BEFORE THE HEARING COMMISSIONERS
AT WAIKATO DISTRICT COUNCIL

IN THE MATTER	of the Resource Management Act 1991 (RMA)
AND	
IN THE MATTER	of submissions and further submissions on the Proposed District Plan

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STATEMENT OF EVIDENCE OF SUBMITTER [#368]:
IAN MARTIN MCALLEY
17 February 2021

Harkness Henry
SPECIALIST LAWYERS

www.harknesshenry.co.nz

Phone (07) 838 2399
Fax (07) 839 4043
Address Level 8, KPMG Centre,
85 Alexandra Street, Hamilton 3204
Mail Private Bag 3077, Hamilton 3240,
New Zealand, DX GP 20015

Submitter Solicitor:
Dr J B Forret
(joan.forret@harkness.co.nz)

Counsel Acting:
P Kaur
(pervinder.kaur@harkness.co.nz)

INTRODUCTION

1 My full name is Ian Martin McAlley.

2 I hold a Bachelor of Planning with Honours from Auckland University, graduating in 1996 and have 25 years' experience in the field of planning, project management and land development. I am a full member of the New Zealand Planning Institute.

3 I am the director of Te Kauwhata Land Limited (TKL), the owner of a property at 24 Wayside Road, Te Kauwhata. TKL holds resource consent (SUB0009/17) from Waikato District Council (WDC) to develop property at 24 Wayside Road, Te Kauwhata into a 148-lot residential subdivision.

4 Notwithstanding my qualifications and planning related experience, my evidence specifically relates to my land development experience, in particular as director of TKL and our proposal to develop land at Te Kauwhata.

5 Expert Planning evidence with respect to my submissions made is provided by Mr Aidan Kirkby-McLeod of BBO.

SUBMITTER: 687, CAMPBELL TYSON

6 TKL is in the early-stage negotiation of a joint venture agreement with the neighbouring landowner (Boldero[1]) to develop their land in conjunction with the TKL land. The Boldero land has an area of 5.686 ha and immediately adjoins the southern boundary of the TKL land. The Boldero land has direct frontage to Te Kauwhata and Wayside Roads.

7 Submissions with respect to the Boldero Block have been made under the name 'Campbell Tyson', submitter: 687. In particular, the Campbell Tyson submission seeks the minimum average net site area of 875 m² that applies to subdivision of the site be reduced to 700 m². The reasons given in the submission is that the minimum average net site area of 875 m² proposed in the Residential West Te Kauwhata Overlay will not give effect to the Future Proof Strategy and does not achieve the minimum density of 12 - 15 households per hectare in the Residential Zone as defined in Policy 4.1.5 of the Proposed Waikato District Plan (**PWDP**).

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[1] HB, LK, MA & PR Boldero

8 I note that an average lot size of 700 m² will not achieve the minimum density target of 12 dwellings per hectare defined in Policy 4.1.5 of the PWDP, because assuming that 70% of land can be used for residential lots (once roads, other infrastructure and reserves are allowed for), then the average lot size would need to be 583 m².

9 I made further submissions to Campbell Tyson's submission, supporting the reduction in average lot size, but seeking that the standard Residential Zone be applied to the site and opposing the retention of the Residential West Te Kauwhata Overlay. Campbell Tyson also made further submissions, in particular in support of my submissions seeking the deletion of the Residential West Te Kauwhata Overlay and the application of the standard Residential Zone to the Boldero site.

SUMMARY OF EVIDENCE

10 The purpose of this evidence is to:

(a) Consider the key outcomes sought in my submissions with respect to the directions provided in the Zone Extents 'Framework Report', prepared by Dr Mark Davey and the documents that informed the Framework Report, and the 'Peer Review' of the Framework Report, prepared by Mr David Hill; and

(b) Detail the investigations that demonstrate the suitability of the TKL and Boldero land for the type of development proposed.

KEY POINTS OF SUBMISSIONS

Maximising the potential of the urban/residential land resource

11 At submission point 368.1 I request the PWDP be amended to ensure the direction related to maximising the potential of the urban/residential land resource is maintained and at submission point 368.2 that the PWDP be amended to maintain a commitment to the Future Proof outcomes, in particular the desire to achieve a more compact and concentrated urban form over time.

12 My reasons for the above two submission points are summarised as:

(a) Underutilising urban zoned land is a poor use of a physical resource;

(b) Maximising the potential of the urban land resource must extend beyond just limiting rural residential development and the use of rural land for residential/non rural purposes;

(c) More efficient development of the existing urban land resource enables economies of scale to be exercised to improve the affordability of land on a per section basis;

(d) The Significant Issues[2] refers to one of the 'Advantages for the Waikato District' being the “relatively good housing affordability” in comparison to national averages and whilst current levels of housing affordability may be better than the national average, this is tested against an overall national direction that is showing decreasing housing affordability;

(e) Delivery of quality urban environments is a relationship between the design of those environments and the ability to efficiently (in both time and cost) deliver those outcomes; and

(f) The type and density of development enabled is important to ensure that over time a development pattern evolves that will accommodate changes to the composition of the population and growth, balance growth inside and outside the existing urban area, provide for shifts in housing preferences, including location and typology, recognise constraints in key bulk infrastructure delivery and funding availability and recognise and provide for changes in strategic direction and/or priorities.

13 Whilst my submission refers to a number of specific changes requested to the PWDP, the key change sought is the amendment of the zoning from Residential West Te Kauwhata Overlay to Residential Zone. The reasoning for this request is as follows:

(a) The Residential West Te Kauwhata Overlay proposed minimum and average lot sizes will not achieve the applicable residential density outcomes sought under the Waikato Regional Policy Statement (12-15 households per hectare), as such the PWDP will not give effect to the Regional Policy Statement. The standard Residential Zone is more applicable as a means to achieve these higher order outcomes.

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[2] PWDP, Chapter 1, para. 1.4.2.2(b)

(b) Provisions that achieve a density less than the Future Proof/Waikato Regional Policy Statement outcomes will result in the Future Proof outcomes not being achieved.[3]

(c) There is potential that the outcomes of the 'Corridor Plan' could seek even greater development capacity be provided for than envisaged under Future Proof and therefore the zoning applied must enable residential growth and be broad enough to accommodate such future change, given that the PWDP as notified is looking at a 25 + year horizon with a 30% + variance in household numbers in the period.

(d) The Residential Zone will provide greater flexibility than the Residential West Te Kauwhata Overlay to enable flexibility in the design and development of the site to accommodate future growth and changes in average household size.

14 I consider the following statements in the Framework Report and the Peer Review support the changes requested in my submissions:

(a) "Despite the noted differences, the tension between the PWDP, WRPS and NPS-UD is not irreconcilable; they can co-exist. This can be achieved by accepting submissions on zoning which seek higher density (up-zoning, for example, to medium density) in existing towns (provided they meet certain locational criteria) … "[4]. "Submissions seeking medium density residential zoning within existing towns should be considered favourably to meet NPS-UD intensification policies and the PWDP objective of consolidation of existing towns and villages."[5] My submissions specifically seek these outcomes.

15 Necessity for additional residential zoning and/or development capacity is clearly needed, where the Framework Report states:

(a) "in its as notified form the PWDP does not "give effect to" the recently gazetted NPS-UD. Specifically, the requirement to include responsive planning policies and provide sufficient plan-enabled, infrastructure-ready and feasibly land supply +20% of demand."[6] The Framework Report goes on to detail that "Based on recent

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[3] Policy 6.15, WRPS states "Waikato District Council shall seek to achieve compact urban environments [and] development provisions shall seek to achieve over time the following average gross density targets: Greenfield development in … Te Kauwhata … 12 – 15 households per hectare."

[4] Pg. 4, para l, Executive Summary, Framework Report

[5] Pg. 4, para m, ibid

[6] Pg. 24, para 93, Framework Report

population and household projections (Cameron, 2020) and NPS-UD requirements related to [provision for assessed] demand … the PWDP is no longer meeting the short, medium and long term demand in the District …[7] . On this basis the PWDP is not "giving effect to" Objective 6(c), Policy 2 and Policy 8 of the NPS-UD … . To meet demand the PWDP needs to consider zoning additional areas."[8] In particular my submissions request a zoning amendment that will enable increased residential development on infrastructure ready, residentially zoned land.

16 In terms of specific direction, the Framework Report directs that:

(a) "Any decisions on the PWDP (provided there is scope through submissions) will need to give effect to the recently gazetted NPS-UD and any other higher order documents in existence at the time of making a decision … . Recommendations by the s42A authors should view favourably submissions which will give rise to the PWDP better giving effect to higher order documents (whilst meeting the objectives and policies of the PWDP)."[9] Removing the Residential West Te Kauwhata Overlay as requested in my submissions, will better align the PWDP to the outcomes required by the NPS-UD.

17 In regard to the NPS-UD 2020, the Framework report states:

(a) "The NPS-UD seeks to improve the responsiveness and competitiveness of land development markets, and generally requires local authorities to open up more development capacity"[10] and that as the Waikato District is considered a Tier 1 local authority, identified as one of the fastest-growing local authorities in the country, there is a requirement to more stringently adhere to the policies set out within the NPS-UD.[11] The relief sought in my submissions will enable greater residential development capacity to be provided within the fast-growing North Waikato area and better align the PWDP outcomes with the NPS-UD.

18 Not only does the Framework Report identify that there is a deficiency in the supply of residentially zoned land both now and into the future, any

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[7] Further noting that "the impacts of COVID-19 and border closures will in fact increase the Waikato District's growth rates". Pg. 40, para 177, Framework Report

[8] Pg. 24, para 92, ibid

[9] Pg. 24, para 94, ibid

[10] Pg. 33, para. 145, Framework Report

[11] Pg. 33, para. 147, ibid

possible relief from this growth pressure appears to be non-existent, for the following reasons:

(a) The Waikato District offers strong locational advantages for rural, employment and residential activities[12], with the impacts of overall population growth in New Zealand being acutely felt in the Waikato District[13],

(b) The Waikato District is proximate to labour markets and consumers (both Auckland and Hamilton), has access to ports and airports, with improving rail connections and access to the North Island Main Trunk rail line[14]. In particular, Te Kauwhata is strategically located, equidistant from Auckland and Hamilton, immediately adjacent to State Highway 1 and bisected by the North Island Main Trunk rail line. Improved accessibility is expected to add to the demand for activities to locate along the Hamilton to Auckland corridor.[15]

19 Te Kauwhata's location adjacent to State Highway 1, with the recently completed grade separated interchange providing for high-volume safe vehicle entry and exit from the State Highway, significantly improves accessibility to and from Te Kauwhata, both north and south. In addition, the Waikato 2070 document (page 26) shows that a Mass Transit (railway) Station is proposed at Te Kauwhata in the Medium (3 – 10 years) to Long-Term (10 – 30 years) time period.

20 Of particular note, the Framework Report concludes that "if the Waikato District can maintain its competitive advantage … and … maintain supply of land for employment and residential activities to locate, then forecasts show that it will maintain its high rates of growth into the foreseeable future."[16]

21 Accepting that the rate of growth will not abate, the type of growth also requires consideration. Figure 3, on page 41 of the Framework Report projects that the number of one and two parent family households in the District will stay relatively constant in terms of numbers over the next 40 year period. However, the numbers of households of couples without children and one person households will steadily increase. In my opinion, this indicates that demand for larger, family homes will stay

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[12] Pg. 38, para. 164, ibid
[13] Pg. 42, para. 183, ibid
[14] Pg. 38, para. 166, ibid
[15] Pg. 39, para. 167, ibid
[16] Pg. 43, para. 186, ibid

relatively stagnant over that period and it can be reasonably expected that demand for smaller homes, generally on smaller sections, will increase comparatively to the overall market, even before issues of affordability are considered.

22 Increasing density by reducing the minimum lot size enables greater numbers of people to be accommodated in the same land area. Furthermore, enabling increased flexibility in the design and development of a subdivision provides greater opportunity to satisfy changes to household structure and provides for the decreasing average occupancy rate of dwellings, both existing and predicted.

23 The Residential West Te Kauwhata Overlay that applies to both the TKL and Boldero land negatively impacts the ability to develop this land efficiently and specifically limits the potential to develop this land in a way that assists in satisfying the predicted demand, which in turn would assist the PWDP to give effect to the NPS-UD 2020.

24 The Framework Report states (pg 50, para. 230) that "Lower densities are required in some overlay areas." From my review of the relevant s32 documentation that supports the PWDP I can find nothing that identifies why the Residential West Te Kauwhata Overlay is considered superior to the Residential Zone and should have density provisions less than or even different from the standard Residential Zone. In particular, I can find nothing in the notified documents underpinning the PWDP that identifies why the residentially zoned Residential West Te Kauwhata Overlay area includes density provisions that will not give effect to the WRPS and the NPS–UD. This lack of information or assessment is highlighted in the Framework Report which states "no rationale or explicit purpose for the respective zones is included in the PWDP."[17]

25 The Peer Review comments on this issue at paragraph 7, stating "the translation of the proposed objectives and policies into the proposed zoning matrix appears not to have been conducted through a particularly thorough process. In other words, in many undefined instances the existing zones have simply been carried forward from the operative district plan, seemingly without close attention to their fit with the broader proposed policy framework. That, itself, creates material room for well-reasoned zone changes."

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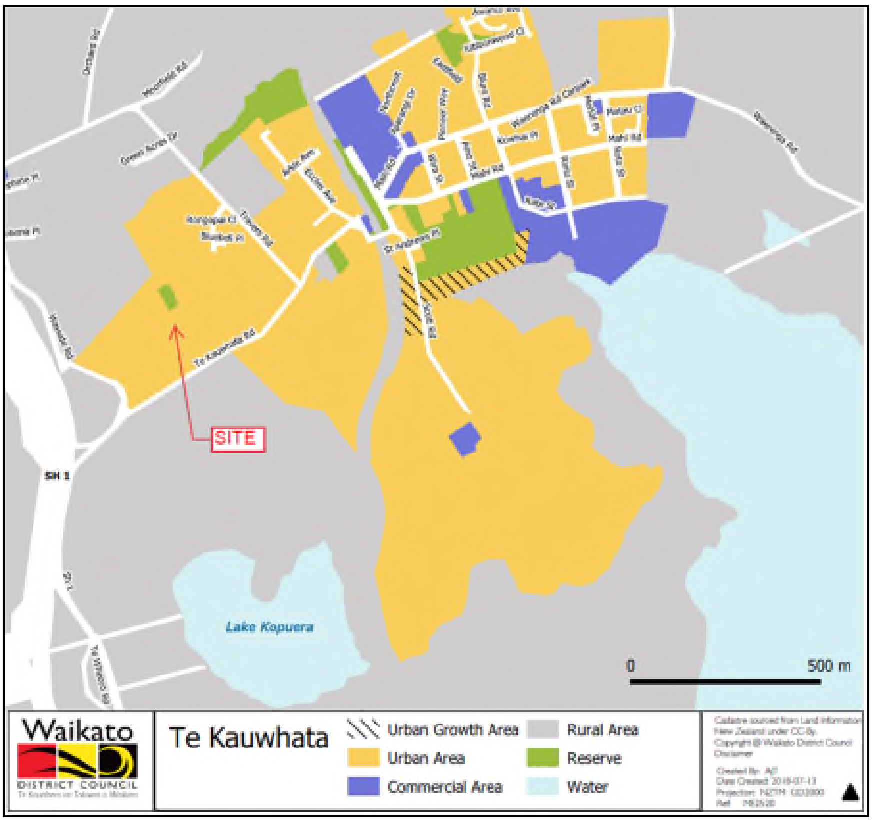
[17] Pg. 45, para. 191, ibid.

26 Specifically, the Framework report notes that (pg. 74, para 43) “A zone boundary is most defensible where it follows natural features, rivers, roads, or railway lines. For example, the Environment Court has held that defensible zone boundaries at Te Kauwhata are formed by State Highway 1/Wayside Road to the west and Swan Road (combined with topography) to the east.” Both the TKL and Boldero sites are within these bounds and are shown as being within the ‘Urban Area’ on the Te Kauwhata Plan that is included with the s32 supporting the PWDP.

Figure 1: PWDP s32 Growth Area – Te Kauwhata



27 Zoning the site standard Residential and removing the Residential West Te Kauwhata Overlay will not require any change to the overall Residential or Urban Area boundary. In particular, poor utilisation of the urban land resource by way of the low-density provisions proposed within the Residential West Te Kauwhata Overlay area will likely result in urban sprawl.

28 In this respect the ‘Natural Environment’ plan on pages 16 and 17 of Waikato 2070 identifies the soils around Te Kauwhata to be ‘Class 1-3’. The discussion document supporting the Proposed National Policy Statement for Highly Productive Land states “When the proposed NPS

comes into effect, the proposed default definition of highly productive land is land with an LUC classification of Class 1, 2 or 3."[18]

29 Urban sprawl into the surrounding rural environment and the Class 1- 3 soils would be contrary to Objectives 5.1.1(a) (i) and (iii) of the PWDP that requires "high class soils [be] protected for productive rural activities" and "urban subdivision, use and development in the rural environment [be] avoided." In instances where urban development is already anticipated on highly productive land, that development should be as intensive as can be accommodated on the site in order to balance the housing benefits under the NPS-UD against the costs associated with loss of that productive potential.

Providing sufficient capacity

30 Growth is predicted to occur in the Waikato District at a rate significantly greater than the historic predictions used by WDC. Appendix 6 of the Framework Report identifies the University of Waikato 2020 Medium Population Projection at 2030 is approximately 20% higher than the equivalent population projections used in the 2014 WDC Long-Term Plan. Likewise, with respect to household numbers, using the same projections, over the same period (Appendix 7 of the Framework Report), shows a 14% variance between the University of Waikato 2020 Medium Household Projections and the household projections used in the 2014 WDC Long-Term Plan.

31 With regard to 'residential land supply' the 'Framework Report' makes the following comments, summarised below:

(a) There are currently estimated to be 30,470 residential dwellings in the District, 16,881 in the urban area and 13,589 in rural areas (para. 264), a split of 55% urban and 45% rural;

(b) The Future Proof Strategy Planning for Growth 2017 seeks that 80% of new residential growth be in identified growth towns and villages (para. 264);

(c) Forecast housing demand in the District is between 38,202 and 39,799 households by 2031 (para. 266), an increase of 8 - 9000 households in the next 10 years, 80% of which are to be within existing urban areas to achieve the Future Proof target. Therefore,

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[18] Section 2.3, pg. 17. Valuing Highly Productive Land, a discussion document on a proposed national policy statement for highly productive land; Ministry for Primary Industries, Ministry for the Environment, August 2019.

640 - 720 new dwellings need to be built within the urban areas of Waikato District each year for the next 10 years;

(d) Forecast housing demand in the District between 2018 and 2045 is an additional 22,216 – 27,387 households (para. 267), this is an additional 822 – 1,010 households per year, every year for the next 24 years across the District. To meet the Future Proof target of 80% of new growth occurring within urban areas, this requires 658 – 808 dwellings per year for the period within the existing urban areas. Therefore, demand for new residentially zoned and serviced land is increasing over the next 24 years. The Framework Report states that "This indicates a shortfall in the PWDP zone capacity to cater to demand."[19]

32 The potential shortfall is also compounded by the following:

(a) The shortfall may or may not be increased/decreased, depending on the extent of household growth assumed to occur in the rural environment versus urban (para. 267). This comment is noted, however the Future Proof Strategy aims for 80% of residential growth to be within urban areas, which is a significant change from the current state, where only 55% of dwellings are in the urban area. Furthermore, the discussion document for the NPS on Highly Productive Land outlines the Government's desire to limit further development within rural areas, particularly on high-class soils, impacting the ability to expand the existing urban limits of Te Kauwhata.

(b) In addition, future capacity "depends on how many of the structure plan areas … zoned in the PWDP have funding allocated for infrastructure servicing in the current LTP … or are planned to be funded and serviced in the forthcoming LTP …" (para. 267).

(c) Finally, para. 268 of the Framework Report outlines the 2021 Future Proof Housing and Business Assessment that is underway, identifying that approximately half (2,863) of the 6,045 lots considered to be able for development in the identified towns are 'infill' lots, "however the actual proportion of this [infill lots] that will be realised could be as low as 10% due to the housing market turnover and developer demand." If this were the case, it would

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[19] Pg. 54, para. 267, Framework Report.

reduce the 6,045 lots considered to be available to 3,468, a reduction of 43%[20].

(d) The reduction in the actual proportion of infill lots realised has the potential to increase the 'Estimated urban shortfall to meet the NPS – UD requirements' as outlined in Table 4 on pages 55 and 56 of the Framework Report. This table includes "plan enabled urban supply including structure plans and infill" of 9,681 units, but this could be significantly reduced should only 10% of the estimated infill units be realised, plus as referenced above, there is uncertainty as to whether all structure plan areas can be relied on to provide for future growth.

(e) Further to the above, the Peer Review comments on the matter of potential capacity reduction as follows, "there is not a 1:1 relationship between zone-enabled land and development feasible land, such that the demand + 20% metric needs substantially more land zoned than the raw number thereby calculated to account for that discrepancy … plan-enabled zoning needs to exceed anticipated demand by a significant quantum both in space (where the market may move over the intervening period) and time (taking into account the lead time for development to materialise on the ground). Experience in Auckland, for example, suggests that this factor required between 50% and 100% more plan-enabled land to meet the actual demand once the reality and contingencies of conversion from live zoning to actual development is taken into account."

(f) In my opinion, this is particularly relevant with respect to the graph included on page 96 of the Framework Report which shows the projected number of households both existing and proposed (in reaction to demand) and the projected supply of housing in Te Kauwhata. At first glance it would suggest that beyond the current supply deficit of approximately 1000 households in comparison to the NPS supply target, that in the near-term supply will significantly outstrip demand to the period 2050 and beyond.

(g) However, to meet the current supply deficit would require approximately 350 houses to be built per year in Te Kauwhata for the period 2020 – 2023. This is more than half the predicted

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[20] Assumed development lots = 6,045 lots – infill lots (2,863 lots) = 3,182 greenfield lots. If only 10% of infill lots realised = 286 lots. Therefore total development probable = 3,182 greenfield lots + 286 infill = 3,468 lots

minimum per annum rate of new dwelling construction in urban areas for the entire Waikato District and significantly greater than the 55 dwellings per year completed (on average) in Te Kauwhata in the period 2019 - 2019[21]. Put another way, the number of dwellings in Te Kauwhata would have to increase by 130% in the period 2020 – 2023, therefore more than doubling the size of Te Kauwhata to fill the current deficit. If the discount rates detailed in both the Framework Report and the Peer Review were applied, it would appear that the realistic rate of development would be unlikely to satisfy the existing shortfall nor keep up with predicted demand.

(h) Overall, and as highlighted in the Framework Report demand is highly unlikely to abate, therefore affordability is unlikely to be improved, particularly when supply is not able to meet demand.

(i) In my opinion, the supply side deficit, the attractiveness of the Region and the ongoing demand is resulting in a constantly increasing average house price and House Price Index[22] in the Region as shown below in **Figures 2 and 3**. As per previous comments, the demand is not predicted to abate.

(j) Increasing land and construction prices decrease affordability. In order to improve affordability, in my opinion, it is necessary to enable greater levels of development to be achieved from the existing urban land resource. I consider this is best achieved in two ways. Firstly, enabling increased density/smaller lot sizes. This provides the opportunity to decrease the raw land value per lot. Secondly, by enabling a greater level of development/density within the same land area enables more efficient use of resources, in particular infrastructure whereby latent carrying capacity could be available within infrastructure because of the volume ranges applicable to pipe sizes and roads etc. By extracting value from this latent capacity provides the opportunity to reduce the infrastructure cost per lot as part of the development process.

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[21] Figure 6, pg. 45, Framework Report

[22] The REINZ House Price Index was developed in partnership with the Reserve Bank of New Zealand and is used by the Reserve Bank's forecasting and macro financial teams, plus the major banks. The REINZ HPI provides a level of detail and understanding of the true movements of housing values over time. It analyses how prices in a market are influenced by a range of attributes such as land area, floor area, number of bedrooms etc. to create a single, more accurate measure of housing market activity and trends over time.

Figure 2: Waikato Region Median House Price,
Past 5 Years – source REINZ Monthly Report, January 2021

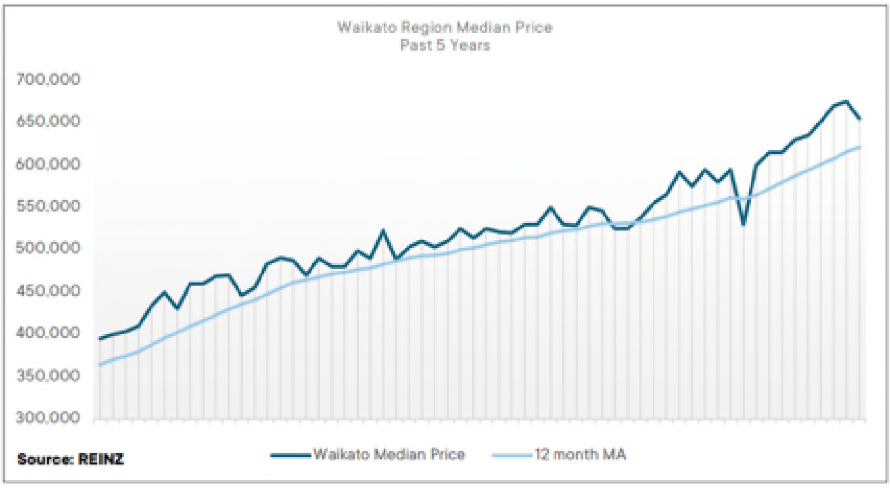
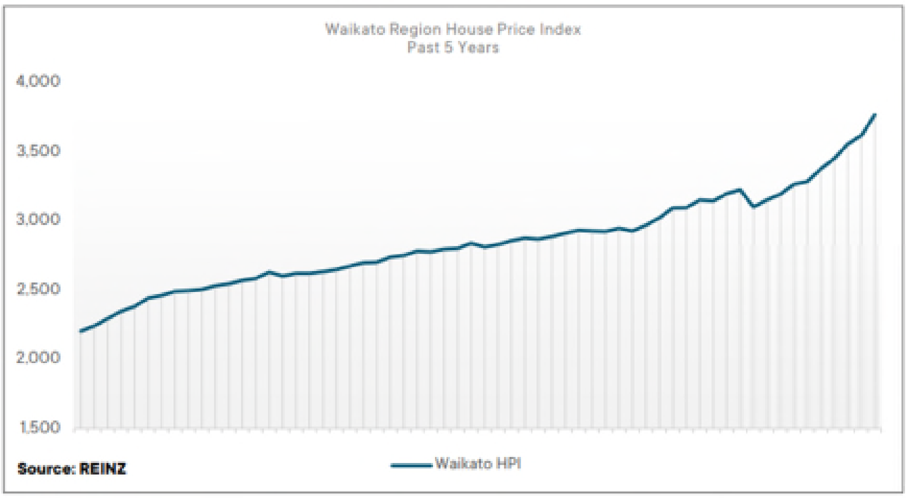


Figure 3: Waikato Region House Price Index,
Past 5 Years – source REINZ Monthly Report, January 2021



(k) Ensuring these forms of efficiencies are pursued, some district plans apply minimum density targets, rather than minimum lot sizes. In my experience working with district plans in both Tauranga and Christchurch, density targets of 15 lots/dwellings per hectare are being written into the subdivision/development rules to force developers to do this. The Peer Review, with respect to reducing the gap between the amount of land zoned for residential purposes and the amount of developed lots supplied to the market, comments as follows “Without defined density minima the correlation between plan-enabled and development feasible is quite poor.” Noting my submissions do not request a minimum number of lots per hectare be written into the District Plan, rezoning of the TKL and Boldero sites to standard Residential opens the door for that land to be used in a more efficient manner, increasing the likely yield achieved across these two blocks from 176 lots to a possible 330.

(l) In terms of the benefits of enabling additional density and potential efficiencies in infrastructure provision being passed onto end purchasers, fundamentally this is achieved by a desire from the developer (both land and housing) to gain a competitive advantage in the market. If the land component (including infrastructure) of a house and land package can be brought to the market cheaper than a competitor and recognising the affordability of an overall house and land package is decreasing, then to support sales, the land developer needs to provide the land component of that package as cheaply as possible (as should the housing developer). Unnecessarily constraining the development capability of land reduces affordability because it increases the per lot cost of the raw land and potentially reduces efficiencies available from better infrastructure provision and utilisation.

(m) I note the NPS-UD specifically includes "housing affordability" as one of the stated quarterly monitoring requirements (s3.9(1)(d)) for Tier 1 Local Authorities. Amending the zoning provisions to enable greater density provides the opportunity to increase affordability and assists in achieving Objective 2 of the NPS-UD that "Planning decisions improve housing affordability by supporting competitive land and development markets."

Suitability of land for development

33 The following considers the suitability of the land for development. Specifically, the TKL land has consent from WDC for a 148-lot residential subdivision, the plan for which is included as **Exhibit A**. Approval of this consent demonstrates that the site is suitable for residential development.

34 Furthermore, WDC has taken a $38m, 10-year interest-free loan from the Housing Infrastructure Fund (HIF) to support major infrastructure projects around Te Kauwhata. At the time the HIF funding was announced, the then Minister of Housing stated in the associated press release that "the loans from the HIF Fund will enable the building of 2,790 houses in an area in desperate need of more housing."[23]

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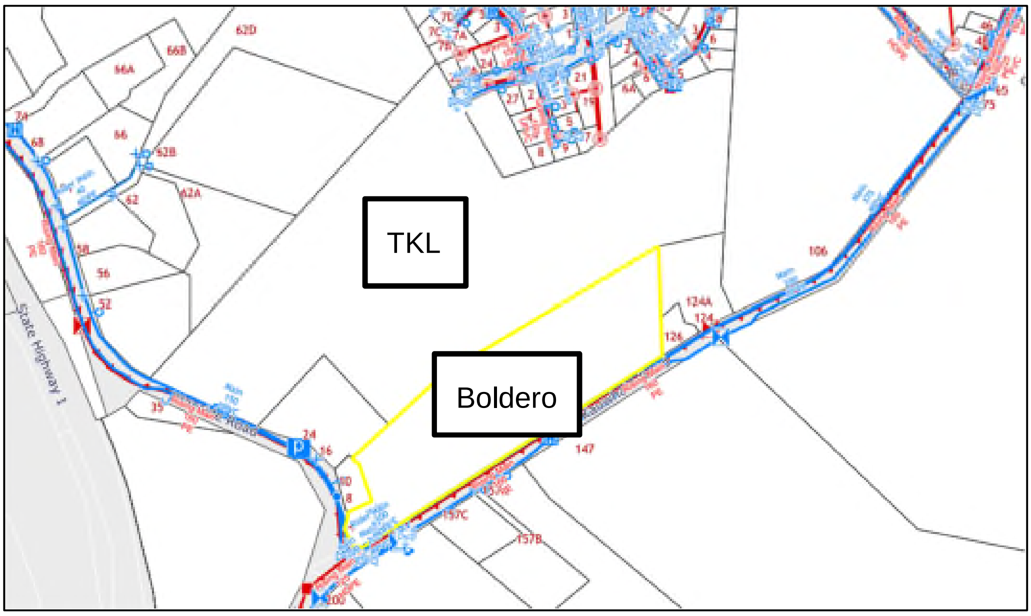
[23] https://www.beehive.govt.nz/release/major-infrastructure-funding-waikato-district , 11 July 2018

Three Waters

35 The Framework Report states “There is an expectation that reticulated water and wastewater services are either available or can be made available to all sites zoned residential on the PWDP.” (para. 233). This statement is reinforced in Appendix 5 (page 78) of the Framework Report, whereby the Travers Road Growth Cell in Te Kauwhata is shown as having water and wastewater services available. Specifically, both the TKL and Boldero blocks have water and wastewater services available at their boundaries (refer **Figure 4**), although it is likely the Boldero block will be connected to wastewater via the TKL block.

Figure 4: WDC Maps,
Water and Wastewater Services



36 With regard to stormwater, TKL holds consent from Waikato Regional Council for discharge from the western catchment (**Exhibit B**) with advanced design undertaken by Wainui Environmental for a stormwater treatment and retention wetland (**Exhibit C**). Stormwater from the eastern catchment of the TKL land and the Boldero land will discharge into the existing WRC reticulation and a WDC stormwater reserve (channel) that leads to existing WDC stormwater reticulation and a downstream stormwater pond (refer **Figure 5**).

37 Overall servicing for the TKL block has been considered in the Opus Subdivision Engineering Report (**Exhibit D**) including stormwater management in the TKL eastern catchment plus the Boldero land and wastewater management across the TKL land. A new pump station and associated storage will be required in the western catchment of the TKL

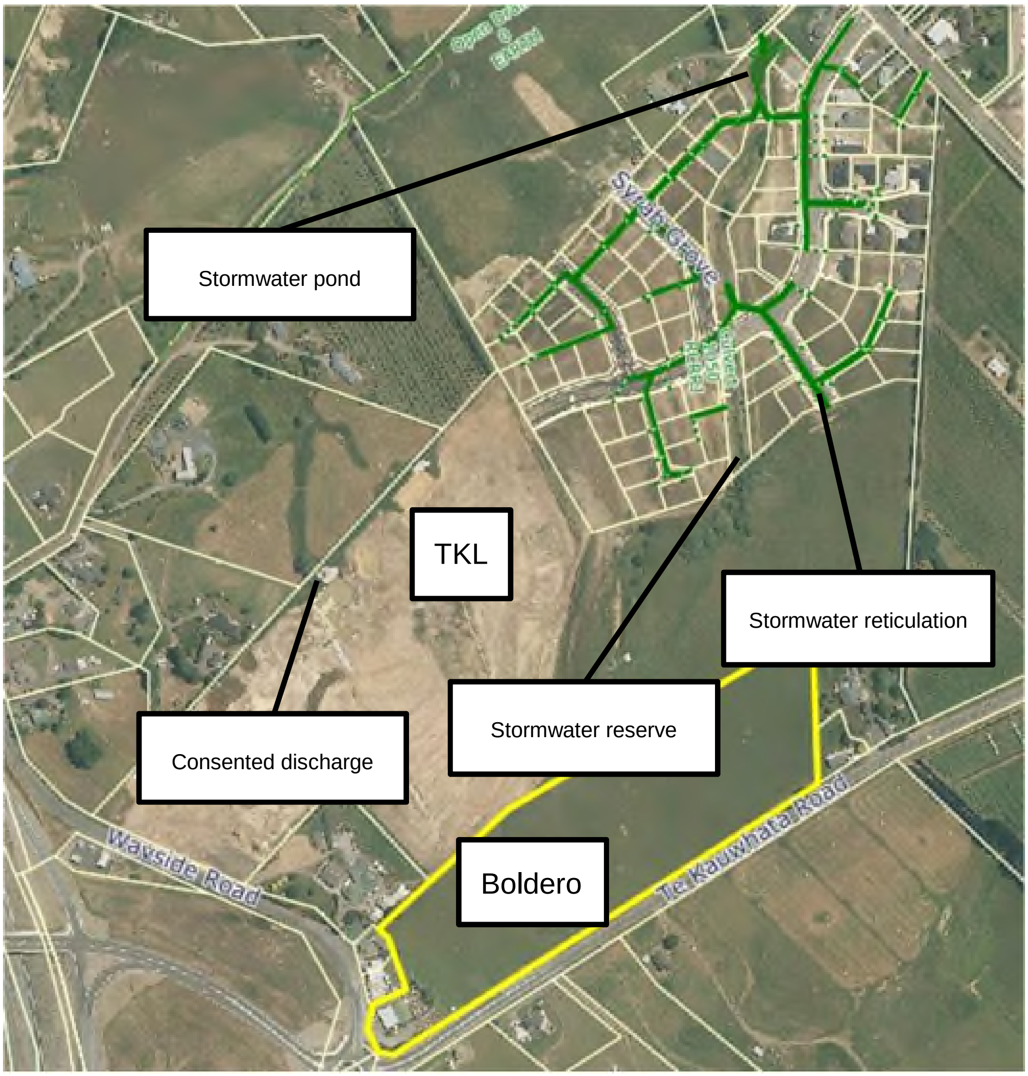
land and improvements made to the storage of the existing WDC pump station downstream of the eastern catchment (in the neighbouring subdivision) in order to accommodate additional flows from the TKL land and the Boldero land.

