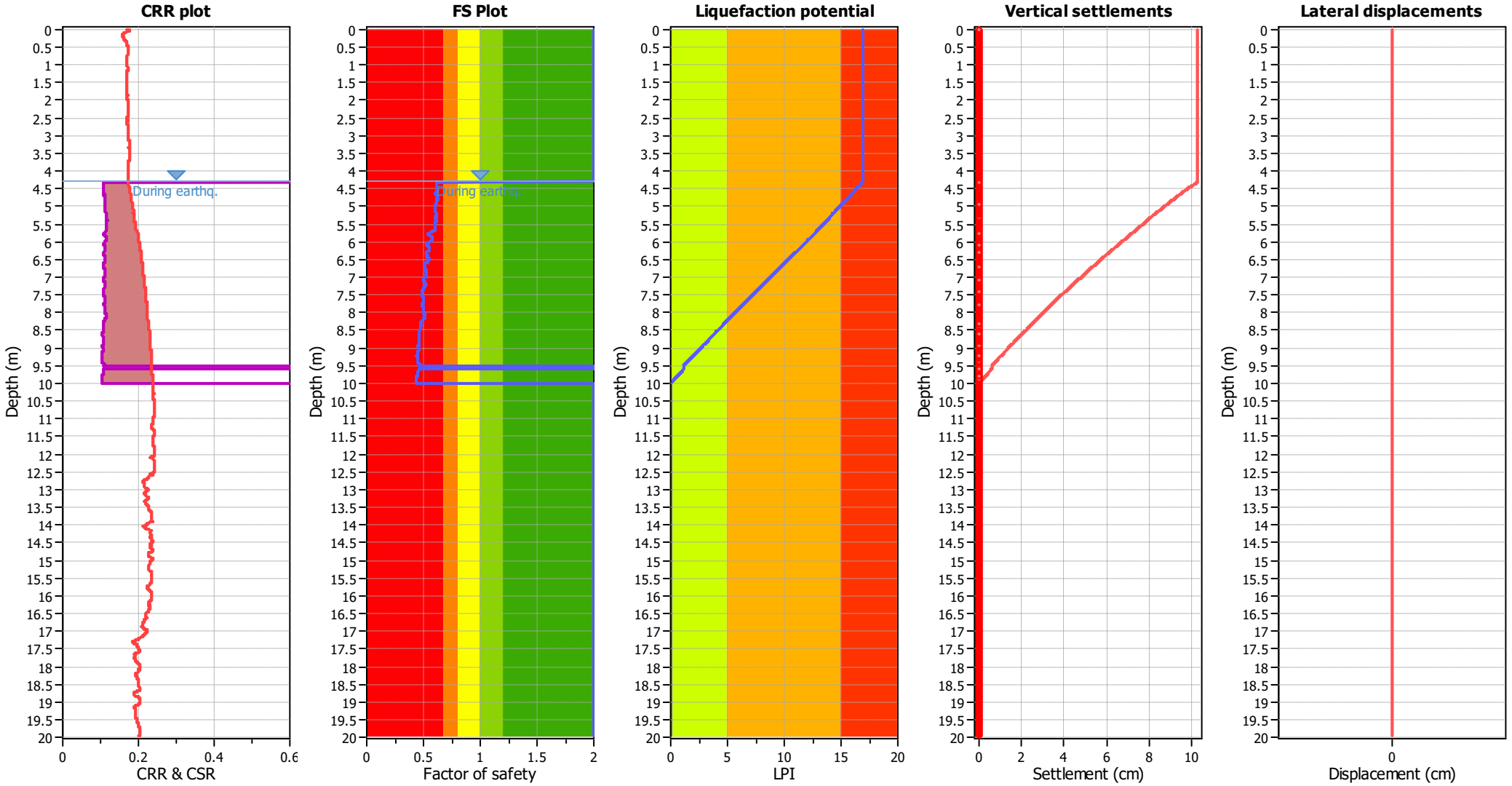
Input parameters and analysis data

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
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.):	4.30 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

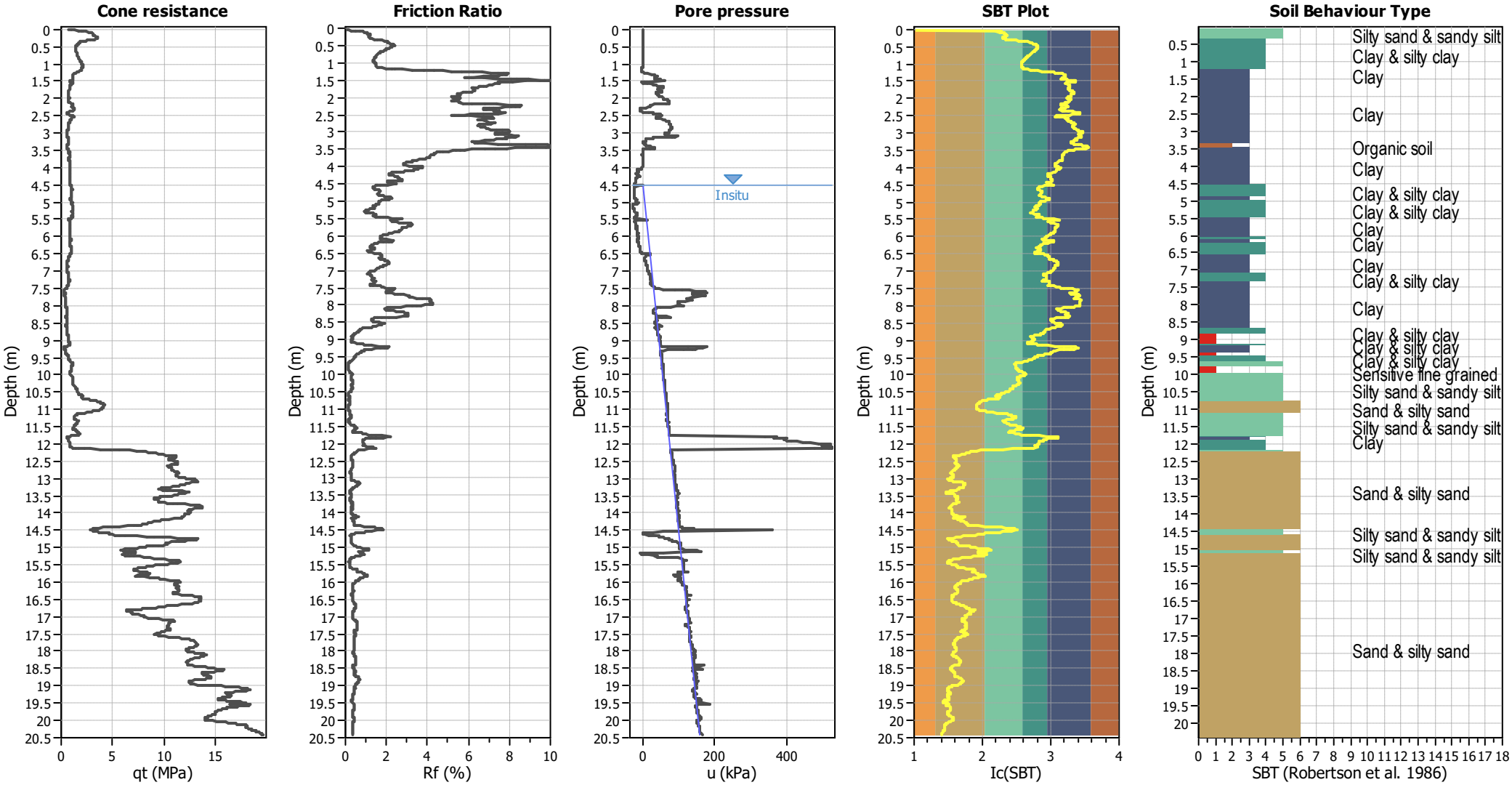
F.S. color scheme

- 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



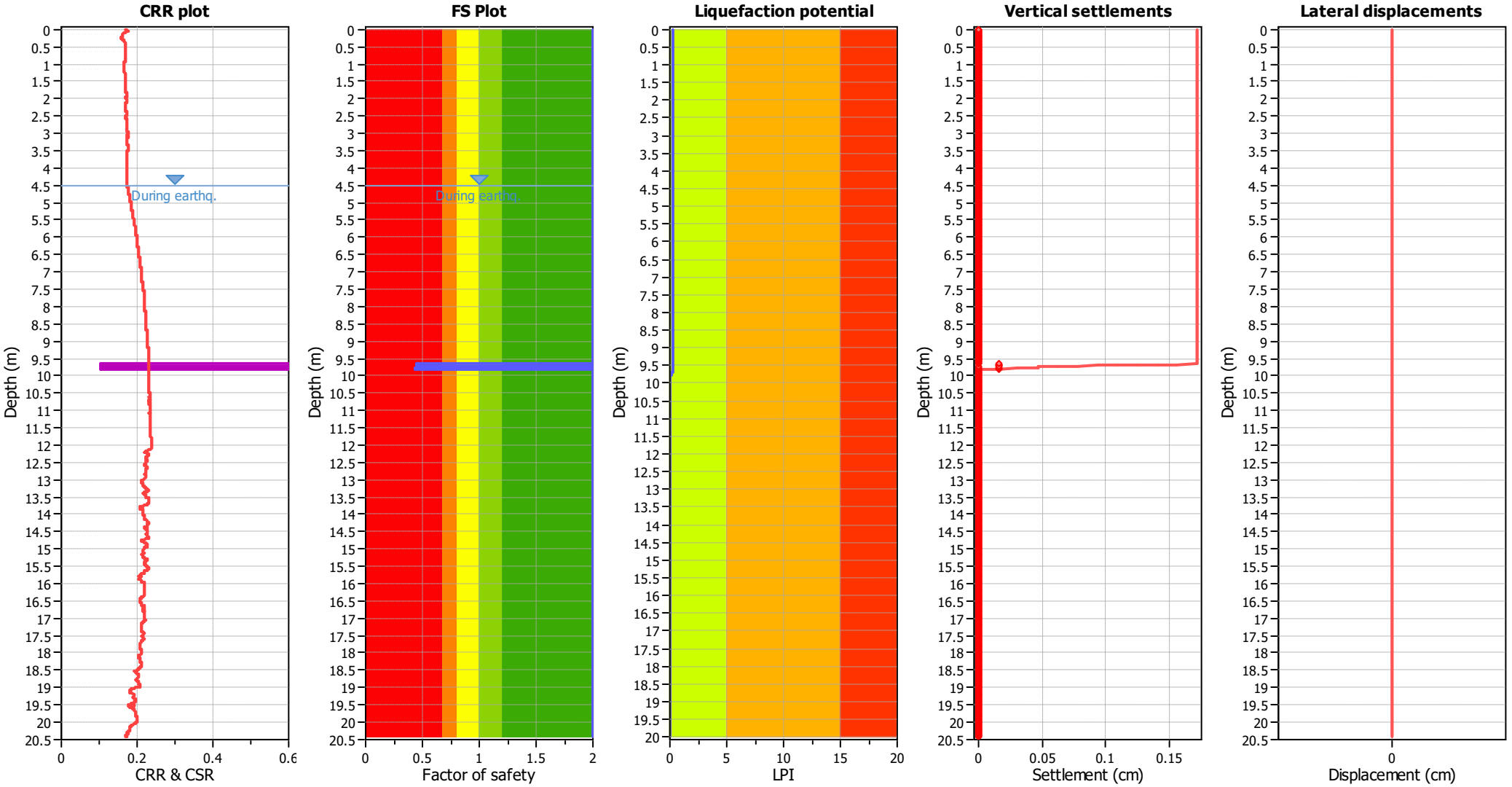
Input parameters and analysis data

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
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:	0.32	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

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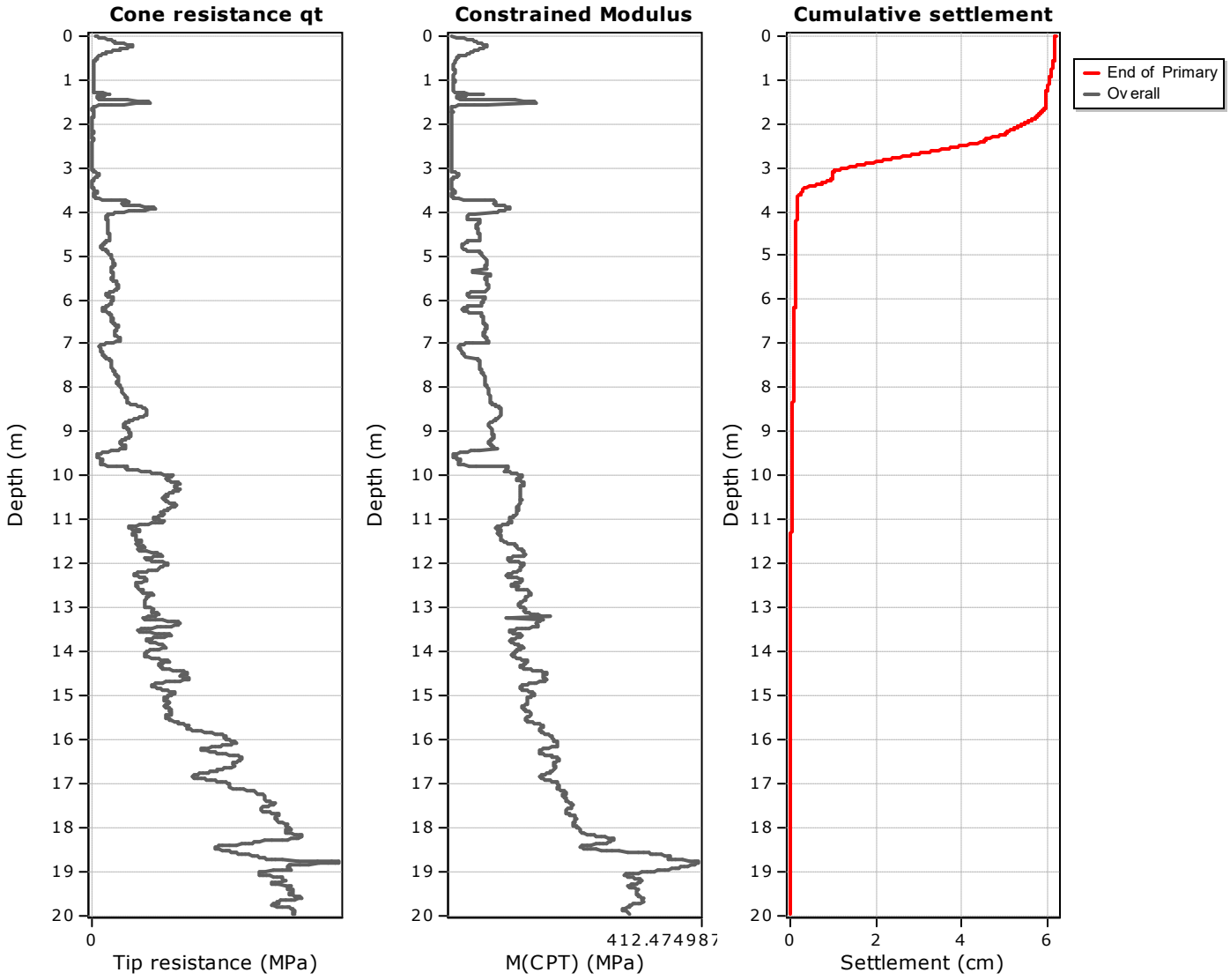
CPT: CPT01
Total depth: 19.96 m, Date: 24/01/2022
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

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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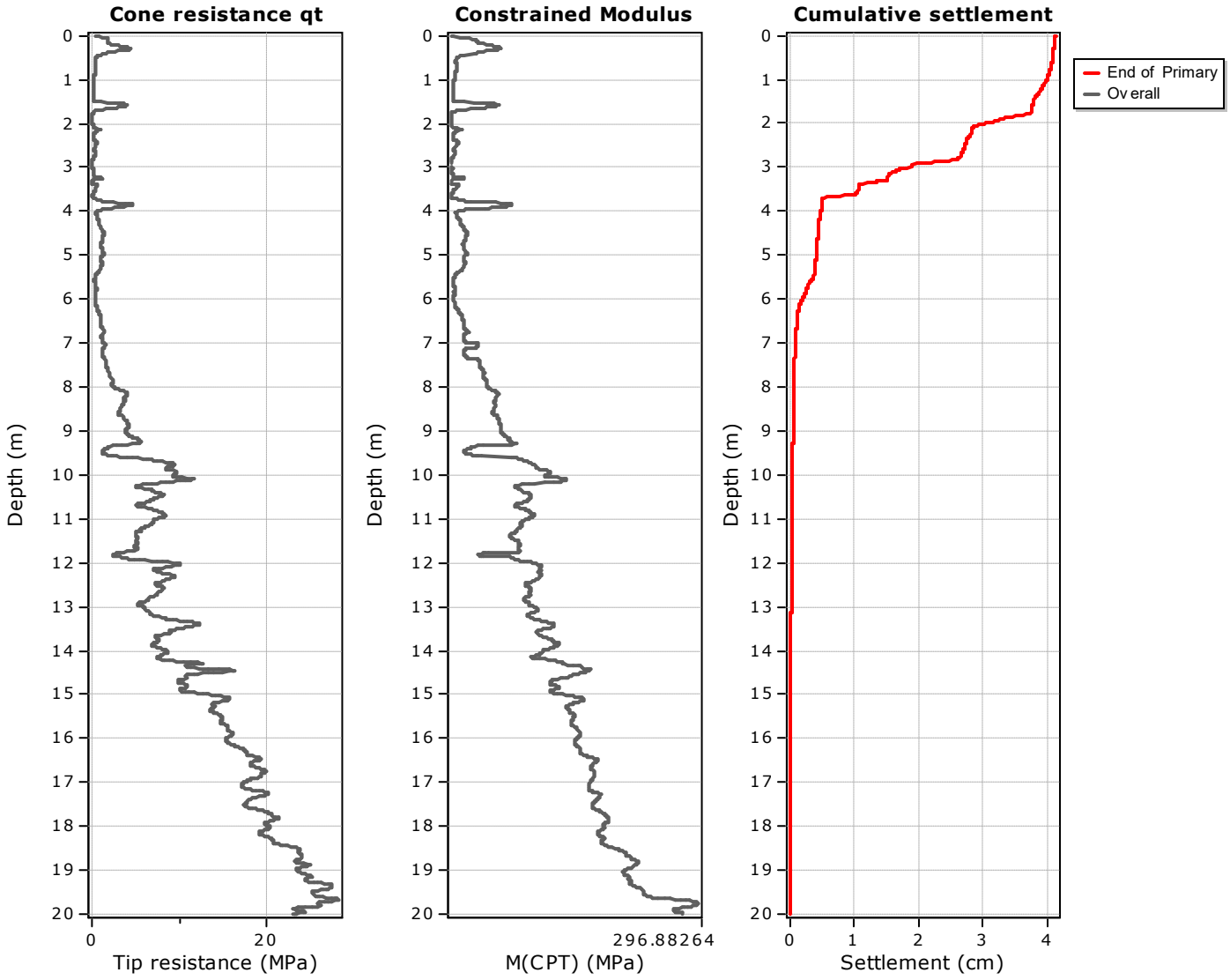
http://www.geologismiki.gr