38 There are no flooding areas shown on the planning maps of the PWDP on either the TKL or the Boldero land.

39 The above information demonstrates the sites are able to be provided with appropriate Three Waters services to support residential development, noting specific detailed design analysis will occur at the time of subdivision consent.

Figure 5: WDC Maps,

Stormwater Services



Geotech and Contamination

40 Geotechnical assessments of the TKL land have been undertaken in both the eastern (**Exhibit E**) and western catchments by HD Geotech

and the western catchment (**Exhibit D**) by Opus. Geotech comment has also been provided by HD Geotech for the consented stormwater wetland in the western catchment (**Exhibit F**).

41 A remediation action plan (**Exhibit G**) by Opus has been prepared to guide management of the minor contamination resulting from the tanalised vine posts that were in place on the TKL site, with a small area of posts still in place at the eastern end of the site. The earthworks completed to date have successfully remediated the site as detailed in the Opus site validation report (**Exhibit H**).

42 From a geotechnical, contamination and remediation perspective, there are no limitations that preclude residential development of the site. The Boldero land is expected to have similar geotechnical characteristics to the TKL site and therefore not considered likely to create any specific challenges in its development beyond those already known, particularly given its easier gradient.

Transportation

43 Notwithstanding the applicable comments made in Mr. Kirkby-McLeod's evidence, Gray Matter Limited, consulting engineers will provide additional comments either before the s42A report or with further evidence in respect of that report.

Other Identified Matters

44 There are no heritage items, areas of significance, significant natural areas, designations, notable trees, natural character areas, landscape areas or similar shown on the planning maps of the PWDP that apply to the TKL and Boldero land that would need to be considered in the development of these sites.

CONCLUSION

45 "Housing is a house and land package. Irrespective of whether housing is a high density inner city apartment or a standalone house on the fringe of the city, land still has to be developed and serviced with infrastructure before it can be used for housing"[24], TKL spent two years attempting to establish a workable solution to the development of the subject site but was constrained by the existing rules that affect layout and yield.

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[24] Using Land for Housing, Issues Paper, November 2014, New Zealand Productivity Commission

46 Whilst considerable effort went into establishing a subdivision proposal that is efficient to build, serviceable and marketable, fundamentally the consented development remains inefficient as it results in section sizes that do not respond to current or future housing needs or demands.

47 It is clearly evident that Te Kauwhata is developing quickly as part of the North Waikato/South Auckland sub regional growth cell. This sub regional growth cell is considered part of a High-Growth Urban Area as defined by the NPS-UD. While there are a number of subdivisions developed and under development in the Te Kauwhata area, the assessments undertaken conclude that demand will not be satisfied, therefore housing affordability will continue to decrease. WDC has made a significant commitment via the Housing Infrastructure Fund to advance the provision of infrastructure in Te Kauwhata and support growth, therefore this investment should be maximised in terms of its effectiveness.

48 Inefficient development, poorly undertaken will not assist WDC in achieving the higher-order outcomes that it is committed to through the Housing Infrastructure Fund process, its commitment to giving effect to Future Proof and the WRPS and its requirement to give effect to the NPS-UD. The TKL submission seeks to ensure that development undertaken on the site results in an efficiently developed, attractive, desirable and saleable product in keeping with the overall urban growth pattern of Te Kauwhata.

Date: 17 February 2021

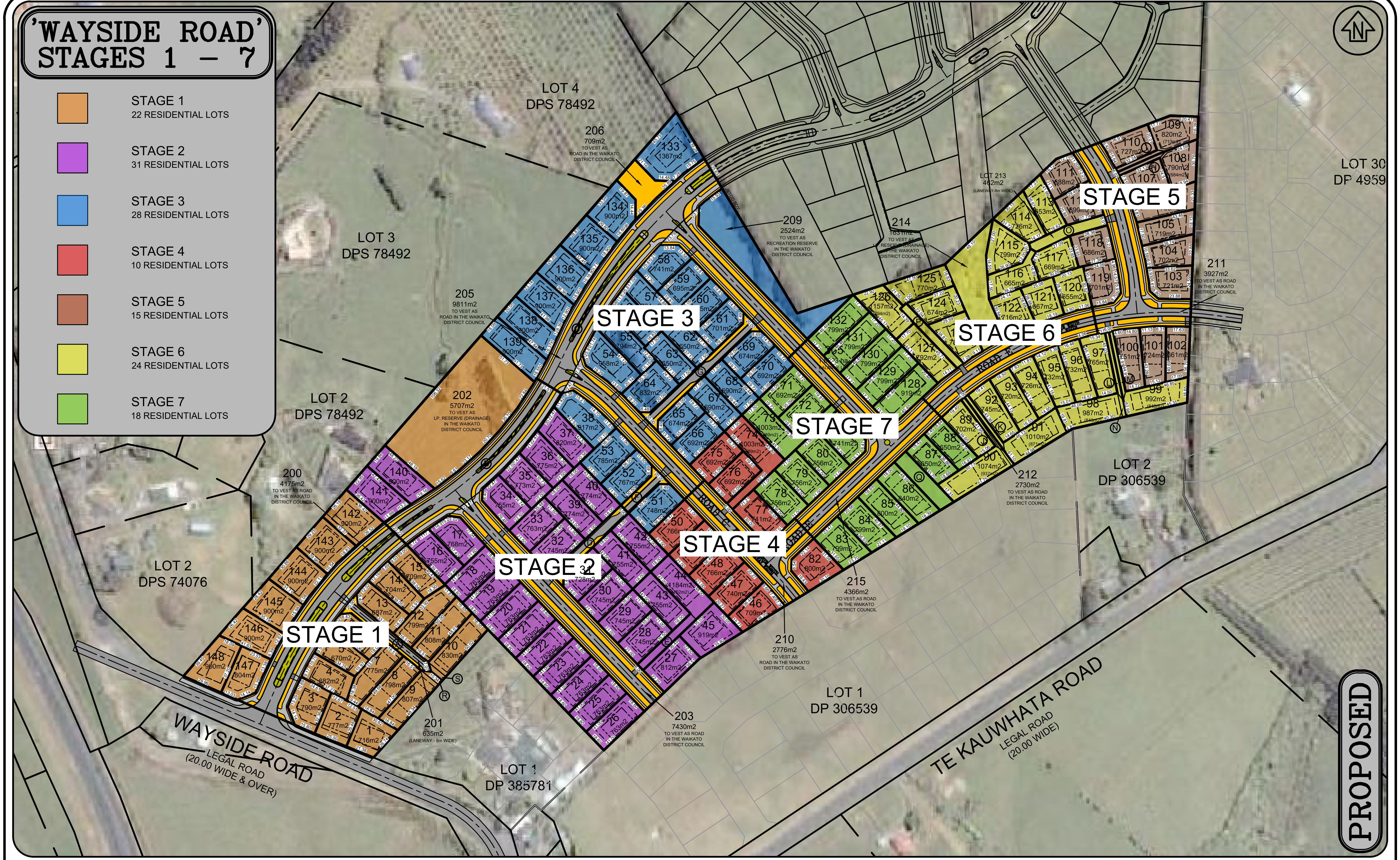
Ian Martin McAlley

Exhibits:

A. Consented subdivision plan
B. Waikato Regional Council stormwater discharge consent
C. Stormwater treatment and retention wetland design report
D. Subdivision engineering and geotech assessment

E. Geotech assessment
F. Stormwater wetland geotech comment
G. Remediation action plan
H. Site validation report

Exhibit A: Granted Subdivision Consent Plan



SCALE: 1:2500 @A3, 1:1250 @A1			DATE: JULY 2019	
No.	Amendment	Init.	Date.	Designed. WAB
1	APPLICATION SCHEME PLAN #19	WAB	07/19	Drawn. WAB 25 JULY 2019
2				Checked.
3				Approved.

S:\2014\14012 - TK LAND\CAD\FOR RC APPROVAL\14012 APPLICATION SCHEME #19 24-07-19.DWG

LOTS 1 - 148 BEING A SUBDIVISION OF
LOT 306 DP 495940
WAYSIDE ROAD - TE KAUWHATA
PREPARED FOR: TE KAUWHATA LAND LTD

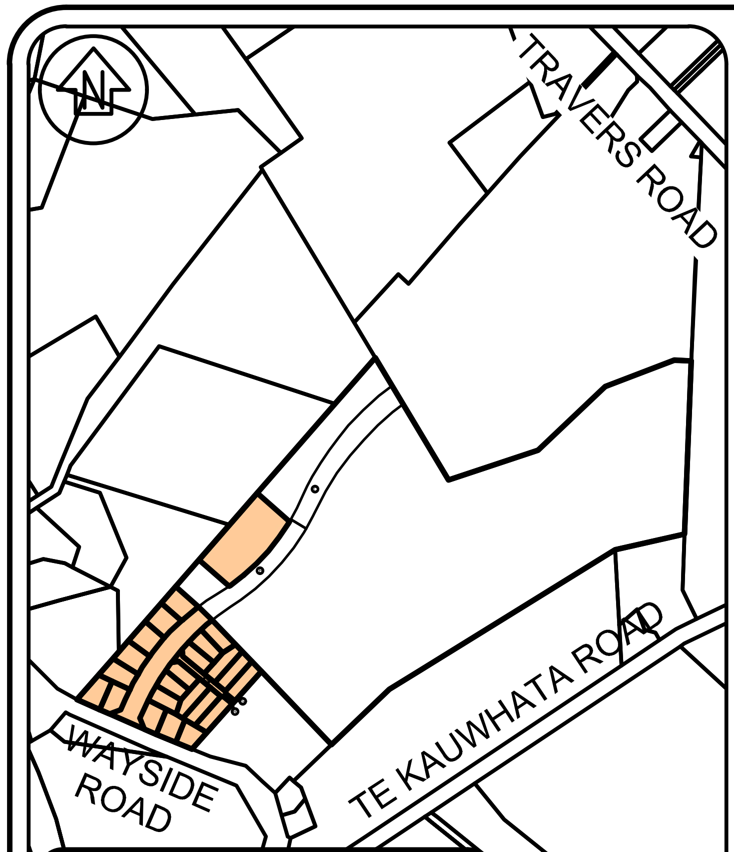
Version #19

Firm's Name

Blue Wallace
Surveyors Ltd.
25 Harwood Street, P O Box 38,
Hamilton Central, HAMILTON.
Phone (07) 839 7799, Fax (07) 839 4455

File Reference
14/012

Drawing No.
3 of 13



LOCATION DIAGRAM
Scale 1:10000

MEMORANDUM OF EASEMENT

PURPOSE	SERV. TENE.	SHOWN	DOM. TENE.
RIGHT OF WAY RIGHT TO CONVEY ELECTRICITY, TELECOMMUNI-CATIONS & WATER RIGHT TO DRAIN SEWAGE & WATER	LOT 201 HEREON	A	LOTS 7 - 12 HEREON

MEMORANDUM OF EASEMENT IN GROSS

PURPOSE	SERV. TENE.	SHOWN	GRANTEE
RIGHT OF WAY RIGHT TO DRAIN SEWAGE	LOT 300 HEREON	B C	WAIKATO DISTRICT COUNCIL
RIGHT TO DRAIN WATER		B	

NOTE:

1) ALL AREAS AND DIMENSIONS SUBJECT TO FINAL SURVEY AND APPROVAL FROM THE WAIKATO DISTRICT COUNCIL

2) LEGAL DESCRIPTION: LOT 306
DP 495940

(CT. 729040)

3) TOTAL AREA: 16.5200 ha.

4) ZONE: LIVING ZONE TE KAUWHATA WEST

5) AERIAL PHOTO SUBJECT TO DISTORTION

6) ALL LEVELS ARE IN TERMS OF MOTURIKI DATUM

'WAYSIDE ROAD' STAGE 1

1) RESIDENTIAL LOTS = 22 LOTS (LOTS 1 - 15, 142 - 148)
TOTAL AREA: 1.7427 ha.

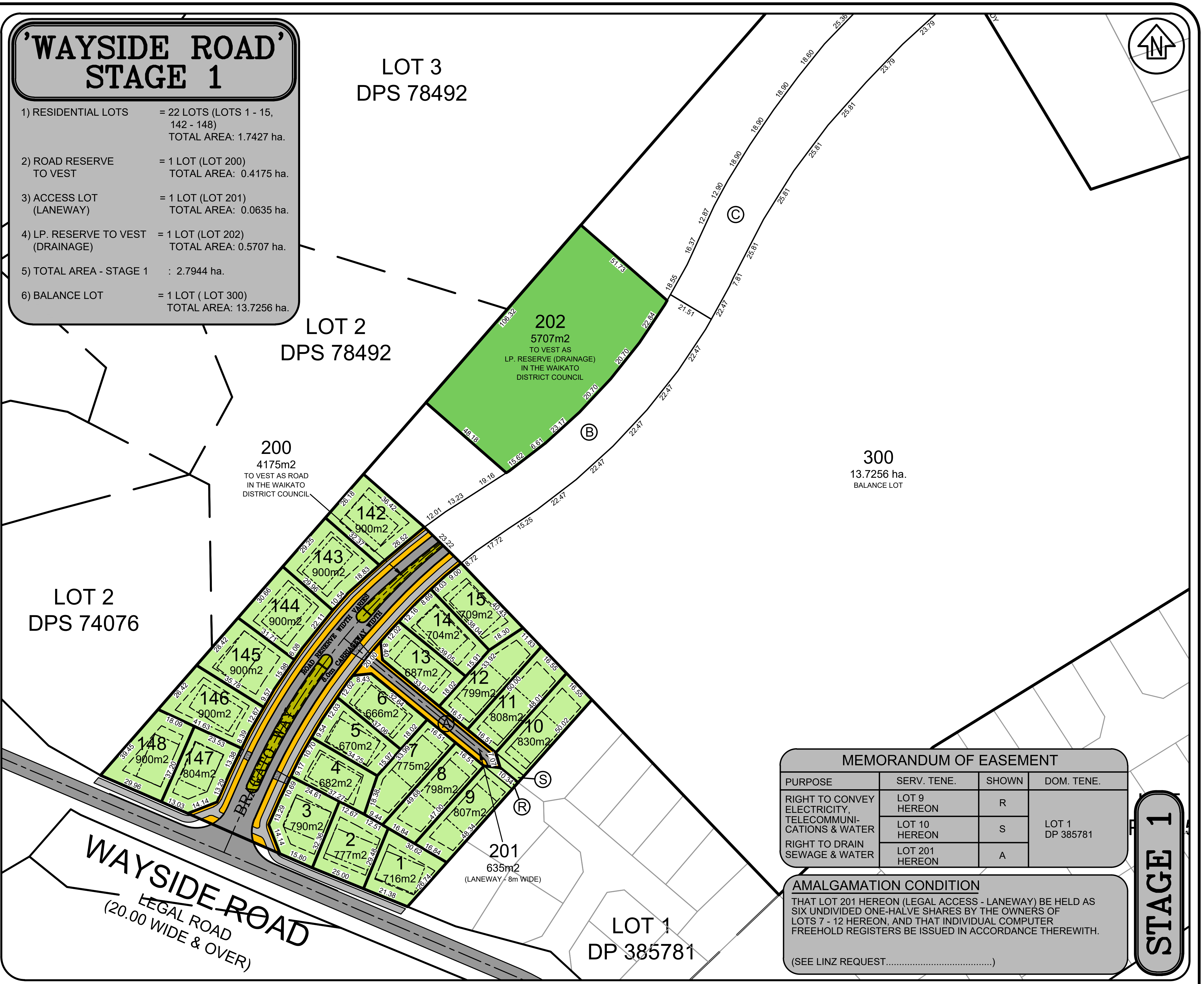
2) ROAD RESERVE TO VEST = 1 LOT (LOT 200)
TOTAL AREA: 0.4175 ha.

3) ACCESS LOT (LANEWAY) = 1 LOT (LOT 201)
TOTAL AREA: 0.0635 ha.

4) LP. RESERVE TO VEST (DRAINAGE) = 1 LOT (LOT 202)
TOTAL AREA: 0.5707 ha.

5) TOTAL AREA - STAGE 1 : 2.7944 ha.

6) BALANCE LOT = 1 LOT (LOT 300)
TOTAL AREA: 13.7256 ha.



MEMORANDUM OF EASEMENT

PURPOSE	SERV. TENE.	SHOWN	DOM. TENE.
RIGHT TO CONVEY ELECTRICITY, TELECOMMUNI-CATIONS & WATER RIGHT TO DRAIN SEWAGE & WATER	LOT 9 HEREON	R	LOT 1 DP 385781
	LOT 10 HEREON	S	
	LOT 201 HEREON	A	

AMALGAMATION CONDITION

THAT LOT 201 HEREON (LEGAL ACCESS - LANEWAY) BE HELD AS SIX UNDIVIDED ONE-HALVE SHARES BY THE OWNERS OF LOTS 7 - 12 HEREON, AND THAT INDIVIDUAL COMPUTER FREEHOLD REGISTERS BE ISSUED IN ACCORDANCE THEREWITH.

(SEE LINZ REQUEST...)

SCALE: 1:1750 @A3
DATE: JULY 2019

No.	Amendment	Init.	Date.	
1	APPLICATION SCHEME PLAN #19	WAB	07/19	Designed. WAB
2				Drawn. WAB 25 JULY 2019
3				Checked.
				Approved.

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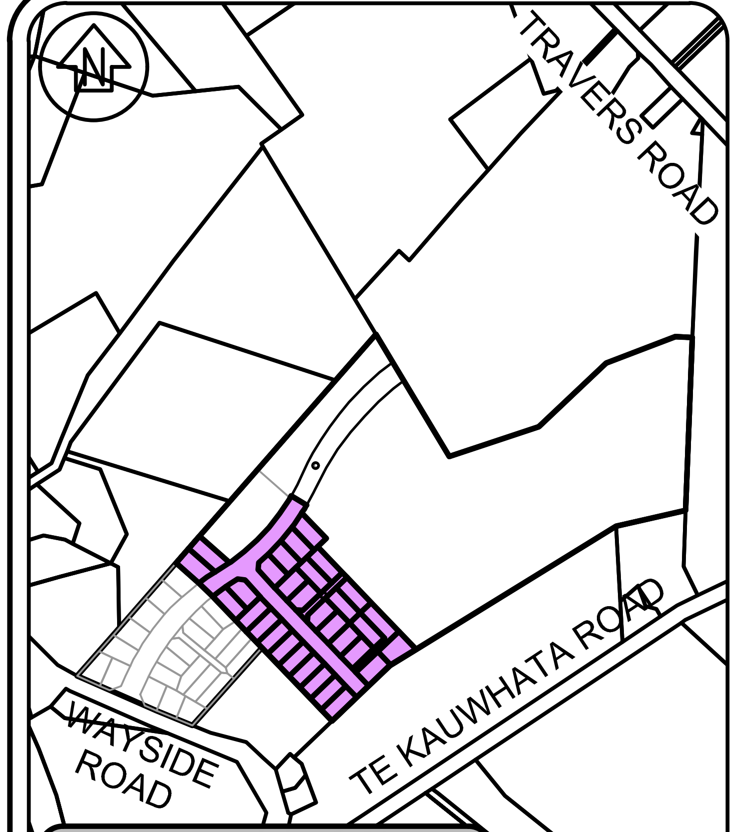
STAGING PLAN - STAGE 1 DETAIL PLAN
LOT 306 DP 495940
WAYSIDE ROAD - TE KAUWHATA
PREPARED FOR: TE KAUWHATA LAND LTD

Version #19

Firm's Name
Blue Wallace
Surveyors Ltd.
25 Harwood Street, P O Box 38,
Hamilton Central, HAMILTON.
Phone (07) 839 7799, Fax (07) 839 4455

File Reference
14/012

Drawing No.
5 of 13



LOCATION DIAGRAM

Scale 1:10000

MEMORANDUM OF EASEMENT

PURPOSE	SERV. TENE.	SHOWN	DOM. TENE.
RIGHT OF WAY RIGHT TO CONVEY ELECTRICITY, TELECOMMUNI-CATIONS & WATER	LOT 204 HEREON	D	LOTS 39 - 42 HEREON
RIGHT TO DRAIN SEWER & WATER	LOT 44 HEREON	E	LOTS 43 & 45 HEREON

SCHEDULE OF EXISTING EASEMENT IN GROSS

PURPOSE	SERV. TENE.	SHOWN	GRANTEE
RIGHT OF WAY RIGHT TO DRAIN SEWAGE	LOT 301 HEREON	C	WAIKATO DISTRICT COUNCIL

NOTE:

1) ALL AREAS AND DIMENSIONS SUBJECT TO FINAL SURVEY AND APPROVAL FROM THE WAIKATO DISTRICT COUNCIL

2) LEGAL DESCRIPTION: LOT 300
DP ??????
(CT. ??????)

3) TOTAL AREA: 13.8156 ha.

4) ZONE: LIVING ZONE TE KAUWHATA WEST

5) AERIAL PHOTO SUBJECT TO DISTORTION

6) ALL LEVELS ARE IN TERMS OF MOTURIKI DATUM

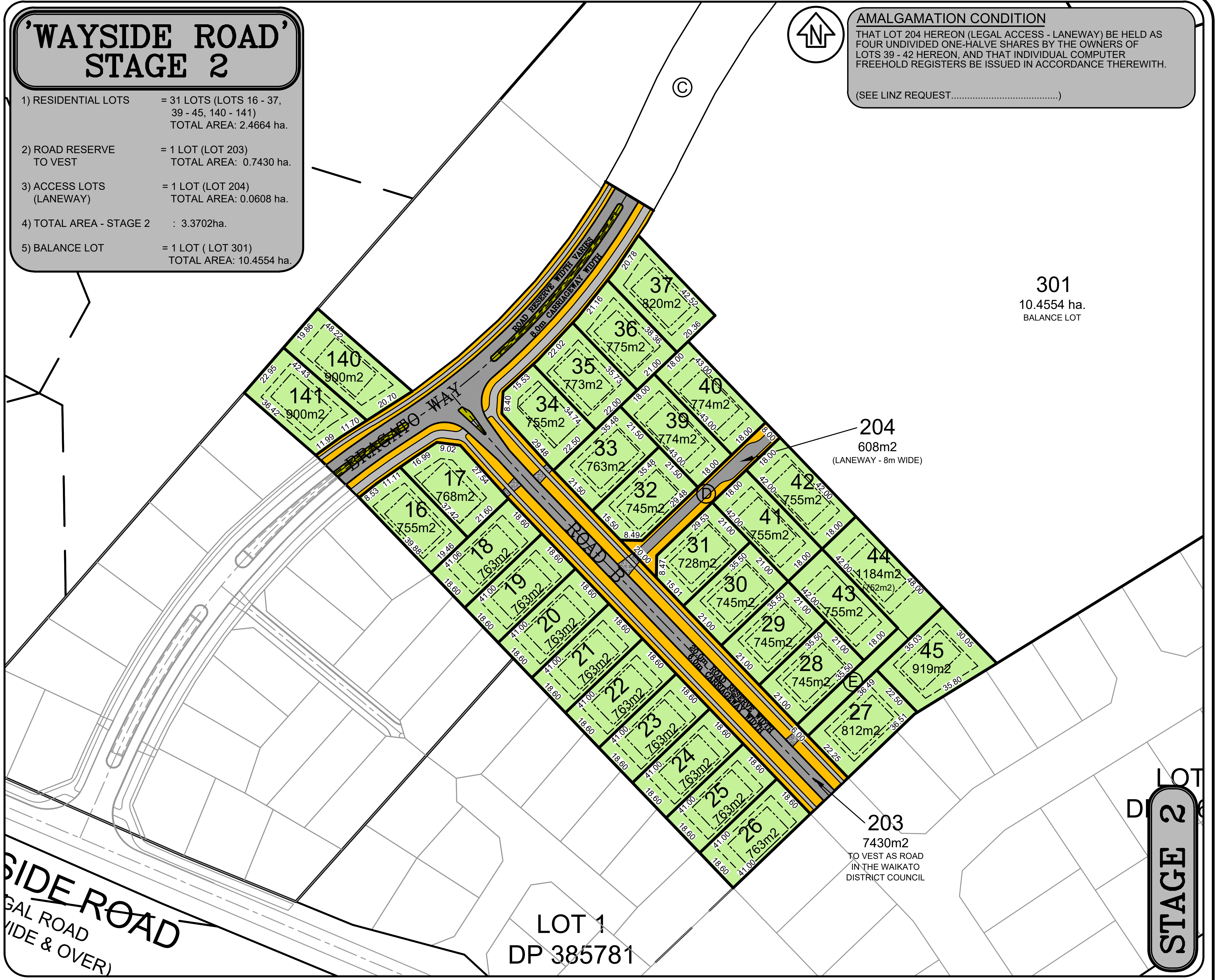
'WAYSIDE ROAD' STAGE 2

1) RESIDENTIAL LOTS	= 31 LOTS (LOTS 16 - 37, 39 - 45, 140 - 141) TOTAL AREA: 2.4664 ha.
2) ROAD RESERVE TO VEST	= 1 LOT (LOT 203) TOTAL AREA: 0.7430 ha.
3) ACCESS LOTS (LANEWAY)	= 1 LOT (LOT 204) TOTAL AREA: 0.0608 ha.
4) TOTAL AREA - STAGE 2	: 3.3702ha.
5) BALANCE LOT	= 1 LOT (LOT 301) TOTAL AREA: 10.4554 ha.

AMALGAMATION CONDITION

THAT LOT 204 HEREON (LEGAL ACCESS - LANEWAY) BE HELD AS FOUR UNDIVIDED ONE-HALVE SHARES BY THE OWNERS OF LOTS 39 - 42 HEREON, AND THAT INDIVIDUAL COMPUTER FREEHOLD REGISTERS BE ISSUED IN ACCORDANCE THEREWITH.

(SEE LINZ REQUEST...)



SCALE: 1:1500 @A3	DATE: JULY 2019

No.	Amendment	Init.	Date.	
				Designed. WAB
1	APPLICATION SCHEME PLAN #19	WAB	07/19	Drawn. WAB 25 JULY 2019
2				Checked.
3				Approved.

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STAGING PLAN - STAGE 2 DETAIL PLAN
LOT 300 DP ?????? (STAGE 1)
WAYSIDE ROAD - TE KAUWHATA
PREPARED FOR: TE KAUWHATA LAND LTD

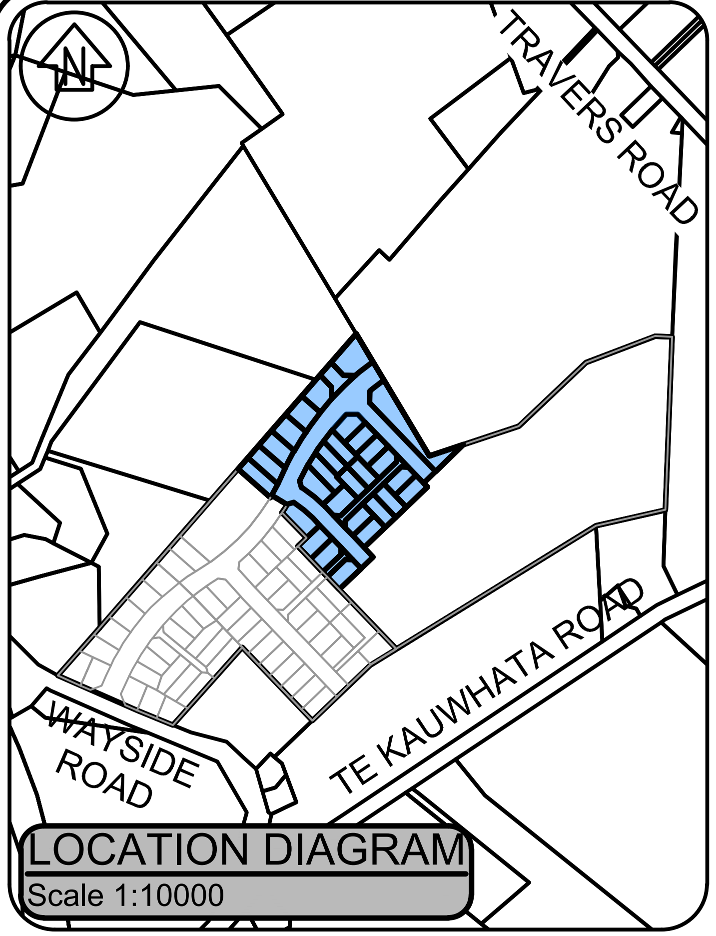
Version #19

Firm's Name

Blue Wallace
Surveyors Ltd.
25 Harwood Street, P O Box 38,
Hamilton Central, HAMILTON.
Phone (07) 839 7799, Fax (07) 839 4455

File Reference
14/012

Drawing No.
6 of 13



LOCATION DIAGRAM
Scale 1:10000

AMALGAMATION CONDITION

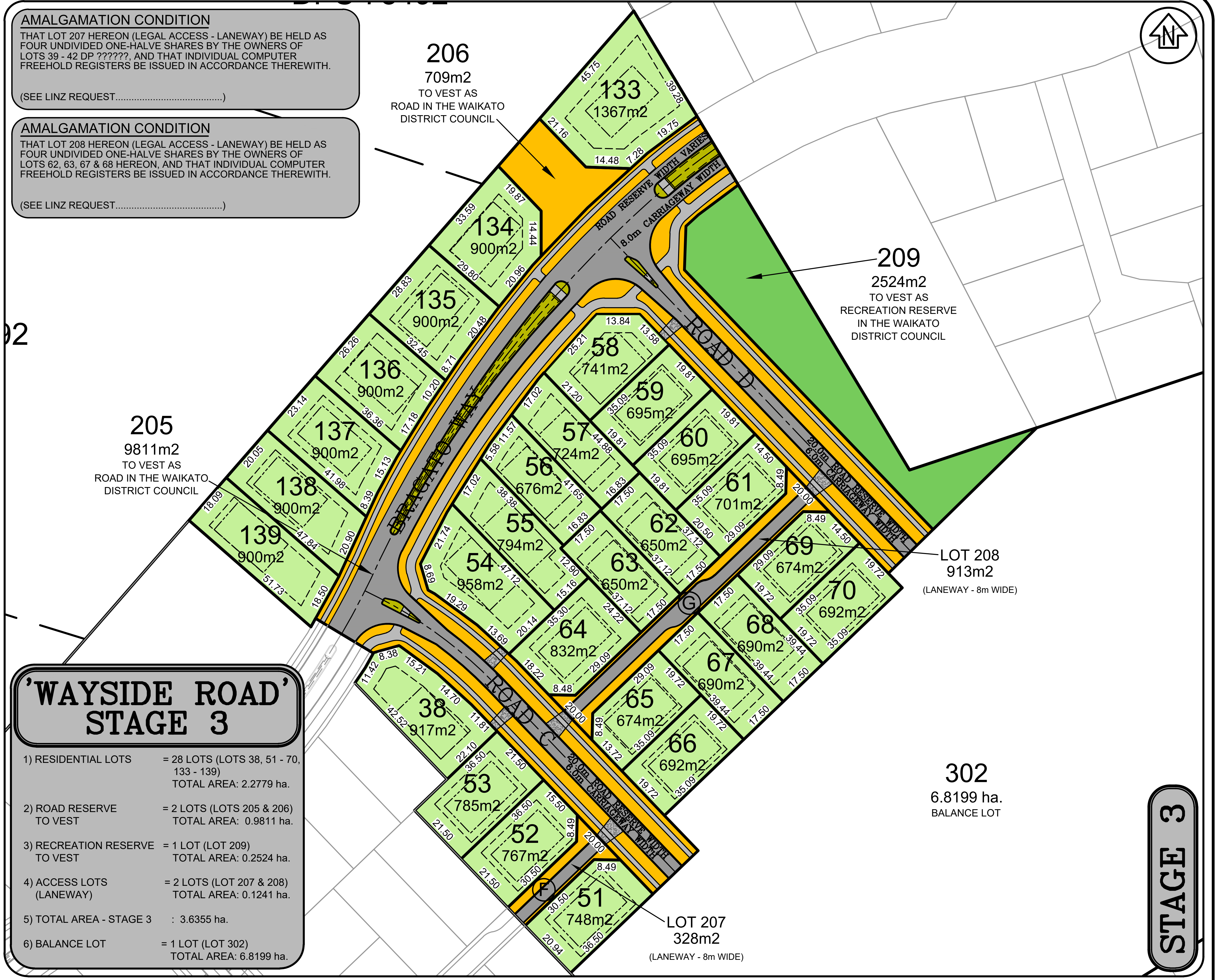
THAT LOT 207 HEREON (LEGAL ACCESS - LANEWAY) BE HELD AS FOUR UNDIVIDED ONE-HALVE SHARES BY THE OWNERS OF LOTS 39 - 42 DP ??????, AND THAT INDIVIDUAL COMPUTER FREEHOLD REGISTERS BE ISSUED IN ACCORDANCE THEREWITH.

(SEE LINZ REQUEST...)

AMALGAMATION CONDITION

THAT LOT 208 HEREON (LEGAL ACCESS - LANEWAY) BE HELD AS FOUR UNDIVIDED ONE-HALVE SHARES BY THE OWNERS OF LOTS 62, 63, 67 & 68 HEREON, AND THAT INDIVIDUAL COMPUTER FREEHOLD REGISTERS BE ISSUED IN ACCORDANCE THEREWITH.