CPT: CPT02
Total depth: 20.00 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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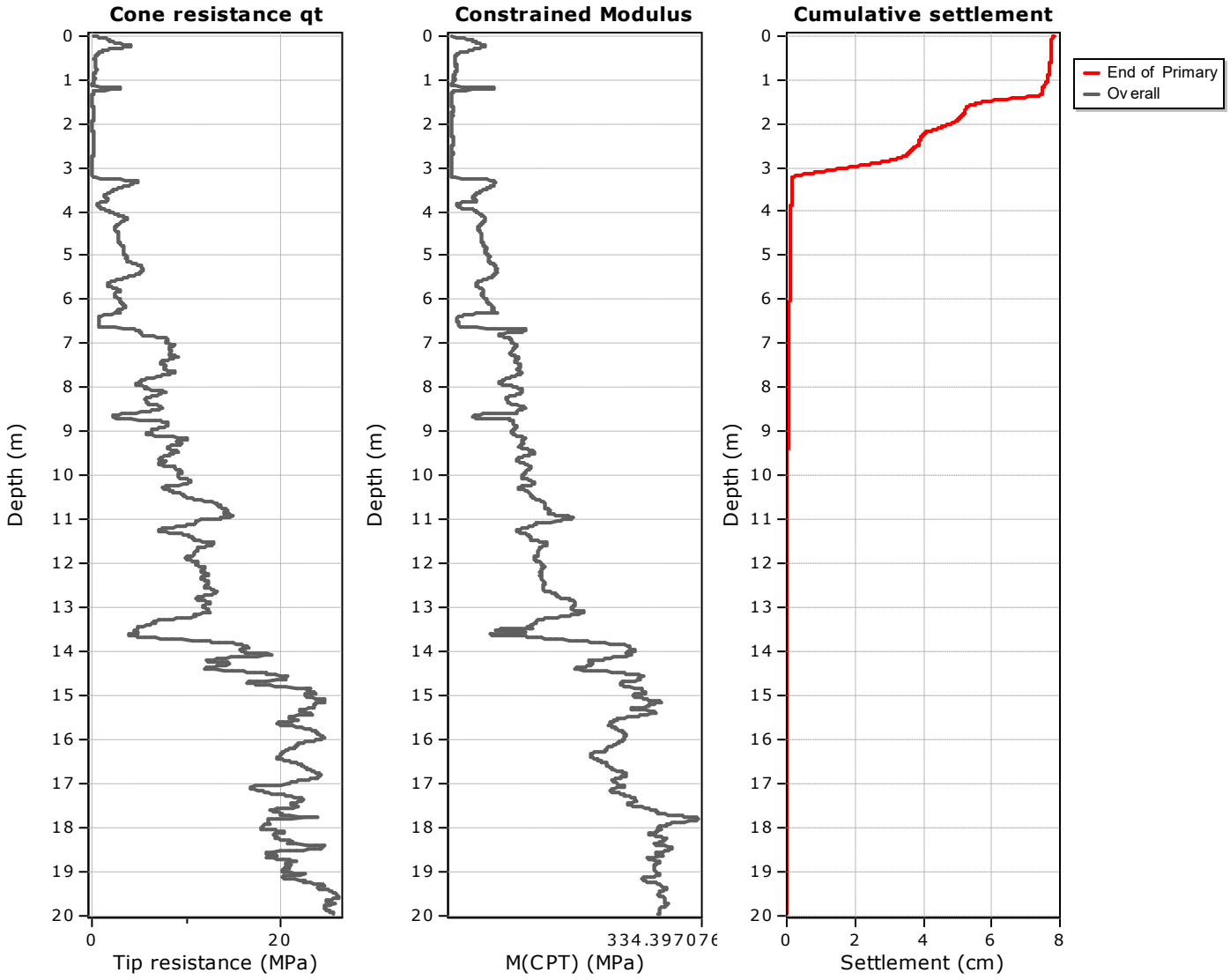
CPT: CPT03
Total depth: 19.97 m, Date: 24/01/2022
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

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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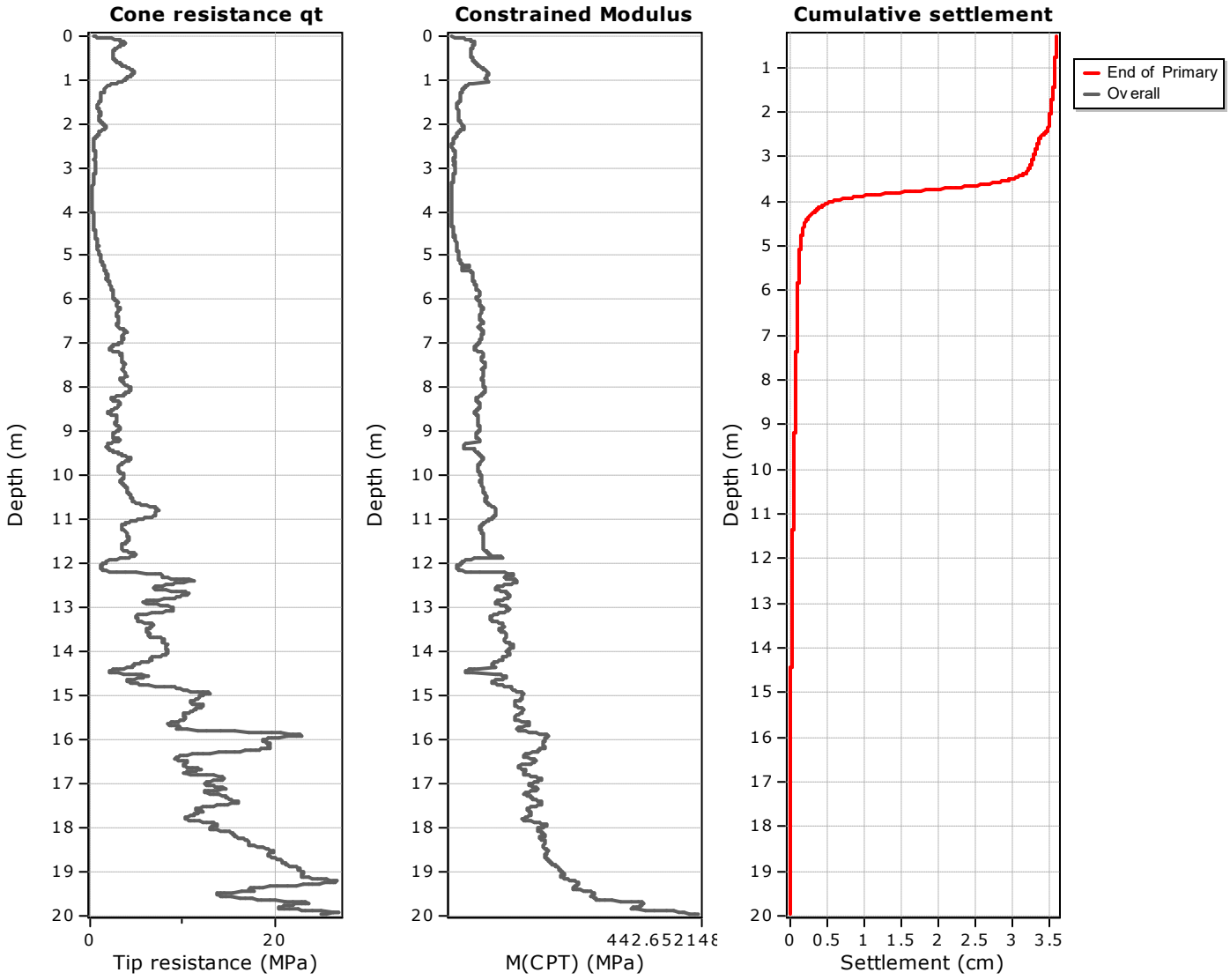
CPT: CPT04
Total depth: 19.97 m, Date: 24/01/2022
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

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:

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

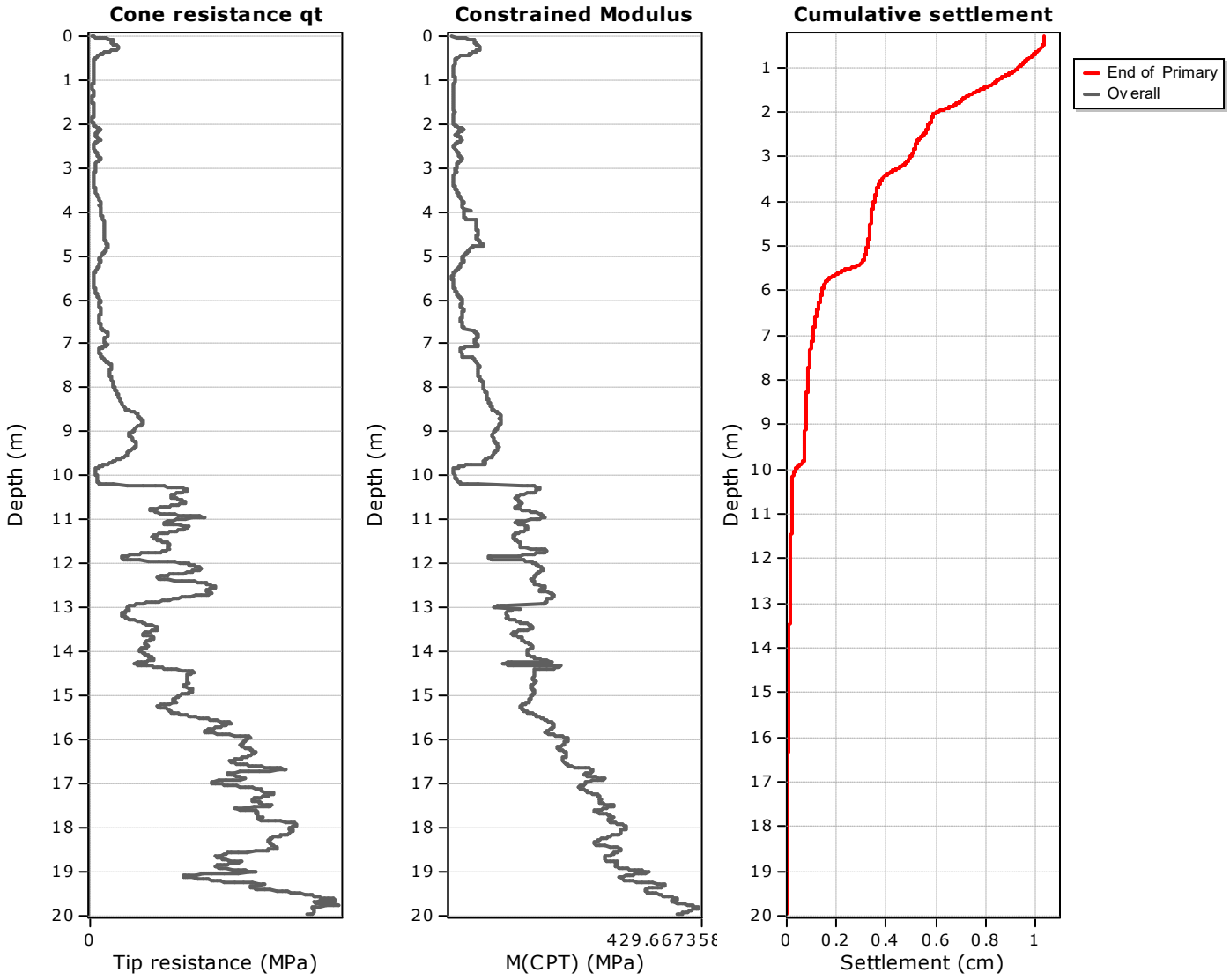
where t_p is the duration of primary consolidation

GeoLogismiki
Geotechnical Engineers
Merarhias 56
http://www.geologismiki.gr

CPT: CPT06
Total depth: 19.96 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:

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

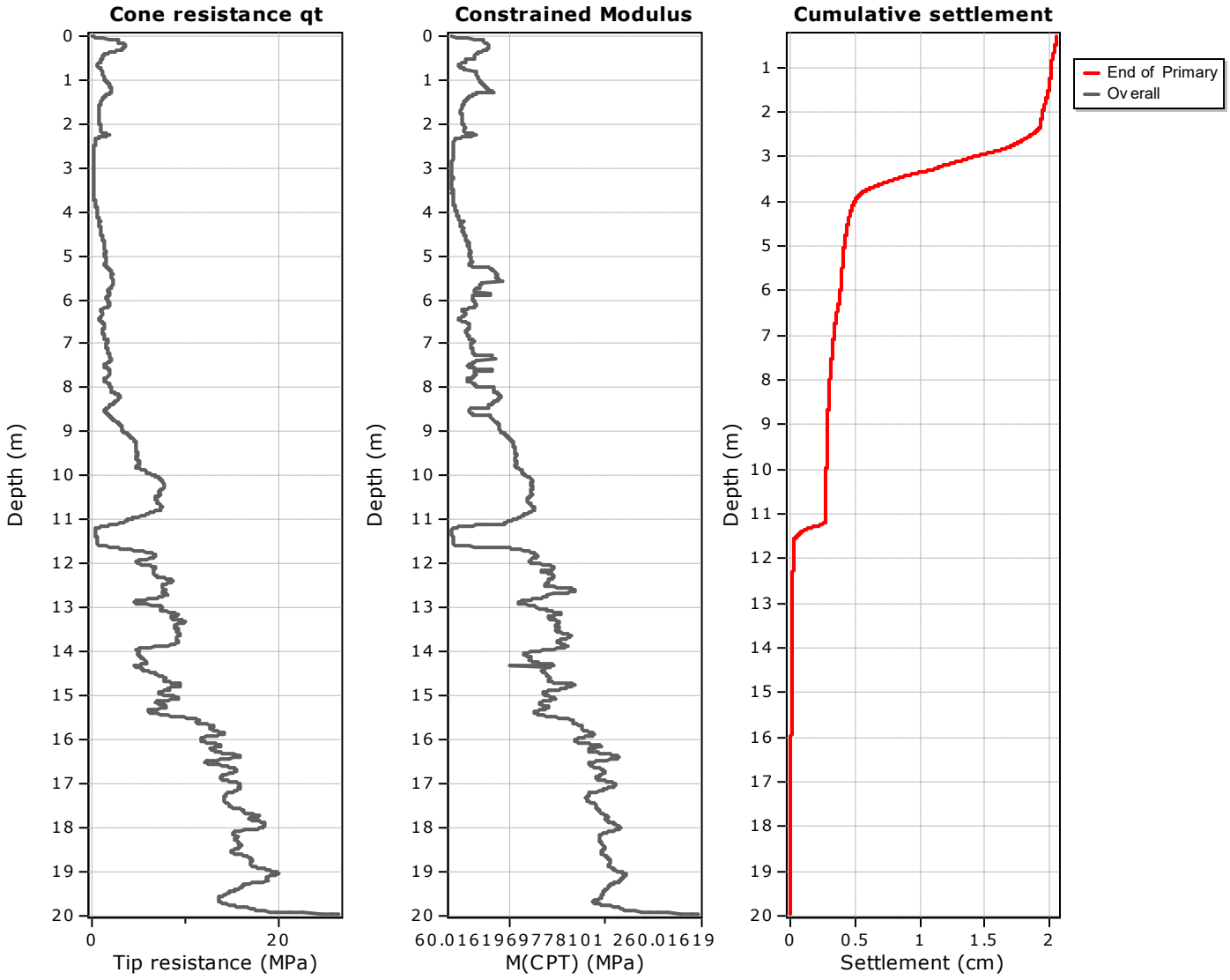
where t_p is the duration of primary consolidation

GeoLogismiki
Geotechnical Engineers
Merarhias 56
http://www.geologismiki.gr

CPT: CPT07
Total depth: 19.96 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:

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

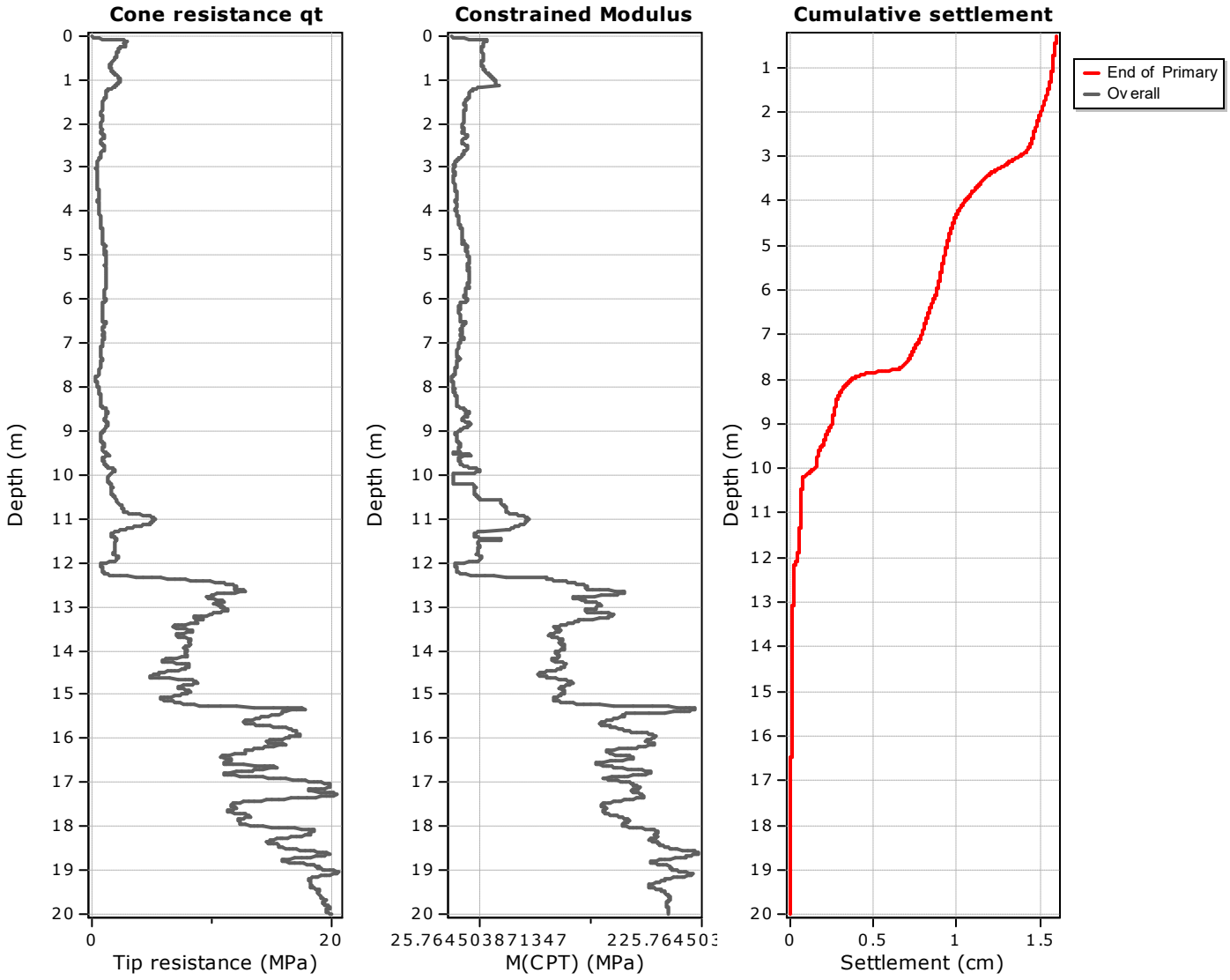
where t_p is the duration of primary consolidation