(SEE LINZ REQUEST...)



PURPOSE	SERV. TENE.	SHOWN	DOM. TENE.
RIGHT OF WAY RIGHT TO CONVEY ELECTRICITY, TELECOMMUNICATIONS & WATER	LOT 207 HEREON	F	LOTS 39 - 42 DP ?????? (STAGE 2)
RIGHT TO DRAIN SEWER & WATER	LOT 208 HEREON	G	LOTS 62, 63, 67, 68 HEREON

'WAYSIDE ROAD' STAGE 3

1) RESIDENTIAL LOTS = 28 LOTS (LOTS 38, 51 - 70, 133 - 139)
TOTAL AREA: 2.2779 ha.

2) ROAD RESERVE TO VEST = 2 LOTS (LOTS 205 & 206)
TOTAL AREA: 0.9811 ha.

3) RECREATION RESERVE TO VEST = 1 LOT (LOT 209)
TOTAL AREA: 0.2524 ha.

4) ACCESS LOTS (LANEWAY) = 2 LOTS (LOT 207 & 208)
TOTAL AREA: 0.1241 ha.

5) TOTAL AREA - STAGE 3 : 3.6355 ha.

6) BALANCE LOT = 1 LOT (LOT 302)
TOTAL AREA: 6.8199 ha.

NOTE:

1) ALL AREAS AND DIMENSIONS SUBJECT TO FINAL SURVEY AND APPROVAL FROM THE WAIKATO DISTRICT COUNCIL

2) LEGAL DESCRIPTION: LOT 301
DP ??????
(CT. ??????)

3) TOTAL AREA: 10.4554 ha.

4) ZONE: LIVING ZONE TE KAUWHATA WEST

5) AERIAL PHOTO SUBJECT TO DISTORTION

6) ALL LEVELS ARE IN TERMS OF MOTURIKI DATUM

SCALE: 1:1250 @A3

DATE: JULY 2019

No.	Amendment	Init.	Date.	
1	APPLICATION SCHEME PLAN #19	WAB	07/19	Designed. WAB
2				Drawn. WAB 25 JULY 2019
3				Checked.
				Approved.

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STAGING PLAN - STAGE 3 DETAIL PLAN
LOT 302 DP ?????? (STAGE 2)
WAYSIDE ROAD - TE KAUWHATA
PREPARED FOR: TE KAUWHATA LAND LTD

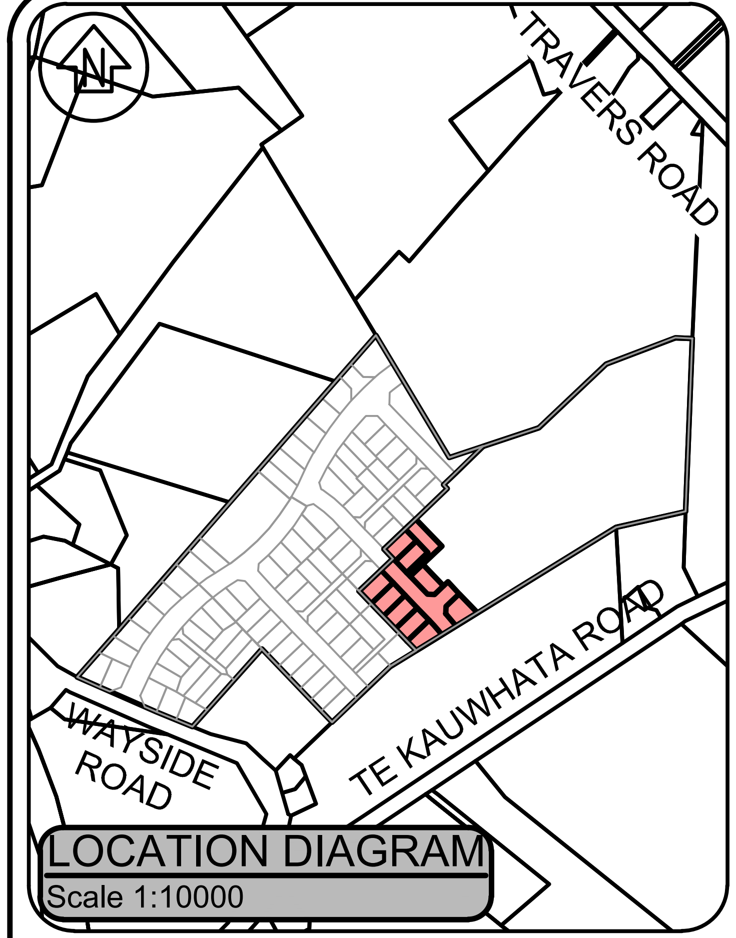
Version #19

Firm's Name

Blue Wallace
Surveyors Ltd.
25 Harwood Street, P O Box 38,
Hamilton Central, HAMILTON.
Phone (07) 839 7799, Fax (07) 839 4455

File Reference
14/012

Drawing No.
7 of 13



LOCATION DIAGRAM
Scale 1:10000

NOTE:

1) ALL AREAS AND DIMENSIONS SUBJECT TO FINAL SURVEY AND APPROVAL FROM THE WAIKATO DISTRICT COUNCIL

2) LEGAL DESCRIPTION: LOT 302
DP ??????
(CT. ??????)

3) TOTAL AREA: 6.8199 ha.

4) ZONE: LIVING ZONE TE KAUWHATA WEST

5) AERIAL PHOTO SUBJECT TO DISTORTION

6) ALL LEVELS ARE IN TERMS OF MOTURIKI DATUM

'WAYSIDE ROAD' STAGE 4

1) RESIDENTIAL LOTS = 10 LOTS (LOTS 46 - 50, 74 - 77 & 82)
TOTAL AREA: 0.7663 ha.

2) ROAD RESERVE TO VEST = 1 LOT (LOT 210)
TOTAL AREA: 0.2776 ha.

3) TOTAL AREA - STAGE 4 : 1.0439 ha.

4) BALANCE LOT = 1 LOT (LOT 303)
TOTAL AREA: 5.7760 ha.

SCALE: 1:1250 @A3			DATE: JULY 2019	
No.	Amendment	Init.	Date.	Designed. WAB
1	APPLICATION SCHEME PLAN #19	WAB	07/19	Drawn. WAB 25 JULY 2019
2				Checked.
3				Approved.

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STAGING PLAN - STAGE 4 DETAIL PLAN
LOT 302 DP ?????? (STAGE 3)
WAYSIDE ROAD - TE KAUWHATA
PREPARED FOR: TE KAUWHATA LAND LTD

Version #19

Firm's Name
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Surveyors Ltd.
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File Reference
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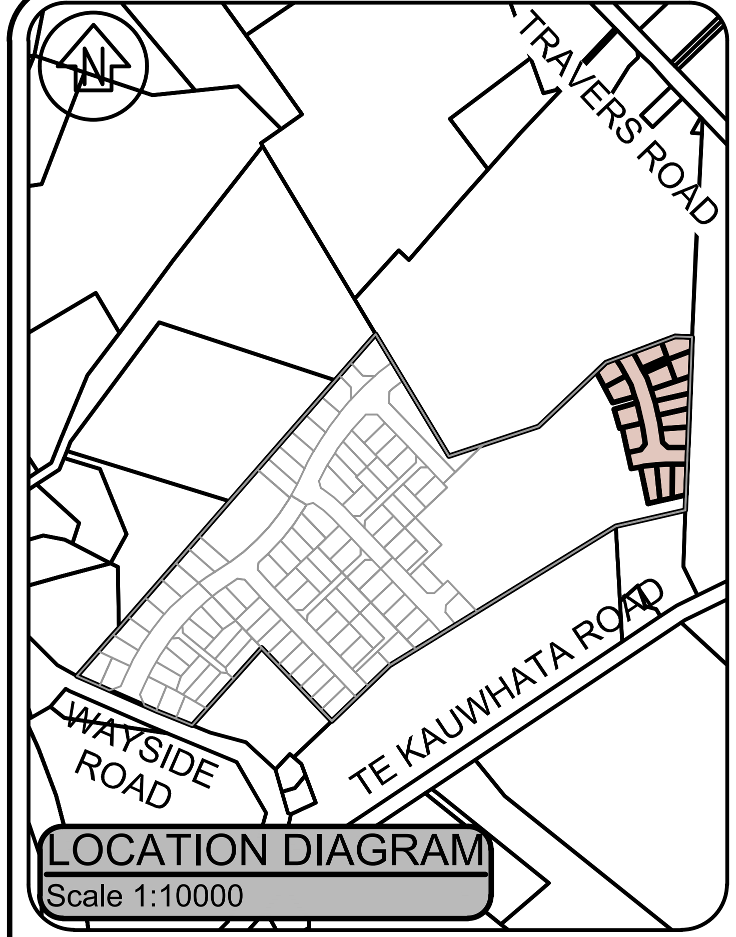
Drawing No.
9 of 13



LOCATION DIAGRAM
Scale 1:10000

MEMORANDUM OF EASEMENT

PURPOSE	SERV. TENE.	SHOWN	DOM. TENE.
RIGHT OF WAY RIGHT TO CONVEY ELECTRICITY, TELECOMMUNI-CATIONS & WATER	LOT 108 HEREON	H	LOT 109 HEREON
RIGHT TO DRAIN SEWER & STORMWATER	LOT 109 HEREON	I	LOT 108 HEREON

NOTE:

1) ALL AREAS AND DIMENSIONS SUBJECT TO FINAL SURVEY AND APPROVAL FROM THE WAIKATO DISTRICT COUNCIL

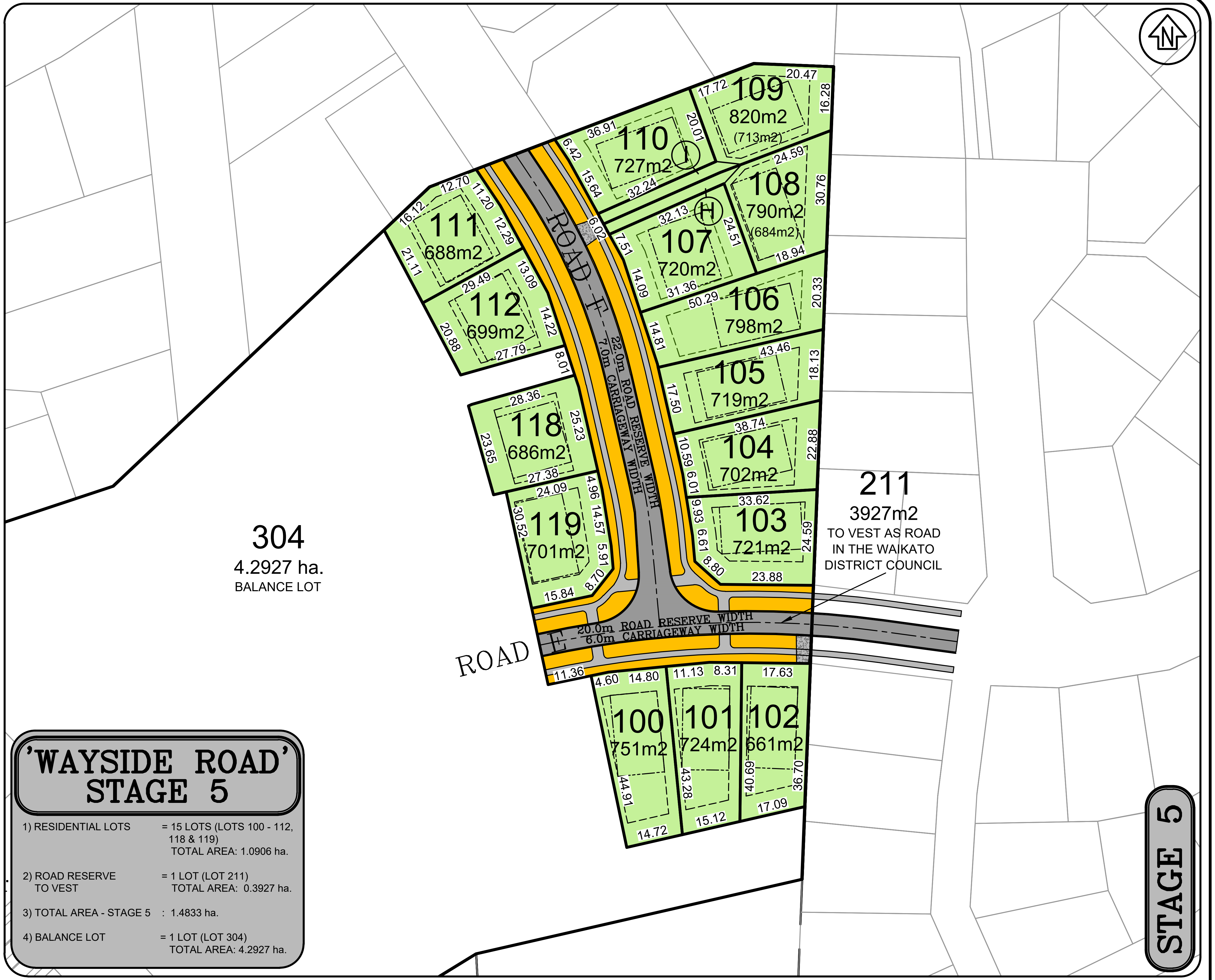
2) LEGAL DESCRIPTION: LOT 303
DP ??????
(CT. ??????)

3) TOTAL AREA: 5.7760 ha.

4) ZONE: LIVING ZONE TE KAUWHATA WEST

5) AERIAL PHOTO SUBJECT TO DISTORTION

6) ALL LEVELS ARE IN TERMS OF MOTURIKI DATUM



'WAYSIDE ROAD' STAGE 5

1) RESIDENTIAL LOTS = 15 LOTS (LOTS 100 - 112, 118 & 119)
TOTAL AREA: 1.0906 ha.

2) ROAD RESERVE TO VEST = 1 LOT (LOT 211)
TOTAL AREA: 0.3927 ha.

3) TOTAL AREA - STAGE 5 : 1.4833 ha.

4) BALANCE LOT = 1 LOT (LOT 304)
TOTAL AREA: 4.2927 ha.

SCALE: 1:1000 @A3
DATE: JULY 2019

No.	Amendment	Init.	Date.	Designed. WAB
1	APPLICATION SCHEME PLAN #19	WAB	07/19	Drawn. WAB 25 JULY 2019
2				Checked.
3				Approved.

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STAGING PLAN - STAGE 5 DETAIL PLAN
LOT 303 DP ?????? (STAGE 4)
WAYSIDE ROAD - TE KAUWHATA
PREPARED FOR: TE KAUWHATA LAND LTD

Version #19

Firm's Name

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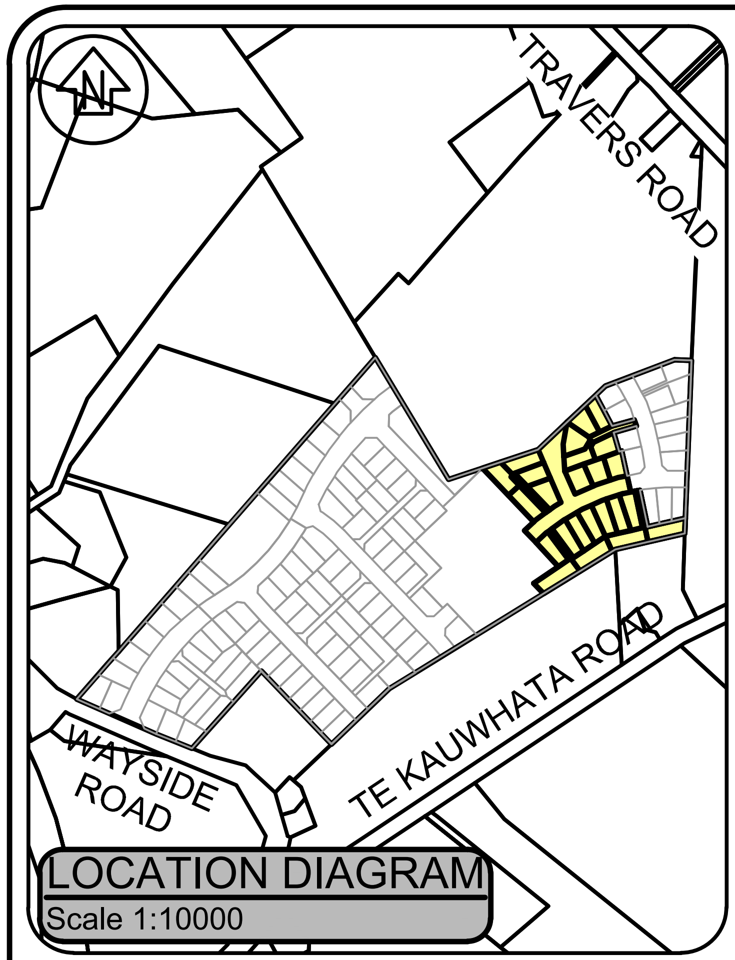
Drawing No.
10 of 13



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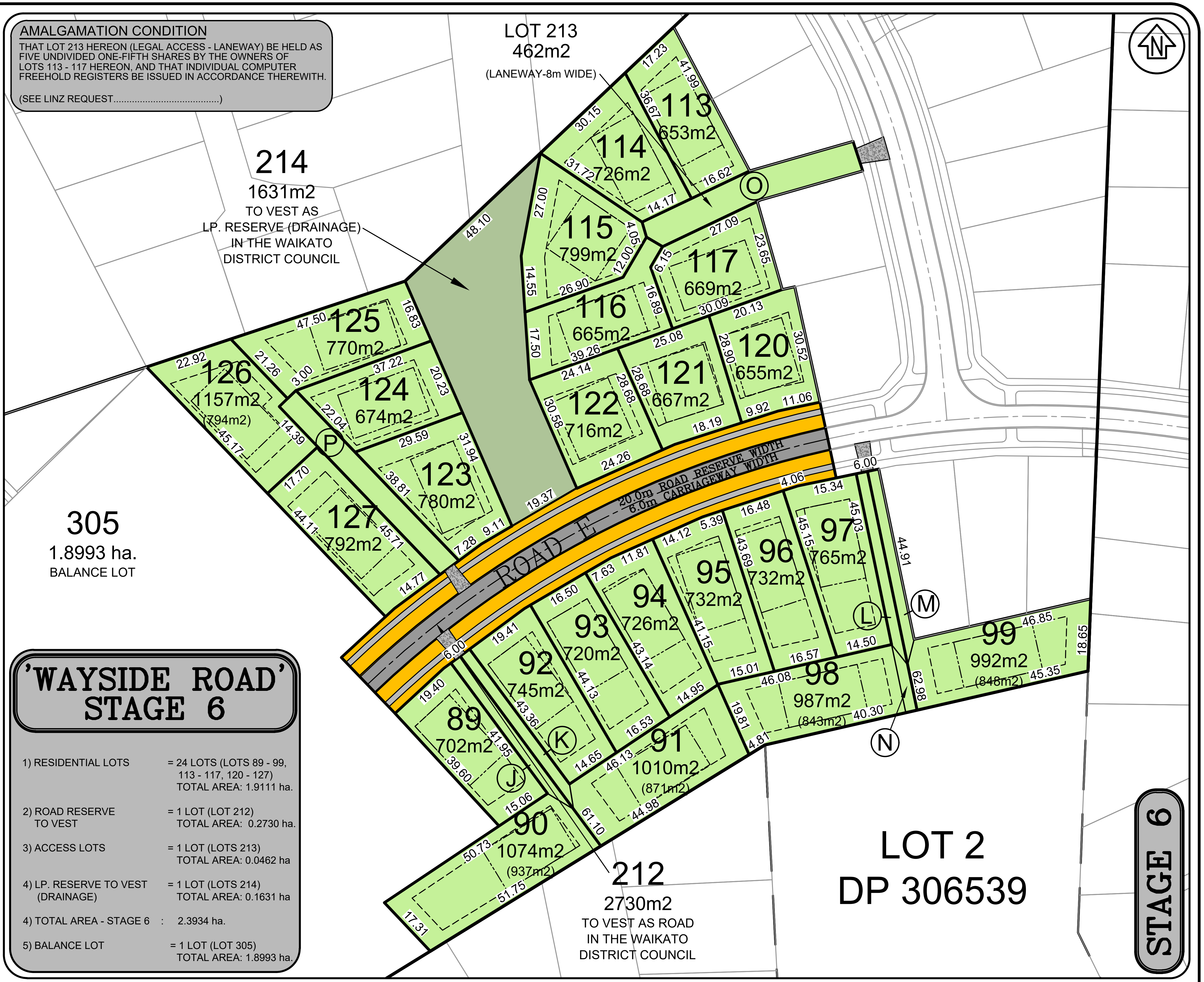
Scale 1:10000



AMALGAMATION CONDITION

THAT LOT 213 HEREON (LEGAL ACCESS - LANEWAY) BE HELD AS FIVE UNDIVIDED ONE-FIFTH SHARES BY THE OWNERS OF LOTS 113 - 117 HEREON, AND THAT INDIVIDUAL COMPUTER FREEHOLD REGISTERS BE ISSUED IN ACCORDANCE THEREWITH.

(SEE LINZ REQUEST..)

'WAYSIDE ROAD' STAGE 6

1) RESIDENTIAL LOTS = 24 LOTS (LOTS 89 - 99, 113 - 117, 120 - 127)
TOTAL AREA: 1.9111 ha.

2) ROAD RESERVE TO VEST = 1 LOT (LOT 212)
TOTAL AREA: 0.2730 ha.

3) ACCESS LOTS = 1 LOT (LOTS 213)
TOTAL AREA: 0.0462 ha

4) LP. RESERVE TO VEST (DRAINAGE) = 1 LOT (LOTS 214)
TOTAL AREA: 0.1631 ha

4) TOTAL AREA - STAGE 6 : 2.3934 ha.

5) BALANCE LOT = 1 LOT (LOT 305)
TOTAL AREA: 1.8993 ha.

MEMORANDUM OF EASEMENT

PURPOSE	SERV. TENE.	SHOWN	DOM. TENE.
RIGHT OF WAY RIGHT TO CONVEY ELECTRICITY, TELECOMMUNICATIONS & WATER RIGHT TO DRAIN SEWER & WATER	LOT 90 HEREON	J	LOT 91 HEREON
	LOT 91 HEREON	K	LOT 90 HEREON
	LOT 98 HEREON	L	LOT 99 HEREON
	LOT 99 HEREON	M	LOT 98 HEREON
	LOT 213 HEREON	O	LOTS 113 - 117 HEREON
	LOT 126 HEREON	P	LOTS 124 & 125 HEREON
RIGHT TO CONVEY ELECTRICITY, TELECOMMUNICATIONS & WATER RIGHT TO DRAIN SEWER & WATER	LOT 98 HEREON	N	LOT 2 DP 306539

NOTE:

1) ALL AREAS AND DIMENSIONS SUBJECT TO FINAL SURVEY AND APPROVAL FROM THE WAIKATO DISTRICT COUNCIL

2) LEGAL DESCRIPTION: LOT 304
DP ??????
(CT. ??????)

3) TOTAL AREA: 4.2927 ha.

4) ZONE: LIVING ZONE TE KAUWHATA WEST

5) AERIAL PHOTO SUBJECT TO DISTORTION

6) ALL LEVELS ARE IN TERMS OF MOTURIKI DATUM

SCALE: 1:1000 @A3

DATE: JULY 2019

No.	Amendment	Init.	Date.	
				Designed. WAB
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2				Checked.
3				Approved.

S:\2014\14012 - TK LAND\CAD\FOR RC APPROVAL\14012 APPLICATION SCHEME #19 24-07-19.DWG

STAGING PLAN - STAGE 6 DETAIL PLAN
LOT 304 DP ?????? (STAGE 5)
WAYSIDE ROAD - TE KAUWHATA
PREPARED FOR: TE KAUWHATA LAND LTD

Version #19

Firm's Name
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Surveyors Ltd.
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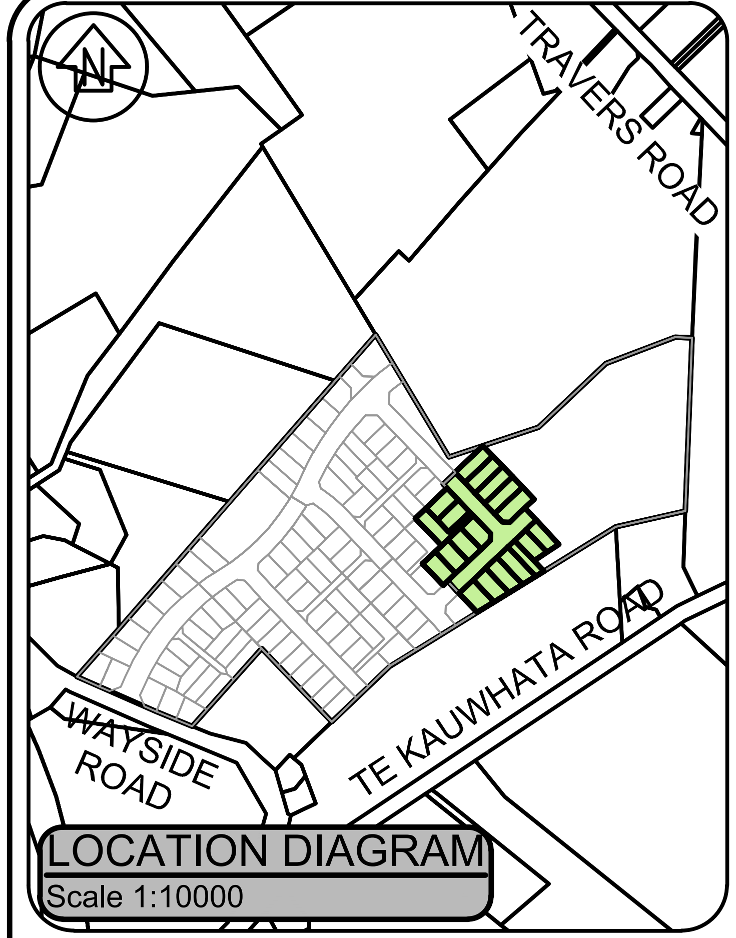
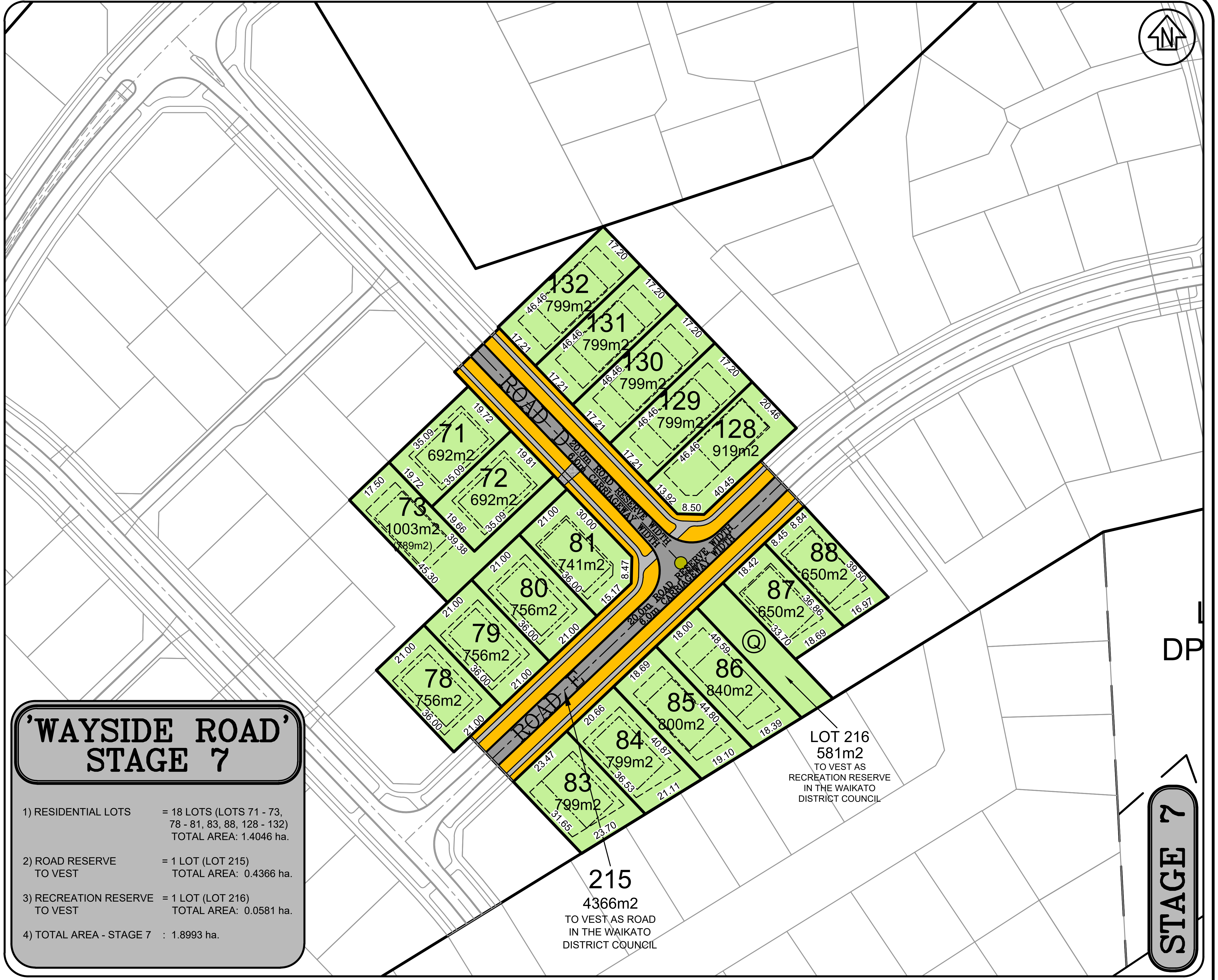
File Reference
14/012

Drawing No.
11 of 13



LOCATION DIAGRAM
Scale 1:10000



MEMORANDUM OF EASEMENT IN GROSS

PURPOSE	SERV. TENE.	SHOWN	GRANTEE
RIGHT OF WAY RIGHT TO DRAIN SEWAGE & WATER	LOT 216 HEREON	Q	WAIKATO DISTRICT COUNCIL

NOTE:

1) ALL AREAS AND DIMENSIONS SUBJECT TO FINAL SURVEY AND APPROVAL FROM THE WAIKATO DISTRICT COUNCIL

2) LEGAL DESCRIPTION: LOT 305
DP ??????
(CT. ??????)

3) TOTAL AREA: 1.8993 ha.

4) ZONE: LIVING ZONE TE KAUWHATA WEST

5) AERIAL PHOTO SUBJECT TO DISTORTION

6) ALL LEVELS ARE IN TERMS OF MOTURIKI DATUM

'WAYSIDE ROAD'
STAGE 7

1) RESIDENTIAL LOTS = 18 LOTS (LOTS 71 - 73, 78 - 81, 83, 88, 128 - 132)
TOTAL AREA: 1.4046 ha.

2) ROAD RESERVE TO VEST = 1 LOT (LOT 215)
TOTAL AREA: 0.4366 ha.

3) RECREATION RESERVE TO VEST = 1 LOT (LOT 216)
TOTAL AREA: 0.0581 ha.

4) TOTAL AREA - STAGE 7 : 1.8993 ha.

SCALE: 1:1250 @A3
DATE: JULY 2019

No.	Amendment	Init.	Date.	
				Designed. WAB
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2				Checked.
3				Approved.

S:\2014\14012 - TK LAND\CAD\FOR RC APPROVAL\14012 APPLICATION SCHEME #19 24-07-19.DWG

STAGING PLAN - STAGE 7 DETAIL PLAN
LOT 305 DP ?????? (STAGE 6)
WAYSIDE ROAD - TE KAUWHATA
PREPARED FOR: TE KAUWHATA LAND LTD

Version #19

Firm's Name
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Phone (07) 839 7799, Fax (07) 839 4455

File Reference
14/012

Drawing No.
12 of 13

Exhibit B: Western Catchment Stormwater Discharge Consent

Consent Evaluation Report

Applicant:	Te Kauwhata Land Limited	**File No.:**	61 66 91A
Address of Site:	24 Wayside Road, Te Kauwhata	**Project Code:**	RC24015
Application Number:	APP138832		

1 Introduction

Wainui Environmental Ltd has made application for resource consent on behalf of Te Kauwhata Land Ltd (the applicant) to divert and discharge stormwater in association with a proposed residential subdivision development at 24 Wayside Road, Te Kauwhata at or about map reference NZTM 1788455E 5857487N.

Reference Id	Activity Subtype	Activity Description
AUTH138832.01.01	Water - stormwater	To divert and discharge stormwater from Stages 1 - 3 of a residential subdivision, 24 Wayside Road, Te Kauwhata.

This report assesses the application for the consent outlined above and the associated effects and recommends whether consent should be granted for the proposed activity. The application is for a new consent.

The application WRC doc ref# is 11230665. A s92(1) RMA Request for further information response was provided by the applicant in regards to stormwater via an email sent on 13 November 2017.

2 Background and Description of Proposal

2.1 Background and Site Description

The applicant is proposing to develop a 163 lot subdivision (Stages 1 – 3) of a residential subdivision within approximately 10 ha of land at 24 Wayside Road, Te Kauwhata.

The entire site is approximately 16.5 ha and is made up of two predominant catchments and associated discharge points. The Western Sub-catchment comprises Stages 1 – 3 of the proposed development and is the subject of this application. The sub-catchment is bounded by high points to the north, adjacent to the Jetco Subdivision, to the east (Eastern Sub-catchment and the Boldero Block), and along Wayside Road to the south.

The subject site is located along Wayside Road and Te Kauwhata Road which is approximately 2 km west of the Te Kauwhata township and 1.5 km from the Southern Expressway. The site is classified as Te Kauwhata West Zone within the Waikato District Plan.

The site currently discharges west into three distinct ephemeral watercourses which join up approximately 130 m downstream of the site. The combined watercourse then continues to the north and flows under Travers Road via an existing culvert and ultimately discharging into the Whangamarino Wetland approximately 650 m downstream of the Travers Road culvert. It has been identified that this existing culvert under Travers Road is undersized and as a result there are both upstream and downstream flooding issues. Waikato District Council (WDC) has proposed that this culvert will be upgrade but there is no indication from WDC when this is likely to occur.

It has also been identified that there are downstream flooding issues immediately downstream of the subject site, in particular at the residential ancillary dwelling at 58 Wayside Road (downstream of the proposed western wetland discharge point).

The applicant has previously been granted an earthworks consent AUTH136015.01.01 in 2016 to enable the soil disturbance, vegetation removal and gully infilling associated with Stage 1 – 3A.

2.2 Proposed Activity

The proposed development will result in the creation of impervious surfaces from roading, buildings and other additional hardstand areas that will require stormwater management. As such, the applicant has engaged Wainui Environmental Ltd to prepare a Stormwater Management Plan to address the stormwater issues for the Western Sub-catchment.