GeoLogismiki
Geotechnical Engineers
Merarhias 56
http://www.geologismiki.gr

CPT: CPT08
Total depth: 20.00 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

GeoLogismiki
Geotechnical Engineers
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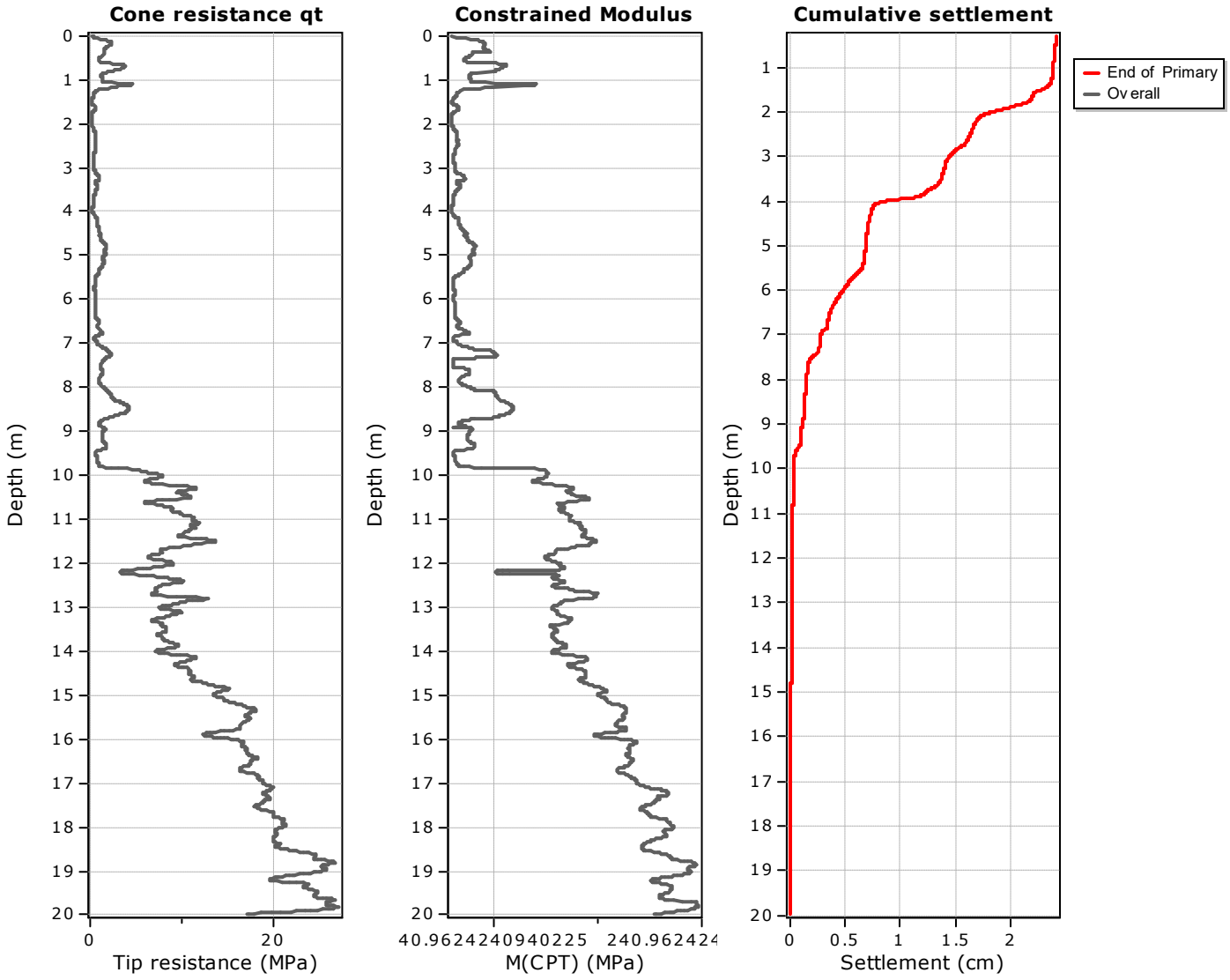
http://www.geologismiki.gr

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:

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

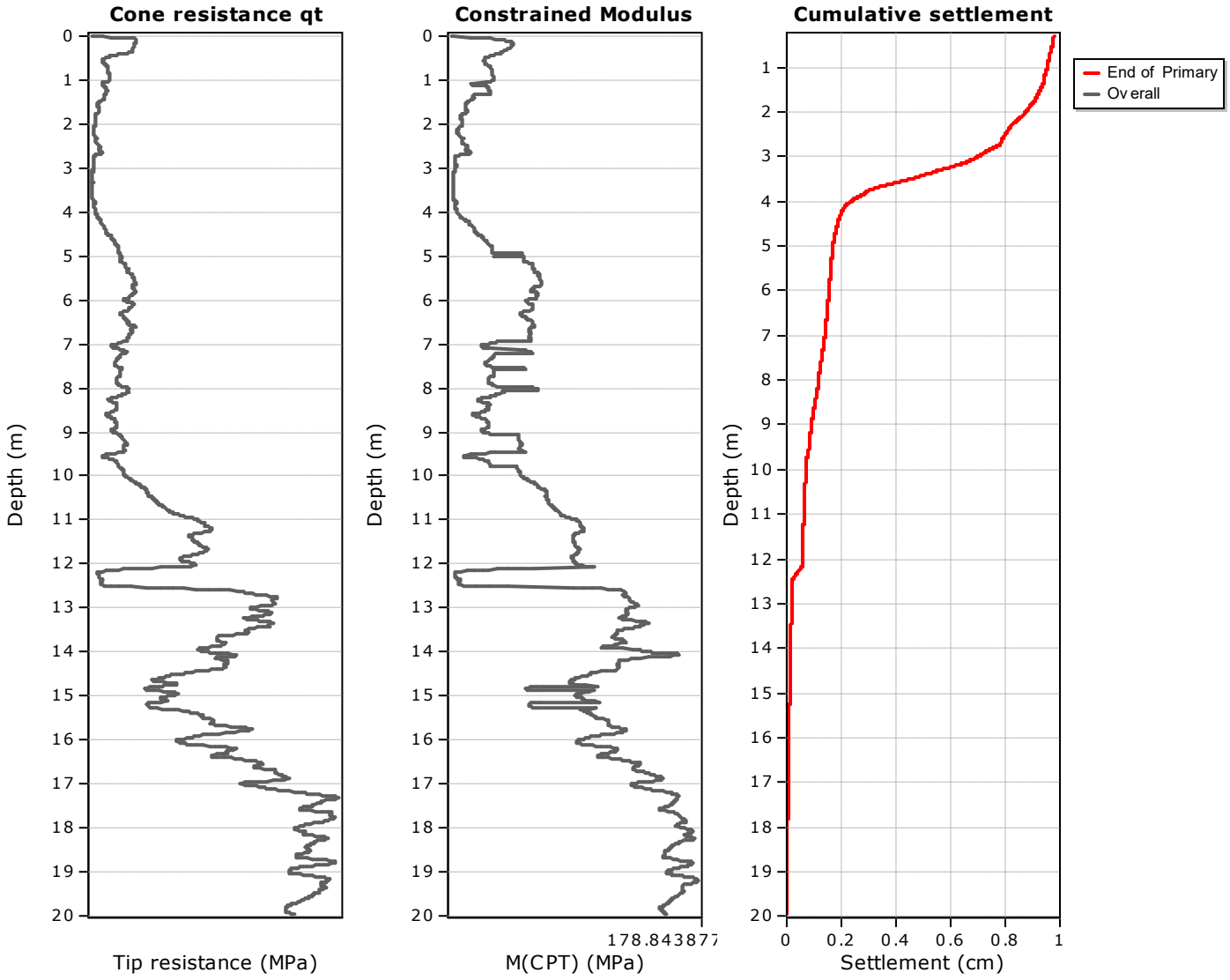
where t_p is the duration of primary consolidation

GeoLogismiki
Geotechnical Engineers
Merarhias 56
http://www.geologismiki.gr

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:

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

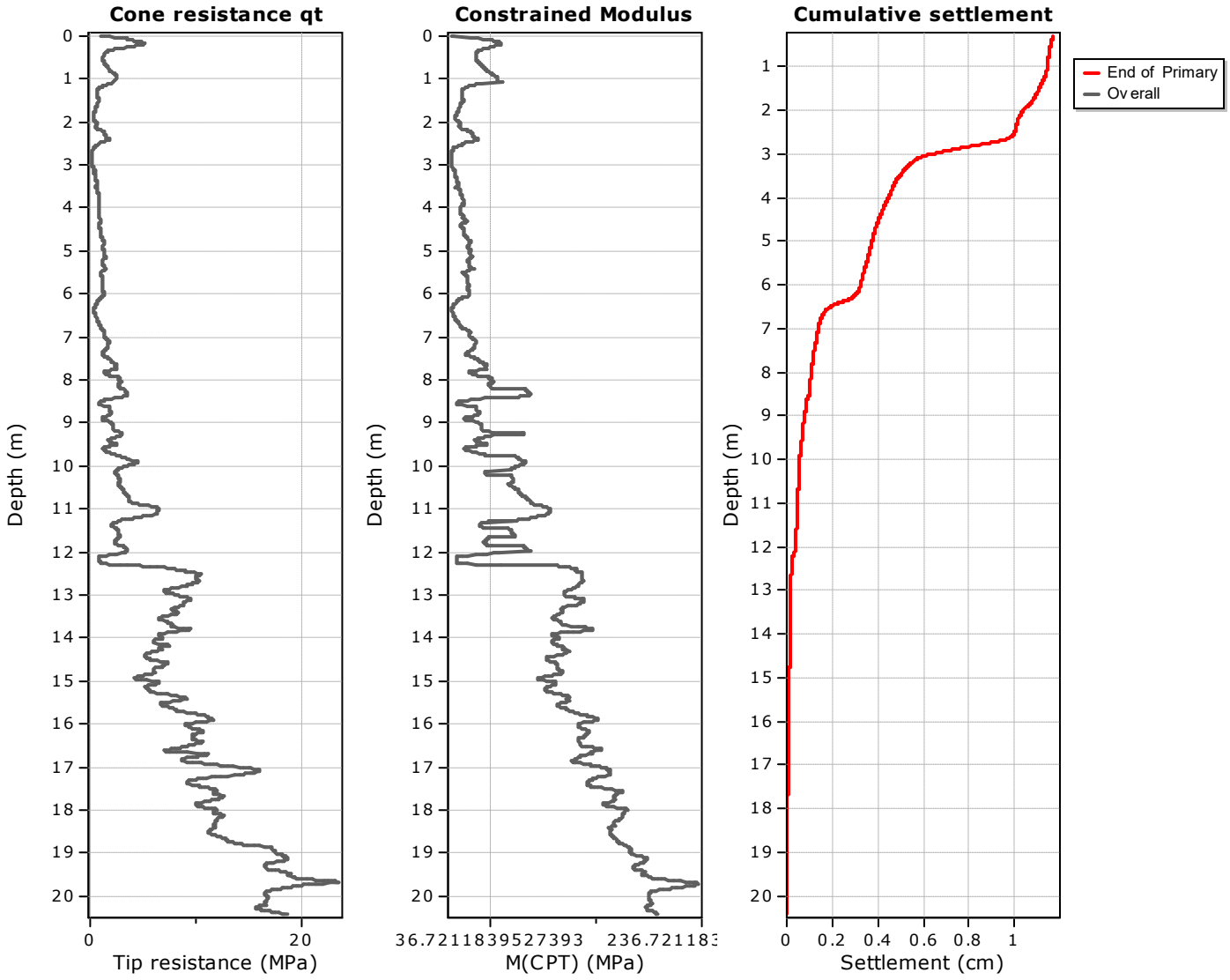
where t_p is the duration of primary consolidation

GeoLogismiki
Geotechnical Engineers
Merarhias 56
http://www.geologismiki.gr

CPT: sCPT05
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:

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

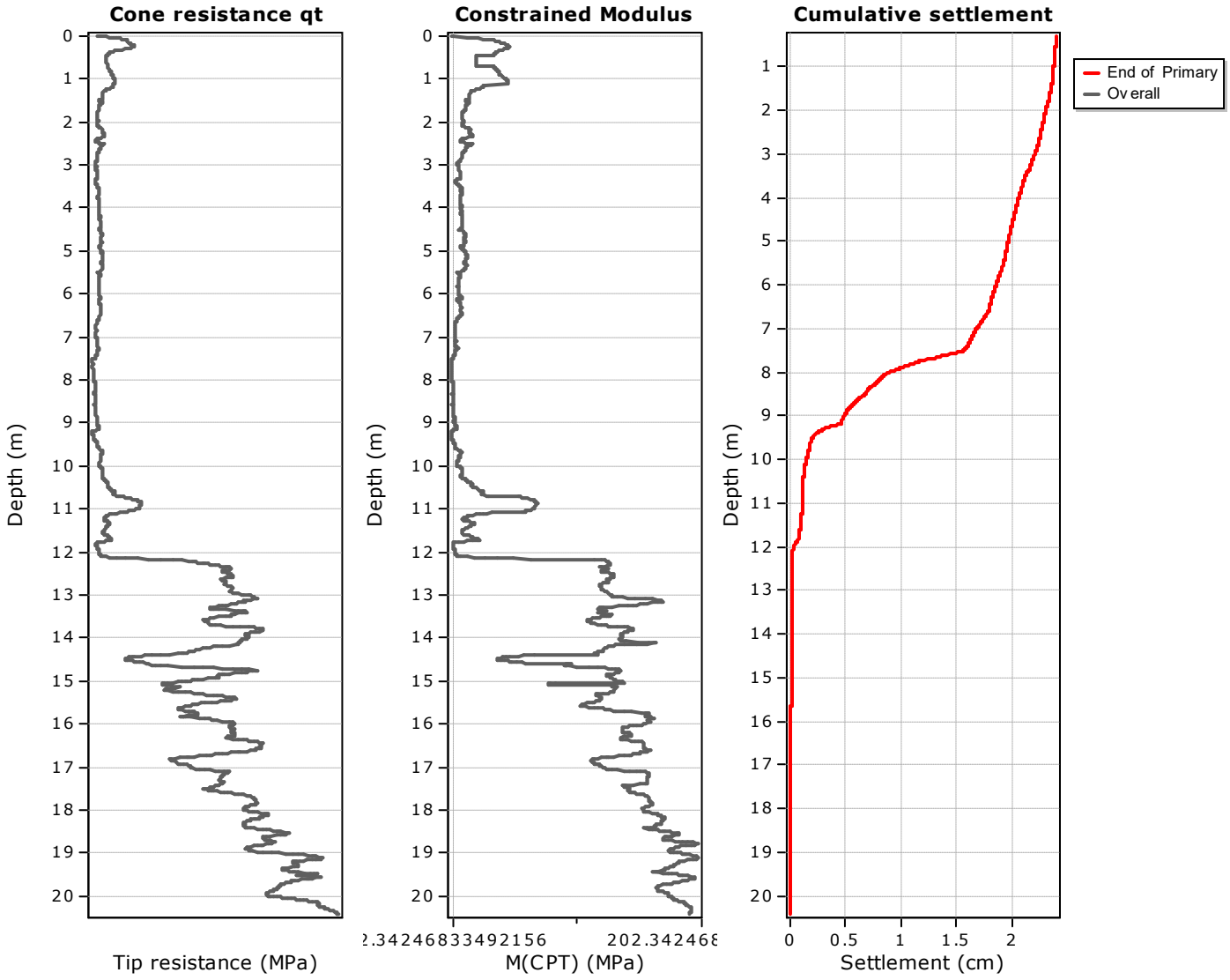
where t_p is the duration of primary consolidation

GeoLogismiki
Geotechnical Engineers
Merarhias 56
http://www.geologismiki.gr

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:

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

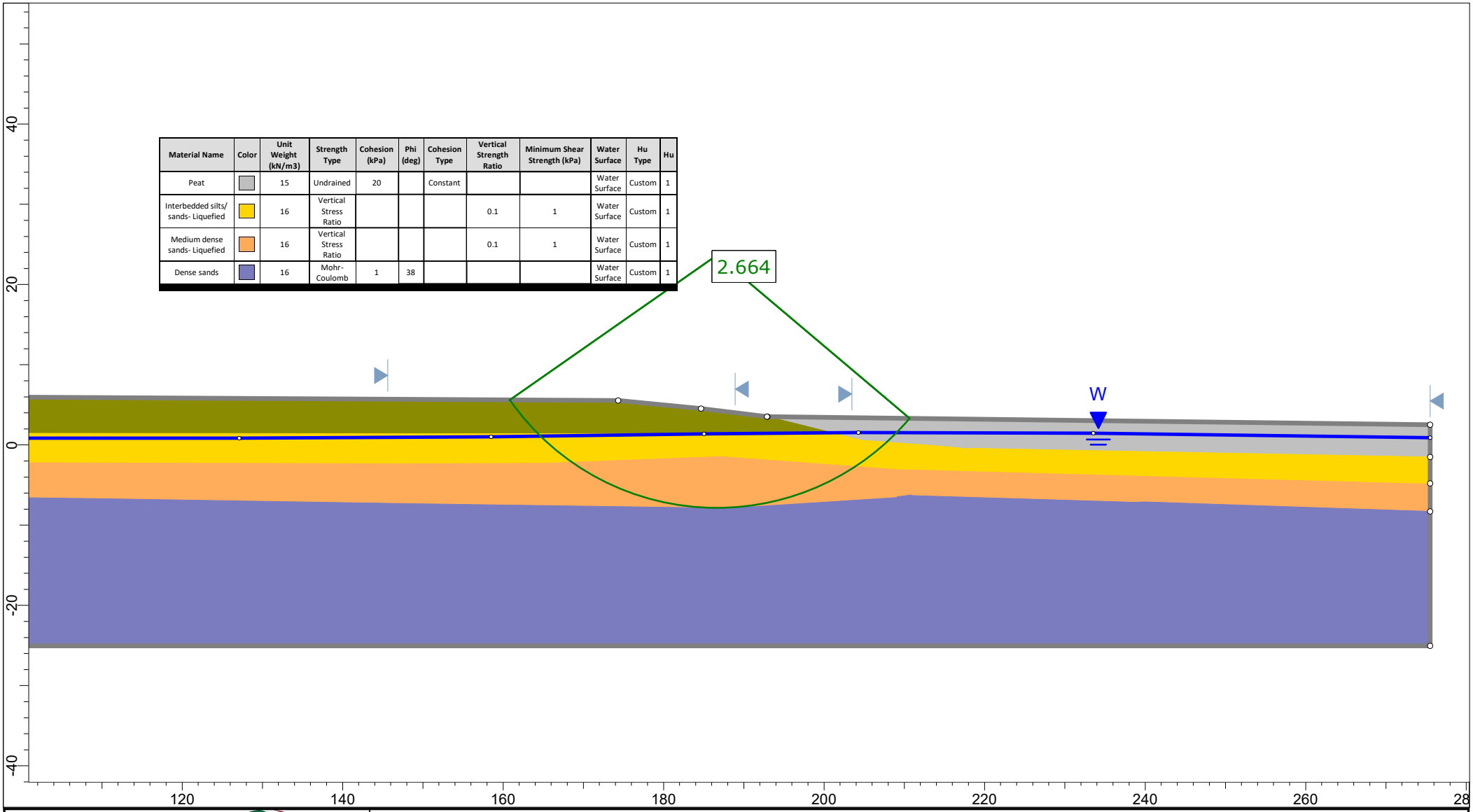
* Secondary (creep) settlements calculation is performed according to the following formula:

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

where t_p is the duration of primary consolidation

Appendix F: Lateral Spread Analyses

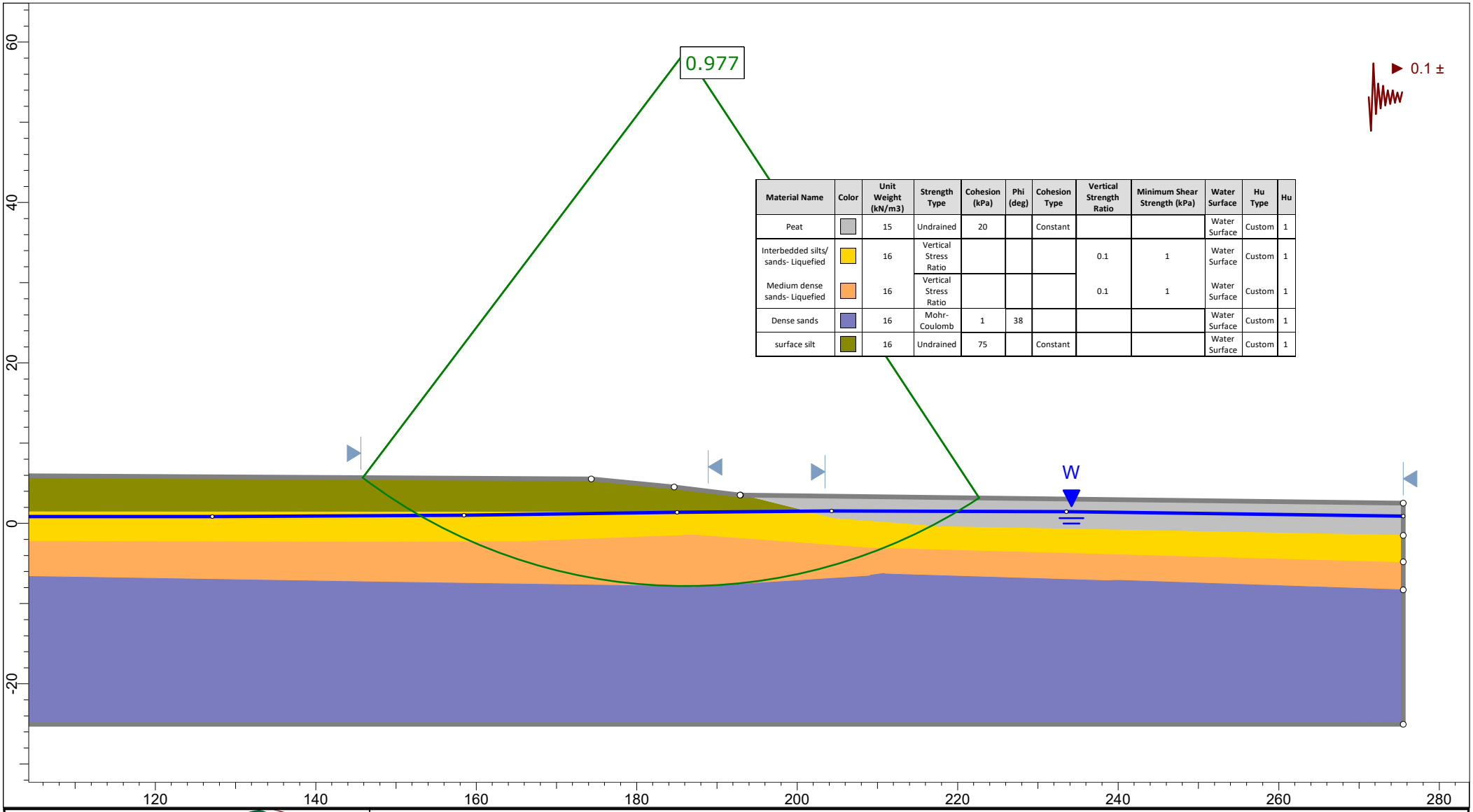
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Vertical Strength Ratio	Minimum Shear Strength (kPa)	Water Surface	Hu Type	Hu
Peat		15	Undrained	20		Constant			Water Surface	Custom	1
Interbedded silts/ sands- Liquefied		16	Vertical Stress Ratio				0.1	1	Water 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

SLIDEINT... 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

SLIDEIN... ...R... 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	m^2			
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	m^2
Side Area	9.48	m^2
Total Infiltration Area	21.49	m^2
Effective Storage Volume	14.61	m^3

Storm Duration	Storm Mean Intensity (10yr)	Volume in (m^3)	Volume Soaked (m^3)	Additional Storage Required (m^3)	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 (m³/d)	130	m³/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 (m³/d)	10	m³/d	
ADWF (l/s)	0.12	l/s	
Peaking Factor	5		
PWWF	0.58	l/s	

Total Wastewater demand

Average Daily Flow	**140.00**	**m³/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**

wastewater specialists

PENCARROW ESTATE, PONGAKAWA

ONSITE WASTEWATER TREATMENT SYSTEM

TECHNICAL MEMO

Report prepared by: Innoflow Technologies NZ Ltd

Date: 3RD April 2024

Innoflow Technologies NZ Ltd has been engaged by Momentum Planning and Design (Momentum), to provide preliminary design recommendations for the onsite wastewater treatment plant and land application system for the proposed Pencarrow Estate (residential subdivision), Pongakawa, Bay of Plenty.

This technical memorandum provides further information to requests for information (RFI's) submitted to Momentum as part of their planning change consent application. The answers here relate to the onsite wastewater system specific questions. In summary, the revised wastewater scheme proposed is as follows.

Peak daily flow:
130 x 3 bedroom houses x 5 people per household at 200 L/person/day = 130,000 L/day
200 commercial staff and users at 50 L/person= 10,000 L/day (assumption, nominal flow)
Total: 140,000 L/day

Influent Parameters
BOD_5:400 mg/L
TSS: 460 mg/L
TKN: 65 mg/L
TP: 15 mg/L

Target Effluent Quality
$cBOD_5$: 15 mg/L
TSS: 15 mg/L
TN: 30 mg/L
E.coli: 1,000 mpn/100mL

Land Application System
Method: sub surface pressure compensating drip irrigation
Design loading rate: 3 L/sqm
Primary area required: 46,667 sqm
Reserve area required: 23,333 sqm

Wastewater System Components (at Full Development)

Pre (on-lot) and primary treatment
- 130 x 4.5m^3 pumped septic tank for residential areas
- 1000-2000m pressurised liquid only sewer (63mm OD, TBC)
- Commercial pumped septic tanks and grease traps where required

Secondary and tertiary wastewater treatment
- 1 x influent flow mag meter
- 2 x 25m^3 pre-anoxic tank with effluent return pump
- 7 x 25m^3 (stage 1) recirculation tank with dosing pumps
- 16 x (stage 1) AX100 packed bed reactor pods
- 7 x 25m^3 post anoxic tank
- 2 x 25m^3 (stage 2) recirculation tank with dosing pumps
- 6 x (stage 2) AX20 packed bed reactor pods
- 7 x 25m^3 treated effluent tank with irrigation pump
- 1 x pulse effluent flow meter
- 1 x UV disinfection unit
- 1 x carbon dosing system
- 1 x alkalinity dosing system
- 1 x TCOM

Land Treatment System
- 100m treated effluent rising main
- Solenoid valves to set up 24 x 1,945 sqm sectors
- 46,667 linear meters of sub surface dripline irridation fields.

For simplicity, we have responded to wastewater specific questions in the table provided in the RFI report.

wastewater specialists

Technical matters: reference or subject	**Position**	**Reason**	**Relief sought**
Wastewater discharge: flow calculation	Revise	The high level calculations and designs of the wastewater treatment system must be revised to ensure the discharge area is appropriately sized. If the wastewater discharge area is undersized, wastewater may contaminate groundwater and/or surface water. This should be correctly calculated and designed at the structure plan stage because if the discharge area is undersized, the layout of the proposed development may need to change. **Correct standard to use in the Bay of Plenty** The Engineering Services Report uses the Auckland Design Manual Wastewater code of practice to estimate the commercial design flow. This is the incorrect standard to calculate flows to the wastewater treatment system for the Bay of Plenty. The Bay of Plenty On-Site Effluent Treatment Regional Plan (OSET Plan) requires the Australian/New Zealand Standard 1547:2012 On-site domestic wastewater management to be used for on-site wastewater discharges in the Bay of Plenty. The Engineering Services Report (Lysaght, 12/12/2022, Revision 5) has calculated the residential flow incorrectly and should be revised to ensure the discharge area is sized correctly. This must be corrected at the structure plan stage because it is likely to affect the layout of the proposed development. The Engineering Services Report uses municipal methods to calculate the flows to the wastewater treatment system, which appears to have led to a significant underestimate of the discharge area required to service the proposed development. Decentralised on-site wastewater design is not subject to the same occupancy and per capita flow assessment methods	Revise the wastewater flow calculation using the Australian/New Zealand Standard 1547:2012 (AS/NZ1547:2012) On-site domestic wastewater management. Revise the residential flow calculation based on AS/NZ1547:2012 methodology for on-site wastewater treatment systems (rather than centralised municipal systems). Provide references for the residential flow calculation. Based on the revised/corrected wastewater flow calculation, revise and redesign the wastewater discharge area. Innoflow response: The revised high level design includes peak flows, as per the following. 130 lots x 3BR houses, 5 persons per house at 200 L/person = 130,000 L/day plus 200 commercial users at 50 L/person=10,000 L/day Total 140,000 L/day Assume 3mm/day for land application field. Primary area = 46,667 sqm Reserve area = 23,333 sqm

Technical matters: reference or subject	**Position**	**Reason**	**Relief sought**
		as developments served by municipal wastewater systems. Infiltration and peak wet weather flows are not applicable to the proposed STEP system because the network will comprise small diameter plastic pipework, which is not susceptible to infiltration. The Engineering Services Report does not provide references for the residential flow calculation. The report concludes a total design flow of 95.4m^3/day, comprising a residential design flow of 85.8m^3/day and a commercial flow allowance of 9.6m^3/day, along with allowances for peak wet weather flows (caused by the infiltration of surface and groundwater into the reticulation network during high rainfall). This methodology is only relevant to development of subdivisions in areas served by a municipal reticulation network and large-scale sewage treatment plant (because they are more prone to infiltration and generally treat wastewater volumes from much larger scale populations).	
Wastewater discharge: occupancy allowance for correct flow calculation	Revise	The Engineering Services Report incorrectly calculates the occupancy allowance of the proposed development. In the Bay of Plenty, Schedule 6 of the OSET Plan sets out the correct way to calculate the occupancy allowances. Average occupancy cannot be used for on-site systems because they must be designed for peak flows.	Revise the occupancy allowance – it should be calculated correctly using Schedule 6 of the Bay of Plenty Regional OSET Plan. The maximum occupancy, not the average, is relevant for onsite wastewater treatment systems. Innoflow response: As per previous response, the flow allowances have been adjusted to reflect peak occupancy and flow allowaces as per ASNZ1547:2012

Wastewater discharge: flow calculation	Revise	A 130 lot residential subdivision comprising 4 bedroom dwellings, occupied by 6 people each would equate to a population of 780 people. Using a per capita flow allowance of 200 litres/person/day (in accordance with AS/NZ1547:2012) equates to a residential design flow of 156,000 l/day (or 156 m^3/day) for the full development (rather than the estimated residential flow of 85.8m^3/day).	Revise the size of the discharge area using the correct wastewater flow calculations. Innoflow response: As per previous response, the flow allowances have been adjusted to reflect peak occupancy and flow allowaces as per ASNZ1547:2012, totaling 140,000 L/day and a primary land application area requirement of 46,667sqm.
Wastewater discharge: flow calculation	Revise	Commercial wastewater production is very specific to the business involved and is difficult to estimate, but the applicant should at least estimate the total daily flow allowances. It appears that the preferred wastewater treatment system suppliers were not aware of the commercial component of the proposal and so have not included this in the high level design and the discharge area is likely to be undersized.	Revise the size of the discharge area using the correct wastewater flow calculations. Innoflow response: The revised proposal now includes an estimation of 200 commercial staff and users, with an allowance of 50L/person, totaling 10,000 L/day. This has been included in the peak daily flow and land application area requirements.

Technical matters: **reference or subject**	**Position**	**Reason**	**Relief sought**
Wastewater treatment system: size of secondary treatment system	Revise	Innoflow Technologies Ltd determined the size of a proposed secondary treatment system based on a 105 lot subdivision with no commercial area. The design provided must be revised to include the additional lots and the commercial area.	Revise the size of the secondary treatment system using the correct number of lots and including the commercial component of the development. Confirm the expected treated effluent quality. Innoflow response: As per revision, the revised design incorporates 130 residential lots plus commercial (domestic) flows. The expected effluent quality advanced secondary (<15mg/L for BOD_5 and TSS) with tertiary disinfection (<1000 mpn E.coli/100mL)
Wastewater discharge: geotechnical issues	Revise	The tanks may be subject to hydrostatic uplift and foundation concerns, given the highly compactable soils. The large concrete tanks represent significant weight (9 tonnes per tank plus 25 tonnes of wastewater) which will need to be appropriately supported. Hydrostatic uplift occurs when an empty or partially empty tank is lifted out of the ground due to the pore pressure of water in the surrounding soil under high groundwater table conditions. This can significantly damage a wastewater treatment system but can be addressed by appropriate geotechnical design. The large tanks may need to be installed above ground, depending on winter groundwater conditions.	Provide an assessment of potential geotechnical issues with installing the wastewater treatment system into peat soils with a high groundwater table, using the highest groundwater. Innoflow response: A specific geotechnical design for tank installation has not been provided yet for this project. However, Innoflow currently offers on-lot septic tanks which are full most of the time. The wastewater treatment plant tanks (except for treated effluent tanks) are also at least 50% full most of the time. Additionally, concrete anti-

			floatation rings around all tanks will be proposed to counteract buoyancy and reduce risk of hydrostatic lift.
Wastewater discharge: depth to groundwater	Revise	The proposed discharge of significant volumes of treated wastewater into peat is not common practice (as areas underlain by peat are generally rural) but is acceptable if there is sufficient clearance with winter groundwater levels because peat is highly permeable. Soakage rates in peat are high and this means that final treatment of wastewater may not occur before wastewater enters groundwater, so there must be sufficient depth of unsaturated soil below the disposal system. The application notes groundwater was intercepted at a depth of 1.2m, however this was assessed in January 2022. The soil type is known for fluctuating water tables, and an accurate winter groundwater table level is very important information to enable an accurate effects assessment. If winter groundwater levels encroach to within 600mm of the ground surface, the disposal area location may not be appropriate.	Include consideration of the highest groundwater before finalising the wastewater treatment system to ensure there is sufficient separation of wastewater and groundwater. Innoflow response: Innoflow awaiting advice from MPAD/Lysaught regarding final groundwater level. In the event that higher groundwater levels are found (within 600mm of ground surface), it is possible to raise the land application area with clean soil.
Wastewater discharge: reserve area	Revise	Policy 12 of the OSET Plan requires all systems to set aside an appropriately sized reserve area to provide for unanticipated operational problems and/or system failure. The area set aside must be consistent with the requirements of AS/NZ1547:2012 and be determined by a risk	Revise the structure plan to show a 50% wastewater discharge reserve area. This should be designed into the proposal because it may. alter the layout of the proposed development. Innoflow response: Final numbers by MPAD/Lysaught to be provided to Innoflow.