The applicant is proposing to increase the maximum site building coverage on each residential lot above what is allowed for in the District Plan. It is proposed to increase building coverage to 30% of the applicable net site area, with a maximum impermeable surface per lot no more than 50% of the net site area. The stormwater design has been prepared based on this impervious surface assumption.

The proposed stormwater management objectives for the stormwater management system are as follows:

- Water quality treatment to remove 75% of total suspended solids;
- Extended detention (capture and slow release of 22.6mm rainfall);
- Attenuation of the 2 and 10 year ARI post development peak flows to pre-development peak flow rates; and
- Attenuation of the 100 year ARI post development peak flows to 80% of the pre-development peak flow rates.

The Waikato District Plan Appendix B B5.7 states that stormwater systems in the Te Kauwhata Structure Plan area should incorporate low impact design features such as rain tanks, swales, infiltration trenches, rain gardens. The applicant is proposing to use a stormwater wetland and swales within the subdivision to treat and attenuate stormwater runoff from the site and to meet the above listed objectives.

In addition, there is an existing 600mm dia culvert under Wayside Road which discharged to an ephemeral gully on the eastern side of the road (upstream catchment of Watercourse 1). As part of the proposed subdivision work at 24 Wayside Road the culvert has been extended by approximately 130m through the proposed subdivision, discharging to Watercourse 1 at the north-western boundary of the site, downstream of the original discharge point. The proposed culvert extension was detailed in a report ‘Proposed Culvert Extension, Wayside Road, Te Kauwhata” (20/4/17).

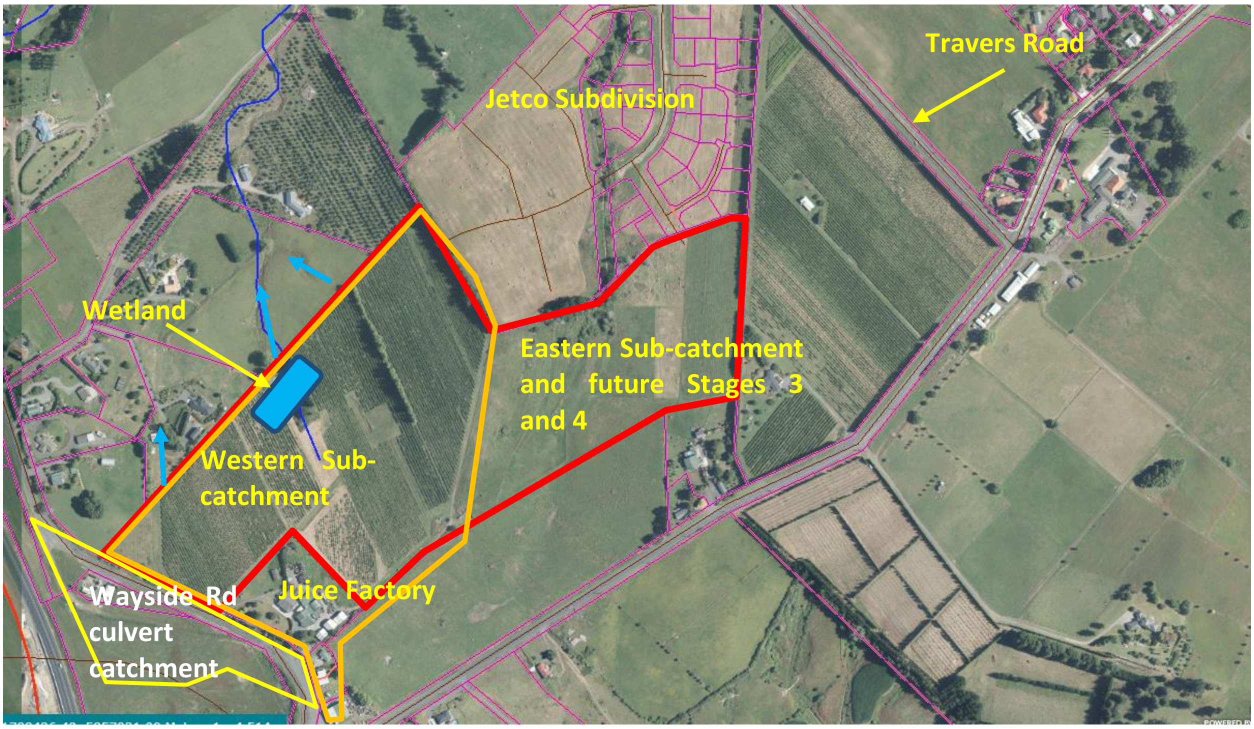

Figure 1: Location of Proposed Subdivision Development 24 Wayside Road, Te Kauwhata

3 Status of Activities under the Plans

The consent activity applied for is regulated through the Waikato Regional Plan (WRP). The WRP became operative on 28 September 2007 therefore no other plans apply. The status of the activity under the WRP is described below:

Rule 3.5.11.4 of the WRP permits discharges of stormwater to water from urban catchments less than 1 ha. The proposed discharges are unable to meet the requirements of permitted activity Rule 3.5.11.4 as the catchment area of the proposed development discharging to the unnamed tributary of the Whangamarino Wetland is greater than 1 ha (approximately 10 ha). Therefore, the discharge of stormwater into water would be considered a discretionary activity under Rule 3.5.11.8 of the WRP, subject to certain conditions being met.

Waikato District Council (WDC)

A consent application for land use and subdivision has been previously lodged and granted in 2015 by the Waikato District Council.

4 Consultation/Affected Party Approvals

4.1 Iwi

The applicant has not consulted with local iwi regarding this particular stormwater discharge application. As the site has been previously granted subdivision and earthworks consents which are ongoing, and the fact that the applicant is proposing best practice mitigation measures in terms of a constructed wetland and low impact design for water quality treatment and attenuation, I do not consider that iwi are an affected party to this application.

4.2 Other Parties

The applicant has received Subdivision Consent from WDC and it is understood that the public stormwater assets will vest with WDC upon their completion along with this stormwater discharge consent.

The applicant has stated that no consultation has taken place with downstream landowners as the proposed constructed wetland will provide attenuation of stormwater discharges from the development to 80% of the pre-development flow for the 100 year flood event. This is considered acceptable and in accordance for managing existing flood effects on downstream properties as per TP 10 Guidelines.

5 Process Matters

Resource consent application APP138832 was received as complete on 12 October 2017. The application was placed on hold under section 92(1) of the RMA on 26 October 2017 for further information. Upon receipt of final information, the application was taken off hold on 14 November 2017. There were no further processing matters of note.

Date	**Process Detail**
12/10/2017	Lodged
17/10/2017	Active
27/10/2017	On Hold s92(1) RMA
14/11/2017	Active
30/11/2017	S37A(4) RMA 5 day extension

6 Statutory Considerations

The application was lodged on 12 October 2017 and therefore all amendments to the RMA apply. For the purposes of decision making the application is further assessed as a discretionary activity. It is also considered in accordance with section 104B of the Act which has regard to the determination of applications for discretionary and non-complying activities.

Section 104 Consideration of Applications
In summary, subject to Part 2 the following matters in Section 104(1) of the RMA are relevant to the consideration of the proposal.

"(1) When considering an application for a resource consent and any submissions received, the consent authority must, subject to Part 2, have regard to –

- *a) any actual and potential effects on the environment of allowing the activity; and*
- *b) any relevant provisions of—*
    - *i. a national environmental standard:*
    - *ii. other regulations:*
    - *iii. a national policy statement:*
    - *iv. a New Zealand coastal policy statement:*
    - *v. a regional policy statement or proposed regional policy statement:*
    - *vi. a plan or proposed plan; and*
- *c) any other matter the consent authority considers relevant and reasonably necessary to determine the application."*

The following statutory instruments and policy documents have been considered in the evaluation of this application:

- Resource Management Act (1991) (RMA);
- National Policy Statement for Freshwater Management (2014);
- Regional Policy Statement (2016) (RPS);
- Waikato Regional Plan (2007) (WRP); and
- Waikato-Tainui Raupatu (Waikato River) Settlement Claims Act 2010.

Due consideration has been given to Section 104 of the RMA. The actual and potential effects have been discussed in the sections below along with measures being taken to avoid, remedy or mitigate these effects.

Section 105
Furthermore, in relation to any discharge permits, Section 105(1) requires that the consent authority must have regard to a number of additional matters as follows:

> *"(1) If an application is for a discharge permit or coastal permit to do something that would contravene section 15 or section 15B, the consent authority must, in addition to the matters in section 104(1), have regard to—*
>
> *(a) the nature of the discharge and the sensitivity of the receiving environment to adverse effects; and*
>
> *(b) the applicant's reasons for the proposed choice; and*
>
> *(c) any possible alternative methods of discharge, including discharge into any other receiving environment.*

Section 107
Furthermore, Section 107 states that a consent authority shall not grant a discharge consent where the discharge may cause any of the following after reasonable mixing:

(a) The production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials:
(b) Any conspicuous change in the colour or visual clarity:
(c) Any emission of objectionable odour:
(d) The rendering of fresh water unsuitable for consumption by farm animals:
(e) Any significant adverse effects on aquatic life.

6.1 Assessment of Environmental Effect

<u>Existing environment</u>
Section 104(1)(a) provides that when considering a consent application, the consent authority must, subject to Part 2, have regard to the actual and potential effects on the environment of allowing the activity.

The environment in this case has been extensively modified by land development in this case as a vineyard and subsequent drainage activites.

<u>Permitted baseline</u>
Section 104(2) provides that when forming an opinion about the actual or potential effects of the activity, the consent authority may disregard an adverse effect of the activity on the environment if the regional plan permits an activity with that effect. This is often referred to as the "permitted baseline" and calls for a discretionary decision to be exercised by the consent authority as to whether or not to discount such permitted effects. This provision requires consideration of:

> "the existing environment overlaid with such relevant activity (not being a fanciful activity) as is permitted by the plan. Thus, if the activity permitted by the plan will create some adverse effect on

> the environment, that adverse effect does not count in the s104 or s105 assessments…it is deemed to be already affecting the environment…The consequence is that only other or further adverse effects emanating from the proposal under consideration are brought to account."
> (Arrigato v ARC)

There are no permitted activity baseline effects relevant to the applications and as such none have been discounted.

Having considered the nature of the proposal and the supporting information provided with the application, the actual and potential environmental effects to consider are those relating to:

- Catchment hydrology and water quality and quantity effects from stormwater discharges post development

6.1.1 Catchment Hydrology and Water Quality Effects Post Development

Urbanisation, development of greenfield site areas and the way in which stormwater management is incorporated into the design of developing catchments, will significantly influence catchment hydrology in the post development situation. Essentially it is the loss of pervious surface area and the piping of stormwater to surface waters that result in reduced rates of groundwater infiltration and recharge, and greater volumes of runoff being discharged from developed catchments. These changes often result in the lowering of groundwater tables, extreme dry and wet weather flow fluctuations in surface waters, and an overall limiting effect in the ability of surface waters to support aquatic life.

In addition to these effects, increased stormwater volumes and peak rates of discharge can result in adverse flooding hazards, stream channel scouring and erosion and diminished receiving water health through reduced ecosystem viability, habitat availability and downstream sedimentation effects. These effects are particularly common in urban catchments that have inappropriately designed stormwater management systems, or no particular management system (the widespread historical situation in existing urban catchments).

Stormwater runoff from roads and impervious areas are known to contain contaminants such as metals, hydrocarbons and sediment. A number of these contaminants, if allowed to enter the environment, will accumulate in the sediments of the receiving environment and may reach levels that are toxic to biota. The highest potential source of contaminants from roading surfaces are heavy metals and hydrocarbons from tyre/brake wear, exhaust fumes and fuel/lubricant leaks onto road surfaces. Other catchment contaminants can include gross pollutants (i.e rubbish) and sediments from associated development and sports fields as well as nutrient input from gardening/landscaping activities and possible sewer overflows/illegal connections. As contaminants often become attached to sediment particles, removal of suspended sediment provides partial treatment of stormwater.

As previously discussed in Section 2 of this report, the applicant has engaged Wainui Environmental Ltd to prepare a Stormwater Management Plan to address the stormwater issues for the Western Sub-catchment development.

Environmental Engineer Ms Megan Wood (Wainui Consulting Ltd) has undertaken an assessment of the stormwater management design on behalf of Waikato Regional Council and provided a comprehensive analysis of the proposal below (technical report dated 21 November 2017 doc ref# 11449563).

Wetland

The applicant has undertaken hydrologic modelling using HEC HMS. Flows have been proposed through the proposed wetland and rainfall data was taken from HRIDS V3 for the Te Kauwhata site. Post development analysis was determined using 2.1 degree climate change adjusted rainfall.

The applicant is proposing a banded bathymetry wetland with areas of raised bunds to maximize contact with vegetation and prevent short-circuiting. The wetland footprint is 2.09% of the contributing catchment.

Landscaping is proposed to be undertaken in accordance with HCC ITS Section 4 Table 4-35. A concept planting plan will be prepared for the wetland. Planting will be required within and below the permanent water level at RL20.30m to meet a target 80% vegetative cover. Vegetation is recommended to shade area of open water, including the inlet forebay to reduce thermal warming effects.

An Operation and Maintenance Plan manual will be prepared for the proposed wetland. I have included conditions of consent for both the O&M Plan as well as the proposed Wetland Planting Plan in the attached resource consent certificate.

Wetland design details are summarized below:

Plan area (top of batter)	3860m^3	3.2% of contributing catchment area
Water quality volume	622m^3	Based on 1/3 2 year 24 hr duration rainfall depth (22.6mm). Halved as ED is provided in the wetland.
Forebay	115m^3 at 1.2m deep RL22.9m	15% of WQV Depth is too shallow
Permanent water level	RL20.3m	Dead storage plan area 2.03% of contributing catchment area
Wetland depth	Variable, 5 pools are proposed within the wetland to create banded bathymetry. Pools 1, 2 and 4 0.3m deep, Pool 3 0.4m deep, Pool 5 0.9m deep.	
EDV	1243m^3. ED level = RL20.924m (624mm above PWL). Peak discharge = 0.029m^3/s.	Based on 1/3 2 year 24 hr duration rainfall depth (22.6mm).
2 year storage	2,293m^3 RL21.402m	
10 year storage	3,705m^3 RL22.03m	
100 year storage	6,059m^3 RL22.81m	
Outlet	1200mm manhole rise ED outlet = 133mm dia Orifice at IL20.3m for 2 and 10 year outlet. 0.506mm slot at IL20.94m for 100 year ARI outlet.	
Emergency Spillway	Rectangular spillway 10m wide at RL22.80m.	
Batter slopes	Above PWL (RL20.3m): 1V:2H Below PWL: 1V:10H max	

The forebay depth is proposed to be 0.9m, shallower than the base of the adjacent wetland pond. This is considered a shallow forebay, as forebays are usually the deepest portion of a wetland. The applicant was requested to deepen the forebay. The applicant has advised that the forebay has been designed as a 'perched' forebay to enable maintenance machinery to access the base of the forebay from the proposed maintenance platform, whilst still providing 15% of the WQ volume in accordance with TP10. The forebay has been deepened to 1.2m providing approximately 115m^3 volume (18% of the WQV). Miss Wood considers the forebay design is now acceptable.

Downstream watercourse assessment

It is proposed to combine the flow from the Western Sub-catchment and discharge the full catchment via a wetland to 'Watercourse 2' on the western boundary. Watercourse 2 is a well-defined channel, heavily vegetated in parts. This results in increased catchment draining to Watercourse 2, and a comparative decrease in the catchment draining to Watercourses 1 and 3. The following table summarises the proposed changes:

Watercourse	Existing catchment (ha)	Proposed catchment (ha)	% change
1	4.16	1.88	-55
2	8.86	12.20	+27
3	0.907	0	-100

The discharge to Watercourse 2 is proposed to increase by 27%. The applicant advises that the proposed wetland over-attenuates flows in the 2 and 10 year ARI events below the pre-development rates. The table below summaries peak flows for the site from the proposed wetland.

ARI event	Pre-developed peak flows (m^3/s)	Post-developed peak flows (m^3/s)	% change
2	0.645	0.324	-50
10	1.321	0.981	-26
100	2.842	2.272	-20

It is considered that the level of over-attenuation provided offsets the increase in catchment area draining to Watercourse 2. Ms Wood considers the level of attenuation that will be achieved by the proposed wetland meets the required criteria of matching pre-development peak flow rates for the 2 and 10 year ARI events, and 80% of 100 year ARI event.

Swales

The applicant is proposing that vegetated swales will be constructed within the Western Sub-catchment along Bragato Way to treat stormwater runoff from the road reserve (1.44ha) and approximately 40m^2 of unconnected driveway area from each of the lots fronting the road (there are 38 lots contributing 40m^2 each which equates to a catchment area of 0.152ha (reported in Table 5).

Four separate swales are proposed centrally within the road corridor with lengths varying from 65m to 110m. Stormwater from lots and road carriageway will sheet flow into the swales. Treated stormwater will then be discharged via catchpit to the piped reticulation and ultimately the Western Wetland. The applicant is proposing that the catchment treated by the swales has been excluded from the wetland water quality volume assessment. However the wetland Extended Detention Volume (EDV) has been sized for this catchment**.** Comments were made that if the runoff from the swales is draining to the wetland then the water quality volume will need to be sized to allow for this contributing catchment, otherwise the input will serve to dilute the level of treatment provided for the un-treated portion of catchment draining to the wetland. The applicant has increased the wetland water quality volume to include the 'swale treatment' catchment. The total water quality volume in the wetland is now proposed at 622m^3. This results in an enhanced treatment train for the Bragato Way swale catchment which Ms Wood considers acceptable.

Proposed typical swale details are as follows:

- Typical swale dimensions: 0.5m wide base, side slopes 1V:8H;
- Maximum longitudinal grades 6.5%;
- Mannings n of 0.25 (based on a planted channel);
- Minimum residence time of 9 mins (in accordance with TP10 design criteria); and
- The swales are designed to convey the 10 year ARI flows.

Detailed design shall be undertaken at Engineering design stage to confirm each swale can treat its contributing catchment in accordance with TP10 design criteria. The design information provided for the vegetated swales is considered acceptable.

Overland flow

Overland flow within Stages 1-3 will be conveyed within the road carriageway, draining to the low point within Bragato Way and into the proposed wetland. Secondary overland flow will bypass the forebay. In the event the main outlet is blocked the emergency spillway will activate. This proposed overland flow is considered acceptable.

In summary, Ms Wood has reviewed the overall stormwater management design and assessed the calculations and engineering drawings for the proposed Stages 1 – 3 of the Te Kauwhata Land Ltd development and considers them to be acceptable.

6.2 Policy Statements, Plans and Regulations

6.2.1 National environment standards

Currently there are five NESs that have come into effect - the National Environmental Standards for Air Quality (where various standards have been in effect since October 2004); Sources of Human Drinking Water; Electricity Transmission Activities; Telecommunication Facilities and Assessing and Managing Contaminants in Soil to Protect Human Health. Only one NES is relevant to this application.

National Environmental Standard for Sources of Human Drinking Water

The National Environmental Standard for Sources of Human Drinking Water commenced on 20 June 2008. This standard is a regulation enacted by an Order in Council, under s43 of the Resource Management Act. The regulation requires that a regional council must not grant a water or discharge permit for an activity that will occur upstream of a drinking water abstraction point if specific criteria at the point of abstraction are exceeded. The matters to be considered as part of an assessment are dependent on the permit being sought and the level of effects on any drinking water supplier located downstream or down gradient of the activity.

Under this regulation a regional council may also impose a condition of consent on any resource consent application requiring the consent holder to notify, as soon as reasonably practical, the registered drinking-water supply operators and the regional council if the activity leads to an event that, or as a consequence of an event, results in a significant adverse effect on the quality of the water at the abstraction point.

In terms of the stormwater discharge activity associated with this consent process, I have reviewed WRC's OurMaps database and can confirm that there are no registered drinking water supplies immediately downstream of the discharge activity.

6.2.2 Other regulations

There are no other regulations considered relevant to this consent process

6.2.3 National policy statements (including NZ Coastal Policy Statement)

National Policy Statement for Freshwater Management 2014

The Freshwater Management NPS has policies and objectives that direct local government to manage water in an integrated and sustainable way while providing for economic growth within specified water quality and quantity limits. The NPS requires regional councils to develop standards to safeguard the life supporting capacity of water bodies, with the objective that water quality will be maintained or improved. This will involve protection of high quality water bodies and implementation of methods to improve degraded water bodies. In the interim, when considering consent applications regional councils must have regard for any effects (actual or cumulative) that contaminants contained in the discharge may have on freshwater and fresh water ecology. The principle of adopting best practicable options in order to minimise effects is included in the decision making process under this policy.

As the discharge consent sought is considered to be a minor activity, it is my opinion that should the application be granted, it will not be contrary to the Freshwater NPS.

The NZ Coastal Policy Statement is not relevant to this application.

6.2.4 Regional Policy Statement

The RPS is a high-level broad-based document containing objectives and policies the purpose of which is to provide an overview of the resource management issues of the region and to achieve integrated management of the natural and physical resources of the Region.

The Waikato Regional Council's new RPS was made operative on 20 May 2016.

Key issues in the RPS relating to this proposal are the state of resources (Issue 1.1), effects of climate change (Issue 1.2), managing the built environment (Issue 1.4), and the relationship of tangata whenua with the environment (te taiao) (Issue 1.5), and the health and well being of the Waikato River (Issue 1.6). There are a number of overlapping objectives under each of these relevant to this proposal. These are listed as follows:

- Integrated management of natural and physical resources (Objective 3.1);
- Resource use and development (objective 3.2);
- Decision making (Objective 3.3);
- Health and well being of the Waikato River (Objective 3.4)
- Adapting to climate change (Objective 3.6)
- Ecosystem services (Objective 3.8);
- Relationship of tangata whenua with the environment (Objective 3.9);
- Built environment (Objective 3.12)
- Mauri and values of fresh water bodies (Objective 3.14);
- Riparian areas and wetlands (Objective 3.16)
- Ecological integrity and indigenous biodiversity (Objective 3.19)
- Amenity (Objective 3.21)
- Natural character (Objective 3.22)

Relevant policies include integrated management (Policy 4), air (Policy 5), built environment (Policy 6), fresh water bodies (Policy 8), landscape natural character and amenity (Policy 12), and soils (Policy 14).

The Fresh water topics are related to this application in that council must establish measureable limits and target for each water body to manage the adverse effects on them. Council must adopt a catchment-based approach to ensure the integrated management of water resources, including the management of quantity and quality of surface waters and groundwater and land and water interactions, including the impacts of land use activities. While the limit-setting process is yet to be undertaken by a regional plan change, the application may still be assessed against the matters to be considered when identifying values (8.1.2A), including: e) the life supporting capacity of fresh water bodies, f) the ability of people and communities to provide for their social, economic and cultural wellbeing, g) adverse cumulative effects of land use activities on fresh water bodies and k) lawfully consented discharges and takes.

Policy 8.3: All fresh water bodies; provides guidance to manage the effects of activities to maintain or enhance the identified values of fresh water bodies by reducing contaminants. Non-point source discharges are to be managed where they are likely to result in loss of values of a water body.

In assessing this application, these objectives and policies have been considered and conditions have been recommended to avoid, remedy, or mitigate potential adverse effects. On this basis I consider that the proposal is consistent with the RPS.

6.2.5 Regional Plan

The Waikato Regional Plan ("WRP") is operative. The purpose of regional plans is to help the Council carry out its functions under s30 of the RMA.

Plan	**Rule/Objective**
Waikato Regional Plan	3.5.11.8 - Discretionary Activity Rule - Discharge of Stormwater

3.1 Water Resources

3.1.2 Objective

The management of water bodies in a way which ensures:

a. that people are able to take and use water for their social, economic and cultural wellbeing

b. net improvement[1] of water quality across the Region

c. the avoidance of significant adverse effects on aquatic ecosystems

d. the characteristics of flow regimes are enhanced where practicable and justified by the ecological benefits

e. the range of uses of water reliant on the characteristics of flow regimes are maintained or enhanced

f. the range of reasonably foreseeable uses of ground water and surface water are protected

g. that significant adverse effects on the relationship tangata whenua as Kaitiaki have with water and their identified taonga such as waahi tapu, and native flora and fauna that have customary and traditional uses in or on the margins of water bodies, are remedied or mitigated

h. the cumulative adverse effects on the relationship tangata whenua as Kaitiaki have with water their identified taonga such as waahi tapu, and native flora and fauna that have customary and traditional uses that are in or on the margins of water bodies are remedied or mitigated

i. the management of non-point source discharges of nutrients, faecal coliforms and sediment to levels that are consistent with the identified purpose and values for which the water body is being managed

j. the natural character of the coastal environment, wetlands and lakes and rivers and their margins (including caves), is preserved and protected from inappropriate use and development

k. concentrations of contaminants leaching from land use activities and non-point source discharges to shallow ground water and surface waters do not reach levels that present significant risks to human health or aquatic ecosystems

l. that the positive effects of water resource use activities and associated existing lawfully established infrastructure are recognised, whilst avoiding, remedying or mitigating adverse effects on the environment.

Section 3.2.3 Management of Water Resource

Policy 1: Management of Water Bodies
Policy 4: Waikato Region Surface Water Class

Section 3.5.3 Discharges

Policy 1: Enabling Discharges to Water that will have only Minor Adverse Effects
Policy 6: Tangata Whenua Uses and Values
Policy 7: Stormwater Discharges

The **Proposed Waikato Regional Plan Change 1 – Waikato and Waipa River Catchments (Healthy Rivers)**, has been publicly notified and therefore came into effect on 22 October 2016 and must be given regard to. However, part of the plan has been withdrawn where Hauraki iwi authorities have mana whenua. The subject site lies within the area to be withdrawn from the plan change and therefore this application will not be given regard to.

In assessing this application I have given regard to the above objectives and policies of the WRP. I consider that this proposal is consistent with the WRP, provided that the recommended consent conditions and requirements of the relevant rule are complied with.

6.3 Other Matters

WDC Comprehensive Stormwater Discharge Consent

In addition to the above policies and plans it is anticipated that the proposed stormwater diversion and discharge activities and associated infrastructural assets, will eventually be transferred to WDC. In this regard WDC was granted a 'Comprehensive Stormwater Discharge Consent' (CSDC) in 2008 which, among other provisions, includes a technical certification process to enable all newly established stormwater activities within the administrative area of Te Kauwhata (AUTH105647.01.01) to become authorised and managed through this consent.

Waikato-Tainui Environmental Plan

The Waikato-Tainui Environmental Plan provides a background to, and identifies key, resource based issues for Waikato-Tainui. The plan sets out Waikato-Tainui's vision statement for environmental and heritage issues and key strategic objectives such as tribal identity and integrity, including "to grow our tribal estate and manage our natural resources." The plan is designed to enhance Waikato-Tainui participation in resource and environmental management.

I have assessed this proposal against the objectives and outcomes within this plan and overall I consider that the proposal is consistent with this Iwi Environmental Plan.

6.4 Waikato-Tainui Raupatu (Waikato River) Settlement Claims Act 2010 or Ngati Tuwharetoa, Raukawa, and Te Arawa River Iwi Waikato River Act 2010 or Nga Wai o Maniapoto (Waipa River) Act 2012

6.4.1 Vision and strategy

As of 24 September 2010 Waikato Regional Council, in addition to any requirement specified in the RMA, must have particular regard to the vision and strategy (Schedule 2 of the Settlement Claims Act). These Acts apply to applications relating to the Waikato River; or activities in the catchment that affect the Waikato River.

The Vision and Strategy is the embodiment of the settlement act, and seeks to restore and protect the health and wellbeing of the Waikato River for future generations. The sections of the Vision and Strategy for which I have had particular regard in terms of this activity are:

a) the restoration and protection of the health and wellbeing of the Waikato River;
e) the integrated, holistic and coordinated approach to management of the natural, physical, cultural and historic resources of the Waikato River;
g) The recognition and avoidance of adverse cumulative effects, of activities undertaken both within the Waikato River and within its catchments on the health and wellbeing of the Waikato River;
h) The recognition that the Waikato River is degraded and should not be required to absorb further degradation as a result of human activities;
i) The protection and enhancement of significant sites, fisheries, flora and fauna;
k) The restoration of water quality within the Waikato River so that it is safe for people to swim in and take food from over its entire length;

The Vision and Strategy forms part of the Proposed Waikato Regional Policy Statement and is given effect through the plans administered by Regional and territorial authorities along the river. The settlement also provides for joint management agreements between Waikato-Tainui and the local authorities; participation in river-related resource consent decision-making; recognition of a Waikato-Tainui environmental plan; provision for regulations relating to fisheries and other matters managed under conservation legislation and an integrated river management plan.

While the subject site is located some distance from the main river channel, development activities within the greater catchment area have the potential to impact on the health and well being of the river. The proposed activities incorporate design features which are considered appropriate to maintain the quality of water and to avoid remedy or mitigate any potential adverse effects on the Whangamarino Wetland (a sub-catchment of the Waikato River) with consent conditions recommended to address these items.

I have included conditions on the attached schedule which aim to maintain the quality of water and to avoid, remedy or mitigate any potential adverse effects on the Waikato River and its tributaries.

I have given regard to the Vision and Strategy and consider that the proposal is consistent with the Vision and Strategy document.

6.4.2 Customary activities

There are no customary activities relevant to this consent process.

6.5 Protected Customary Rights and/or Customary Marine Titles (Marine and Coastal Act 2011 (Takutai Moana))

The application does not fall within an area where a customary marine right has come into effect or a protected customary rights order is sealed.

6.6 Relevant Part 2 Considerations

Part 2 of the Resource Management Act 1991 details the matters that must be considered for the sustainable management of natural and physical resources including matters of national importance, other matters, and the Treaty of Waitangi.

The proposed activity has been considered in the context of the matters outlined in Part 2 of the Resource Management Act 1991 and in my opinion the activity does not compromise any of these issues and therefore the overall purpose of the Act.

7 Discussion/Conclusions

Wainui Environmental Ltd has made application for resource consent on behalf of Te Kauwhata Land Ltd to divert and discharge stormwater in association with a proposed residential subdivision development at 24 Wayside Road, Te Kauwhata at or about map reference NZTM 1788455E 5857487N.

The main potential adverse environmental effects associated with the proposed works are considered to be:

- Catchment hydrology and water quality and quantity effects from stormwater discharges post development

However, for the reasons outlined in section 6.1 of this report, I am satisfied that these adverse effects can be avoided, remedied or mitigated such that the adverse environmental effects associated with the activities are likely to be minor.

The overall proposal has been assessed in respect to their consistency with the objectives and policies of the Regional Council's policies and plans, and the statutory provisions of the RMA. It has further been considered in accordance with section 10B of the RMA which has regard to the determination of applications for discretionary or non-complying activities. Provided the activity is undertaken in accordance with the application for consent and subsequent supporting documentation, and the recommended consent conditions in the attached Resource Consent Certificate, I consider that it will not be inconsistent with Council's policy and plans, or the statutory provisions of the RMA.

I consider the proposed stormwater management system has been designed in accordance with TP108 and TP10 and will provide a good level of water quality treatment for a development of this size and nature.

For these reasons I recommend that consent be granted subject to the consent conditions in the attached Resource Consent Certificate.

- Resource Consent AUTH138832.01.01 – 35 years (Stormwater Discharge)

The following considerations have been taken into account in recommending these terms:

- The stormwater discharge is designed to be permanent;
- The design of the stormwater management system;
- The various proposed mitigation measures and ongoing monitoring requirements;
- The actual and potential adverse effects of the proposed activities on the environment;
- Consistency with Regional Council policies, objectives and plans;
- Consistency with the purpose and principals of the RMA; and
- Waikato Regional Council's internal guidelines for consent duration.

8 Monitoring

Waikato Regional Council has a statutory obligation under section 35 of the RMA to monitor the effects of resource consents being exercised in its region. The actual and reasonable costs incurred by Waikato Regional Council when undertaking this monitoring will be recovered from the consent holder. It should be noted that if a condition(s) of consent is not complied with, the activity may receive an elevated level of monitoring until Waikato Regional Council is satisfied that the consent is being exercised in accordance with consent conditions.

It is recommended that the consent holder undertakes regular monitoring and maintenance of the stormwater system (inclusive of all stormwater management devices, and in particular the wetland pond and grassed swales to ensure optimum stormwater treatment is achieved at all times.

With respect to the wetland pond, it is recommended that ongoing maintenance of planted areas is undertaken to ensure plants become well established and replaced when needed.

The actual and reasonable costs incurred by Waikato Regional Council when undertaking this monitoring will be recovered from the consent holder.

9 Recommended Decision

I recommend that in accordance with s104B resource consent AUTH138832.01.01 be granted in accordance with the duration and conditions prescribed in the attached Resource Consent Certificate for the following reasons:

- The activity will have no more than minor actual or potential adverse effects on the environment
- The activity is not contrary to any relevant plans or policies
- The activity is consistent with the purpose and principles of the Resource Management Act 1991

Brian Richmond **Date: 1 December 2017**

Resource Officer - Infrastructure

Resource Use

10 Decision

That the resource consent application is granted in accordance with the above recommendations.

Hugh Keane

Team Leader - Infrastructure

Resource Use

Date: 1 December 2017

RESOURCE CONSENT CERTIFICATE

Resource Consent: AUTH138832.01.01

File Number: 61 66 91A

Pursuant to the Resource Management Act 1991, the Regional Council hereby grants consent to:

Te Kauwhata Land Limited
C/- McAlley Group Ltd
PO Box 1138
Cambridge 3450

(hereinafter referred to as the Consent Holder)

Consent Type: Discharge Permit

Consent Subtype: Water - stormwater

Activity authorised: To discharge stormwater from a residential subdivision, Wayside Road, Te Kauwhata.

Location: 24 Wayside Road - Te Kauwhata

Map reference: NZTM 1788455 E 5857487 N

Consent duration: This consent will commence on the date of decision notification and expire on 30 November 2052.

Subject to the conditions overleaf:

Conditions
General

1. The stormwater diversion and discharge activities authorised by this resource consent shall be undertaken in general accordance with the application for this resource consent (WRC doc ref #11230665), titled ***'TKL Lands Ltd – TKL Subdivision, Wayside Road, Te Kauwhata - Stormwater Management Plan (Western Sub-catchment)'***, dated 20 September 2017, prepared by Wainui Environmental Ltd and in particular the document titled ***'Resource Consent s92 – Request for Further Information – APP138832 – TKL Lands Ltd – TKL Subdivision, Wayside Road, Te Kauwhata'*** dated 10 November 2017, and all other subsequent supporting documentation submitted, except where otherwise required in the resource consent conditions below. Where there is any discrepancy between the application documents and the resource consent conditions, the conditions below shall prevail.