			Working on Total 140,000 L/day Soil loading rate= 3mm/day Primary area = 46,667 sqm Reserve area (50%) = 23,337 sqm

Technical matters: **reference or subject**	**Position**	**Reason**	**Relief sought**
		assessment. The reserve area must be shown on the structure plan and must not be used for permanent structures, including buildings and impervious surfaces. In this case, provision of a 50% reserve area is appropriate (i.e. 50% of the size of the discharge area). Regional Council has concerns that adding a reserve area as required by the OSET Plan may take up a larger portion of highly productive land.	
Wastewater discharge: separation from Puanene Stream	Clarify	The application does not identify the appropriate separation distance of the wastewater discharge from the Puanene Stream. This should be calculated based on Table R2 of AS/NZ1547:2012.	Provide a risk assessment of the potential effects of contaminants (including biological oxygen demand, total suspended solids, nutrients and pathogens) entering the stream. TBC
Wastewater discharge: effects on soils and groundwater	Clarify	The discharge of treated wastewater can have adverse effects on groundwater quality.	Provide an assessment of the effects of the nutrient loads on the underlying soils and groundwater from the discharge, and how these align with baseline activities such as farming.

Wastewater discharge: public health assessment	Clarify	UV disinfection is expected to address public health concerns from pathogens in the wastewater discharge but does not remove public health effects from the nitrogen discharge.	Provide a public health assessment. TBC
Wastewater treatment system: management and maintenance	Clarify	The applicant has not provided a description of how the wastewater system will be managed into the future. The plan change application should specify which legal body will be the consent holder (for the wastewater discharge), and how the responsibility for installation of the future stages of the system and ongoing maintenance will be managed. If the wastewater system is intended to be vested to council, the applicant should include a discussion of the ongoing cost burden of the proposal. Likewise, confirmation that Western Bay of Plenty District Council will take over the management and maintenance of the system and the discharge consent, is crucial.	The application should specify: 1. Which legal body will be the consent holder for the wastewater discharge. 2. How responsibility for the installation of future stages of the wastewater system and ongoing maintenance will be managed. 3. If the wastewater system is intended to be vested to council. 4. The ongoing cost burden of the wastewater system. Innoflow response Budget estimates: • Annual on-lot septic tank O&M: $90+ GST/tank • Wastewater treatment plant and land application field annual O&M (at final stage): $20,000 + GST • Chemical top ups and telemetry management additional 5. Confirmation that council will take over the management and maintenance of the system and the discharge consent.

We trust this provides you with the clarifications you require at this stage.

Salma Rayan
Technical Business Development Manager
Innoflow Technologies NZ Ltd
salma@innoflow.co.nz
027 474 9124

APPENDIX 5 – PRELIMINARY WATER SUPPLY CALCULATIONS

WATER SUPPLY - DEVELOPMENT DEMAND

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

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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

19 Totara Street, Mount Maunganui 3116
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Email: jordy@lysaght.net.nz
www.lysaght.co.nz

Appendix F

wastewater specialists

PENCARROW ESTATE, PONGAKAWA

ONSITE WASTEWATER TREATMENT SYSTEM

TECHNICAL MEMO

Report prepared by: Innoflow Technologies NZ Ltd

Date: 3RD April 2024

Innoflow Technologies NZ Ltd has been engaged by Momentum Planning and Design (Momentum), to provide preliminary design recommendations for the onsite wastewater treatment plant and land application system for the proposed Pencarrow Estate (residential subdivision), Pongakawa, Bay of Plenty.

This technical memorandum provides further information to requests for information (RFI's) submitted to Momentum as part of their planning change consent application. The answers here relate to the onsite wastewater system specific questions. In summary, the revised wastewater scheme proposed is as follows.

Peak daily flow:
130 x 3 bedroom houses x 5 people per household at 200 L/person/day = 130,000 L/day
200 commercial staff and users at 50 L/person= 10,000 L/day (assumption, nominal flow)
Total: 140,000 L/day

Influent Parameters
BOD_5:400 mg/L
TSS: 460 mg/L
TKN: 65 mg/L
TP: 15 mg/L

Target Effluent Quality
$cBOD_5$: 15 mg/L
TSS: 15 mg/L
TN: 30 mg/L
E.coli: 1,000 mpn/100mL

Land Application System
Method: sub surface pressure compensating drip irrigation
Design loading rate: 3 L/sqm
Primary area required: 46,667 sqm
Reserve area required: 23,333 sqm

Wastewater System Components (at Full Development)

Pre (on-lot) and primary treatment
- 130 x 4.5m^3 pumped septic tank for residential areas
- 1000-2000m pressurised liquid only sewer (63mm OD, TBC)
- Commercial pumped septic tanks and grease traps where required

Secondary and tertiary wastewater treatment
- 1 x influent flow mag meter
- 2 x 25m^3 pre-anoxic tank with effluent return pump
- 7 x 25m^3 (stage 1) recirculation tank with dosing pumps
- 16 x (stage 1) AX100 packed bed reactor pods
- 7 x 25m^3 post anoxic tank
- 2 x 25m^3 (stage 2) recirculation tank with dosing pumps
- 6 x (stage 2) AX20 packed bed reactor pods
- 7 x 25m^3 treated effluent tank with irrigation pump
- 1 x pulse effluent flow meter
- 1 x UV disinfection unit
- 1 x carbon dosing system
- 1 x alkalinity dosing system
- 1 x TCOM

Land Treatment System
- 100m treated effluent rising main
- Solenoid valves to set up 24 x 1,945 sqm sectors
- 46,667 linear meters of sub surface dripline irridation fields.

For simplicity, we have responded to wastewater specific questions in the table provided in the RFI report.

wastewater specialists

Technical matters: reference or subject	**Position**	**Reason**	**Relief sought**
Wastewater discharge: flow calculation	Revise	The high level calculations and designs of the wastewater treatment system must be revised to ensure the discharge area is appropriately sized. If the wastewater discharge area is undersized, wastewater may contaminate groundwater and/or surface water. This should be correctly calculated and designed at the structure plan stage because if the discharge area is undersized, the layout of the proposed development may need to change. **Correct standard to use in the Bay of Plenty** The Engineering Services Report uses the Auckland Design Manual Wastewater code of practice to estimate the commercial design flow. This is the incorrect standard to calculate flows to the wastewater treatment system for the Bay of Plenty. The Bay of Plenty On-Site Effluent Treatment Regional Plan (OSET Plan) requires the Australian/New Zealand Standard 1547:2012 On-site domestic wastewater management to be used for on-site wastewater discharges in the Bay of Plenty. The Engineering Services Report (Lysaght, 12/12/2022, Revision 5) has calculated the residential flow incorrectly and should be revised to ensure the discharge area is sized correctly. This must be corrected at the structure plan stage because it is likely to affect the layout of the proposed development. The Engineering Services Report uses municipal methods to calculate the flows to the wastewater treatment system, which appears to have led to a significant underestimate of the discharge area required to service the proposed development. Decentralised on-site wastewater design is not subject to the same occupancy and per capita flow assessment methods	Revise the wastewater flow calculation using the Australian/New Zealand Standard 1547:2012 (AS/NZ1547:2012) On-site domestic wastewater management. Revise the residential flow calculation based on AS/NZ1547:2012 methodology for on-site wastewater treatment systems (rather than centralised municipal systems). Provide references for the residential flow calculation. Based on the revised/corrected wastewater flow calculation, revise and redesign the wastewater discharge area. Innoflow response: The revised high level design includes peak flows, as per the following. 130 lots x 3BR houses, 5 persons per house at 200 L/person = 130,000 L/day plus 200 commercial users at 50 L/person=10,000 L/day Total 140,000 L/day Assume 3mm/day for land application field. Primary area = 46,667 sqm Reserve area = 23,333 sqm

Technical matters: reference or subject	**Position**	**Reason**	**Relief sought**
		as developments served by municipal wastewater systems. Infiltration and peak wet weather flows are not applicable to the proposed STEP system because the network will comprise small diameter plastic pipework, which is not susceptible to infiltration. The Engineering Services Report does not provide references for the residential flow calculation. The report concludes a total design flow of 95.4m^3/day, comprising a residential design flow of 85.8m^3/day and a commercial flow allowance of 9.6m^3/day, along with allowances for peak wet weather flows (caused by the infiltration of surface and groundwater into the reticulation network during high rainfall). This methodology is only relevant to development of subdivisions in areas served by a municipal reticulation network and large-scale sewage treatment plant (because they are more prone to infiltration and generally treat wastewater volumes from much larger scale populations).	
Wastewater discharge: occupancy allowance for correct flow calculation	Revise	The Engineering Services Report incorrectly calculates the occupancy allowance of the proposed development. In the Bay of Plenty, Schedule 6 of the OSET Plan sets out the correct way to calculate the occupancy allowances. Average occupancy cannot be used for on-site systems because they must be designed for peak flows.	Revise the occupancy allowance – it should be calculated correctly using Schedule 6 of the Bay of Plenty Regional OSET Plan. The maximum occupancy, not the average, is relevant for onsite wastewater treatment systems. Innoflow response: As per previous response, the flow allowances have been adjusted to reflect peak occupancy and flow allowaces as per ASNZ1547:2012

Wastewater discharge: flow calculation	Revise	A 130 lot residential subdivision comprising 4 bedroom dwellings, occupied by 6 people each would equate to a population of 780 people. Using a per capita flow allowance of 200 litres/person/day (in accordance with AS/NZ1547:2012) equates to a residential design flow of 156,000 l/day (or 156 m^3/day) for the full development (rather than the estimated residential flow of 85.8m^3/day).	Revise the size of the discharge area using the correct wastewater flow calculations. Innoflow response: As per previous response, the flow allowances have been adjusted to reflect peak occupancy and flow allowaces as per ASNZ1547:2012, totaling 140,000 L/day and a primary land application area requirement of 46,667sqm.
Wastewater discharge: flow calculation	Revise	Commercial wastewater production is very specific to the business involved and is difficult to estimate, but the applicant should at least estimate the total daily flow allowances. It appears that the preferred wastewater treatment system suppliers were not aware of the commercial component of the proposal and so have not included this in the high level design and the discharge area is likely to be undersized.	Revise the size of the discharge area using the correct wastewater flow calculations. Innoflow response: The revised proposal now includes an estimation of 200 commercial staff and users, with an allowance of 50L/person, totaling 10,000 L/day. This has been included in the peak daily flow and land application area requirements.

Technical matters: **reference or subject**	**Position**	**Reason**	**Relief sought**
Wastewater treatment system: size of secondary treatment system	Revise	Innoflow Technologies Ltd determined the size of a proposed secondary treatment system based on a 105 lot subdivision with no commercial area. The design provided must be revised to include the additional lots and the commercial area.	Revise the size of the secondary treatment system using the correct number of lots and including the commercial component of the development. Confirm the expected treated effluent quality. Innoflow response: As per revision, the revised design incorporates 130 residential lots plus commercial (domestic) flows. The expected effluent quality advanced secondary (<15mg/L for BOD_5 and TSS) with tertiary disinfection (<1000 mpn E.coli/100mL)
Wastewater discharge: geotechnical issues	Revise	The tanks may be subject to hydrostatic uplift and foundation concerns, given the highly compactable soils. The large concrete tanks represent significant weight (9 tonnes per tank plus 25 tonnes of wastewater) which will need to be appropriately supported. Hydrostatic uplift occurs when an empty or partially empty tank is lifted out of the ground due to the pore pressure of water in the surrounding soil under high groundwater table conditions. This can significantly damage a wastewater treatment system but can be addressed by appropriate geotechnical design. The large tanks may need to be installed above ground, depending on winter groundwater conditions.	Provide an assessment of potential geotechnical issues with installing the wastewater treatment system into peat soils with a high groundwater table, using the highest groundwater. Innoflow response: A specific geotechnical design for tank installation has not been provided yet for this project. However, Innoflow currently offers on-lot septic tanks which are full most of the time. The wastewater treatment plant tanks (except for treated effluent tanks) are also at least 50% full most of the time. Additionally, concrete anti-

			floatation rings around all tanks will be proposed to counteract buoyancy and reduce risk of hydrostatic lift.
Wastewater discharge: depth to groundwater	Revise	The proposed discharge of significant volumes of treated wastewater into peat is not common practice (as areas underlain by peat are generally rural) but is acceptable if there is sufficient clearance with winter groundwater levels because peat is highly permeable. Soakage rates in peat are high and this means that final treatment of wastewater may not occur before wastewater enters groundwater, so there must be sufficient depth of unsaturated soil below the disposal system. The application notes groundwater was intercepted at a depth of 1.2m, however this was assessed in January 2022. The soil type is known for fluctuating water tables, and an accurate winter groundwater table level is very important information to enable an accurate effects assessment. If winter groundwater levels encroach to within 600mm of the ground surface, the disposal area location may not be appropriate.	Include consideration of the highest groundwater before finalising the wastewater treatment system to ensure there is sufficient separation of wastewater and groundwater. Innoflow response: In the event that higher groundwater levels are found (within 600mm of ground surface), it is possible to raise the land application area with clean soil.
Wastewater discharge: reserve area	Revise	Policy 12 of the OSET Plan requires all systems to set aside an appropriately sized reserve area to provide for unanticipated operational problems and/or system failure. The area set aside must be consistent with the requirements of AS/NZ1547:2012 and be determined by a risk	Revise the structure plan to show a 50% wastewater discharge reserve area. This should be designed into the proposal because it may. alter the layout of the proposed development. Innoflow response:

			Working on Total 140,000 L/day Soil loading rate= 3mm/day Primary area = 46,667 sqm Reserve area (50%) = 23,337 sqm

Technical matters: **reference or subject**	**Position**	**Reason**	**Relief sought**
		assessment. The reserve area must be shown on the structure plan and must not be used for permanent structures, including buildings and impervious surfaces. In this case, provision of a 50% reserve area is appropriate (i.e. 50% of the size of the discharge area). Regional Council has concerns that adding a reserve area as required by the OSET Plan may take up a larger portion of highly productive land.	
Wastewater discharge: separation from Puanene Stream	Clarify	The application does not identify the appropriate separation distance of the wastewater discharge from the Puanene Stream. This should be calculated based on Table R2 of AS/NZ1547:2012.	Provide a risk assessment of the potential effects of contaminants (including biological oxygen demand, total suspended solids, nutrients and pathogens) entering the stream. TBC
Wastewater discharge: effects on soils and groundwater	Clarify	The discharge of treated wastewater can have adverse effects on groundwater quality.	Provide an assessment of the effects of the nutrient loads on the underlying soils and groundwater from the discharge, and how these align with baseline activities such as farming.

Wastewater discharge: public health assessment	Clarify	UV disinfection is expected to address public health concerns from pathogens in the wastewater discharge but does not remove public health effects from the nitrogen discharge.	Provide a public health assessment. TBC
Wastewater treatment system: management and maintenance	Clarify	The applicant has not provided a description of how the wastewater system will be managed into the future. The plan change application should specify which legal body will be the consent holder (for the wastewater discharge), and how the responsibility for installation of the future stages of the system and ongoing maintenance will be managed. If the wastewater system is intended to be vested to council, the applicant should include a discussion of the ongoing cost burden of the proposal. Likewise, confirmation that Western Bay of Plenty District Council will take over the management and maintenance of the system and the discharge consent, is crucial.	The application should specify: 1. Which legal body will be the consent holder for the wastewater discharge. 2. How responsibility for the installation of future stages of the wastewater system and ongoing maintenance will be managed. 3. If the wastewater system is intended to be vested to council. 4. The ongoing cost burden of the wastewater system. Innoflow response Budget estimates: • Annual on-lot septic tank O&M: $90+ GST/tank • Wastewater treatment plant and land application field annual O&M (at final stage): $20,000 + GST • Chemical top ups and telemetry management additional 5. Confirmation that council will take over the management and maintenance of the system and the discharge consent.

We trust this provides you with the clarifications you require at this stage.

Salma Rayan
Technical Business Development Manager
Innoflow Technologies NZ Ltd
salma@innoflow.co.nz
027 474 9124

Meeting Record

Location: Western Bay of Plenty District Council
1484 Cameron Road, Greerton
Tauranga 3112

Date: Thursday 29th February 2023

Time: 2:00-4:00pm

Purpose: To discuss technical matters (in particular, concerning reserves, traffic, and three waters) and points of clarification to be provided as part of closing out further engagement/dispute resolution prior to s.42A reporting and the hearing being held in May 2024.

Attendance

- Abi Mark, Fiona Crotty (WBOPDC – Planning)
- Ken Lawton (WBOPDC – Infrastructure/Development Engineering)
- Sam Prendergast (WBOPDC – Transport)
- Peter Watson (WBOPDC – Reserves)
- Bryan Norton (WBOPDC – Reserves)
- Jason Crummer (WBOPDC – Reserves)
- Paul Van Den Berg (WBOPDC – Water Engineering)
- James Abraham (WBOPDC – Asset Management)
- Ashnil Kumar (WBOPDC – Asset Management/Development Engineering)
- Richard Coles (Applicant – MPAD – Planning)
- Vincent Murphy (Applicant – MPAD – Planning)
- Bruce Harrison (Applicant – Harrison Transportation – Transport)

Agenda Items

As per attached agenda issued by WBOPDC.

Action Items

1. Reserves – MPAD to investigate putting reserve on opposite side of internal road, for further discussion with WBOPDC Reserves:
    a. Better visual profile of reserve and sense of entrance to wider Pencarrow Estate.
    b. Reverse sensitivity effects/reduced flexibility acknowledged, suspected by WBOPDC however may be better outcome overall.

2. Reserves – planned recreational improvements to Arawa Road are definitely going ahead. Therefore reserve infrastructure should clearly complement this. Action - MPAD to demonstrate on revised context plans.
3. Reserves – to check 400m proximity of planned dwellings to a reserve. Also existing tree types to be made clear on plans.
4. Reserves/Watercourse – Expect more engagement with stream, 10m-setback, access to the stream via tracks etc. Action - MPAD to discuss with Marsh's and reflect on revised plans.
5. Water Supply – Pipe upgrade from reservoir on Maniatutu Road is Council's preferred option. MPAD to remove from Structure Plan Stage Pre-Requisites the potential for the reservoir option unless Marsh's want to maintain flexibility. Discuss with Marsh's.
6. Water Supply – some uncertainty on firefighting requirements being met. Lysaghts to confirm for applicant. Paul Van Den Berg suggested 3 hydrants required within plan change area are needed.
7. Water Supply – WBOPDC expect firefighting capacity to be provided bythe pipe upgrade to service Penelope Place development. MPAD to consider and come back to WBOPDC on. This is a positive consequential outcome for the Pongakawa community. Firefighting storage at Penelope can be removed once capacity has improved as it will then be redundant.
8. Traffic – MPAD/Harrison Transportation to prepare revised plans addressing the following:
    a. WBOPDC would prefer width of 8.5m to allow parking either side of Arawa Road. To be reconciled against safety audit recommendation of entrance width being restricted to 6.5m-7m for slowing traffic entering a 40km/h speed environment. Needs further discussion and agreement with WBOPDC traffic – may require speed threshold and landscaping maybe 30m back from intersection.
    b. Ensure accurate/up-to-date reflection of culvert/swale details at SH2/Arawa Road intersection – were possibly altered with recent footpath improvements. Expected to be very tight to make upgrade work without requiring private land to do so.
    c. WBOPDC expect a footpath on application side of Arawa Road. Acknowledged unfortunate with recent construction of footpath on opposite side. Action – add to structure plan.
    d. Structure plan roads wide enough for carriageway width, berm requirements (including for rubbish collection), and road radii sufficient for turning of rubbish trucks which are 11m long.

9. Traffic – accuracy of current culverts/swales at SH2/Arawa Road intersection being factored into concept design for intersection? Have been recently altered. Action – take photos or obtain as built records from Council.
10. Wastewater – Concern with nitrogen loading, long-term cumulative effects of discharging and dispersing treated WW, upon modified/pre-loaded land, as alluded to in CMW report at disposal field location. Action - MPAD to investigate with CMW/Innoflow and come back to Council.
11. Wastewater – Disposal backup reserve area to be detailed/explained, and calculations are expected to reflect maximum typical household occupancy (4 persons). Action - MPAD to address with Lysaght/Innoflow.
12. Wastewater – is it a stepped system (first treatment in tanks, with further treatment immediately prior to dispersal), or grinder and single treatment immediately prior to dispersal? MPAD to clarify and respond.
13. Wastewater – WBOPDC want to know OPEX costs of the wastewater system. Concerns the potential for WBOPDC to manage the asset, setting targeted rates etc. MPAD to investigate and respond.
14. Geotechnical/groundwater – cumulative effects upon groundwater are a concern. Pre-loading in numerous locations is proposed, which pushes groundwater somewhere else. Nitrogen loading above from pre-loaded areas will then seep back into groundwater once discharged. Needs comprehensive and cumulative assessment and response. Action - MPAD to investigate with CMW/Innoflow and come back to WBOPDC.
15. MPAD to investigate potential risks to Little Waihi Drainage Scheme. WBOPDC state it is irrefutable that SW volumes downstream are going to be increased owing to impervious surface increase and point-source discharge. Whilst pre-development flows per second might be met, the excess water will be discharged over a protected time. More water through the Little Waihi Drainage Scheme infrastructure. Risk needs to be investigated further. MPAD to discuss with Lysaghts and confirm effects less than minor due to downstream catchment area, discharge energy dissipation.
16. Lysaghts to ensure correct rainfall event being used – RCP 8.5.
17. Lysaghts to change terminology to refer to BOPRC SW Management Guidelines rather than Auckland guidelines. James Abraham agreed with Lysaghts they are just a re-incarnation of the guidelines referred to by Lysaghts, however relates to BOPRC being able to utilize revised BOP-specific guidelines in the future.

18. Existing SW Easement from Awara Road - supposedly discharge to Plan change site. Need to check all titles and locate this as it may impact on future subdivision design, and stormwater treatment volume calculations.

Other Notes

MPAD to discuss with Abi – one-to-one engagement requirements with individual submitters, as opposed to a group meeting.

Bay of Plenty Regional Council submission on Proposed Plan Change 95 (Pencarrow Estate) to the Western Bay of Plenty District Plan

Bay of Plenty Regional Council's submission separates the issues identified with the proposed plan change into strategic and technical matters.
The strategic issues with the proposed plan change are as follows:

Strategic matters: reference or subject	Position	Reason	Relief sought	MPAD Response
PPC95 is not anticipated in SmartGrowth and UFTI	Oppose	Bay of Plenty Regional Council (Regional Council) does not support Proposed Plan Change 95 (PPC95) because it is not assessed or anticipated in the SmartGrowth Strategy and represents ad hoc development and inefficient development and use of infrastructure. While development of this type appears attractive in the short term (providing housing), it leads to a sporadic, non-strategic growth pattern and decentralised infrastructure that is costly to maintain in the long term. Significant planning has been undertaken by the SmartGrowth partners to support the preferred urban form, through previous iterations of the SmartGrowth Strategy and the Urban Form and Transport Initiative 2020 (UFTI). UFTI was approved by all SmartGrowth partners, which include central and local government representatives and tāngata whenua, in July 2020. UFTI does not identify any short, medium, or long term greenfield residential development in the Pongakawa/PPC95 vicinity.	Decline Proposed Plan Change 95	The Smartgrowth Strategy/previously UFTI identifies a Connected Centres approach. It is acknowledged Pongakawa is not identified as one of the strategic centres for growth. The plan change is not intended or expected to supplant or compromise delivery of other centres identified in the strategy, but rather be a logical extension as a village/hamlet and reflecting the live-work-play-learn principles that are central to the Connected Centres approach. Delivering an urban area building off the existing urban/residential environment of Pongakawa at Arawa Road, adding commercial amenities, community and recreational infrastructure and improved safety for local children to access local schools (proposes removal of SH2 bus stop into the site). UFTI/Smartgrowth identifies the need for growth in the eastern corridor of the WBOPDC which extends to Pongakawa. This has been communicated in 3x HBA's, and further detailed in the economic report of Kevin Counsells, NERA Consulting, appended to this response. Some growth accommodation is therefore necessary.
PPC95 is not anticipated in the updated SmartGrowth Strategy 2023-2053	Oppose	Regional Council does not agree with the applicant's assertion that PPC95 is suitably consistent with the direction of UFTI and SmartGrowth (section 9.4 of the application[1]). The Strategy does not identify any short, medium, or long term greenfield residential development in the Pongakawa/PPC95 vicinity. The draft SmartGrowth Strategy 2023 includes the Future Development Strategy 2023-2053, which has statutory weight on planning decisions in the resource management system. Hearings on the draft SmartGrowth Strategy 2023 have concluded and a decision is expected in early 2024. SmartGrowth Strategy 2023 does not allocate residential or commercial growth to Pongakawa/the PPC95 area. It identifies the following growth areas consistent with the UFTI connected centres settlement pattern: • existing growth areas, where land is already zoned • planned growth areas, where investigations have been completed, and • potential long-term growth areas. These allocations cover the period 2024-2054 and were informed by the latest housing and business capacity assessment and draft long-term plans of the local authorities in the region. The 2023 connected centres settlement pattern does not allocate residential or commercial growth to Pongakawa, the PPC95 area.	Decline Proposed Plan Change 95	See above. Sequencing of capacity to keep up with demand is not provided for by UFTI, with insufficient capacity to remain in the Eastern Corridor until at least 2034 following current Smartgrowth provisions. Therefore spatially growth is not provided for at Pongakawa, however sequentially further demand is needed and recognised by Smartgrowth in the Eastern Corridor, with no further supply forecast until 2034 (expected to be later). HBA's to date accommodate supply added by PC92 in Te Puke with shortfalls in short, medium and long-terms remaining. The economic report appended to this response acutely considers the growth and demand pressure in Pongakawa that is apparent by the Smartgrowth Strategy which understandably takes a broader view.
PPC95 is not enabled by the NPS-UD or RPS PC6	Oppose	Regional Council does not agree with the applicant's assertion that PPC95 is clearly consistent with the relevant direction of the National Policy Statement for Urban Development (section 9.2.1 of the application[2]) and that PPC95 is provided for in Proposed Change 6 to the Regional Policy Statement (RPS PC6) (section 9.1 of the application).	Decline Proposed Plan Change 95	The 'soften the edges' approach here is BOPRC's view, and is not one seemingly directed by the NPS-UD. Which rather entertains unanticipated or out of sequence development, *which affect urban environments*, where certain criteria are met. This plan change

[1] Momentum Planning and Design, 9 November 2023. Application for plan change rural to residential, Arawa Road, Pongakawa
[2] Momentum Planning and Design, 9 November 2023. Application for plan change rural to residential, Arawa Road, Pongakawa

Strategic matters: reference or subject	Position	Reason	Relief sought	MPAD Response
		The objective of the NPS-UD and RPS PC6 (to give effect to the NPS-UD) is to soften the edges of existing urban environments, not to enable satellite expansion or an ad-hoc growth pattern such as proposed by PPC95. The applicant's planning framework assessment (section 9 of the application) misinterprets the purpose of RPS PC6 (to give effect to the NPS-UD). The assessment concludes that RPS PC6 will remove the urban limits and therefore enable PPC95. However, the NPS-UD and RPS PC6 enable out of sequence development *only in urban environments*. Pongakawa is not defined as an urban environment under the NPS-UD[3]. As such, the NPS-UD and RPS PC6 *do not enable PPC 95*.		would affect, and contribute demand to reduce, established shortfalls in the sub-region (inherently Eastern Corridor), being the greater Tauranga urban environment which extends from Omokoroa to Te Puke (as defined by BOPRC – Plan Change 6). It also responds positively to the live, work play concept, and responds to increases in employment from growth in the local horticultural industry and also the Rangiuru Business Park – Stage 1 anticipated 2025.
PPC95 is contrary to key RPS objectives and policies	Oppose	Regional Council considers PPC 95 to be contrary to RPS Objective 25 and Policies UG 5A, UG 6A, 7A, UG 10B and UG 14B which relate to sequencing growth within defined urban limits for the following reasons: • The PPC 95 area is not within or near an existing defined urban management or growth area in RPS Appendix E, nor any urban environment as defined by the NPS-UD: the adjacent existing residential area is a rural settlement, without reticulated wastewater or stormwater services. On this basis Regional Council disagrees with the applicant that *'development enabled in this location is not sporadic or isolated – rather, an existing urban area would be consolidated*.' • The proposed development area is not identified as an area with demand for growth[4]. While the Housing and Business Capacity Assessment 2022 (HBA) reports (as quoted by the applicant) that there is an urgent need to investigate future growth areas in the Eastern Corridor, this refers to Te Puke and the future eastern town of Te Kainga, not the broader Eastern Corridor or Pongakawa specifically. It is also noted that more intensification capacity has been provided by the Medium Density Residential Standard plan changes than was anticipated by UFTI, and so less greenfield land is required than originally anticipated. • PPC95 does not integrate with local authority long term planning and funding mechanisms or respond to strategic growth plans. • The PPC95 area does not achieve strategic integration of infrastructure services because the area has no existing reticulated wastewater services. The engineering report acknowledges that a new reservoir and pump system will be required. Issue 2.8.1(2) of the RPS identifies that inefficient patterns of land use and ad hoc development are difficult and costly to service and maintain.	Decline Proposed Plan Change 95	Plan Change 6 to the RPS is now operative and has removed urban limits to give effect to the NPS-UD. Existing water supply infrastructure to Arawa Road is in-place and would be improved; informal stormwater (overland flowpath) infrastructure servicing the existing urban area will be robustly established and sized alongside the plan change. Strictly new three-waters infrastructure is wastewater, which is comprehensively proposed to service the plan change area. Overall agree to disagree regarding sporadic/isolated. The 2022 and 2023 HBA's confirm growth in Waihi Beach, Katikati, Omokoroa, Te Puke and a future Eastern Town Centre are expected to assist in addressing projected housing shortfall beyond 2025. Both HBA's acknowledge when accounting for competitiveness margins as required by the NPS-UD, beyond 2025 supply will not meet expected demand in WBOPDC. The plan change would assist to further meet the remaining shortfall.
PPC95 is contrary to key RPS objectives and policies	Oppose	Regional Council disagrees with the applicant (section 9.1 of the application) that PPC95 is consistent with RPS Objective 26, which aims to sustain the productive potential of the region's rural land resource and the growth and efficient operation of rural production activities. Issue 2.8.1(2) of the RPS identifies that unplanned growth and inefficient land use have the potential to adversely affect rural production activities and to reduce the ability of versatile land to be used for a range of productive purposes. Regional Council believes the application to be contrary to RPS Objective 26 and policies UG 18B, IR 1B and IR 5B for the following reasons: • PPC95 will result in versatile land being used for non-productive purposes outside existing	Decline Proposed Plan Change 95	No change to previous assessments, agree to disagree with the inconsistency as assessed by BOPRC.

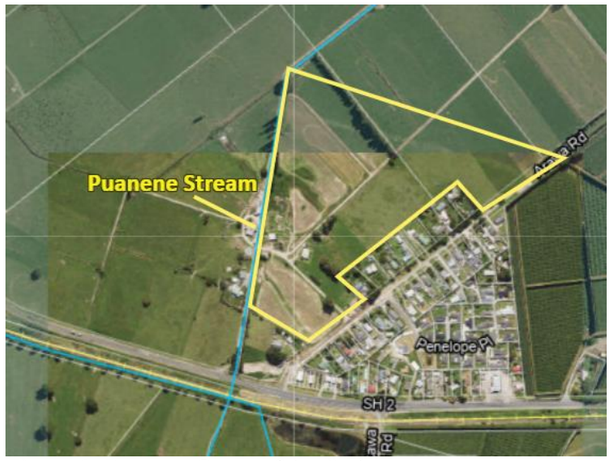
[3] *any area of land (regardless of size, and irrespective of local authority or statistical boundaries) that:*
- *is, or is intended to be, predominantly urban in character; and*
- *is, or is intended to be, part of a housing and labour market of at least 10,000 people.*

[4] Phizacklea Consulting, July 2022. *Housing development capacity assessment for Tauranga and the Western Bay of Plenty 2022*

Strategic matters: reference or subject	Position	Reason	Relief sought	MPAD Response
		and planned urban-zoned areas, and is not for regionally significant infrastructure which has a functional, technical, or locational need to be located there, and • PPC95 will result in a loss of rural productivity and versatile land, which is a finite resource, and will reduce the potential for food/other primary production.		
PPC95 is contrary to key RPS objectives and policies	Oppose	Regional Council disagrees with the applicant (section 9.1 of the application) that PPC95 is consistent with RPS Objectives 10, 11 and 29 and their relevant policies (which aim to appropriately manage cumulative effects of new activities and integrate resource management). The applicant's assessment concludes that PPC95 is consistent with these provisions because cumulative effects are not considered to result in any unacceptable impacts on the receiving environment. Regional Council considers PPC95 to be *contrary* to RPS Objectives 10, 11 and 29 and their policies for the following reasons: • PPC95 will result in irreversible adverse effects of versatile land being used for non-productive purposes outside existing and planned urban-zoned areas, and • PPC95 will result in cumulative effects from inefficient use of space associated with sporadic new subdivision. • PPC95 does not integrate with local authority long term planning and funding mechanisms or respond to strategic growth plans. • PPC95 does not sustainably manage growth because it is not coordinated, sequenced, or serviced in an efficient and integrated manner.	Decline Proposed Plan Change 95	Objective 10 calls for cumulative effects of existing and new activities to be appropriately managed. Objective 11 calls for an integrated approach to resource management. Objective 29 calls for land-use activities which the subject land can support, are integrated with wider environmental values, and within the capacity of receiving waters to assimilate any discharge. BOPRC's assessment considers effects of the development as governed by these policies, without placing them in a cumulative context i.e. in combination with the quantum of the same effects already existing. Agree to disagree the effects contravene the intent of these objectives and policies as per BOPRC's position.
PPC95 is contrary to key RPS objectives and policies	Oppose	Regional Council disagrees with the applicant (section 9.1 of the application) that PPC95 is consistent with RPS Objectives 23 and 24 and their relevant policies, which direct a sustainable urban form that efficiently accommodates the region's urban growth, and an efficient, sustainable, safe, and affordable transport network, integrated with the region's land use patterns. While the development meets the 5 hectare large scale threshold, it does not support multi modal transport options (RPS Policy UG 13B).	Decline Proposed Plan Change 95	The plan change does strictly support multi-modal transport, expressly providing for a much safer bus stop to service the community compared to the reliance on SH2. Agreements are in place for local schools to utilise the improved bus stop within the commercial zone. A network of tracks/connections is also proposed to improve connectivity to new services and infrastructure (parks, commercial area etc) to the existing Arawa Road residential community. Unsure of what more can be done to encourage public transport use.
PPC95 is contrary to the NPS-HPL	Oppose	Regional Council considers PPC95 to be contrary to the relevant National Policy Statement for Highly Productive Land (NPS-HPL) objective and policies. The NPS-HPL directs urban development and urban rezoning away from highly productive land by preventing inappropriate rezoning, subdivision, and use of highly productive land, with few exceptions. The entire PPC95 area is highly productive land under the NPS-HPL. The PPC95 site is zoned rural and is not identified for future urban development. As such, Regional Council considers PPC95 contrary to all relevant NPS-HPL provisions: • Objective: highly productive land is protected for use in land-based primary production, both now and for future generations. • Policy 4: the use of highly productive land for land based primary production is prioritised and supported. • Policy 5: urban rezoning of highly productive land is avoided except as provided for in the NPS-HPL. • Policy 7: subdivision of highly productive land is avoided, except as provided in the NPS-HPL. • Policy 8: highly productive land is protected from inappropriate use and development.	Decline Proposed Plan Change 95	Expert economic evidence has been provided demonstrating how Clause 3.6 of the NPS-HPL is satisfied, thus being a re-zoning provided for by the NPS-HPL. Noting this, original assessment unchanged, agree to disagree.