2. The stormwater diversion and discharge activities authorised by this resource consent relates to the Te Kauwhata Lands Ltd Development Stages 1 - 3 'stormwater network' which includes, but is not necessarily limited to, the constructed wetland treatment pond, swales, catchpits, stormwater inlet and outlet structures, pipe reticulation, and overland flow paths (as described in the application). No alterations shall be made to the stormwater network (other than to meet the requirements of this resource consent) without the prior written approval of the Waikato Regional Council acting in a technical certification capacity.

3. The consent holder shall be responsible for the design, structural integrity and maintenance of the stormwater network, and shall operate and maintain the stormwater network to avoid, remedy or mitigate any actual or potential adverse effects of the stormwater diversion and discharge activities authorised by this resource consent on the downstream watercourse (a tributary of the Whangamarino Wetland).

4. The consent holder shall appoint a representative, who shall be the Waikato Regional Council's principal contact person in regard to matters relating to this resource consent. The consent holder shall inform the Waikato Regional Council of the representative's name and how they can be contacted. Should that person change during the term of this resource consent, the consent holder shall give written notice to the Waikato Regional Council of the new representative's name and how they can be contacted.

5. The consent holder shall be responsible for all contracted operations related to the exercise of this resource consent, and must ensure contractors are made aware of the conditions of this resource consent and ensure compliance with those conditions.

6. The consent holder shall not undertake any changes to the stormwater network which would increase the scale or intensity of the actual and potential adverse effects of the stormwater diversion and discharge activities authorised by this consent on the environment.

Detailed Engineering Design

7. The consent holder shall retain an appropriately qualified and experienced person to complete and finalise detailed engineered design drawings and plans of the stormwater network, comprising the constructed wetland treatment pond, swales, catchpits, stormwater inlet and outlet structures, pipe reticulation, and overland flow paths. The detailed engineering design and drawings shall be to a standard acceptable to the Waikato Regional Council and shall be submitted to the Waikato Regional Council for written approval in a technical certification capacity, prior to construction of the permanent stormwater network.

Stormwater Operations and Maintenance Plan

8. The consent holder shall retain an appropriately qualified and experienced person to prepare a ***'Stormwater Operations and Maintenance Plan'*** for the stormwater network inclusive of all stormwater management devices for each relevant stage of development. The ***'Stormwater Operations and Maintenance Plan'*** shall be developed in consultation with Waikato District Council and in general accordance with Auckland Council's Technical Publication 10 document titled *"Design Guideline Manual for Stormwater Treatment Devices"* (Auckland Council, 2003). The ***'Stormwater Operations and Maintenance Plan'*** shall provide for all operational, maintenance, planting and monitoring measures associated with the stormwater discharge activity authorised by this resource consent and may include but not be limited to:

    a. A programme for regular monitoring and inspection of the stormwater management system including details of monitoring and inspection frequency;

    b. A programme for the regular collection and disposal of debris and sediment collected by the stormwater management devices to ensure that attenuation volumes are not compromised and that appropriate contaminant removal procedures are established;

    c. Inspection checklists for all aspects of the stormwater management system including monitoring and management of the constructed wetlands;

    d. Details of who will be responsible for the operation and maintenance works;

    e. Details of recording and reporting of operation and maintenance activities;

    The ***Stormwater Operations and Maintenance Plan'*** shall be submitted to the Waikato Regional Council for written approval in a technical certification capacity, prior to commencement of the activities authorised by this resource consent.

9. The consent holder shall implement the operations, monitoring, and maintenance activities adopted by the ***'Stormwater Operations and Maintenance Plan'***, in accordance with that plan and as required by Condition 8 of this resource consent.

10. The ***'Stormwater Operations and Maintenance Plan'*** shall be reviewable at any time with the agreement of both the Waikato Regional Council and the consent holder. Any proposed changes to the ***'Stormwater Operations and Maintenance Plan'*** shall be subject to the written approval of the Waikato Regional Council acting in a technical certification capacity.

Wetland Planting Plan

11. The consent holder shall retain an appropriately qualified and experienced person to prepare a ***'Wetland Planting Plan'*** for the constructed wetland treatment pond. The ***'Wetland Planting Plan'*** shall be developed in consultation with the Waikato District Council and in general accordance with Auckland Council's Technical Publication 10 document titled *"Design Guideline Manual for Stormwater Treatment Devices"* (Auckland Council, 2003) and Auckland Council's Technical Report TR2009/083 document titled *"Landscape and Ecology Values within Stormwater Management"* (Auckland Council, 2009) or similar best practice guidelines. The ***'Wetland Planting Plan'*** shall be to a standard acceptable to the Waikato Regional Council and shall be submitted to the Waikato Regional Council for written approval in a technical certification capacity, prior to commencement of the activities authorised by this resource consent.

12. The consent holder shall implement the planting, monitoring and maintenance activities adopted by the ***'Wetland Planting Plan'***, in accordance with that plan and as required by Condition 11 of this resource consent.

As Built Certification Statements

13. The consent holder shall retain an appropriately qualified and experienced person to prepare and sign 'As Built Certification Statements', which certify that the stormwater network described in Condition 2 has been constructed in accordance with the approved detailed engineering design details and drawings required by Condition 7 of this resource consent. The 'As Built Certification Statements' shall be submitted to the Waikato Regional Council within 3 months of completion of the activities authorised by this resource consent.

Stormwater Quantity and Receiving Environment

14. The consent holder shall manage the stormwater network to avoid as far as practicable and otherwise minimise, the following stormwater quantity effects:

    a. Adverse scour, erosion and sediment deposition on land, property and the beds of stormwater receiving water bodies;
    b. Adverse flooding of land, property and stormwater receiving water bodies;
    c. Adverse effects on aquatic ecosystems.

    All such adverse effects that are more than minor shall be addressed in the manner provided for in Condition 15 hereof, where they have been caused by the stormwater diversion and discharge activities authorised by this consent.

    Advice Note: *Stormwater diversion and discharge activities in conjunction with urban land-use, can adversely affect flood potential by either limiting the rate at which stormwater drains from a catchment, or by increasing the rate and volume of discharge to downstream catchments. Whilst such effects are the subject of this consent, it is also recognised that 'levels of service' for flood alleviation in urban catchments are established by territorial authorities through separate statutory procedures and community consultation. The 'levels of service' that are established between the territorial authority and the community are not the subject of this resource consent.*

15. As soon as practicable after becoming aware of any of the adverse effects of the nature specified in Condition 14 that are more than minor, the consent holder shall submit a report to the Waikato Regional Council in relation to the adverse effects. As a minimum, the report shall include:

    a. A description of the adverse effects;
    b. A description of the cause of the adverse effects;
    c. An explanation of any measures taken to remedy or mitigate the adverse effects, the outcome of those measures, and whether further measures are necessary and reasonably practicable;
    d. If no measures have been taken in accordance with (c), a description of any reasonably practicable measures that could be taken to remedy or mitigate the adverse effects and a recommendation as to whether those measures are necessary.

    The consent holder shall liaise with the Waikato Regional Council with a view to determining any reasonably practicable measures which should be taken to remedy or mitigate the adverse effects.

***Advice Note:** Separate resource consents may be required to undertake remedial or mitigation works. The consent holder is advised to obtain all such consents at its sole expense, prior to any works being undertaken.*

Stormwater Quality and Receiving Environment

16. The consent holder shall manage the stormwater network to avoid as far as practicable and otherwise minimise, the discharge of any substance that is likely to cause the production of conspicuous oil, or grease films, scums or foams, or floatable suspended materials in stormwater receiving water bodies after reasonable mixing.

17. The consent holder shall manage the stormwater network to avoid as far as practicable and otherwise minimise, the discharge of suspended solids and any other substances that are likely to cause the following effects in the downstream watercourse (a tributary fo the Whangamarino Wetland) after reasonable mixing:

    a. Conspicuous changes in colour or visual clarity;
    b. Increases in suspended solids concentrations by more than 10 percent;
    c. 100 grams per cubic metre suspended solids concentrations or greater.

***Advice Note:** For the purposes of this condition, the suspended solids discharge parameters referenced above shall only apply to the post development stormwater discharges authorised by this resource consent and do not apply to the earthworks activities which are authorised under a separate land disturbance resource consent.*

18. The consent holder shall manage the stormwater network to avoid as far as practicable and otherwise minimise, the discharge of hazardous substances in concentrations that are likely to adversely affect aquatic life, or the suitability of water for human consumption after treatment. Where a question arises as to whether the concentration of any particular hazardous substance is causing these effects, it shall be determined through the application of the United States Environmental Protection Agency National Recommended Water Quality Criteria (USEPA, 2009) – Criteria Maximum Concentration, or any other technical publication approved in advance by the Waikato Regional Council in a technical certification capacity.

19. The consent holder shall manage the stormwater network to avoid as far as practicable and otherwise minimise, the discharge of any contaminant that may affect the suitability of water for human consumption after treatment.

20. All stormwater catchpits which connect to the stormwater network shall, as a minimum, be designed to capture and retain the majority of gross pollutants and floatable contaminants such as oil and grease, unless any discharges of floatable contaminants to the receiving environment would have no more than minor adverse effects.

Stormwater Treatment Devices

21. All stormwater treatment devices which form part of the stormwater network and are designed to attenuate and/or treat contaminated stormwater (for example constructed wetland treatment ponds, stormwater catchpits, inlet / outlet structures), shall be operated and maintained by the consent holder to provide best practicable stormwater treatment efficiency at all times.

Review Clause

22. The Waikato Regional Council may at any time two months either side of January of 2023, 2028, 2033, 2038, 2043, and 2048 serve notice on the consent holder under section 128(1) of the

Resource Management Act (1991), and commence a review of the conditions of this resource consent for the following purposes:

a. To review the effectiveness of the conditions of this resource consent in avoiding, remedying or mitigating any adverse effects on the environment from the exercise of this resource consent, and if necessary to avoid, remedy or mitigate such effects by way of further or amended conditions;

b. If necessary and appropriate, to require the consent holder to adopt the Best Practicable Option or other specific measures to avoid, remedy or mitigate any adverse effects on the environment that result from the exercise of this resource consent;

c. To review the adequacy of and necessity for the monitoring and reporting undertaken by the consent holder, and if necessary, to amend and/or introduce new conditions to monitor any adverse effects on the environment that result from the exercise of this resource consent;

d. To achieve consistency with any future changes to the Waikato Regional Council's plans or policies in regard to catchment management planning and stormwater management.

Costs associated with any review of the conditions of this resource consent will be recovered from the consent holder in accordance with the provisions of section 36 of the Resource Management Act (1991).

Administrative

23. The consent holder shall pay the Waikato Regional Council any administrative charge fixed in accordance with section 36 of the Resource Management Act (1991), or any charge prescribed in accordance with regulations made under section 360 of the Resource Management Act (1991).

In terms of s116 of the Resource Management Act 1991, this consent commences on 1 December 2017

Advice Notes - General

- In accordance with section 125 RMA, this consent shall lapse five (5) years after the date on which it was granted unless it has been given effect to before the end of that period.
- This resource consent does not give any right of access over private or public property. Arrangements for access must be made between the consent holder and the property owner.
- Where a resource consent has been issued in relation to any type of construction (e.g. dam, bridge, jetty) this consent does not constitute authority to build and it may be necessary to apply for a Building Consent from the relevant territorial authority.
- This resource consent is transferable to another owner or occupier of the land concerned, upon application, on the same conditions and for the same use as originally granted (s.134-137 RMA). The transfer of water, including changes of location, may occur as provided for in Chapter 3.4 of the Waikato Regional Plan, subject to the requirements of those rules.
- The consent holder may apply to change the conditions of the resource consent under s.127 RMA.
- The reasonable costs incurred by Waikato Regional Council arising from supervision and monitoring of this/these consents will be charged to the consent holder. This may include but not be limited to routine inspection of the site by Waikato Regional Council officers or agents, liaison with the consent holder, responding to complaints or enquiries relating to the site, and review and assessment of compliance with the conditions of consents.
- Note that pursuant to s332 of the RMA 1991, enforcement officers may at all reasonable times go onto the property that is the subject of this consent, for the purpose of carrying out inspections, surveys, investigations, tests, measurements or taking samples.
- If you intend to replace this consent upon its expiry, please note that an application for a new consent made at least 6 months prior to this consent's expiry gives you the right to continue exercising this consent after it expires in the event that your application is not processed prior to this consent's expiry.

Exhibit C: Western Catchment Stormwater Wetland Design Report

wainui...
environmental

21st August 2019 WE Ref: WE1713_04

TKL Lands Ltd
C/- McAlley Group Ltd
PO Box 1138
Cambridge 3450

Attn: Ian McAlley

TKL Lands Ltd- TKL Subdivision, 24 Wayside Road, Te Kauwhata – Western Catchment Stormwater Wetland Preliminary Design Report

1 Introduction

Wainui Environmental Ltd have undertaken detailed design of a stormwater wetland for the Stages 1-4 (Western catchment) of the proposed subdivision located at 24 Wayside Road, Te Kauwhata.

This report has been prepared to support the wetland design plans as part of the subdivision application to Council.

1.1 Report Scope

This report provides an overview of the design of the proposed Wetland. The report specifically addresses:

a) A review of design criteria and objectives

b) Description and analysis of the catchment and the downstream receiving environment.

c) Detailed hydrologic (HEC-HMS) modelling of pre and post-development site catchments and wetland basin

d) Developed design of the constructed stormwater wetland.

1.2 Proposed Development

The proposed TKL subdivision comprises an area of approximately 16.5Ha. The proposed development allows for 148 residential lots with sizes ranging from 650m^2 – 1184m^2, associated roads and accessways.

The subdivision consists of two sub-catchments and associated discharge points. The Western Sub-catchment comprises Stages 1-4 of the proposed development, bounded by high points to the north, adjacent to the Jetco subdivision, and to the east (eastern sub-catchment boundary and the Boldero Block/Lot 1 DP 306539), and Wayside Road to the south.

Stages 1-4 consist of lots 1-77, 82 and 133-148, part of 'High Park' (Lot 209) and associated roads and access ways. The Western Sub-Catchment also consists of the adjacent Juice Factory Block (Lot 1 DP 385781) which comprises potential for an additional 13 Lots.

It is proposed to increase the maximum site building coverage on each residential lot over and above that allowed in the District Plan. It is proposed to increase building coverage to 30% of the applicable net site area, with a maximum building coverage of 280m^2 on lots with a net site area of 800m^2 or more. The maximum impermeable surfaces per lot (inclusive of building coverage) shall be no more than 50% of the net site area.

The stormwater management design has been undertaken based on the above proposed impervious areas.

Refer to Appendix A for details of the proposed development layout.

1.3 Receiving Environment

The existing western sub-catchment currently discharges to three distinct drains/watercourses which join at a confluence approximately 130m downstream of the western boundary of the site. The combined watercourse continues to the north and passes under Travers Road via an existing culvert, ultimately discharging to the Whangamarino Wetland approx. 650m downstream of the Travers Road culvert.

There are known flooding issues in the downstream catchment including:

- Flooding in the 100 year ARI event at the residential ancillary dwelling at 58 Wayside Road (downstream of the proposed western wetland discharge point). A Flood impact assessment was undertaken by Opus[1] to determine likely flood levels in the 100 year ARI event at the downstream property. The assessment provides mitigation options including providing over-attenuation of the 100 year ARI event to 80% of pre-developed discharge rates in the upstream TKL development.
- Flooding issues both upstream and downstream of the Travers Road culvert.

It is proposed to combine the post-developed flows from the western catchment, discharging via a wetland to 'Watercourse 2' on the western boundary. The photo below shows the watercourse immediately downstream of the discharge point. Watercourse 2 is a well-defined channel, low gradient and heavily vegetated. The drain is fenced on one side, with the other side open to stock. Refer to section 3.10 below for further analysis of the cross-catchment flows.

Photo of the existing drain ('Watercourse 2') downstream of proposed wetland discharge point

1.3.1 Wayside Road Culvert Extension

There is an existing 600mm diameter culvert under Wayside Road which historically discharged to an ephemeral gully on the eastern side of the Road within he proposed development site (upstream catchment of 'Watercourse 1'). As part of the proposed subdivision works the culvert has been extended by approximately 130m through the proposed subdivision, discharging to Watercourse 1 at the north-western boundary of the subject site, downstream of the original discharge point. The proposed culvert extension was detailed in a report titled "Proposed Culvert Extension, Wayside Road, Te Kauwhata" dated 20/04/17.

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[1] Wayside Road Subdivision – Existing Flood Impact Assessment. Opus Ltd 13 May 2016

2 Proposed Stormwater Management Methodology

The design of the stormwater management system has considered the following guidance and policy documents, in order of priority:

- Waikato District Council's District Plan
- Waikato Regional Infrastructure Technical Specifications
- Objectives, policies, and rules for the management of water quality and stormwater discharges, as set out in the Proposed Waikato Regional Plan; and
- Waikato Regional Council Stormwater Management and Modelling Guidelines 2018

2.1 Stormwater Management Objectives

Based on the receiving environment, the following stormwater management objectives are proposed to mitigate the effects of the proposed development on the receiving environment:

- Water quality treatment to achieve removal of 75% of total suspended solids.
- Extended Detention. The capture and slow release of the first 24mm of rainfall, shall be provided within the wetland to assist in erosion control in the downstream receiving environment.
- Attenuation of the 2 and 10 year ARI events to pre-development rates.
- Attenuation of the 100 year ARI event to 80% of pre-development rates[2].

It is proposed to construct a stormwater wetland to treat and attenuate stormwater runoff to achieve the above objectives.

3 Wetland Design (Western Sub-Catchment)

3.1 Preliminary Design

Plans showing the proposed layout and advanced design details of the proposed stormwater wetland are included within Appendix A.

Detailed modelling of the wetland live storage volume has been undertaken, and a stage/storage relationship developed for hydrologic modelling.

3.2 Hydrology

Hydrologic modelling has been undertaken using HEC-HMS v4.2 to reflect the proposed development and associated imperviousness within the catchment. Flows have been routed through the proposed wetland.

The RITS Manual requires that for all catchments where detention storage is required, stormwater modelling shall be undertaken using 24-hour nested design storm. Rainfall data was taken from Hirds v4 software for the subject site. The post development analysis was determined using the 2.1 degree climate change adjusted rainfall.

The Water Quality Volumes were calculated based on 1/3 of the 2 year ARI 24hr storm.

The EDV storm has been routed through the proposed wetland with the nested storm profile used for the 24mm rainfall event. Model runs of 48-hour duration were undertaken and the outflow curve analysed to determine the peak orifice discharge and the EDV discharge duration (the point at which the EDV is considered to be fully discharged has been taken at the ‘knee’ of the outflow hydrograph as beyond this point the ‘tail’ of the graph becomes infinitely long).

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[2] The Waikato Stormwater Management Guideline 2018 states that when discharging to existing or potential flooded areas, and in the absence of a catchment management plan, attenuation of the 100 year ARI to 80% of pre-developed rates is required to ensure downstream flood levels do not increase. Accordingly, attenuation of the 100yr ARI event to 80% of the pre-development rates is considered necessary for the western catchment in accordance with current best practice, to ensure flooding is not exacerbated downstream of the site.

3.2.1 Catchment Description

Aerial LIDAR survey, specific topographic survey and review of design levels were utilized to determine the catchment extents and various physical properties of the sub-catchments.

The proposed development is in the Te Kauwhata West Zone. As highlighted above an application was made to the Waikato Council to increase the building coverage and maximum impermeable surfaces allowed on each lot. Accordingly, all catchments have been assumed to be fully developed according to their proposed land use and have been assigned impervious fractions according to the maximum proposed levels outlined above. Roads have been allocated impervious areas based on the proposed engineering design (as per the Blue Wallace Plans) typically 50-60%, with an average imperviousness of 58%. Table 1 presents the adopted sub-catchments and their associated properties.

Refer to Appendix B for the pre and post developed catchment plans.

Table 1 Western Sub-Catchment Details – Post Development

Stage 1-4 Sub-Catchments*	Area (Ha)	Fraction Impervious
Lots	8.138	50%
Roads	2.957	58%
High Park	0.466	10%
Stormwater Reserve	0.570	80%
Total	**12.13**	**52%**

A time of concentration of 10 minutes was calculated for the post-developed sub-catchments.

Existing soil types across the catchment have been assessed as Soil Type C. In the pre-developed scenario with grass surface cover in fair condition (CN=79). For the post-developed scenario, weighted CN runoff curve numbers were calculated based on proposed impervious percentages in accordance with WRC methodology. As no soil remediation is proposed for the post-developed pervious areas the soil type has been increased to Type D. Accordingly, a curve number of CN = 80 was adopted for all post developed pervious areas, and a curve number of CN =98 adopted for all impervious/hardstand areas.

3.3 Hydrology Results

HEC HMS modelling results and WRC stormwater calculations can be found in the attachments. The HEC HMS model is available on request.

A summary of the stage and peak discharge rates is presented in Table 2 below.

Table 1: Western Wetland Discharges

Return Period (ARI)	Greenfields/Allowable discharge rate (m^3/s)*	Wetland Peak outflow (m^3/s)	Peak Stage, RL (m)	Peak Storage (m^3)
Extended Detention	-	0.035	20.76	525
2- Year	0.65	0.53	21.39	1,942
10- Year	1.33	1.13	21.87	3,223
100- Year	2.89	2.31	22.63	5,676

'* Allowable discharge rate based on total site catchment

A summary of the wetland design is presented in Table 3 below. Refer to the attached drawings WE1713-01-310-750 for plans of the proposed wetland.

Table 2 Wetland Design Summary

Parameter	Value
WATER QUALITY TREATMENT	
Water Quality Volume	644m^3
- Adjusted for planting (x 25%)	805m^3
Dead storage plan area	2251m^2
- % of contributing catchment	2.0%
Permanent Water Level (PWL)	RL20.5m in main wetland
WATER QUANTITY CONTROL	
Extended Detention Volume	525m^3
Extended Detention Depth	0.26m (routed via HMS)
2 year ARI Detention Volume (Live Storage)	1,942m^3
10 year ARI Detention Volume (Live Storage)	3,223 m^3
100 year ARI Detention Volume (Live Storage)	5,676 m^3
WETLAND DESIGN	
Total Plan Area (top of batter)	4240m^2 @RL23.15.m
Batter slopes - Above permanent WL (RL20.50m)	1V:3H
Batter slopes - below permanent WL	1V:3H to 1V:8H max.
Outlet Configuration	ED Outlet = 210mm dia. Orifice @ IL20.50m 2, 10 and 100 year Outlet = 0.47m slot @ IL20.76m

3.4 Wetland Forebay

A forebay has been designed for the main inlet into the wetland. The sediment forebay is provided to capture coarse sediments and is located to ensure ease of access to remove sediment accumulation. The forebay has been designed to provide more than 30% of the adjusted Water Quality Volume in accordance with WRC requirements. The proposed forebay has a total volume of 224m^3 at 0.9m deep (RL22.10m). Due to the depth of the wetland main body, the proposed forebay has been designed as a ‘perched’ forebay. Maintenance access is via an access track and maintenance platform at the base of the forebay.

3.5 Extended Detention

In accordance with WRC requirements the capture and slow release of 1/3 of the 2-year ARI 24hr rainfall (24mm event) is required for erosion control. The ED event has been routed through the wetland, discharging over 24hours. A summary of the EDV event is below;

- EDV = 525 m^3
- ED Level within wetland = RL20.76m (260mm above PWL)
- Peak Discharge @ ED level, Q_p = 0.0352m^3/s (via 210mm outlet orifice)
- EDV emptying time = 24hrs (to the ‘knee’ of the hydrograph)

3.6 Water Quality Treatment

As the wetland will provide extended detention, the required dead storage/permanent water volume is equal to 50% of the calculated WQV. Calculations show the required WQV = 644m^3 (based on the 1/3 of the 2 year 24hr storm). The actual WQV provided in the wetland has been increased by 25% to account for planting in accordance with the RITS.

Banded bathymetry within the wetland has areas of raised bunds proposed to maximise contact with vegetation and prevent short-circuiting.

3.7 Planting/Landscaping

Landscaping of the constructed wetland shall be undertaken in general accordance with the RITS Section 4 Table 4-35 – Approved Plant Species.

A planting plan will be prepared for the wetland as part of detailed design. It should be noted that planting will be required within and below the permanent water level (wet zone) at RL20.50m to meet a target of 80% vegetative cover.

It is also recommended that vegetation is used to shade areas of open water where possible, including the inlet forebay, to reduce thermal warming effects.

3.8 Operation and Maintenance

An operation and maintenance manual will be prepared for the proposed wetland as part of the detailed design process.

The proposed wetland will be accessed from Bragato Way, with a maintenance platform provided adjacent to the forebay. The forebay has been designed so that all parts are within 12m of the maintenance tracks, in accordance with RITS requirements. Vehicular access is provided around three sides of the wetland via 4m wide access track. The track has been designed such that a 99th percentile truck (6-wheeler) can easily maneuver around the access track. Dual entrance/exit point are provided to Bragato Way.

3.9 Outlet Structure and Spillway

The wetland detention orifice and weir are proposed within a manhole located adjacent to the wetland. The detention orifice and weir will discharge via a ∅1050mm pipe to a USBR Type VI Impact Structure which has been designed to dissipate energy prior to discharge over the northern boundary.

Design of the Outlet structure has been undertaken in accordance with HEC14 Hydraulic Design of Energy Dissipators for Culverts and Channels, Chapter 9.4. Design calculations are attached. A summary of the external dimensions of the outlet structure are presented below;

- Length = 4.65m
- Width = 3.5m
- Height = 2.68m
- Opening/Sill Height = 0.58m

Design calculations show the impact structure will slow peak flow velocities from 3.32m/s to less than 2.26m/s (critical flow) in the 100-year ARI event. The outlet structure has been designed so that is discharges an angle of approximately 130 degrees to the existing watercourse. Flows exiting the outlet structure will be conveyed over a riprap apron to the boundary. The rock rip apron has been sized in accordance with the QUDM 2007. A summary of the required rip rap apron design and dimensions is presented below;

- Pipe size = 1050mm
- Outlet velocity = 2.26m/s
- Apron Length (8D) = 8.4m
- Rock rip rap size d_{50} = 300mm
- Downstream width = 7m
- Thickness = 600mm

A minimum 8.4m length of rock rip rap apron is proposed on the inside of the apron. The outer edge of the apron has a length of approximately 15m. The rock rip rap apron will to return the flows to a natural flow condition at the boundary reducing the potential for scour in the downstream water course.

In the event the main outlet structure and pipe becomes blocked, flows will discharge via a 26m wide emergency trapezoidal spillway located centrally on the main wetland bund. The spillway has been designed to pass the full un-attenuated 100 year ARI flows form the catchment. The spillway has been designed with slopes of 1V:10H to enable vehicles to drive through. Key design parameters of the spillway are presented below;

- Peak 100-year ARI flow = 4.88m^3/s (unattenuated)
- Length = 26m
- Side slopes = 1V:10H
- Invert level RL23.63m
- Flow depth = 0.22m
- Top of Bund = RL23.15m

The spillway has been designed to pass the full 100-year flows maintaining a freeboard of 300mm from the water level to the top of the wetland bund.

The spillway will discharge flows down the rock lined bund batter to the existing water course at the boundary. Rock size down the bank below the spillway is to be designed at Engineering design stage using HEC15.

3.10 Downstream Watercourse Assessment

The proposed discharge from the wetland results in increased catchment to Watercourse 2, with Watercourses 1 and 3 seeing a comparative decrease in area. Table 3 below presents the existing and proposed catchments to each watercourse.

Table 3 Downstream Watercourse catchments

Watercourse	Existing catchment (Ha)	Post-developed catchment (Ha)	% change
1*	4.16	1.88	-55%
2	8.86	12.13	+37%
3	0.907	0**	-100%

'* includes Wayside Road culvert catchment

'** Contributing catchment from site extents only

The discharge to Watercourse 2 will result in an increase of 37% in catchment area. The wetland has however been designed to over-attenuate flows in the 2 and 10-year ARI events back to approximate pre-development rates based on the original hydrological catchment. Refer Table 4 below for a comparison in pre and post peak flows to Watercourse 2. The minor increase in peak flows is not expected to have adverse effects on the downstream watercourse.

Table 4 Peak Flow Comparison

ARI Event	Hydrological catchment peak flows (m^3/s)	Post-Developed Catchment (Wetland Discharge) (m^3/s)
2 year	0.49	0.51
10 year	1.00	1.08

As discussed above the attenuation of the 100 year ARI event to 80% of pre-developed rates (for the entire catchment) has been undertaken to prevent exacerbating the known flooding issues at 58 Wayside Road and at Travers Road, downstream of the confluence of the three watercourses.

3.10.1 Watercourse 2 Erosion Potential

An assessment of the potential for erosion in the downstream watercourse as a result of the proposed development and wetland outlet has been undertaken.

The receiving watercourse is a low-gradient, heavily vegetated 'channel', with no signs of erosion visible. The erosion potential of this grass lined channel has been assessed based the 'Design of Reinforced Waterways' publication (Hewlett et al, 1987). Figure 9 in the manual contains a plot of the limiting velocities against flow duration for a number of surface types within a channel (Refer to Figure 1 below for the referenced figure).

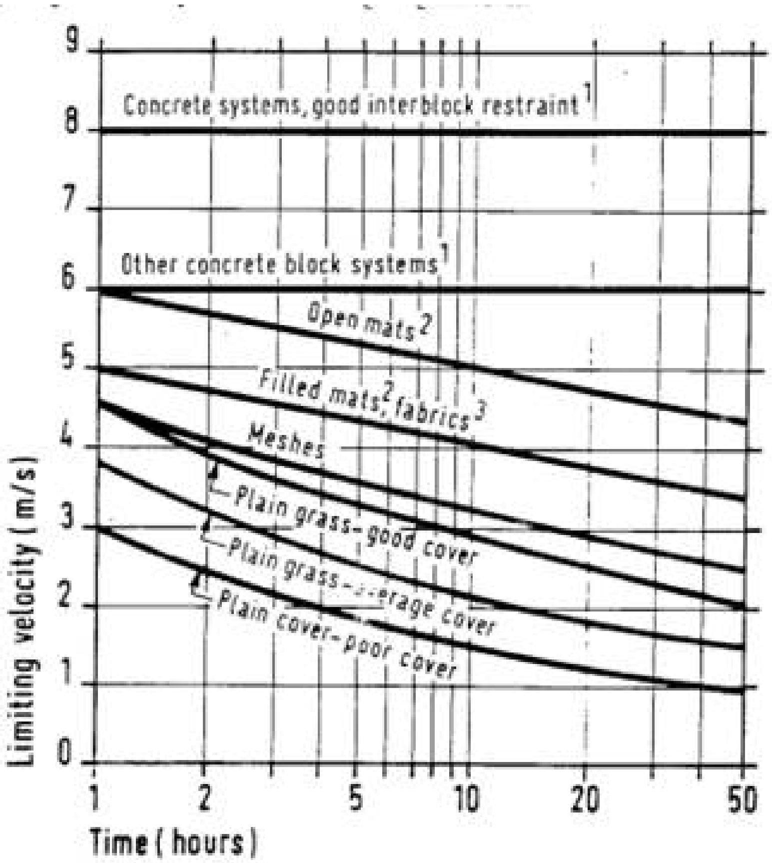


Figure 9 *Recommended limiting values for erosion resistance of plain and reinforced grass*

Figure 1: Limiting velocities and durations for grassed waterways (Source Hewlett et al 1987)

The figure shows that the existing grass lined watercourse (conservatively assumed ‘average cover’), can withstand velocities well in excess of the expected peak flows and durations from the wetland. Analysis of the HEC HMS model time series data for the wetland outflows and corresponding outlet pipe velocities from HY8 has been undertaken to determine whether the peak wetland discharges, velocities and durations will be approaching ‘limiting velocities’ in the design storms and cause scour in the receiving watercourse. This is summarised below;

- Peak flow velocities* from the wetland outlet structure in the 100-year ARI event are 3.32m/s when the wetland is full i.e. for a short 20min duration and only exceeds 2.5m/s for a period of 1 hour
- Peak velocities in the 100-year ARI event are only above 1.5m/s (corresponding flow rate = 0.10m^3/s) for approximately 16hrs.

*Note the above velocities presented above do not take into account the effect of the impact structure and rock rip apron which further reduce flow velocities.

Comparing the peak velocities and durations form the wetland outlet to the limiting velocities for the receiving watercourse indicates that the velocities from the wetland outlet in the 100 year ARI event will not exceed the limiting velocities for the receiving environment at any time. Accordingly, it is considered that peak wetland discharges will not result in an increased risk of scour in the downstream watercourse.

4 Overland Flow

Overland flow within stages 1-3 of the subdivision will be generally conveyed within the road carriageways, generally draining to the low point within Bragato Way and into the stormwater wetland. Secondary overland flows shall discharge directly to the main wetland body, by-passing the forebay.

In the event the main outlet structure and pipe becomes blocked, flows will discharge via the emergency spillway as described above.

5 Conclusion

It is proposed to manage stormwater within the western sub-catchment of the TKL subdivision via a constructed stormwater wetland designed to provide Water Quality treatment, Extended Detention and attenuation to greenfield rates in the 2, 10 and to 80% of the 100 year ARI event. The wetland has been designed in accordance with WRC Stormwater Management Guidelines, The Waikato RITS and in discussions with WDC Engineers.

The wetland outlet structure and downstream rock rip rap pad has been sized to reduce peak flow velocities exiting the wetland and return them to a normal conditions at the boundary. The diversion of minor adjacent catchments to watercourse 2 has been mitigated by over-attenuation of the peak flows to approximately meet pre-developed hydrological catchment discharges in the 2 and 10 year ARI event.

Peak flows from the developed catchment have been attenuated to meet 80% of the pre-developed discharges in the 100 year ARI event for the entire catchment to avoid exacerbating known flooding issues downstream of the development.

Overall the proposed stormwater management for the proposed subdivision is considered in-line with current best-practices.

We trust the above is to your satisfaction. Should you require any further information please do not hesitate to contact the undersigned.

Yours faithfully

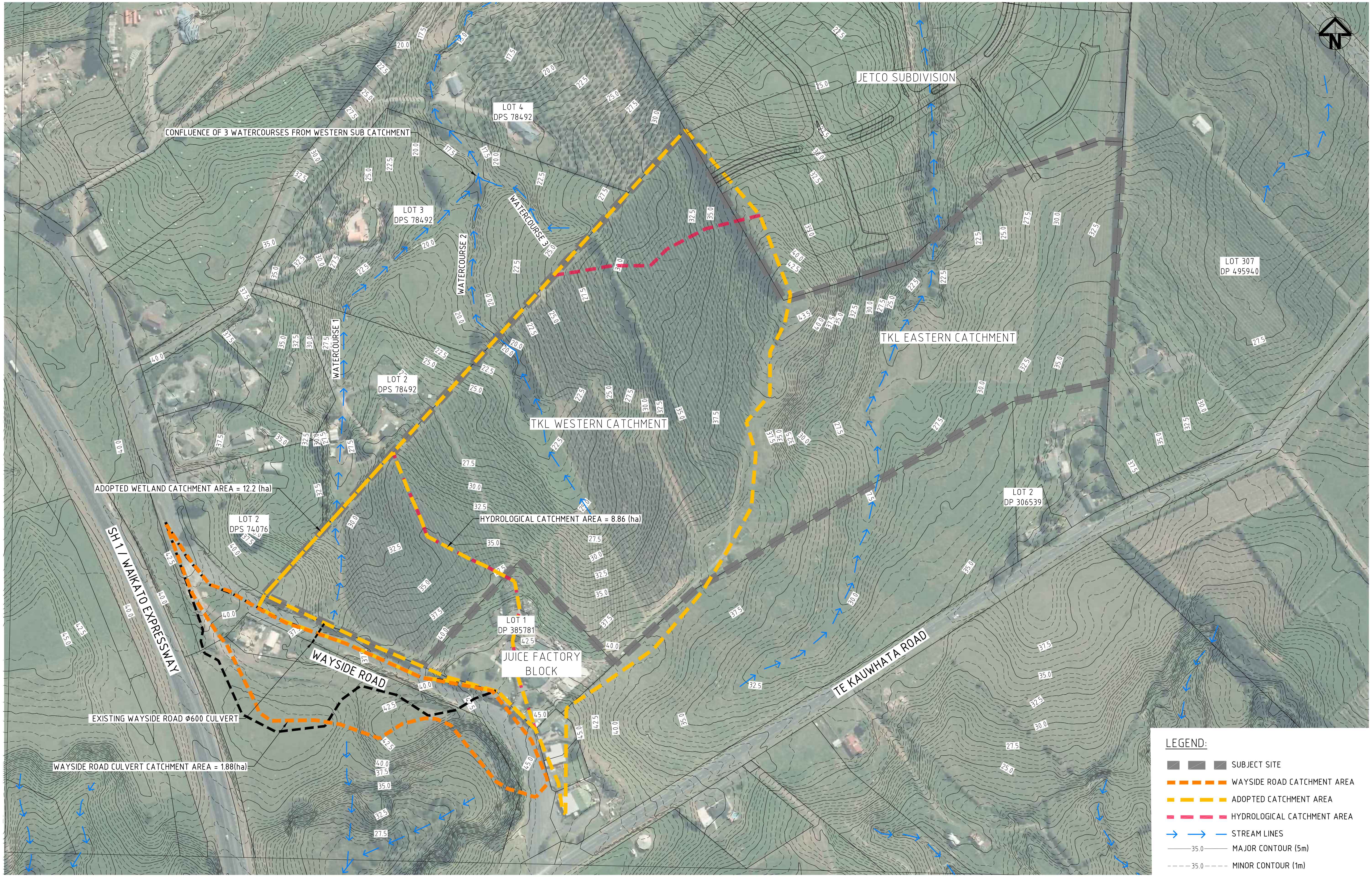
WAINUI ENVIRONMENTAL LTD

James Oakley
Civil and Environmental Engineer
T: +64 7 825 8336
M: +64 21 077 0550

Reviewed by:

Hayden Vink
Senior Civil and Environmental Engineer
T: +64 7 825 8336
M: +64 22 028 5411

APPENDIX A – Wetland Plans



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SCALE (AT ORIGINAL SHEET SIZE)

SHEET SIZE A1

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NOTES

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wainui...
environmental
PO Box 32245, Raglan 3225, NZ
p: 07 825 8336 e: office@wainuienvironmental.co.nz
www.wainuienvironmental.co.nz

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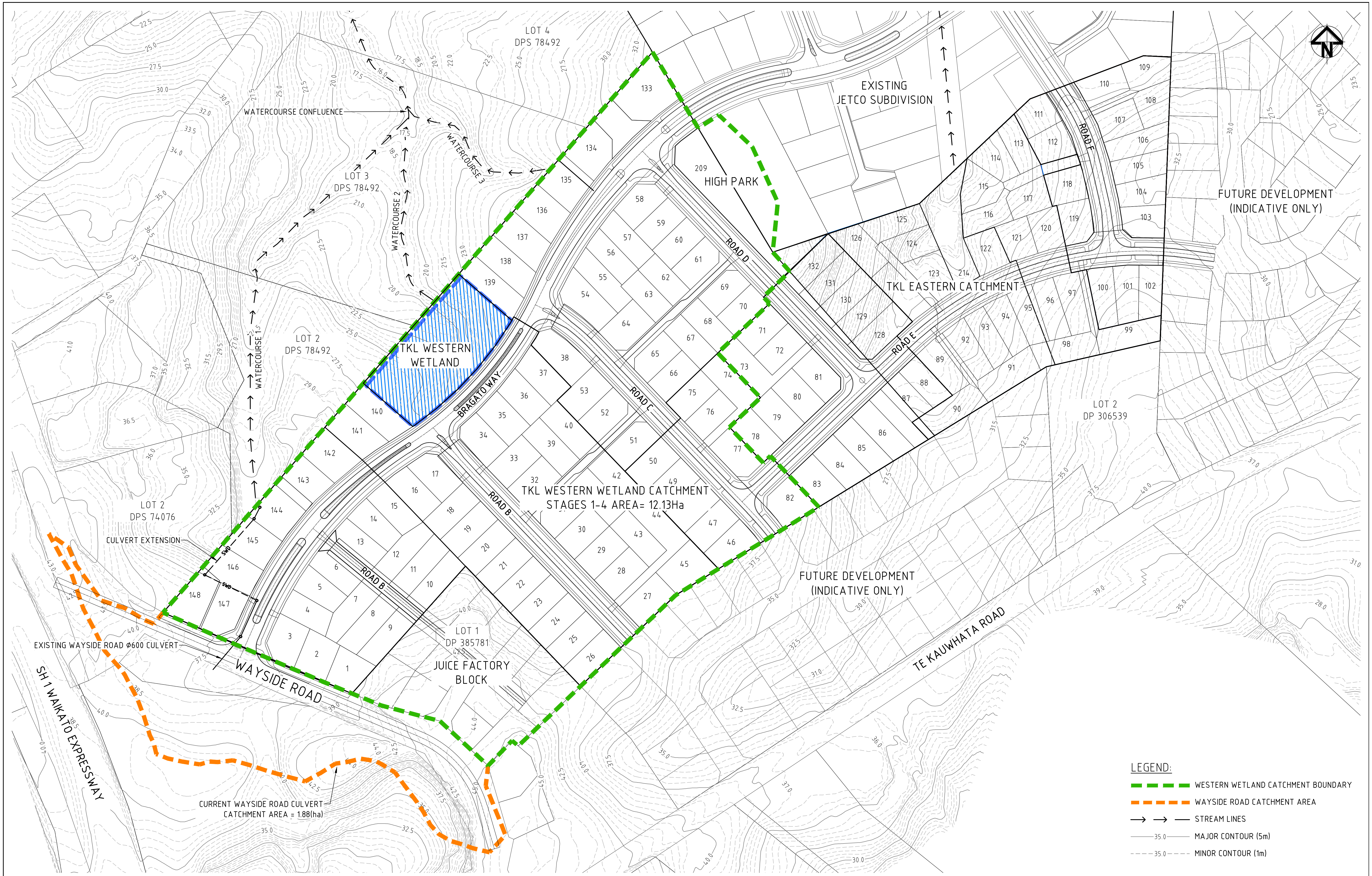
PROJECT
WAYSIDE ROAD,
TE KAUWHATA

PRE-DEVELOPED CATCHMENT PLAN

Status
FOR RESOURCE CONSENT

DRAWING NUMBER
WE1713-01-470

Rev.
A



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No.	BY	DATE	DESCRIPTION	APPD
B	J.O	13/08/2019	WESTERN CATCHMENT BOUNDARIES UPDATED	
A	J.O	19/09/2017	ORIGINAL ISSUE	

SCALE (AT ORIGINAL SHEET SIZE)

SHEET SIZE A1

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NOTES

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wainui environmental

PO Box 32245, Raglan 3225, NZ
p: 07 825 8336 e: office@wainuienvironmental.co.nz
www.wainuienvironmental.co.nz

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POST DEVELOPMENT CATCHMENT PLAN

Status
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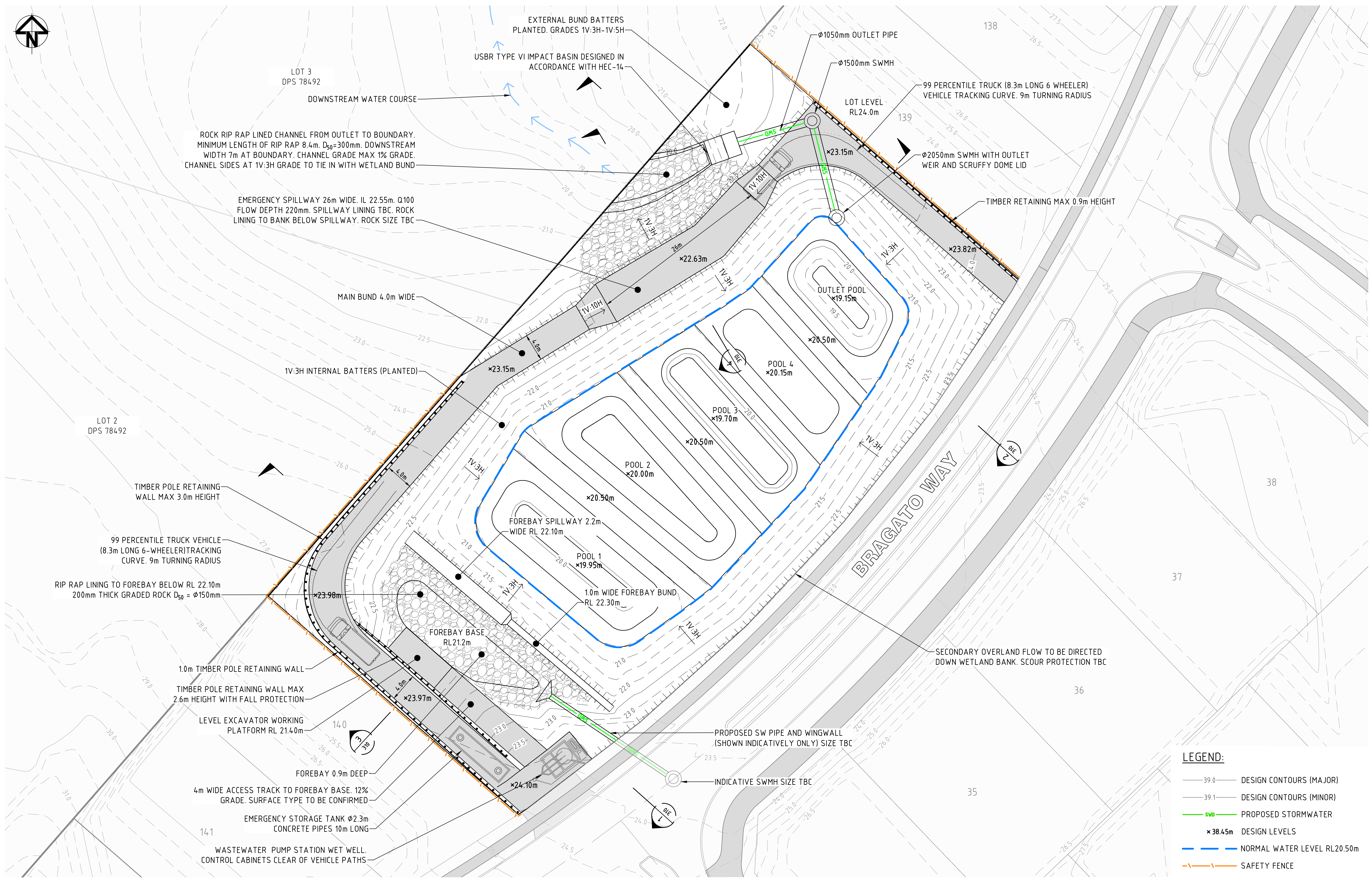
DRAWING NUMBER
WE1713-01-471

Rev.
B



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No.	BY	DATE	DESCRIPTION	APPD
E	Z.W	05/08/2019	WETLAND RE-DESIGNED	
D	M.K	10/07/2019	WETLAND LAYOUT AMENDED	
C	J.O	12/05/2019	WETLAND BOUNDARIES AND LAYOUT ALTERED	
B	J.O	26/03/2019	SECTION MARKERS ADDED	
A	J.O	08/02/2019	ORIGINAL ISSUE	

SCALE (AT ORIGINAL SHEET SIZE)
SHEET SIZE A1
SCALE 5 0 5 10 1:250

NOTES

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wainui environmental
PO Box 32245, Raglan 3225, NZ
p: 07 825 8336 e: office@wainuienvironmental.co.nz
www.wainuienvironmental.co.nz

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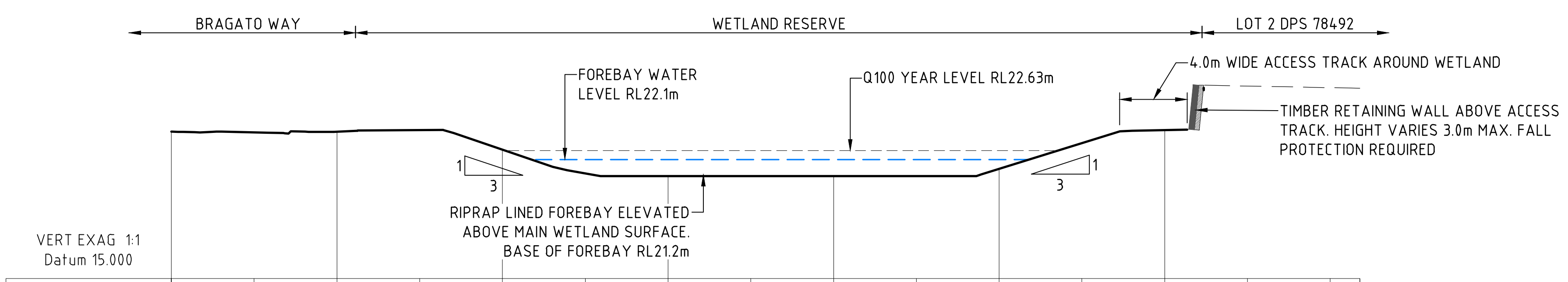
BRAGATO WAY WETLAND CONCEPT PLAN

Status
FOR RESOURCE CONSENT

DRAWING NUMBER
WE1713-01-750

Rev.
E



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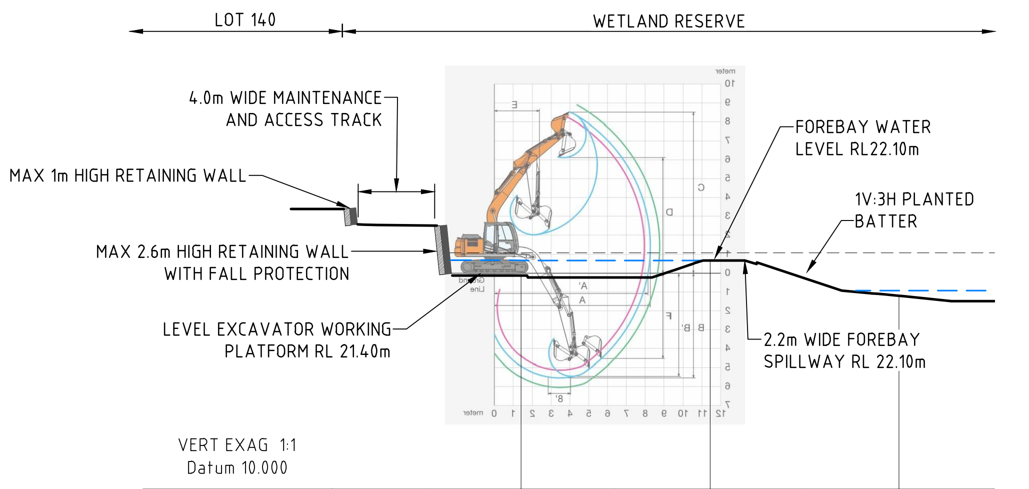
WETLAND 1 LONG SECTION



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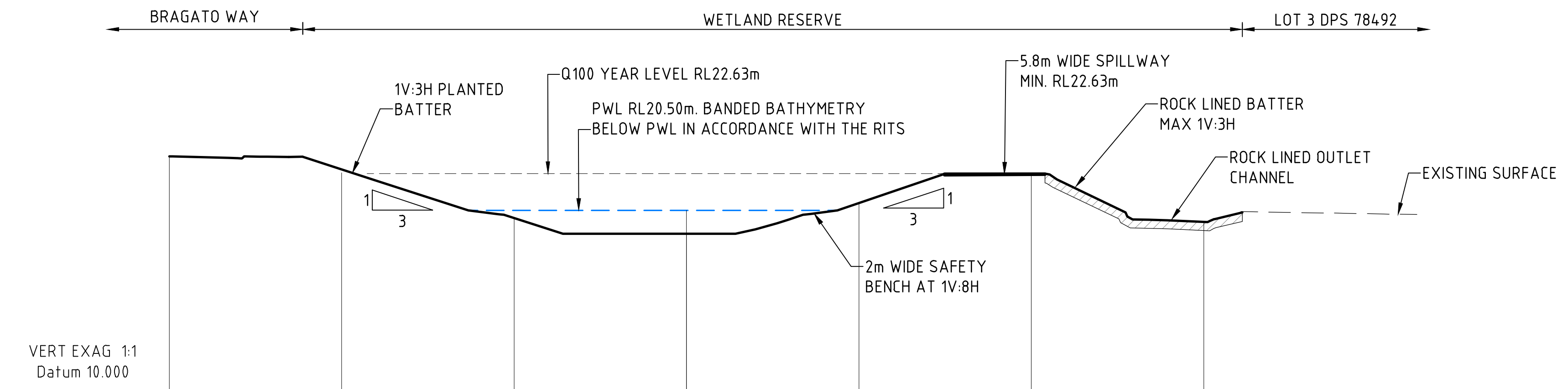
12 TONNE DIGGER WORKING DIAGRAM



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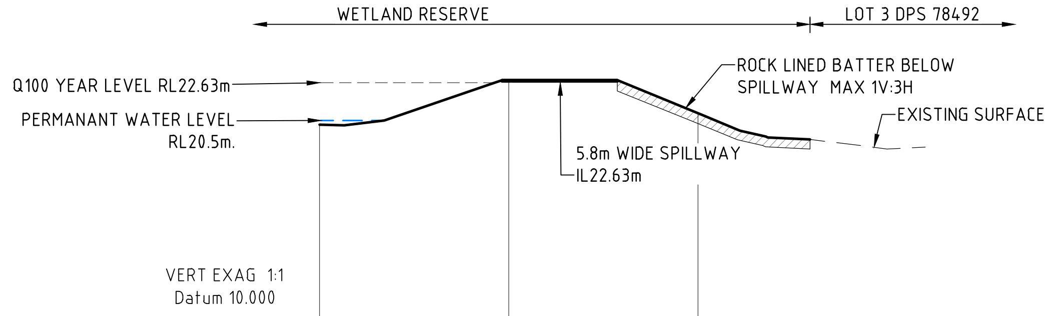
WETLAND 2 LONG SECTION



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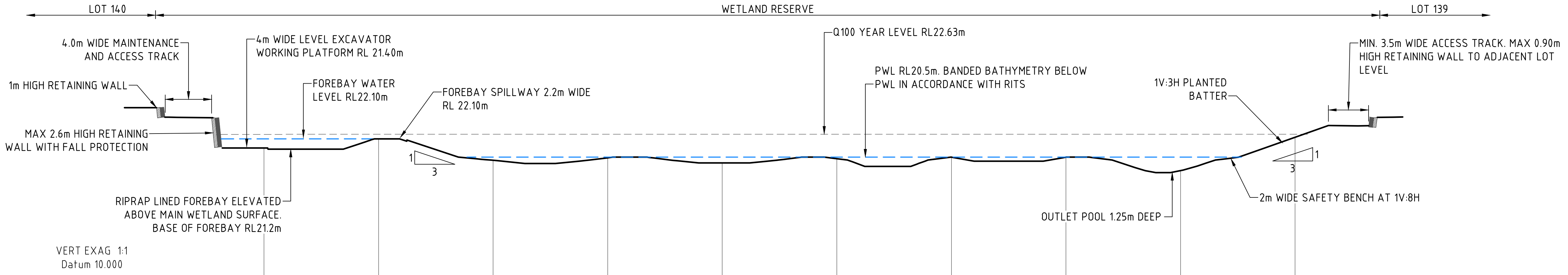
WETLAND 4 TYPICAL WETLAND BUND CROSS SECTION I



DESIGN LEVELS		23.946	21.300	21.200	22.100	21.152	20.227	19.950	20.445	20.305	20.000	20.261	20.366	19.700	20.495	20.150	20.497	19.929	19.326	20.489	22.233	23.236	23.245	
CHAINAGE	0.000	5.000	10.000	15.000	20.000	25.000	30.000	35.000	40.000	45.000	50.000	55.000	60.000	65.000	70.000	75.000	80.000	85.000	90.000	95.000	100.000	105.000	106.415	109.393

WETLAND 3 LONG SECTION

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No.	BY	DATE	DESCRIPTION	APPD
D	J.O	05/08/2019	WETLAND RE-DESIGN	
C	J.O	10/07/2019	WETLAND LAYOUT ALTERED	
B	J.O	12/05/2019	WETLAND BOUNDARIES AND LAYOUT ALTERED	
A	J.O	26/03/2019	ORIGINAL ISSUE	

SCALE (AT ORIGINAL SHEET SIZE)

SHEET SIZE A1

SCALE 2 1 0 2 4 6 8 10 1:200

NOTES

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APPROVED	HV	DATE	05/08/2019

wainui environmental
PO Box 32245, Raglan 3225, NZ
p: 07 825 8336 e: office@wainuienvironmental.co.nz
www.wainuienvironmental.co.nz

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BRAGATO WAY WETLAND CONCEPT CROSS SECTIONS

Status
FOR RESOURCE CONSENT

DRAWING NUMBER
WE1713-01-310

Rev.
D

APPENDIX B – Calculations and Hydrologic Modelling Summary

RATIONAL METHOD CALCULATIONS

Client:	TKL Ltd	**Computed:**	JO
Project:	Wayside Road Subdivision, Te Kauwhata	**Date:**	2/02/2017
Job No.	WE1713	**Revision:**	A

CATCHMENT ASSESSMENT

Catchment Area, A =	121,330	m^2	Apprx. 7% impervious
	12.1330	Ha	
	0.1213	km^2	

EQUAL AREA CALCULATION

Area under slope	7206.2	m^2		
*Length (m) of flow path from catchment divide to outlet **(L)***	503	m		
Height difference in main channel, H	27	m		
Equivalent Height of Triangle	28.65	m		
Equal Area Slope	0.05696	m/m =		5.70%

TIME OF CONCENTRATION

TIME OF CONCENTRATION

BRANSBY-WILLIAMS

tc = (58 L) / ($A^{0.1}$ $S^{0.2}$) =	16.05	min	0.268	hrs

TIME OF ENTRY

Adopting 5 minutes using NZBC 2.3.2 E1/VM1 for residential areas where the impervious area exceeds 50% of gross area

Adopted Time of Concentration	**Tc + Te =**	**20.00**	**min**	0.33	hr
Average Channel Velocity		0.42	m/s		

calculation sheet

PRE-DEVELOPMENT - Hydrology

client:	TKL Ltd	computed:	JO
project:	Wayside Road Subdivision, Te Kauwhata	date:	13/08/2019
job No.	WE1713	revision:	1

Notes:

1. Runoff calculations in accordance with WRC TR 2018 methodology
2. Soil Type C adopted for pre developed pervious areas

		EXISTING CATCHMENT	
Total Area	ha	12.133	
	km^2	0.12133	
Site Impervious	%	5.2%	
		Impervious	Pervious
Area	ha	0.627	11.506
	km^2	0.006	0.115
SCS Curve Number		98.0	79.0
CN Weighted		80.0	
Initial Abstraction, Ia		0.3	3.4
weighted Initial Abstraction, Ia		3.21	
Channelisation Factor , C		1.0	1.0
Catchment Storage , S		5.18	67.52
Time of concentration, min		20	
SCS Lag (tp), min		13.33	

calculation sheet

POST-DEVELOPMENT - Hydrology

client:	TKL Ltd	computed:	JO
project:	Wayside Road Subdivision, Te Kauwhata	date:	13/08/2019
job No.	WE1713	revision:	1

Notes:

1. Runoff calculations in accordance with WRC TR 2018 methodology
2. Soil Type D adopted for post-developed pervious areas

		SUBJECT SITE - DETENTION CATCHMENT								
		LOTS		ROADs and ROWs		STORMWATER RESERVE		High Park		TOTAL
Total Area	ha	8.138		2.957		0.5707		0.4666		12.133
	km2	0.0814		0.02957		0.00571		0.00467		0.12133
Site Impervious	%	50%		58%		80%		10%		52%
		Impervious	Pervious	Impervious	Pervious	Impervious	Pervious	Impervious	Pervious	
Area	ha	4.069	4.069	1.715	1.242	0.457	0.114	0.047	0.420	
	km^2	0.0407	0.0407	0.0172	0.0124	0.00457	0.00114	0.00047	0.00420	
SCS Curve Number		98.0	80.0	98.0	80.0	98.0	80.0	98.0	80.0	
CN Weighted		89.00		90.44		94.40		81.80		
Initial Abstraction, Ia		0.3	3.2	0.3	3.2	0.3	3.2	0.3	3.2	
weighted Initial Abstraction, Ia		1.72		1.48		0.84		2.88		
Channelisation Factor , C		0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	
Catchment Storage , S		5.18	63.5	5.18	63.5	5.18	63.5	5.18	63.5	
Time of concentration, min		10		10		1		10		
SCS Lag (tp), min		6.67		6.67		0.67		6.67		

WQ VOLUME CATCHMENT TO WETLAND											
		LOTS		ROADs and ROWs		STORMWATER RESERVE		High Park RESERVE		TOTAL	
Total Area	km^2	0.0814		0.02957						0.1110	
		Impervious	Pervious	Impervious	Pervious						
Area	km^2	0.041	0.0407	0.0172	0.0124						
1/3 24hr rainfall depth, P24	mm	22.6	22.6	22.6	22.6						
c*		0.680	0.113	0.680	0.113						
Runoff Depth, Q24	mm	18.101	4.536	18.101	4.536						
Runoff Volume, V24	m^3	736.56	184.59	310.47	56.34						
ED Provided ?		YES		YES							
WQV	**m^3**	460.58		183.41						644.0	
				FOREBAY VOLUME (15% WQV)						193.19	m^3

STAGE STORAGE RELATIONSHIP

client:	TKL Ltd	computed:	JO
project:	Wayside Road Subdivision, Te Kauwhata	date:	31/08/2017
job No.	WE1713	revision:	1

Bragato Way Western Catchment Wetland

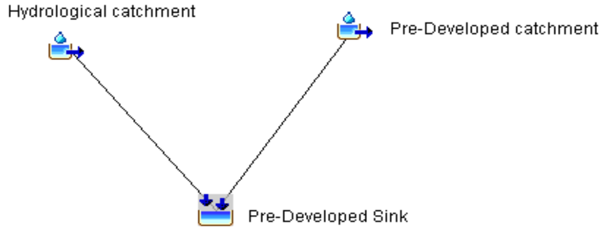
RL (m)	Depth	volume	Live Volume	$1000m^3$
20.5	0.00	580	0.00	0.000
20.7	0.20	974	394.00	0.394
20.9	0.40	1391	811.00	0.811
21.1	0.60	1832	1252.00	1.252
21.3	0.80	2297	1717.00	1.717
21.5	1.00	2794	2214.00	2.214
21.7	1.20	3317	2737.00	2.737
21.9	1.40	3868	3288.00	3.288
22.1	1.60	4447	3867.00	3.867
22.3	1.80	5104	4524.00	4.524
22.5	2.00	5801	5221.00	5.221
22.7	2.20	6539	5959.00	5.959
22.8	2.30	6921	6341.00	6.341

HEC HMS RESULTS

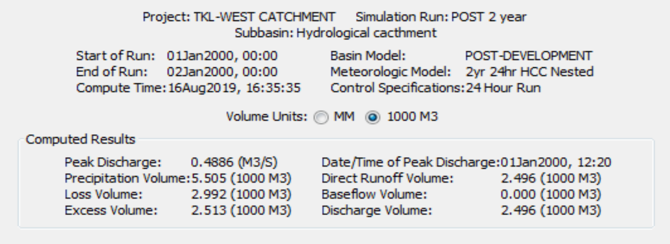
client: TKL Ltd
project: Wayside Road Subdivision, Te Kauwhata
job No. WE1713

computed: JO
date: 15/08/2019
revision: 1

1.Pre- developed Model



2. Pre-Developed Model outputs

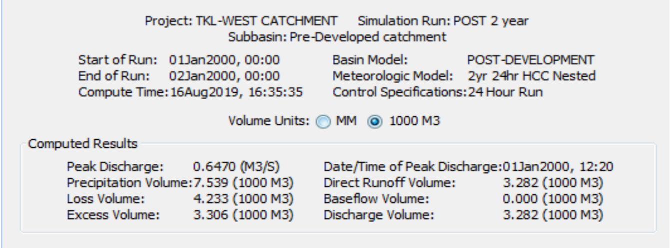


```
Project: TKL-WEST CATCHMENT    Simulation Run: POST 2 year
Subbasin: Hydrological cacthment

Start of Run:   01Jan2000, 00:00        Basin Model:           POST-DEVELOPMENT
End of Run:     02Jan2000, 00:00        Meteorologic Model:    2yr 24hr HCC Nested
Compute Time:16Aug2019, 16:35:35        Control Specifications:24 Hour Run

Volume Units: ○ MM  ● 1000 M3

Computed Results
Peak Discharge:      0.4886 (M3/S)      Date/Time of Peak Discharge:01Jan2000, 12:20
Precipitation Volume:5.505 (1000 M3)    Direct Runoff Volume:        2.496 (1000 M3)
Loss Volume:         2.992 (1000 M3)    Baseflow Volume:             0.000 (1000 M3)
Excess Volume:       2.513 (1000 M3)    Discharge Volume:            2.496 (1000 M3)
```



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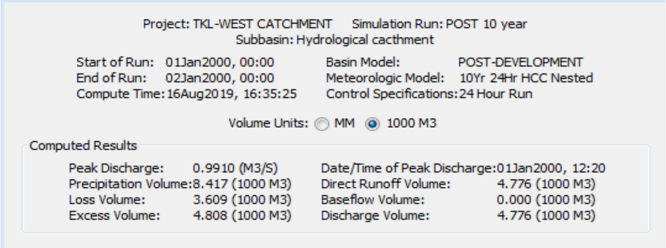
Project: TKL-WEST CATCHMENT    Simulation Run: POST 2 year
Subbasin: Pre-Developed catchment

Start of Run:   01Jan2000, 00:00        Basin Model:           POST-DEVELOPMENT
End of Run:     02Jan2000, 00:00        Meteorologic Model:    2yr 24hr HCC Nested
Compute Time:16Aug2019, 16:35:35        Control Specifications:24 Hour Run

Volume Units: ○ MM  ● 1000 M3

Computed Results
Peak Discharge:      0.6470 (M3/S)      Date/Time of Peak Discharge:01Jan2000, 12:20
Precipitation Volume:7.539 (1000 M3)    Direct Runoff Volume:        3.282 (1000 M3)
Loss Volume:         4.233 (1000 M3)    Baseflow Volume:             0.000 (1000 M3)
Excess Volume:       3.306 (1000 M3)    Discharge Volume:            3.282 (1000 M3)
```



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Project: TKL-WEST CATCHMENT    Simulation Run: POST 10 year
Subbasin: Hydrological cacthment

Start of Run:   01Jan2000, 00:00        Basin Model:           POST-DEVELOPMENT
End of Run:     02Jan2000, 00:00        Meteorologic Model:    10Yr 24Hr HCC Nested
Compute Time:16Aug2019, 16:35:25        Control Specifications:24 Hour Run

Volume Units: ○ MM  ● 1000 M3

Computed Results
Peak Discharge:      0.9910 (M3/S)      Date/Time of Peak Discharge:01Jan2000, 12:20
Precipitation Volume:8.417 (1000 M3)    Direct Runoff Volume:        4.776 (1000 M3)
Loss Volume:         3.609 (1000 M3)    Baseflow Volume:             0.000 (1000 M3)
Excess Volume:       4.808 (1000 M3)    Discharge Volume:            4.776 (1000 M3)
```
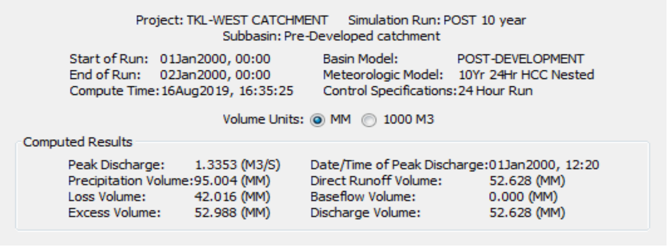
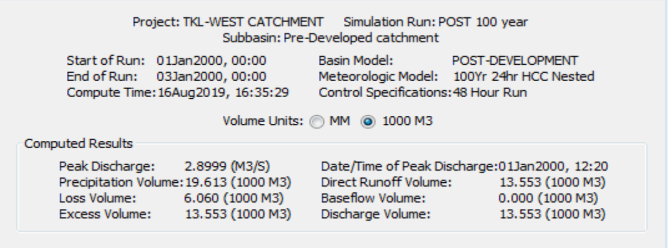



```
Project: TKL-WEST CATCHMENT    Simulation Run: POST 10 year
Subbasin: Pre-Developed catchment

Start of Run:   01Jan2000, 00:00        Basin Model:           POST-DEVELOPMENT
End of Run:     02Jan2000, 00:00        Meteorologic Model:    10Yr 24Hr HCC Nested
Compute Time:16Aug2019, 16:35:25        Control Specifications:24 Hour Run

Volume Units: ● MM  ○ 1000 M3

Computed Results
Peak Discharge:      1.3353 (M3/S)      Date/Time of Peak Discharge:01Jan2000, 12:20
Precipitation Volume:95.004 (MM)        Direct Runoff Volume:        52.628 (MM)
Loss Volume:         42.016 (MM)        Baseflow Volume:             0.000 (MM)
Excess Volume:       52.988 (MM)        Discharge Volume:            52.628 (MM)
```



```
Project: TKL-WEST CATCHMENT    Simulation Run: POST 100 year
Subbasin: Pre-Developed catchment

Start of Run:   01Jan2000, 00:00        Basin Model:           POST-DEVELOPMENT
End of Run:     03Jan2000, 00:00        Meteorologic Model:    100Yr 24hr HCC Nested
Compute Time:16Aug2019, 16:35:29        Control Specifications:48 Hour Run

Volume Units: ○ MM  ● 1000 M3

Computed Results
Peak Discharge:      2.8999 (M3/S)      Date/Time of Peak Discharge:01Jan2000, 12:20
Precipitation Volume:19.613 (1000 M3)   Direct Runoff Volume:        13.553 (1000 M3)
Loss Volume:         6.060 (1000 M3)    Baseflow Volume:             0.000 (1000 M3)
Excess Volume:       13.553 (1000 M3)   Discharge Volume:            13.553 (1000 M3)
```