Strategic matters: reference or subject	Position	Reason	Relief sought	MPAD Response
PPC95 does not meet NPS-HPL clause 3.6	Oppose	Regional Council considers that PPC95 does not satisfy clause 3.6 of the NPS-HPL because there is no evidence of demand for housing in the Pongakawa area and capacity has already been enabled in more efficient locations. Regional Council acknowledges there is a housing shortage, but the applicant has not provided evidence of why housing in Pongakawa specifically is required. The applicant refers to the workforce increase needed to support horticultural land, however the HBA does not assess or identify Pongakawa as having a demand for additional development capacity. The HBA has identified demand in Te Puke, but PPC95 is 15km from Te Puke. The demand for Eastern Corridor capacity quoted throughout the PPC95 application refers to Te Puke and the proposed Te Kainga, not the broader Eastern Corridor or Pongakawa. Capacity has already been enabled in more efficient locations than Pongakawa. The nearest urban environment, as defined in the NPS-UD, is Te Puke approximately 16km west of the plan change site. Te Puke has an existing urban population of over 8,000 and a broad range of social and community infrastructure including all levels of schooling and public transport services. Significant capacity for further brownfield and greenfield growth of residential and business activity in and around Te Puke is already planned and/or enabled through the Western Bay of Plenty District Plan, notably Plan Change 92, and WBOPDC's long-term plan. Planning decisions for this growth of Te Puke will further contribute to it being a well-functioning urban environment as required by Policy 1 of the NPS-UD. NPS-HPL clause 3.6(1)(b) states that urban rezoning of highly productive land may be allowed if there are no other reasonably practicable and feasible options for providing at least sufficient development capacity 'within the same locality and market'. This means the PPC95 area must be close to where the HBA has identified demand for additional development capacity and the proposal is for the types of dwelling or business land in demand. The HBA does not identify a need for housing in/near the Pongakawa area and the PPC95 application does not justify why Pongakawa is required to meet the demand. If there is no evidence of housing demand in Pongakawa, consideration of the same locality and market is unnecessary. To meet subclause 3.6(1)(b), a range of reasonably practicable options for providing the required development capacity must be considered, including: a. greater intensification in existing urban areas; and b. rezoning land that is not highly productive land; and c. rezoning different highly productive land that has a relatively lower productive capacity. The other reasonably practical options for addressing the housing shortfall are greater intensification in existing urban area Te Puke, as enabled by Plan Change 92, which is in the final stages of the plan change process. The Te Puke Spatial Plan may result in rezoning of additional land, which is not highly productive, adjacent to Te Puke.	Decline Proposed Plan Change 95	Expert economic evidence has now been provided demonstrating the shortage further specific to Pongakawa. As stated above, repeated HBA assessments whilst accounting for capacity expected to be delivered by Plan Change 92 still does not meet expected demand hence the identified shortfall in all scenarios as at September 2023. Hence, PC92 enabled growth in Te Puke does not completely address housing shortfall in the Eastern Corridor as implied. The Te Puke Spatial Plan is an unknown possibility, and the future Eastern Town Centre is not forecast to start delivering dwellings until at least 2034 at which point that future town starts to contribute to meeting shortfalls. Given there is a 10 year lead in time for this spatial planning exercise, plan change to establish the new zoning and Long term Financial Planning to provide the infrastructure, we believe this is an optimistic timeframe to deliver housing and far from certain.

Should this plan change progress then the following technical matters should be considered:

Technical matters: **reference or subject**	**Position**	**Reason**	**Relief sought**	**MPAD Response**
Puanene Stream classification	Oppose/ revise	The Assessment of Ecological Effects (Wildlands Consultants Ltd, May 2022) identifies the watercourse flowing along the PPC95 western margin (Figure 1) as a drain. No supporting evidence for this classification was provided.  ***Figure 1:*** *Puanene Stream (blue line)* The following is evidence from a suitably qualified and experienced ecologist that this is the Puanene Stream. The Regional Natural Resources Plan (RNRP) classifies this stream as a 'modified watercourse with ecological values'. Regional Council mapping shows the upstream reach of the stream, which becomes less modified further up the catchment. The New Zealand topographic map identifies this as the Puanene Stream. The New Zealand River Environment Classification (REC) identifies this section of watercourse as a natural "river". It classifies this section as a middle-order stream (stream order 3 or 4), meaning that it has a moderate sized upstream catchment. Historic imagery from 1943 highlights the presence of a watercourse approximately within its current path. This imagery does not rule out the possibility of the watercourse being a deliberately dug drainage channel for the purpose of land drainage (as opposed to for the purpose of watercourse modification). However, the presence of what appears to be a natural headwater system is a strong indication that a natural watercourse would have existed in this general location before the stream was channelised and straightened. Overall, when considering the different lines of evidence, the Puanene Stream is a natural watercourse and should be considered a "modified watercourse" as described in the RNRP and is not a farm drain as	Reclassify the watercourse flowing along the western margin of the proposed plan change area as the Puanene Stream. Provide an assessment of the effects on the stream from the proposed plan change, in accordance with the RNRP and the NPS-FM.	The correct classification of the stream is acknowledged as a heavily modified watercourse, and applicability of the NPS-FM and NES-F.

Technical matters: **reference or subject**	**Position**	**Reason**	**Relief sought**	**MPAD Response**
		described in the Wildlands report. The Puanene Stream will therefore be subject to the policies for river/stream management in the RNRP and the National Policy Statement for Freshwater Management (NPS-FM).		
Puanene Stream mitigation	Revise	As the Puanene Stream is a natural stream not a drain, it is subject to the objective and policies of the NPS-FM. Freshwater management within the site should be reconsidered and an appropriate setback from the stream should be applied allowing the stream riparian zone to be restored and to limit encroachment of future residential or commercial developments into this zone. Regional Council supports development setbacks from permanently flowing streams. A riparian margin can be fragmented by residential structures such as decks and patios. Allowing such structures and activities to encroach into the riparian margin results in less space for the stream and its floodplain, adverse effects on biodiversity and the ability of the system to cope with the increased pressure of residential development. Streams are dynamic systems that need space to meander and interact naturally with the floodplain. Streams provide important habitat for indigenous flora and fauna and are dynamic systems that need room to move. If adequate space is not allowed for these features, there can be unintended consequences on the adjacent built environment which may require hard engineering to protect buildings, to the detriment of the natural environment. Providing a setback provides protection for both the natural and built environment. The values of these waterbodies and freshwater ecosystems are to be protected under the NPS-FM. A vegetated riparian margin provides an even greater benefit and improves the level of protection afforded to water bodies. Vegetation in these areas not only improves filtration but also improves aquatic ecological values and water quality through increased shading, reducing sediment and contaminants reaching the waterbodies and improving water quality. Vegetation with appropriate species in riparian zones has been found to assist with slope and bank stability[5]. A development setback should be zoned under the structure plan of 10 metres from the top of the bank, or as defined by an appropriately qualified and experienced ecologist. The wider the vegetated margin the more effective it is at providing ecosystem services, protecting the adjacent waterbodies and instream fauna and improving water quality. A wider vegetated buffer is also better in terms of self-sustainability and a reduction in the risk of weed invasion and maintenance needs in the long term[6,7]. The structure plan should designate this riparian setback as Conservation Reserve. The Conservation Reserve should be planted with appropriate	Revise the structure plan to include a Conservation Zone 10 metres back from the top of the bank along the Puanene Stream as it passes next to the PPC95 site. The Conservation Zone should preclude subdivision and development and should be set aside for conservation, ecology, recreation and amenity. The Conservation Reserve should be planted with appropriate species of eco-sourced native plants.	WBOPDC District Plan does not include a Conservation Zone, Reserve or Open Space zone or similar outside of Omokoroa. It is not considered proportionate or necessary to create one just for this plan change site. A reserve to vest is now clearly signalled on structure plan drawings, in addition to requirements for planting establishment along the entire stream (within each stage of development). Future subdivision would be required to vest the specified reserve in order to be consistent with the structure plan. The reserve encompasses a 6m-wide corridor from the stream bank. 6m to one side of the stream is considered adequate as it is sufficient space for riparian planting, and access including for maintenance vehicles, without compromising farm buildings may remain between development stages. Once vested, only Council can authorise any development or works within the reserve. As a reserve for conservation and access purposes, the only activities anticipated are restoration planting, maintenance and possibly public access. No consents would be required for such work under the NES-F. Southern parts of the stream frontage have been kept within a private landscape buffer corridor. The same planting requirements as the reserve however are specified to apply to this area, and would have to be implemented pursuant to stage prerequisites in the same manner as the vested reserve. The riparian planting included on the structure plan draws on native planting appropriate to stream environments. Riparian planting and stream improvements would give effect to the objective and policies of the NPS-FM, improving the quality of the watercourse and its constituent ecosystems.

[5] Marden M, Rowan D, Phillips C 2005.Stabilising characteristics of New Zealand indigenous riparian colonising plants. Plant and Soil 278:95-105
[6] Parkyn S; Shaw W; Eades P. 2004. Review of information on riparian buffer widths necessary to support sustainable vegetation and meet aquatic functions. NIWA Client Report ARC00262.
[7] Parkyn SM, Davies-Colley R, Halliday NJ, Costley KJ, Croker G.F. 2003. Planted riparian buffer zones in New Zealand: do they live up to expectations? Restoration Ecology 11: 436-447.
Parkyn, S.M.; Davies-Colley, R.; Halliday, N.J.; Costley, K.J.; Croker, G.F. (2003). Planted riparian buffer zones in New Zealand: do they live up to expectations? *Restoration Ecology 11*: 436-447.

Technical matters: **reference or subject**	**Position**	**Reason**	**Relief sought**	**MPAD Response**
		species of eco-sourced native plants.		
Stormwater management	Revise	Regional Council recommends a stormwater management plan is provided for this plan change area to ensure the issues identified in the following submission points about stormwater are addressed in an integrated manner, as required by section 30(1)(a) of the Resource Management Act 1991, RPS Objective 11 and RPS Policy IR 3B. Land use and development decisions are closely connected to the health and wellbeing of water and the risks of water-related natural hazards to communities, and so catchment planning is needed at the land use decision stage. It is not appropriate to consider stormwater matters after the structure plan has been drafted – integrating land use and water planning is essential to protecting and enhancing the life supporting capacity of the region's waters and te mana o te wai. The stormwater discharge consent process under the regional plan is not the appropriate mechanism to manage stormwater effects of large developments for two main reasons: 1. If the permanent stormwater discharge consent is applied for after the development is completed, there is little or no ability to consider alternative stormwater management options or ability to improve stormwater quality. 2. It is difficult or impossible to consider catchment-wide cumulative effects from stormwater discharges under a resource consent process. Stormwater effects need to be considered collectively on a catchment or sub-catchment basis to enable cumulative effects to be assessed at the structure planning stage and implemented via provisions in the district/city plan.	Provide a stormwater management plan (SMP), which sets out the stormwater management for the proposed structure plan area. The SMP should: 1. Set out the objectives for stormwater management and the receiving environment for the proposed structure plan area. 2. Demonstrate how the proposed stormwater management is the best practicable option (BPO), taking into account the existing site features. 3. Set out how stormwater quality and quantity will be managed in an integrated way. 4. Outline draft planning provisions to manage stormwater in the structure plan area, to be incorporated into the plan change.	This is addressed in the Lysaght revised report and addendum (page 2) appended to this post-notification amendments/revisions package.
Stormwater management	Revise	Regional Council supports onsite soakage to discharge stormwater from individual lot areas (roofs, paved areas, driveways) where possible. However, based on the Geotechnical Investigation Report (CMW Geosciences, 11/02/2022, TGA2021-0096AC Rev 0), a high groundwater table may preclude the use of soakage in the lower lying areas.	The conceptual stormwater design should check there is sufficient capacity in the stormwater pond/wetland to provide treatment and attenuation of stormwater from those areas (if needed).	This is addressed in the Lysaght revised report and addendum (page 3) appended to this post-notification amendments/revisions package.
Stormwater management	Clarify	The Engineering Servicing Report (Lysaght, 12/12/2022, Revision 5) states that stormwater from roads will be collected in catchpits and piped to the stormwater detention pond. The structure plan states that roadside swales will drain the roads.	Clarify at structure plan stage if swales or pipes will be used to drain the roads. Regional Council supports grassed swales to provide water quality treatment before discharging to the receiving environment. If swales are proposed, they must be appropriately sized and designed.	This is addressed in the Lysaght revised report and addendum (page 4) appended to this post-notification amendments/revisions package. Separate overland flowpaths and stormwater infrastructure are detailed on revised structure plan drawings.
Stormwater quality	Clarify	The Assessment of Ecological Effects (Wildlands, May 2022, Contract Report No. 6334) recommends the stormwater detention area is planted with wetland plants. The Engineering Servicing Report (Lysaght, 12/12/2022, Revision 5) and proposed planning map (Private Plan Change 95 Pencarrow Estate – Pongakawa, proposed Planning Map) refer mainly to a stormwater pond.	Clarify if a stormwater wetland or stormwater pond will be used. Regional Council's Stormwater Management Guidelines (page 161) favour constructed wetlands over ponds because they provide better filtration of contaminants, including dissolved contaminants, due to densities of wetland plants, incorporation of contaminants in soils, adsorption,	A constructed treatment wetland is proposed. See explanation at Lysaght addendum (pages 4-5).

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			plant uptake, and biological microbial decomposition. In addition, wetlands, being shallow water bodies, do not have the safety issues associated with deeper ponds. Constructed wetlands must have a spillway to carry the 1% AEP flood with a minimum of 0.5 metre embankment freeboard.	
Stormwater quality and quantity	Revise	The design and sizing of the stormwater pond is based on using a 10mm/hr rainfall intensity. This approach is taken from GD01 in Auckland, which is not the appropriate guideline to use in the Bay of Plenty. The 10mm/hr was based on continuous simulation of Auckland rainfall to determine appropriate rainfall intensity criteria for sizing flow based on proprietary treatment devices such as stormfilters or upflo filters. Using the 10mm/hr rainfall intensity depth is likely to lead to the device being undersized.	Use the Stormwater Management Guidelines for the Bay of Plenty region (Bay of Plenty Regional Council Guidelines 2012/01) to determine water quality and detention volumes based on the 90th percentile rainfall event, and the volumes needed to attenuate the relevant larger storms, such as the 2, 10 and 100 year ARI event). Feasibility for spacing requirements for the stormwater detention area should be redone based on BOPRC guidelines, not Auckland guidelines.	Addressed at page 5 of Lysaght addendum.
Stormwater quality	Revise	The stormwater treatment pond does not appear to achieve the correct length to width ratio to meet the treatment requirements in the Stormwater Management Guidelines for the Bay of Plenty Region (Bay of Plenty Regional Council Guideline 2012/01).	Provide size calculations that meet the Stormwater Management Guidelines for the Bay of Plenty Region (Bay of Plenty Regional Council Guideline 2012/01).	Addressed at page 5 of Lysaght addendum. The shape of the pond has been elongated/re-shaped on the structure plan drawings to reflect the necessary width to length ratio as advised by Lysaght engineers.
Stormwater quality: water sensitive design	Revise	The Puanene Stream on the northwest boundary of the site is a stream, not a drain. As such, extended detention is required for all impervious areas (except those discharging via soakage) that drain to the stream. Holding water back (detention) and releasing it slowly helps to reduce erosion. Ensuring that impervious surfaces do not flow directly into streams can clean dirty stormwater and better manage instream erosion, for example by using water sensitive design such as rain gardens and swales and providing extended stormwater detention. Water sensitive design (WSD) should be used for all developments five hectares or larger. WSD is consistent with the Stormwater Management Guidelines for the Bay of Plenty region and the NPS-FM. The most effective WSD method is a treatment train approach, which is a series of sequential stormwater treatments to maximise pollutant removal. This ensures that all stormwater runoff is treated at source or as close to the source as possible to maintain or improve stormwater quality post-development. This includes runoff from all roads, car parks, houses, and commercial areas.	Revise the stormwater plans to include extended detention, including a treatment train approach, for all impervious areas draining to the treatment wetland/pond.	See page 6 of Lysaght addendum. Treatment train and extended detention is delivered with proposed stormwater infrastructure.
Stormwater discharge	Clarify	The proposal states that stormwater attenuation will be provided. However, the Engineering Services Report (page 10) notes that the watercourse will need to be upgraded where the pond discharges to prevent erosion of the watercourse banks in large storm events. More stormwater flowing into streams as a result of residential development can cause erosion and destabilise stream channels and the	Clarify if post-development Puanene Stream flows will be erosive, or if this refers to localised erosion at the outlet which requires erosion protection. Avoiding the requirement for new erosion protection structures in rivers and streams as a result of increased flows from the development is	Addressed at page 7, Lysaght addendum. The erosion and protection measures improve the resilience of the modified watercourse, and are in tandem with riparian margin creation and wetland planting treating stormwater and overland flows prior to entering the Puanene Stream. The health

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		ground. Holding water back (detention) and releasing it slowly helps to reduce erosion.	consistent with Objective 1 and Policies 1, 3, and 7 of the NPS-FM. Stormwater discharges and any associated structures must be designed to avoid accelerated stream channel erosion and scour of any river/stream. Erosion protection of outlets, streams, channels and overland flowpaths must be consistent with the Stormwater Management Guidelines for the Bay of Plenty region (Bay of Plenty Regional Council Guideline 2012/01).	of water would be improved, integrated with respect to upstream and downstream land-uses and environments, and improving the quality and value of the modified fresh watercourse, consistent with Objective 1 and Policies 1, 3 and 7 of the NPS-FM. See pages 11-13 of the revised Lysaght engineering report, velocity and volumes of stormwater discharges will be reduced with the proposed combination of stormwater infrastructure (soakage on-lots, swale and pond, and separate OLFP provision). Discharge outlets will be designed with scour control measures to dissipate the energy form the discharging water. Therefore erosion and scour of watercourse channel would not occur. Future regional consents would ensure compliance of detailed design with BOPRC Stormwater Management Guidelines.
Effects on privately owned drainage scheme	Clarify	The plan change area drains into an area currently managed by a privately owned drainage system (Little Waihī Drainage Scheme), which relies on conveyance through modified water courses (including drains, channels and pump stations). An increase in impervious areas will result in: • more stormwater discharging to the drainage scheme, • more stormwater volume pumped during storm events, and • associated increase in operational cost. The proposal fails to address the effect of increase in stormwater volume in relation to the drainage scheme design scenarios.	Clarify the appropriate stormwater volume mitigation and effects on the Little Waihī Drainage Scheme.	See page 7 of Lysaght addendum, and pages 11-13 of the revised Lysaght report. With reductions from pre-runoff rates, and delivering of extended detention, no material risk of adverse effects to infrastructure making up the downstream Little Waihi Drainage Scheme is expected.
Stormwater soakage ability	Clarify	The proposal indicates that 50% of the site's stormwater runoff (e.g. from buildings and driveways) will be discharged via ground soakage for the 10 year 10 minute storm and as such assumes that peak flow rates will not increase. The geotechnical investigation was undertaken during summer after a year of low flow conditions. The report identified groundwater at depths ranging from 1.0m to 4.3m below ground level and concludes that shallow groundwater below the more low-lying areas and swales may preclude the use of ground soakage in these areas. In addition, it is expected that during prolonged phases of rain and following rain events beyond the design levels of the drainage scheme, these groundwater levels will be elevated, and soakage will become less effective. For the secondary events up to 1% AEP 2130, a stormwater pond is proposed to manage peak flows. The report provides for a pond volume but fails to indicate the required area; the likely shallow groundwater in this area will limit the available pond depth. Visually the area seems to be around 2000m^2, which would require the pond to be around 2m deep.	Clarify the required size of the stormwater pond/wetland. This information should be worked out at structure plan stage as the stormwater wetland/pond size may affect the structure plan layout.	See page 8 of Lysaght addendum. Sizing of treatment wetland has been reviewed and updated design requirements reflected in the Lysaght revised engineering report and updated structure plan drawings.
Overland flow paths	Revise	The proposal identifies three overland flow paths and proposes to maintain their capacity. Calculations were based on a 1% AEP 2040 climate change. To avoid an increase in upstream flood risk, the capacity must be based on 1% AEP RCP8.5 to 2130.	Revise the calculations of the overland flow paths based on 1% AEP RCP8.5 to 2130. Revise the structure plan to show all overland	See page 8 of Lysaght addendum, calculations revised and all OLFP's shown and provided for to the standard suggested.