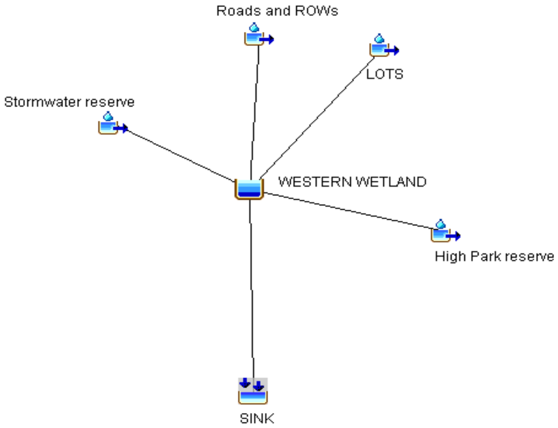
HEC HMS RESULTS

client: TKL Ltd
project: Wayside Road Subdivision, Te Kauwhata
job No. WE1713

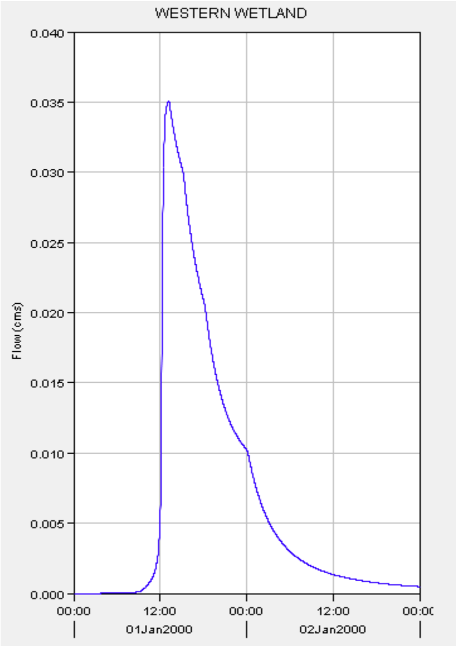
computed: JO
date: 15/08/2019
revision: 1

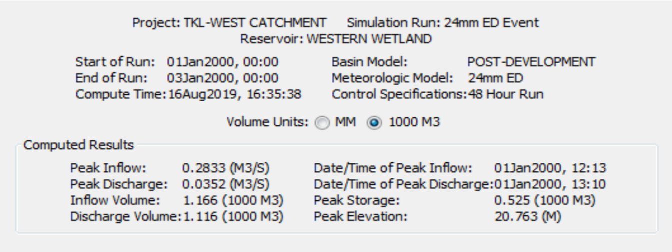
---

3. Post-Developed Model



4. Post-Developed Model outputs -Extended detention





Project: TKL-WEST CATCHMENT Simulation Run: 24mm ED Event
Reservoir: WESTERN WETLAND

Start of Run: 01Jan2000, 00:00
End of Run: 03Jan2000, 00:00
Compute Time: 16Aug2019, 16:35:38

Basin Model: POST-DEVELOPMENT
Meteorologic Model: 24mm ED
Control Specifications: 48 Hour Run

Volume Units: ○ MM ● 1000 M3

Computed Results

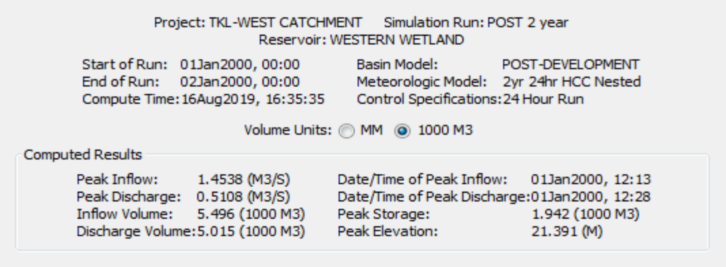
Peak Inflow: 0.2833 (M3/S)
Peak Discharge: 0.0352 (M3/S)
Inflow Volume: 1.166 (1000 M3)
Discharge Volume: 1.116 (1000 M3)

Date/Time of Peak Inflow: 01Jan2000, 12:13
Date/Time of Peak Discharge: 01Jan2000, 13:10
Peak Storage: 0.525 (1000 M3)
Peak Elevation: 20.763 (M)

HEC HMS RESULTS

client:	TKL Ltd	computed:	JO
project:	Wayside Road Subdivision, Te Kauwhata	date:	15/08/2019
job No.	WE1713	revision:	1

5. Post-Developed Model outputs -2 Year ARI



Project: TKL-WEST CATCHMENT Simulation Run: POST 2 year
Reservoir: WESTERN WETLAND

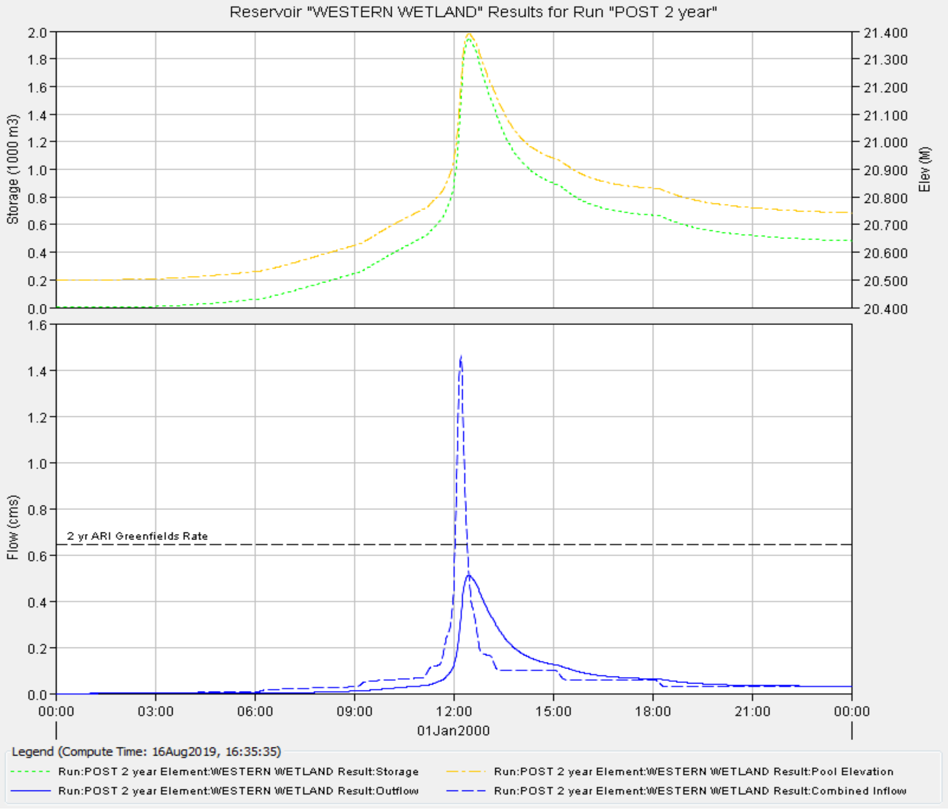
Start of Run: 01Jan2000, 00:00
End of Run: 02Jan2000, 00:00
Compute Time: 16Aug2019, 16:35:35

Basin Model: POST-DEVELOPMENT
Meteorologic Model: 2yr 24hr HCC Nested
Control Specifications: 24 Hour Run

Volume Units: ○ MM ● 1000 M3

Computed Results

Peak Inflow:	1.4538 (M3/S)	Date/Time of Peak Inflow:	01Jan2000, 12:13
Peak Discharge:	0.5108 (M3/S)	Date/Time of Peak Discharge:	01Jan2000, 12:28
Inflow Volume:	5.496 (1000 M3)	Peak Storage:	1.942 (1000 M3)
Discharge Volume:	5.015 (1000 M3)	Peak Elevation:	21.391 (M)

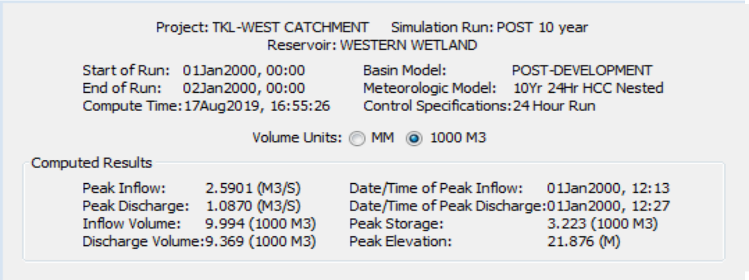


HEC HMS RESULTS

client: TKL Ltd
project: Wayside Road Subdivision, Te Kauwhata
job No. WE1713

computed: JO
date: 15/08/2019
revision: 1

6. Post-Developed Model outputs -10 Year ARI



Project: TKL-WEST CATCHMENT Simulation Run: POST 10 year
Reservoir: WESTERN WETLAND

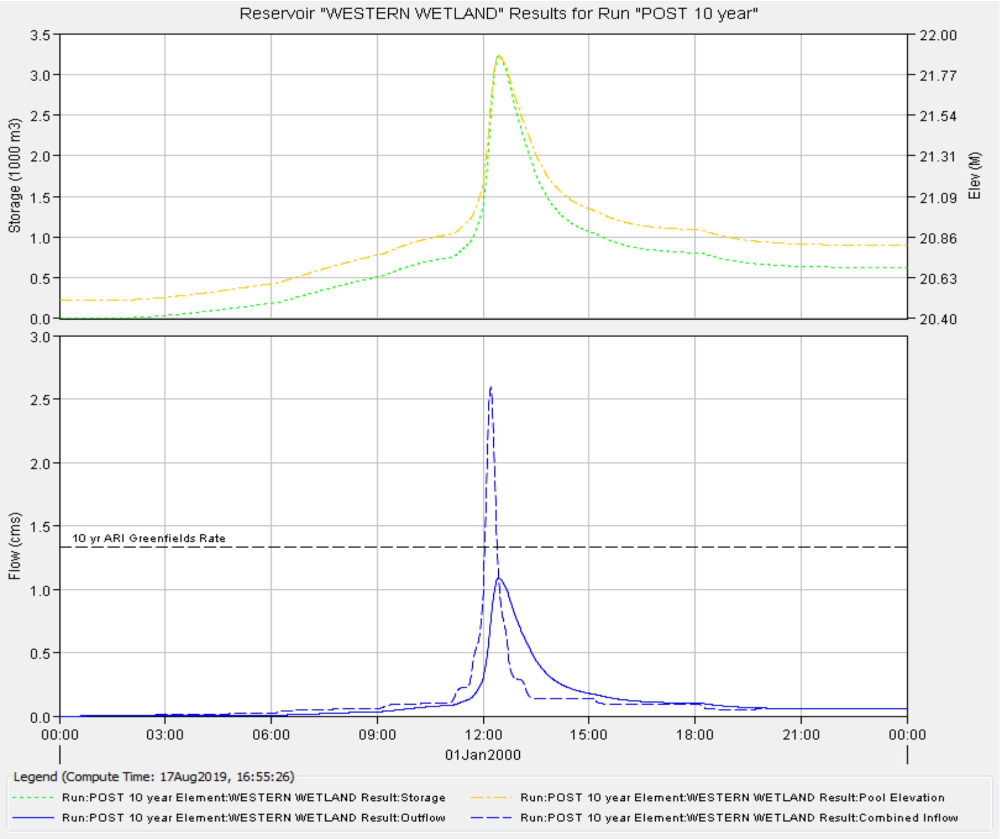
Start of Run: 01Jan2000, 00:00
End of Run: 02Jan2000, 00:00
Compute Time: 17Aug2019, 16:55:26

Basin Model: POST-DEVELOPMENT
Meteorologic Model: 10Yr 24Hr HCC Nested
Control Specifications: 24 Hour Run

Volume Units: ○ MM ● 1000 M3

Computed Results

Peak Inflow:	2.5901 (M3/S)	Date/Time of Peak Inflow:	01Jan2000, 12:13
Peak Discharge:	1.0870 (M3/S)	Date/Time of Peak Discharge:	01Jan2000, 12:27
Inflow Volume:	9.994 (1000 M3)	Peak Storage:	3.223 (1000 M3)
Discharge Volume:	9.369 (1000 M3)	Peak Elevation:	21.876 (M)

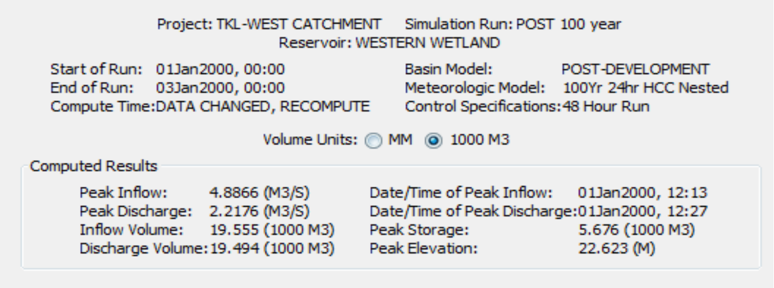


HEC HMS RESULTS

client: TKL Ltd
project: Wayside Road Subdivision, Te Kauwhata
job No. WE1713

computed: JO
date: 15/08/2019
revision: 1

7. Post-Developed Model outputs -100 Year ARI



Project: TKL-WEST CATCHMENT Simulation Run: POST 100 year
Reservoir: WESTERN WETLAND

Start of Run: 01Jan2000, 00:00
End of Run: 03Jan2000, 00:00
Compute Time: DATA CHANGED, RECOMPUTE

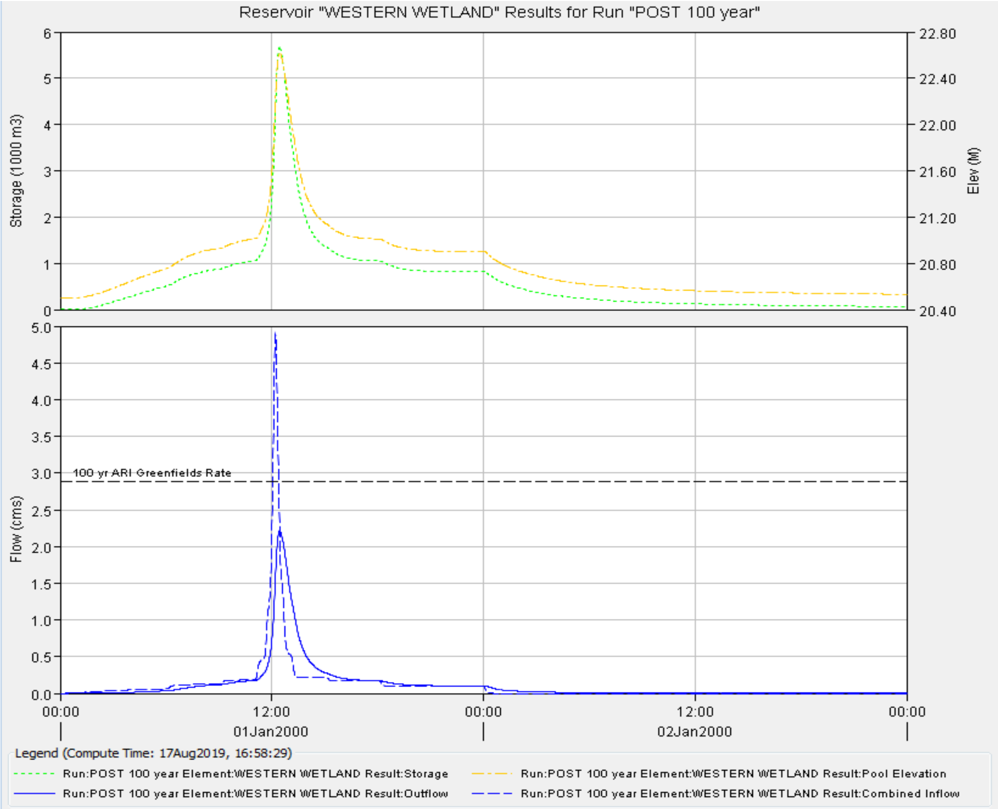
Basin Model: POST-DEVELOPMENT
Meteorologic Model: 100Yr 24hr HCC Nested
Control Specifications: 48 Hour Run

Volume Units: ○ MM ● 1000 M3

Computed Results

Peak Inflow: 4.8866 (M3/S)
Peak Discharge: 2.2176 (M3/S)
Inflow Volume: 19.555 (1000 M3)
Discharge Volume: 19.494 (1000 M3)

Date/Time of Peak Inflow: 01Jan2000, 12:13
Date/Time of Peak Discharge: 01Jan2000, 12:27
Peak Storage: 5.676 (1000 M3)
Peak Elevation: 22.623 (M)

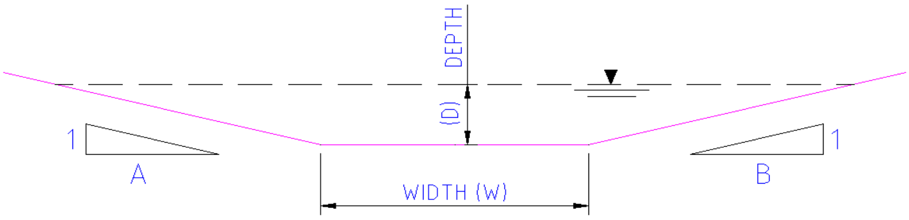


TRAPEZOIDAL SPILLWAY DESIGN

client:	TKL Ltd	computed:	JO
project:	Wayside Road Subdivision, Te Kauwhata	date:	16/08/2019
job No.	WE1713	revision:	1

Notes:

1. Emergency spillway designed to discharge full unattenuated 100 year ARI flows



Peak 100 year ARI flows	4.88	m^3/s
Spillway Width	26	m
Batters	10	
Flow depth , h	0.22	m
Confirm flow over weir	4.89	m^3/s

calculation sheet

USBR Type VI Impact Structure Calcuation Sheet

client: TKL
project: TKL Western Wetland
job No. WE1713

computed: JO
date: 13/08/2019
revision: 2

Notes:

1. Type VI Impact Structure calculated in accordance with HEC14

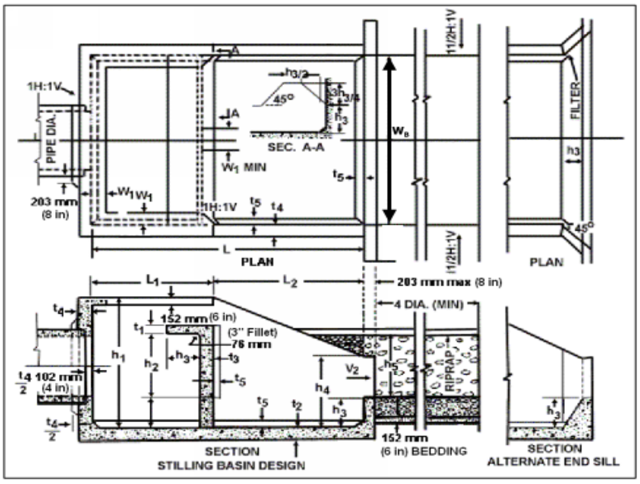


Figure 9.13. USBR Type VI Impact Basin

Wetland Outlet Details

Q100 Flow	2.36	m^3/s	From HY8
Pipe Diameter	1.05	m	From HY8
Outlet veloc.	3.35	m/s	From HY8
Outlet depth	0.78	m	From HY8
Critical depth	0.87	m	From HY8
Gravity	9.81	m/s^2	
Froude no.	1.211		
Outlet Energy, H_o	1.352	m	

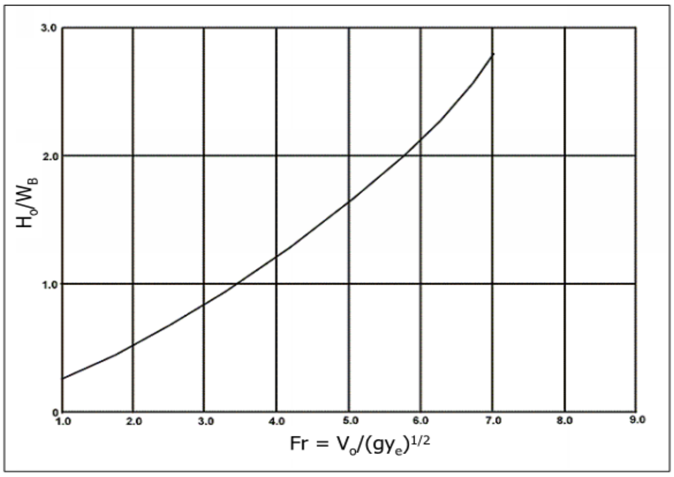


Figure 9.14. Design Curve for USBR Type VI Impact Basin

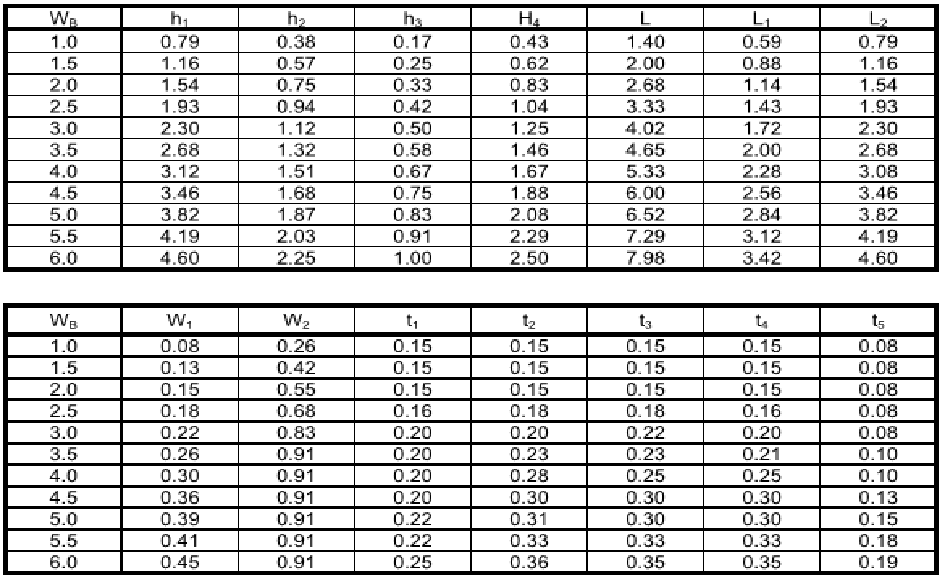
Ho/Wb = 0.35 from figure 9.14

Wb = 3.86

3.50 Adopted

Required Basin Dimensions from Table 9.2 below.

Table 9.2 (SI). USBR Type VI Impact Basin Dimensions (m) (AASHTO, 1999)



W_B	h_1	h_2	h_3	H_4	L	L_1	L_2
1.0	0.79	0.38	0.17	0.43	1.40	0.59	0.79
1.5	1.16	0.57	0.25	0.62	2.00	0.88	1.16
2.0	1.54	0.75	0.33	0.83	2.68	1.14	1.54
2.5	1.93	0.94	0.42	1.04	3.33	1.43	1.93
3.0	2.30	1.12	0.50	1.25	4.02	1.72	2.30
3.5	2.68	1.32	0.58	1.46	4.65	2.00	2.68
4.0	3.12	1.51	0.67	1.67	5.33	2.28	3.08
4.5	3.46	1.68	0.75	1.88	6.00	2.56	3.46
5.0	3.82	1.87	0.83	2.08	6.52	2.84	3.82
5.5	4.19	2.03	0.91	2.29	7.29	3.12	4.19
6.0	4.60	2.25	1.00	2.50	7.98	3.42	4.60

W_B	W_1	W_2	t_1	t_2	t_3	t_4	t_5
1.0	0.08	0.26	0.15	0.15	0.15	0.15	0.08
1.5	0.13	0.42	0.15	0.15	0.15	0.15	0.08
2.0	0.15	0.55	0.15	0.15	0.15	0.15	0.08
2.5	0.18	0.68	0.16	0.18	0.18	0.16	0.08
3.0	0.22	0.83	0.20	0.20	0.22	0.20	0.08
3.5	0.26	0.91	0.20	0.23	0.23	0.21	0.10
4.0	0.30	0.91	0.20	0.28	0.25	0.25	0.10
4.5	0.36	0.91	0.20	0.30	0.30	0.30	0.13
5.0	0.39	0.91	0.22	0.31	0.30	0.30	0.15
5.5	0.41	0.91	0.22	0.33	0.33	0.33	0.18
6.0	0.45	0.91	0.25	0.36	0.35	0.35	0.19

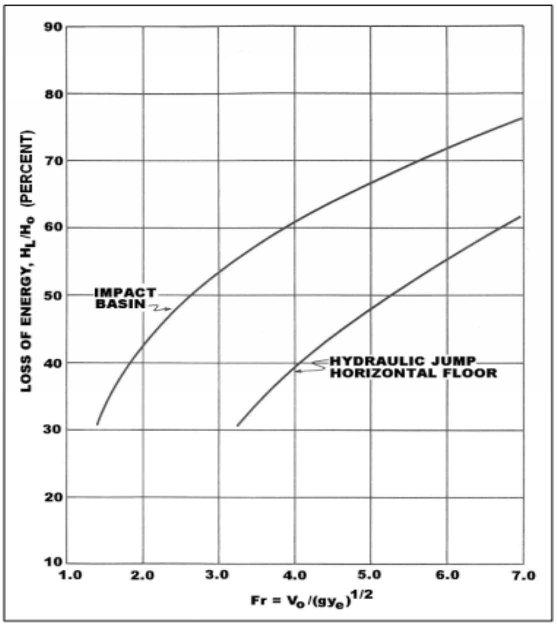


Figure 9.15. Energy Loss of USBR Type VI Impact Basin versus Hydraulic Jump

HL/Ho 30% from figure 9.15

Outlet Velocity

$H_B = Q/(W_B V_B) + V_B^2/(2g) = H_o(1\text{-}H_L/H_0)$

1. Super critical Solution

HB = 0.9464 m
HB = 0.9464 m
VB = 3.895 m/s Trial
Yb = 0.246 m

2. Subcritical solution

HB = 0.9464 m
HB = 0.9461 m
VB = 0.734 m/s Trial
Yb = 1.304 m

3. Critical Flow (Yb= Yc)

Yc = 0.3592 m
Yb = 0.3598 m
VB = 2.66 m/s Trial
Hb = 0.720 m
Hl/Ho= 47%

As the opening and sill height within the basin (H3) is greater than the critical depth within the impact basin, supercritical flow will not occur. It is unknown if sufficient tailwater will occur to allow sub-critical flow to occur. Therefore it is assumed velocity will be somewhere between sub-critical and critical flow i.e. max 2.66m/s.

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: User Defined

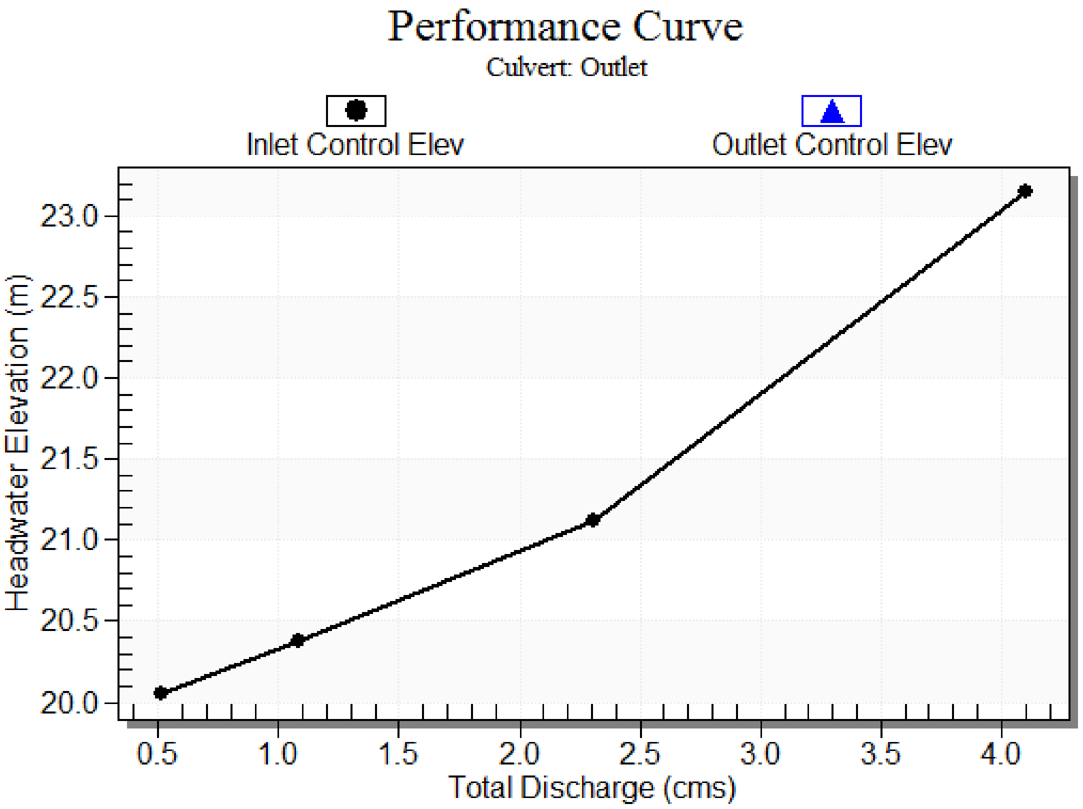
Table 1 - Summary of Culvert Flows at Crossing: West Wetland outlet

Headwater Elevation (m)	Discharge Names	Total Discharge (cms)	Outlet Discharge (cms)	Roadway Discharge (cms)	Iterations
20.05	Q2	0.51	0.51	0.00	1
20.38	Q10	1.08	1.08	0.00	1
21.12	Q100	2.31	2.31	0.00	1
23.15	Overtopping	4.10	4.10	0.00	Overtopping

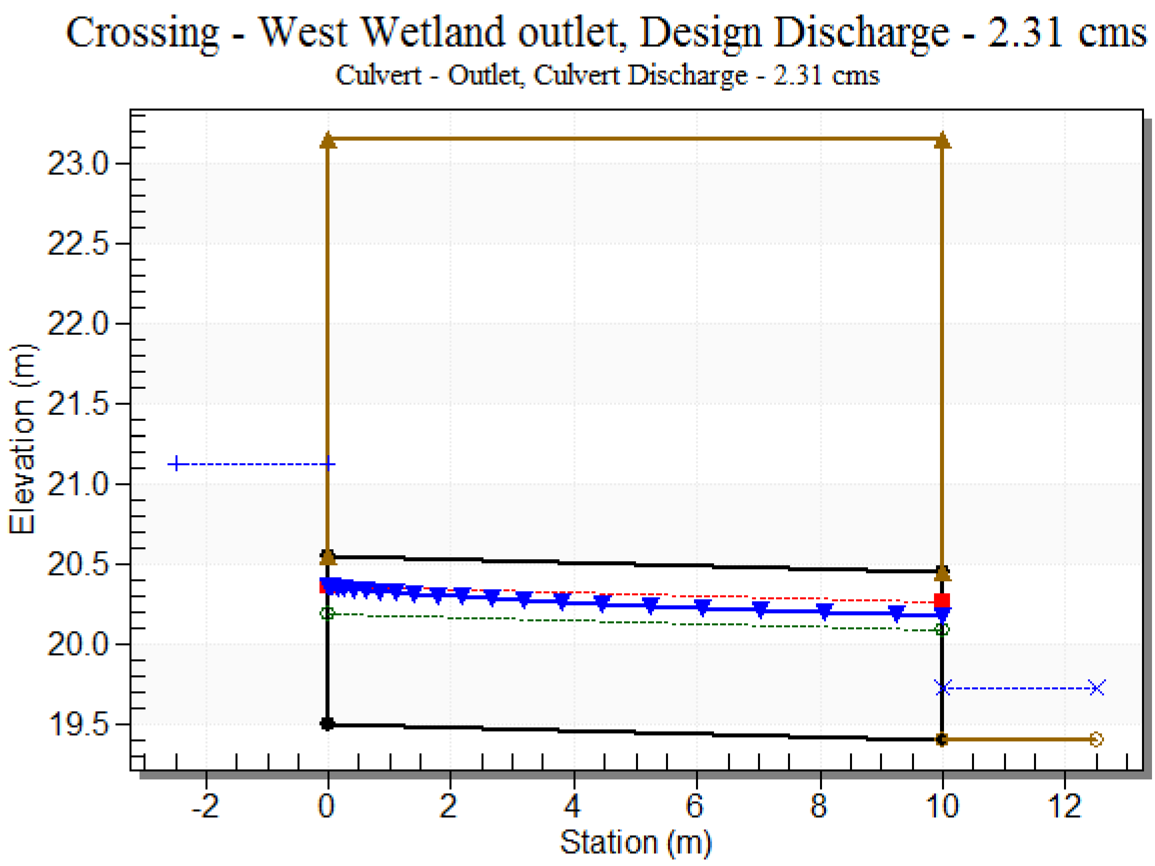
Table 2 - Culvert Summary Table: Outlet

Discharge Names	Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)
Q2	0.51	0.51	20.05	0.551	0.037	1-S2n	0.287	0.396	0.320	0.137	2.198
Q10	1.08	1.08	20.38	0.879	0.619	1-S2n	0.427	0.587	0.489	0.211	2.640
Q100	2.31	2.31	21.12	1.620	0.224	5-S2n	0.679	0.860	0.766	0.324	3.319

Culvert Performance Curve Plot: Outlet



Water Surface Profile Plot for Culvert: Outlet



Site Data - Outlet

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 19.50 m

Outlet Station: 10.00 m

Outlet Elevation: 19.40 m

Number of Barrels: 1

Culvert Data Summary - Outlet

Barrel Shape: Circular

Barrel Diameter: 1050.00 mm

Barrel Material: Concrete

Embedment: 0.00 mm

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: West Wetland outlet)

Flow (cms)	Water Surface Elev (m)	Depth (m)	Velocity (m/s)	Shear (Pa)	Froude Number
0.51	19.54	0.14	1.09	67.07	1.00
1.08	19.61	0.21	1.41	103.40	1.06
2.31	19.72	0.32	1.80	158.66	1.12

Tailwater Channel Data - West Wetland outlet

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 3.00 m

Side Slope (H:V): 3.00 (_:1)

Channel Slope: 0.0500

Channel Manning's n: 0.0500

Channel Invert Elevation: 19.40 m

Roadway Data for Crossing: West Wetland outlet

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 10.00 m

Crest Elevation: 23.15 m

Roadway Surface: Paved

Roadway Top Width: 10.00 m

Exhibit D: Opus subdivision Engineering Report

Opus International Consultants Ltd
Hamilton Environmental Office
Opus House, Princes Street
Private Bag 3057, Waikato Mail Centre,
Hamilton 3240
New Zealand

t: +64 7 838 9344
f: +64 7 838 9324
w: www.opus.co.nz

TO	Ian McAlley
COPY	
FROM	Paul King
DATE	14 July 2016
FILE	3-38720.01
SUBJECT	Engineering Report Summary - TK Land Ltd Residential Development

1 Purpose/Objective

The purpose of this memorandum is to summarise the Opus engineering reports for the stormwater, wastewater, and geotechnical engineering to support the TK Land Ltd. application for the Wayside Road Subdivision Development, Te Kauwhata resource consent.