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		The structure plan dated October 2023 does not show one of the overland flow paths (OLFP3). This is inconsistent with the Engineering Services Report.	flowpaths.	
Flooding: Wharere Canal catchment	Oppose/ revise	Regional Council does not have a flood model for this catchment (the Wharere Canal catchment). However, flood modelling results from WBOPDC's rural settlement model indicate that the Puanene Stream capacity is limited. In addition, the bridges underneath State Highway 2 and the Kiwirail embankment appear to be undersized, resulting in ponding and overtopping in the 1% AEP RCP8.5 2130 climate change adjusted event. To avoid failures of this nationally important infrastructure, these assets may need to be upgraded in the future, which could result in increased flood flows downstream through the plan change area.		See page 9 of Lysaght addendum. Should upgrades be elected to be pursued by Waka Kotahi or Kiwi Rail beneath their upstream infrastructure, it will be the responsibility of those authorities to ensure downstream adverse flooding effects do not occurs. The function and capacity of overland flowpaths within the site will be re-provided with development of the site in accordance with the structure plan. These service local flooding events, and by way of their continuance within the plan change site, and a lack of constricting of the Puanane Stream, flood risk downstream of existing significant infrastructure is not considered to be exacerbated.
Flooding: Wharere Canal catchment	Revise	The proposal estimates some flood displacement for the 1% AEP through infilling, although this is not based on flood modelling. The applicant identifies this effect as negligible. However, the proposal fails to identify this effect as part of a cumulative effects assessment including increased stormwater volumes due to land use change. Flood modelling is recommended to identify cumulative effects for a variety of events (flood risk and system performance).	Assess cumulative effects of floodplain filling and land-use change, identify appropriate mitigation measures and revise the proposal accordingly.	More robust stormwater runoff calculations have been undertaken in addressing BOPRC comments. This demonstrates a reduction in velocity and volume of stormwater runoff from the site, with no change in runoff volumes from OLFP's to be provided alongside development enabled by the plan change. The Lysaght assessment nonetheless considers flooding effects in tandem with mapped flood risk downstream. No other plan changes or land-use consents enabling large-scale introduction of impervious surfaces are known to exist nearby in the same catchment as the site, and permitted development revolves around production activities i.e. use of land for farming where impermeable surface cover is proportionally low. As such, the cumulative flooding effects assessment is considered proportionate and adequate.
Natural hazards	Amend	The application is supported by a natural hazard risk assessment undertaken in general accordance with the RPS natural hazard provisions (NH 9B and NH 4B) for liquefaction, active faults and coastal hazards. However, the risk assessment does not clearly state there will be no increase in risk offsite from flooding when the development is completed, including to lifeline infrastructure. This is a requirement of RPS Policy NH 4B and should be addressed. The following further information is required to assess flood risk: • Appropriate stormwater sizing and groundwater interaction to confirm low risk onsite is achieved. • Appropriate stormwater volume mitigation to confirm no increase in risk offsite is achieved. • Appropriate overland flow path sizing to confirm low risk is	As required by RPS Policy NH 4B: 1. Amend the natural hazards flooding risk assessment for the **100 year ARI flood** to clearly identify how low risk can be achieved on site. 2. Amend the natural hazards flooding risk assessment for the **500 year ARI flood** to confirm that the flood risk offsite is not increased when the development is completed.	There will be limited displacement of the downstream floodwaters as a result of the filling likely to occur as part of this Plan Change or future urban development. Lysaght has addressed the onsite attenuation of stormwater for the Plan Change Area, and neither the peak discharge rate or total volume discharged will be increased as a result of this development. Therefore the risk in a 100-year event is low. While the 500-year ARI flood plain has not been modelled (by the applicant or BOPRC), as the majority of the proposed plan change land is between 1.0m and 1.5m above the 100 Year ARI event it is likely to be well above the 500-year

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		achieved on site and risk is not increased offsite. • Assess cumulative effects of floodplain infilling and land use change to confirm risk is not increased offsite.		flood level, meaning that the properties within the development are unlikely to be inundated by the downstream flooding. The displacement effect of the proposed filling within the site will likely be negligible in the 500-year event, as the flood plain downstream is contiguous with the ocean and therefore of an almost infinite surface area (3000 Ha in the flood plain alone). The effects of the increased discharge will also likely be negligible, as the increased volume discharged from the site will also be spread across the almost infinite flood plain. The more likely effects of a 500-year storm on the development are to arise from the overtopping of the overland flowpaths that flow through the site. However, that risk will be mitigated by ensuring that all habitable spaces within the development are provided with 500mm of freeboard above the top water level in nearby overland flow paths. Therefore, the land in the vicinity of the overland flowpaths may flood in a 500-year event, but the dwellings themselves should remain dry.
Wastewater discharge: flow calculation	Revise	The high level calculations and designs of the wastewater treatment system must be revised to ensure the discharge area is appropriately sized. If the wastewater discharge area is undersized, wastewater may contaminate groundwater and/or surface water. This should be correctly calculated and designed at the structure plan stage because if the discharge area is undersized, the layout of the proposed development may need to change. **Correct standard to use in the Bay of Plenty** The Engineering Services Report uses the Auckland Design Manual Wastewater code of practice to estimate the commercial design flow. This is the incorrect standard to calculate flows to the wastewater treatment system for the Bay of Plenty. The Bay of Plenty On-Site Effluent Treatment Regional Plan (OSET Plan) requires the Australian/New Zealand Standard 1547:2012 On-site domestic wastewater management to be used for on-site wastewater discharges in the Bay of Plenty. The Engineering Services Report (Lysaght, 12/12/2022, Revision 5) has calculated the residential flow incorrectly and should be revised to ensure the discharge area is sized correctly. This must be corrected at the structure plan stage because it is likely to affect the layout of the proposed development. The Engineering Services Report uses municipal methods to calculate the flows to the wastewater treatment system, which appears to have led to a significant underestimate of the discharge area required to service the proposed development. Decentralised on-site wastewater design is not subject to the same occupancy and per capita flow assessment methods as developments served by municipal wastewater systems. Infiltration and peak wet weather flows are not applicable to the proposed STEP system because the network will comprise small diameter plastic pipework, which is not susceptible to infiltration.	Revise the wastewater flow calculation using the Australian/New Zealand Standard 1547:2012 (AS/NZ1547:2012) On-site domestic wastewater management. Revise the residential flow calculation based on AS/NZ1547:2012 methodology for on-site wastewater treatment systems (rather than centralised municipal systems). Provide references for the residential flow calculation. Based on the revised/corrected wastewater flow calculation, revise and redesign the wastewater discharge area.	See page 3, Innoflow addendum. Revised calculations, primary and reserve wastewater field sizes have been undertaken as directed. See revised structure plan drawings for enlarged wastewater field provision consistent with revised calculations.

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		The Engineering Services Report does not provide references for the residential flow calculation. The report concludes a total design flow of 95.4m^3/day, comprising a residential design flow of 85.8m^3/day and a commercial flow allowance of 9.6m^3/day, along with allowances for peak wet weather flows (caused by the infiltration of surface and groundwater into the reticulation network during high rainfall). This methodology is only relevant to development of subdivisions in areas served by a municipal reticulation network and large-scale sewage treatment plant (because they are more prone to infiltration and generally treat wastewater volumes from much larger scale populations).		
Wastewater discharge: occupancy allowance for correct flow calculation	Revise	The Engineering Services Report incorrectly calculates the occupancy allowance of the proposed development. In the Bay of Plenty, Schedule 6 of the OSET Plan sets out the correct way to calculate the occupancy allowances. Average occupancy cannot be used for on-site systems because they must be designed for peak flows.	Revise the occupancy allowance – it should be calculated correctly using Schedule 6 of the Bay of Plenty Regional OSET Plan. The maximum occupancy, not the average, is relevant for onsite wastewater treatment systems.	See Innoflow addendum. An average of three bedrooms per dwelling across the plan change site is considered appropriate given variation in densities, and has been adopted for the purposes of the calculations (i.e. not 6 persons). It is also further noted that census data for Pongakawa indicates average dwelling occupancy of 2.8 persons per dwelling. The requisite wastewater fields have been re-sized as requested, however will be refined at resource consent (for OSET) stage.
Wastewater discharge: flow calculation	Revise	A 130 lot residential subdivision comprising 4 bedroom dwellings, occupied by 6 people each would equate to a population of 780 people. Using a per capita flow allowance of 200 litres/person/day (in accordance with AS/NZ1547:2012) equates to a residential design flow of 156,000 l/day (or 156 m^3/day) for the full development (rather than the estimated residential flow of 85.8m^3/day).	Revise the size of the discharge area using the correct wastewater flow calculations.	See above.
Wastewater discharge: flow calculation	Revise	Commercial wastewater production is very specific to the business involved and is difficult to estimate, but the applicant should at least estimate the total daily flow allowances. It appears that the preferred wastewater treatment system suppliers were not aware of the commercial component of the proposal and so have not included this in the high level design and the discharge area is likely to be undersized.	Revise the size of the discharge area using the correct wastewater flow calculations.	See Innoflow addendum. 10,000 litres of human wastewater from the future commercial area users (staff and visitors – 200 allowed per day) has been allowed for in revised wastewater field sizing.
Wastewater treatment system: size of secondary treatment system	Revise	Innoflow Technologies Ltd determined the size of a proposed secondary treatment system based on a 105 lot subdivision with no commercial area. The design provided must be revised to include the additional lots and the commercial area.	Revise the size of the secondary treatment system using the correct number of lots and including the commercial component of the development. Confirm the expected treated effluent quality.	See page 6, Innoflow addendum.
Wastewater discharge: geotechnical issues	Revise	The tanks may be subject to hydrostatic uplift and foundation concerns, given the highly compactable soils. The large concrete tanks represent significant weight (9 tonnes per tank plus 25 tonnes of wastewater) which will need to be appropriately supported. Hydrostatic uplift occurs when an empty or partially empty tank is lifted out of the ground due to the pore pressure of water in the surrounding soil under high groundwater table conditions. This can significantly damage a wastewater treatment system	Provide an assessment of potential geotechnical issues with installing the wastewater treatment system into peat soils with a high groundwater table, using the highest groundwater.	See page 6, Innoflow addendum.

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		but can be addressed by appropriate geotechnical design. The large tanks may need to be installed above ground, depending on winter groundwater conditions.		
Wastewater discharge: depth to groundwater	Revise	The proposed discharge of significant volumes of treated wastewater into peat is not common practice (as areas underlain by peat are generally rural) but is acceptable if there is sufficient clearance with winter groundwater levels because peat is highly permeable. Soakage rates in peat are high and this means that final treatment of wastewater may not occur before wastewater enters groundwater, so there must be sufficient depth of unsaturated soil below the disposal system. The application notes groundwater was intercepted at a depth of 1.2m, however this was assessed in January 2022. The soil type is known for fluctuating water tables, and an accurate winter groundwater table level is very important information to enable an accurate effects assessment. If winter groundwater levels encroach to within 600mm of the ground surface, the disposal area location may not be appropriate.	Include consideration of the highest groundwater before finalising the wastewater treatment system to ensure there is sufficient separation of wastewater and groundwater.	See page 6, Innoflow addendum. Necessary (600mm) separation to groundwater levels can be achieved with raising ground levels with clean soil. This would be secured at detailed design and through future OSET consenting.
Wastewater discharge: reserve area	Revise	Policy 12 of the OSET Plan requires all systems to set aside an appropriately sized reserve area to provide for unanticipated operational problems and/or system failure. The area set aside must be consistent with the requirements of AS/NZ1547:2012 and be determined by a risk assessment. The reserve area must be shown on the structure plan and must not be used for permanent structures, including buildings and impervious surfaces. In this case, provision of a 50% reserve area is appropriate (i.e. 50% of the size of the discharge area). Regional Council has concerns that adding a reserve area as required by the OSET Plan may take up a larger portion of highly productive land.	Revise the structure plan to show a 50% wastewater discharge reserve area. This should be designed into the proposal because it may alter the layout of the proposed development.	Included based on Innoflow calculations referred to above, delineated adjacent to primary disposal field, see revised structure plan drawings.
Wastewater discharge: separation from Puanene Stream	Clarify	The application does not identify the appropriate separation distance of the wastewater discharge from the Puanene Stream. This should be calculated based on Table R2 of AS/NZ1547:2012.	Provide a risk assessment of the potential effects of contaminants (including biological oxygen demand, total suspended solids, nutrients and pathogens) entering the stream.	Table R2 of AS/NZ1547:2012 has been reviewed, a 20m setback from the Puanene Stream is required. This widened space is included in the conservation reserve adjacent to the wastewater field, see revised Structure Plan drawings. As such, risk of contaminants/nutrient loading on the stream are considered to be appropriately mitigated by the structure plan design.
Wastewater discharge: effects on soils and groundwater	Clarify	The discharge of treated wastewater can have adverse effects on groundwater quality.	Provide an assessment of the effects of the nutrient loads on the underlying soils and groundwater from the discharge, and how these align with baseline activities such as farming.	See page 6, Innoflow addendum. Necessary (600mm) separation to groundwater levels can be achieved with raising groundlevels with clean soil. This would be secured at detailed design and through future OSET consenting.
Wastewater discharge: public health assessment	Clarify	UV disinfection is expected to address public health concerns from pathogens in the wastewater discharge but does not remove public health effects from the nitrogen discharge.	Provide a public health assessment.	The plan change site is currently used for grazing by dairy cattle, which are understood to produce higher concentrations of nitrogen in the environment owing to their pasture-based diet. This disposal field in contrast will be disposing at slow rates twice-treated human waste which is derived from diverse food sources, not exclusively pasture. The potential for increased nitrogen runoff or dispersal from the land is therefore considered inherently low.

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				The wastewater fields have been designed to project away from the plan change site to land that remains substantially above the 100-year mapped flood extent. As evidenced in the Innoflow memo, the application field can be raised with suitable soil if needed to respond to flood/groundwater levels. As such, the risk of floodwater washing treated wastewater is considered to be low and able to be appropriately mitigated at further resource consent (OSET) stage. It is also to be noted pressure-compensated driplines with anti-floatation devices are laid 150mm below the land surface. Similarly, the risk to public and environmental health, in the low-likelihood event of treated wastewater being washed from the disposal field location, is considered low given the change in nitrogen profile, distances to other dairy/sheep and beef farms relying on grass for feed, or waterways/canals.
Wastewater treatment system: management and maintenance	Clarify	The applicant has not provided a description of how the wastewater system will be managed into the future. The plan change application should specify which legal body will be the consent holder (for the wastewater discharge), and how the responsibility for installation of the future stages of the system and ongoing maintenance will be managed. If the wastewater system is intended to be vested to council, the applicant should include a discussion of the ongoing cost burden of the proposal. Likewise, confirmation that Western Bay of Plenty District Council will take over the management and maintenance of the system and the discharge consent, is crucial.	The application should specify: 1. Which legal body will be the consent holder for the wastewater discharge. 2. How responsibility for the installation of future stages of the wastewater system and ongoing maintenance will be managed. 3. If the wastewater system is intended to be vested to council. 4. The ongoing cost burden of the wastewater system. 5. Confirmation that council will take over the management and maintenance of the system and the discharge consent.	It is envisaged that the wastewater system would ultimately be vested in Council as a Council asset. The associated operating costs would be spread across the plan change site and recouped through annual rates charge for the residential and commercial properties created. The wastewater treatment system proposed has been used and consented within the district and Council is therefore familiar with the operating costs (the same system in existence at Ongare Point is proposed here). It will be developed and extended progressively as per the structure plan staging plan.
WBOPDP Chapter 12 12.4.24.3 Pencarrow Estate Pongakawa Structure Plan – Stage Prerequisites	Revise	Reference to the Engineering Service Report (Lysaght, reference 225216 Rev 2 dated 1/9/2022) in the proposed addition to the District Plan would lock in the wastewater treatment system design inaccuracies noted in earlier submission points.	A revised report should be referenced in the District Plan once the inaccuracies noted in our submission points are satisfactorily corrected.	The Structure Plan pre-requisites have been revised as part of addressing submitter feedback. Rather than specify the Lysaght report, the necessary outcomes of their investigations for future development have been specified as development pre-requisites. This is to avoid technical structure plan compliance issues if the rationale in the current report is appropriately revised or amended, whilst still delivering the infrastructure and mitigation required.
Traffic Impact Assessment	Revise	RPS Policy UG 3A promotes travel demand management across the region, including increasing public transport use, reducing use of private cars and ensuring adequate provision for and increased use of future public transport, walking, cycling networks and corridors, while providing for connectivity.	PPC95 should be amended to provide for the following: 1. The traffic impact assessment should provide information on multi-modal transport, notably public transport, walking and cycling. 2. The development's internal road network should provide more detail about how it will	Multi-modal transport is considered in the TAR at Section 12. Multiple additional walking connections within and from the plan change site to the existing Arawa Road residential area are provided. See access corridors, one of which is pedestrian-only,

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			support people to access dwellings by providing a low speed environment supported with internal walking connections. 3. Provide bicycle parking in the vicinity of the development to encourage multi-modal travel. 4. Provide an accessibility map (or appropriate further analysis) that clarifies how walking and cycling is supported through the development, and how it integrates with the wider network. 5. Given the scale of the development, footpaths should also be provided along the frontage of the development to integrate to the wider network. 6. Consider undertaking a safety assessment to understand whether pedestrian crossing facilities are needed to support safe movement. 7. Recognise how the site could provide people with access to public transport, and services in the wider area.	included on Structure Plan, and reserve network. Cycle parking is required to be provided alongside permitted activities able to establish in the Commercial Zone, pursuant to the provisions of Chapter 4B of the WBOPDC District Plan. Footpaths have been added to the frontage of the commercial zone, and either side of the intersection into the site. Pedestrian crossing requirements, low speed and traffic-calming measures etc, would be more appropriately assessed at the time of subdivision when precise yields and traffic generation rates are known. Imperative safety requirements known at this stage (at SH2/Arawa Road intersection) are conversely directly addressed at this plan-change stage. The plan change absolutely recognises how enabled development could provide people with access to public transport. Agreements are in place for school buses to use a safer bus stop in the commercial area, as opposed to loading/unloading on the side of SH2 as presently occurs. The bus stop is a pre-requisite of development to ensure at least some public transport mode use stems from the plan change.