The full reports have been included as appendices to the summary document below. The updated Scheme Plan drawings have also been included in **Appendix D.**

2 Stormwater Assessment

The stormwater design has been undertaken to meet the development requirements as outlined in the Te Kauwhata Catchment Management Plan (2009). In addition to these requirements this assessment has used the following guidance documents in the development of this design: HCC ITS (HCC, 2015), TP108 (ARC, 1999), TP10 (ARC, 2003)) for stormwater quantity and quality.

The Stormwater Assessment Report is provided in **Appendix A**. Key design outcomes of the stormwater quantity and management are outlined as follows:

- Detention basins have been designed to attenuate increased runoff (non-worsening at legal point of discharge) from the 50% and 10% AEP design storms incorporating climate change. Storage volumes required are presented in **Table 1**.
- The 1% AEP design storm does not require attenuation as it is demonstrated that downstream properties are not impacted for the existing scenario.

Key design outcomes of the stormwater quality management are outlined as follows:

- Wetlands will treat regular flows from internal catchments via an energy dissipation device and a sediment forebay.
- Wetland volumes required to achieve the water quality objectives outlined in **Table 1**.

Table 1 Detention and wetland key storage volumes and lengths

Parameter	Western Detention Basin and Wetland Volumes	Eastern Detention Basin and Wetland Volumes
Wetland Treatment Volume (m^3)	1100	1100
Flood Control (10% AEP) (m^3)	1500	3000
Combined Wetland/Detention Basin Volume (m^3)	**2600**	**4100**

Scour and erosion control will be provided at all pipe/culvert outlets and inlets (where applicable). Scour and erosion control works will be determined at the detailed design stage of the project.

It has been identified that downstream flooding as a result of the development may impact a downstream property to the west of the development (western catchment). Mitigation works will be undertaken to alleviate flooding as a result of the development at this site.

3 Wastewater Assessment

The wastewater assessment has been developed to meet the objectives of the Hamilton City Council Development Manual (Part 5 of Volume 2). A detailed Wastewater Assessment Memo is provided in **Appendix B.**

3.1 Wastewater Infrastructure

The wastewater options assessment recommends that wastewater infrastructure for Stage 1A of the Wayside Road subdivision consists of the following infrastructure:

- New reticulation and new wastewater pumping station (PS1) to service the project area.
- New emergency storage for PS1.
- New rising main pipeline from PS1 to a discharge point located in the Jetco subdivision.
- Upgrade the existing Jetco pumpstation (PS) and rising main to accommodate the increased hydraulic loading.

3.1.1 New Pump Station (PS1) and Rising Main

The new pump station and rising main will be provided with the following configuration:

- Wet-well: 1800mm diameter @ 5.7m depth
- Emergency Storage Tank: $44m^3$
- Rising Main: 240m of DN125 PE100 SDR13.6
- Pump: Flygt NP3102 SH3 – Adaptive (258) with a 4.5kW motor

3.1.2 Upgrade of Existing Jetco Pump Station (PS)

The existing Jetco Pump Station will be provided with the following upgrades:

- Rising Main: Replace existing pipe with DN180 PE100 SDR13.6 pipe
- Pump - Two options available:
  - Option 1 - upsize the impellor of the existing 11kW pump to a 273 (188mm) increases the pumped flowrate to between 16l/s and 18.7l/s (depending on system roughness).
  - Option 2 - replacement of the pumps with larger 15kW pumps.

4 Geotechnical Assessment

The geotechnical assessment has been undertaken to determine constraints on the site and to detail engineering and infrastructure constraints to developing the land. The summary Geotechnical Assessment Memo is provided in **Appendix C.** Note that a significant amount of additional geotechnical work has been undertaken to address the recommendations of this memo. However this information will be provided to support the application for engineering approval. A summary of findings is outlined below.

4.1 Background

In August 2014, Opus conducted a Stage 1 geotechnical investigation and prepared a geotechnical assessment to accompany the development proposal submission. The intention of our original Stage 1 Geotechnical Assessment letter (dated 15 August 2014) was to provide an assessment of any geotechnical constraints on the site and to detail engineering and infrastructure constraints to developing the land. Since the original consent application, and following the formation of Te Kauwhata Land Limited, significant changes to the development design have been proposed. These changes include the removal of up to 7m of in situ material from the top of the ridge which bi-sects the site, and the creation of 35 additional residential lots. Although the scheme design has changed, the geotechnical issues associated with the site are unchanged.

4.2 Ground Conditions

Soils at the site have been investigated using CPTs and hand augers. The soils present at the site generally comprise firm silts and clay, over soft sandy silts, over soft to stiff silty, with softer organic soils at lower elevations. It is considered that the upper firm silts and clays are the best option for foundations of houses and roads, and are expected to have the desired bearing capacity for residential development. Soils beneath the upper firm silts and clays are weaker and may contain excessive moisture making the difficult to use as fill.

Laboratory testing has shown that in situ materials are silt rich, and highly sensitive to moisture and re-working. However, we consider that a majority of the cut materials will be suitable for use as engineered fill to form the new contours of the site, although a portion of these cut materials will require some conditioning prior to placement. Great care will be needed in the handling of soils that are initially suitable on excavation so that they are not overworked and remoulded to an extent where they become unacceptable for use as fill.

Cut materials will generally require an undrained shear strength in the order of 70kPa – 120kPa to be suitable for compaction. These compacted strengths, however, do not guarantee “good ground” as defined in NSZ3604 – Timber framed buildings. Therefore in many cases, a specific engineering design may be required for house foundations.

Individual lot geotechnical investigations will be required to comply with building standards and localised ground treatment may be required. The area directly east of the central ridge has potentially unstable slopes. These will need measures to improve the stability and allow construction in this area. This could be achieved by regarding the slope or retaining structures. This can be confirmed at the detailed design stage.

4.3 Ground Water

Ground water was detected at the site between ground level and 16m below ground level.

4.4 Liquefaction Risk

Liquefaction poses a risks to some parts of the site, however the lower lying areas are likely to be filled and this will reduced the liquefaction risk due to the increased depth between the housing foundation and the groundwater. This will be considered both during detailed design of the subdivision (which will included a more detailed liquefaction analysis of the site) and the individual foundation design phases by using ground improvement or reinforcing measures. We recommend that rib raft type foundations are used for the construction.

4.5 Further Stages of Investigation

Following the completion of an earthworks plan, further stages of ground investigation will be undertaken to provide information for the following to enable detailed design.

- Delineate the extent of the soft soils at the CPT10 location,
- Founding properties beneath fills,
- Cut slope properties (stability and drainage),
- Cut material properties (for re-use as structural fill),
- Foundation properties beneath structures,
- Ground water levels,
- CBR values for pavement design.

Further stages of investigation and analysis have been carried out to address these requirements since the preparation of the initial Stage 1 Geotechnical Assessment, however the conclusions are dependent on the updated earthworks plan, and will be reported on separately.

5 Summary

The detailed engineering reports have been included in the Appendices of this memorandum. In addition further works have been carried out to support the development of the detailed engineering design of the subdivision and the application for discharge consent from the Waikato Regional Council and this additional information will be provided at this time.

APPENDIX A - Stormwater Assessment Report

Wayside Road Residential Development

Conceptual Stormwater Assessment

Wayside Road Residential Development

Stormwater Management Plan

Prepared By	Britta Jensen Senior Environmental Engineer		
Reviewed By	Paul King WGM – Water Engineering		

Opus International Consultants Ltd
Hamilton Environmental Office
Opus House, Princes Street
Private Bag 3057, Waikato Mail Centre,
Hamilton 3240
New Zealand

Telephone: +64 7 838 9344
Facsimile: +64 7 838 9324

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Status: Final

Contents

1 Introduction

Opus International Consultants have been engaged by Blue Wallace Surveyors to prepare a Stormwater Management Plan (SMP) for the Wayside Road residential development. This SMP has been developed in conjunction with the requirement of the Te Kauwhata Catchment Management Plan (2009).

The key scope and objectives for this SMP included:

- Stormwater quality modelling and assessment to develop a stormwater quality treatment train to demonstrate compliance with Stormwater Management Devices: Design Guidelines Manual (TP10) (Auckland City Council, 2003).
- Stormwater quantity modelling to meet the objectives of the Hamilton City Council (HCC) Infrastructure Design Guidelines (ITS) (HCC, 2013) and TP10, namely:
    - Achieve stormwater detention requirements for the 50% Annual Exceedance Probability (AEP) and 10% AEP to ensure no adverse impacts occur external to the site.
    - Demonstration that the 1% AEP does not cause adverse impacts to downstream properties.
    - Demonstration the detention basin achieves freeboard and 1% AEP spillway requirements.

An upgrade to the Travers Road culverts is linked to the proposed development occurring in this upstream catchment. The Travers Road culvert upgrade assessment is addressed in the Travers Road Culvert Upgrade Assessment (OPUS, 2016) report.

2 Project Description and Key Features

The proposed development area bounded by Te Kauwhata and Wayside Roads, Te Kauwhata and is predominantly rural, comprising of rural/rural-residential properties, and open pasture. The site is at the top of the catchment, on a gently grading hillside that drains in northerly direction. The site outfalls at two locations to a defined tributary that contributes to the Travers Road culvert catchment.

Key features and the location of the proposed development is provided in **Figure 1**. The proposed development addressed in this report includes the areas presented in blue and yellow, known as the eastern and western catchments.

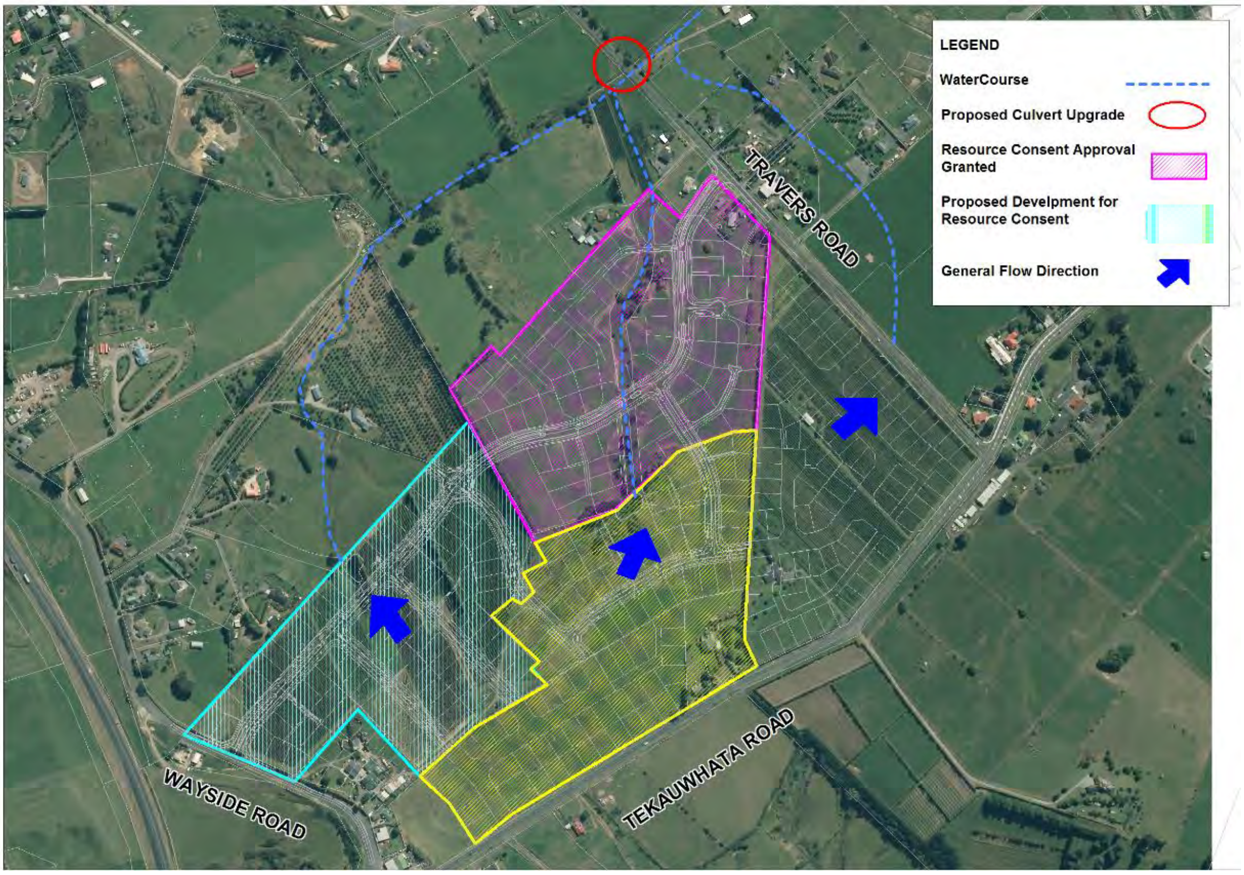

Figure 1: Proposed development area, general flow location and key features.

3 Study Input Data and Available Information

3.1 Catchment and Drainage Data

The following data has been utilised for this study:

- 2010-11 LIDAR land survey covering the study area.
- 2011 aerial imagery of the study area.
- Conceptual development layout.
- Te Kauwhata – Stormwater Catchment Management Plan (BECA, 2009).

3.2 Design Rainfall Data and Climate Change

Rainfall data is required to calculate runoff volumes and peak flow rates for stormwater management, water quality management. NIWA's High Intensity Rainfall Distribution System (HIRDS) V3 rainfall data has been used for this study. As detention is required up to the 10% AEP design rainfall event (the 1% AEP design rainfall event does not impact downstream properties as desonstrated in Section 6.2).

3.3 Groundwater Levels

The site is considered to have poor soakage qualities and therefore this option has not been investigated.

3.4 Site Inspection

A site inspection was undertaken to gather an appreciation of the catchment in terms of catchment roughness (Manning's 'n') and hydraulic controls (i.e. earth embankments, impacted properties etc.).

4 Stormwater Quantity Design Assessment Criteria

Management of flow from the proposed development and the subsequent culvert upgrade has been undertaken using the following design criteria provided in the HCC ITS, in particular:

- 50% and 10% AEP post-development design flow attenuated to respective 50% and 10% pre development (existing) greenfield flow (including an allowance for climate change);
- 1% AEP existing design flow does not impact downstream residential properties, if it is determined that flooding does occur, post development flow shall be attenuated to 80% of the 1% AEP design flow (incorporating climate change);
- The emergency spillway will convey flows beyond the service spillway's capacity. It should be designed to convey at least the 1% AEP design storm with a freeboard of at least 300 mm.
- Determination of the water quality volume.
- Suitable energy dissipation and erosion control measures shall be provided at all discharge locations.

Impacts of the proposed designation area on water quality are addressed in **Section 6**.

5 Hydrologic Assessment

The hydrologic assessment has been undertaken for the eastern and western catchments of the Wayside Development. Methodology, assumptions and results are outlined in the following sections.

5.1 Hydrologic Model Development

A HEC-HMS rainfall-runoff model for both existing and future scenarios was developed to estimate the runoff hydrographs from individual sub-catchments based on rainfall intensities, rainfall losses, fraction impervious, soil type, temporal patterns and catchment area. SCS curve numbers, SCS unit hydrographs and Standard PRF 484 where adopted for the catchment inputs. A HEC-HMS model was chosen due to its ability to more accurately calculate detention basin volumes when compared to a standard peak runoff calculation.

Flood hydrographs have been determined for the 50%, 10% and 1% AEP design rainfall events (incorporating climate change).

Model input data, parameters and all assumptions for the hydrologic model created for this study are detailed below in the following sections.

5.1.1 Catchment and Landuse

Catchment areas have been adopted for both existing and proposed layout. Two separate catchments have been adopted, draining to two separate legal points of discharge. Sub-catchment mapping is presented in **Figure 2** (western catchment) and **Figure 3** (eastern catchment).

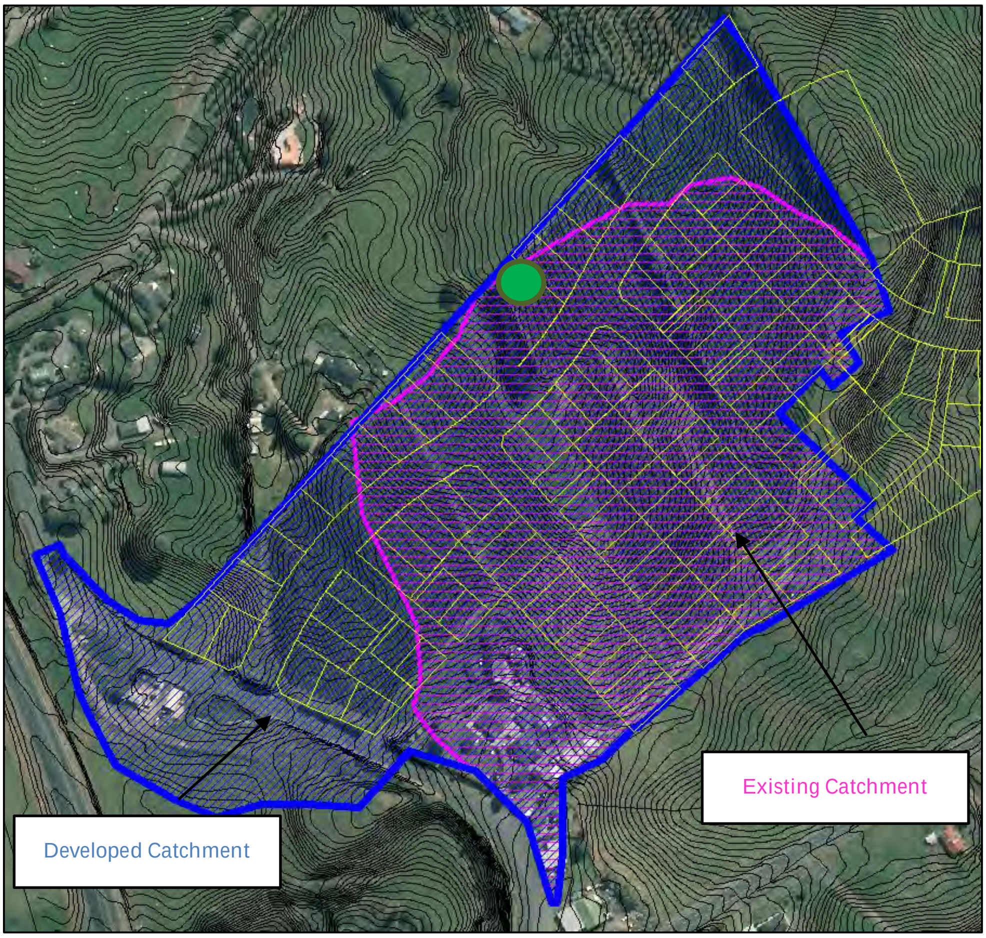

Figure 2. Existing and Developed Catchments – Western Catchment

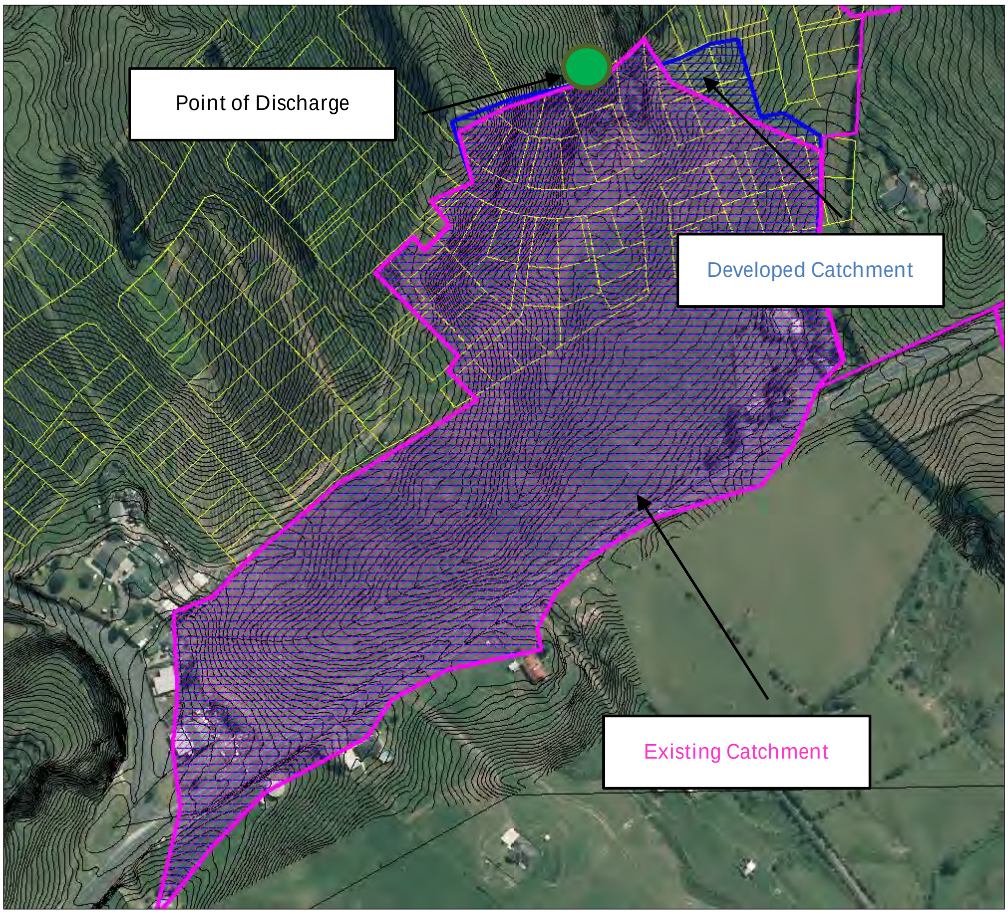

Figure 3. Existing and Developed Catchments – Eastern Catchment

Parameters based on catchment land use (including percentage impervious values, initial abstraction and runoff curve values) have been established based on TP108 (ARC, 1999) and proposed lot areas.

5.1.2 Time of Concentration

Time of concentration has been adopted based on the TP108 method and the assumption that all stormwater discharge will be conveyed by the stormwater drainage network.

5.2 Hydrologic Results and Validation

Flood hydrographs for the 50%, 10 % and 1% AEP design rainfall events have been calculated for the existing and developed scenarios. The reporting location of the flows is at the development boundary and proposed legal point of discharge.

A comparison of flows for the existing and proposed development scenarios within the study area are summarised in **Table 1**. As a result of the proposed development within the catchment, the total peak discharge at the outlet of the catchment has increased due to an increase in impervious area and concentration of flow at the outlet.

Table 1 HEC HMS Model Results

Catchment	Contributing Catchment Area (Km²)	Peak Discharge (m³/s) 50% AEP Deign Storm	Peak Discharge (m³/s) 10% AEP Deign Storm	Peak Discharge (m³/s) 1% AEP Deign Storm
Existing Wayside Road Catchment - West	0.09	0.25	0.55	1.32
Developed Wayside Road Catchment (un-mitigated and incorporating climate change) - West	0.14	0.41	0.84	1.91
Existing Wayside Road Catchment - East	0.12	0.25	0.56	1.38
Developed Wayside Road Catchment (un-mitigated and incorporating climate change) - East	0.13	0.79	1.33	2.5

TP108 Method validation was performed under existing scenario. The results of this validation is provided in **Table 2**. The results indicate that the comparative flows are within the acceptable range of 30% and HEC HMS flows are conservative in value. As such, it is considered the HEC HMS model parameters are suitable for predicting design flows within the study area.

Table 2 HEC HMS Model Validation

Catchment	HEC HMS Existing Peak Discharge (m³/s) (1% AEP)	TP108 Existing Peak Discharge (m³/s) (1% AEP)	% difference
Existing Wayside Road Catchment - West	1.32	1.39	5%

6 Hydraulic Assessment

A hydraulic assessment was undertaken to determine the following:

- Determine the impacts on downstream properties as a result of the 1% AEP design runoff from the existing development scenario.
- The volume and outlet configuration of a proposed detention basin required to ensure "non-worsening" peak flows resulting from the 50% and 10% AEP design storm events on downstream properties as a result of the development.
- Ensure that whilst the detention basin is sized for the 10% AEP design storm event. Flow as a result of the 1% AEP design storm event passes safely through the proposed outlet structures.

6.1 Detention Basin Design

Detention basin sizing has been undertaken mitigate the increased peak flows as a result of the proposed development. The basins will be located at the eastern and western outlets of the development and will discharge directly to the downstream tributaries. The locations of these basins shall be included in the **scheme plan**[1] .

It is envisaged that the outlet configuration from the detention basins will include energy dissipation devices to control velocities and minimise scour at the outlet. Refer to overall **scheme plan**[1] for the conceptual outlet configurations.

6.1.1 Detention Basin West

A depth-volume relationship represents the storage required in HEC HMS. It is proposed to have a combined treatment and detention basin system to allow for some additional storage above the water quality zone (refer to Section 7). As such, the outlet structure was modelled as a **25 mm** orifice at the basin floor level to cater for the extended detention (1/3 of the 50% AEP) above the wetland water quality volume. This is coupled with a **250 mm** dia outlet to cater for the 50% AEP design storm, a **1050 mm** dia scruffy dome to cater for the 10% AEP design storm event. A high level **14.5 m** spillway has also been incorporated to allow for the safe conveyance of the 1% AEP design storm and minimum 300 mm freeboard.

Peak storage required for detention of the 10% AEP design storm, conveyance off the 1% AEP design storm with 300 freeboard is **1500** m^3. Combined wetland and detention volume would be approx. **2600** m^3.

Refer to **Table 3** for a summary of the existing and proposed mitigated development peak discharges from the catchment and proposed detention requirements for the EDD, 50%, 10% and 1% AEP design rainfall events.

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[1] The basin locations shall be shown on the subdivision scheme plan supplied by Blue Wallace Surveyors Ltd.

Table 3 Detention Basin Details – Western Catchment

AEP	Existing Peak Discharge (m^3/s)	Mitigated Post Development Peak Discharge (m^3/s)	Peak Detention Basin Water Level (m)	Approximate Outlet level (m Moturiki VD 1953)	Outlet Configuration
EDD	0.014	0.014	19.07	19.0	orifice of area 0.02 m2
50 %	0.25	0.24	19.26	19.1	orifice of area 0.2 m2
10 %	0.55	0.54	19.41	19.49	1050 mm dia scruffy dome inlet
1 %	N/A	N/A	19.69	19.6	14.5 m high level weir with 300 freeboard to top of bund

6.1.2 Detention Basin East

A depth-volume relationship represents the storage required in HEC HMS. It is proposed to have a combined treatment and detention basin system to allow for some additional storage above the water quality zone (refer to Section 7). As such, the outlet structure was modelled as a **95 mm** orifice at the basin floor level to cater for the extended detention (1/3 of the 50% AEP) above the wetland water quality volume. This is coupled with a **350 mm** dia outlet to cater for the 50% AEP design storm, a **1050 mm** dia scruffy dome to cater for the 10% AEP design storm event. A high level **14.5 m** spillway has also been incorporated to allow for the safe conveyance of the 1% AEP design storm and minimum 300 mm freeboard.

Peak storage required for detention of the 10% AEP design storm, whilst allowing for the conveyance of the 1% AEP design storm with 300mm freeboard is approximately **3000** m^3. The combined wetland and detention volume would be approx. **4100** m^3. It is likely that this volume can be refined and lowered during the detailed engineering design stage of the project as a result of the adopted conservative development peak runoff.

Refer to **Table 4** for a summary of the existing and proposed mitigated development peak discharges from the catchment and proposed detention requirements for the EDD, 50%, 10% and 1% AEP design rainfall events.

Table 4 Detention Basin Details – Eastern Catchment

AEP	Existing Peak Discharge (m^3/s)	Mitigated Post Development Peak Discharge (m^3/s)	Peak Detention Basin Water Level (m)	Approximate Outlet level (m Moturiki VD 1953)	Outlet Configuration
EDD	0.014	0.014	21.62	21.05	orifice of area 0.007 m2
50 %	0.25	0.25	21.7	22.45	orifice of area 0.1 m2
10 %	0.55	0.49	23.66	23.6	1050 mm dia scruffy dome inlet
1 %	N/A	N/A	24.06	24	14.5 m high level weir with 300 freeboard to top of bund

6.2 Overland Flow Path Assessment

It was identified that a property downstream of the Wayside Road development western catchment may potentially flood during the 1% AEP design storm for the existing scenario. Works at this downstream property have mitigated the impacts of future flooding at this location, up to the 1% AEP design storm event.

7 Stormwater Quality Management

7.1 Design Criteria

Management of water quality has been undertaken using the following design criteria and accepted design methods for residential developments provided in the Auckland Regional Council Water Quality Spreadsheet (Mike Timperley and ARC) and TP10 in particular:

- Best practice approach for treatment of runoff, where water quality volume is based on 1/3 of the 2 year ARI 24 hour rainfall depth = 21mm and extended detention (ED) equal to 24mm.
- Treatment device performance should achieve greater than 75% removal of total suspended solids (TSS) and achieve maximum removal rates for other contaminants.
- Wetlands to be densely planted and or bathymetric design.

7.2 Stormwater Quality Management Strategy

It is envisaged that constructed wetlands will be located at the base of the detention basins at the east and west catchments to treat flows from the proposed development. Wetland have been chosen due to its ability to effectively remove storm water pollutants associated with fine to colloidal particles and dissolved contaminants. Due to these properties it will be effective in reducing loads of TSS and the associated absorbed/attached pollutants (hydrocarbons etc.).

Regular flows will enter the wetland systems from the underground drainage network via an energy dissipation device and coarse sediment forebay (which acts to remove course sediment in order to protect the wetlands macrophyte zone). Once each of the wetland extended depths are exceeded stormwater will “surcharge” from the wetlands and into the detention basins. The low level outlet from the detention basins will act as the overflow from the wetland. Scour protection and coarse sediment forebay calculations will be undertaken as part of the detailed design stage of the application.

The macrophyte zone of the wetlands will be densely vegetated using wetland species effective in nutrient removal from the stormwater. Fluctuating water levels within the wetland mimic natural wetting and drying cycles which is a key in their long-term health.

7.3 Model Development

The pollutant export loads from the catchment and treatment train effectiveness and sizing were assessed using the Auckland Regional Council Water Quality Spreadsheet (Mike Timperley and ARC) and TP108 calculations. Whilst the Auckland Regional Council Water Quality Spreadsheet (Mike Timperley and ARC) is no longer supported, the outputs are still generally accepted and therefore suitable for this study. These calculations and models are a decision support tool, used to plan and design appropriate urban stormwater management systems at the conceptual level. Model parameters including rainfall runoff and pollutant export parameters were adopted based on the recommendations from TP108 and Auckland Regional Council Water Quality Spreadsheet (Mike Timperley and ARC).

7.3.1 Model Parameters

Sub-catchment areas were based on the proposed road layout and correspond with the stormwater management catchments provided in **Figure 2**. Rainfall-runoff parameters match those developed for the stormwater management and align with TP108 ((ARC, 1999). Pollutant export parameters were adopted from recommended values for design developed by Auckland Regional Council Water Quality Spreadsheet (Mike Timperley and ARC).

7.3.2 Water Quality Results

The adopted treatment train approach incorporates the 'best practice approach" implemented as 'end of line' controls at the outlet of each sub-catchment.

A plan showing the location and size of the proposed stormwater treatment infrastructure and outlet configuration is provided in **design drawings**. Properties of the proposed treatment devices for both the western and eastern catchments are provided in **Table 5**.

Table 5 Treatment Device Properties

Parameter	Western Wetland	Eastern Wetland
Extended Detention Volume (m^3)	1215	1125
Normal Surface Volume (m^3)	1100	1100

The results of the modelling are summarised below in **Table 6**. The results show that the proposed treatment measures are consistent in achieving the required treatment objectives for TSS.

Table 6 Resultant Combined TSS Pollutant Yields and Percentage Reduction

	Existing Yields kg ha-1 a-1	Developed Yields kg ha-1 a-1	Developed with Treatment kg ha-1 a-1	Percentage Reduction (%)
Wayside Road Development	500	185	43	-77

8 Conclusion

This stormwater assessment has been developed to achieve the objectives for the Project outlined in the HCC ITS (HCC, 2015), TP108 (ARC, 1999), TP10 (ARC, 2003)) for stormwater quantity quality. Key design outcomes of the stormwater quantity and management are outlined as follows:

- Detention basins have been designed to attenuate increased runoff form the 50% and 10% AEP design storms incorporating climate change. Storage volumes required are presented in **Table 7**.
- The 1% AEP design storm does not require attenuation as it is demonstrated that downstream properties are not impacted for the existing scenario.

Table 7 Detention and wetland key storage volumes and lengths

Parameter	Western Detention Basin and Wetland Volumes	Eastern Detention Basin and Wetland Volumes
Wetland Normal Surface (m^3)	1100	1100
Flood Control (10% AEP) (m^3)	1500	3000
Combined Wetland/Detention Basin Volume (m^3)	**2600**	**4100**

Key design outcomes of the stormwater quality management are outlined as follows:

- Wetlands will treat regular flows from internal catchments via an energy dissipation device and a sediment forebay.
- Wetland volumes required to achieve the water quality objectives outlined in **Table 6**.

Scour and erosion control will be provided at all pipe/culvert outlets and inlets (where applicable). Scour and erosion control works will be determined at the detailed design stage of the project.

9 References

- *TP10 Stormwater Management Devices Design Guideline Manual*, Auckland City Council, 2003.

- *Hamilton City Council Infrastructure Technical Specification- October 2014,* Hamilton City Council, 2014.

- *Auckland Regional Council Water Quality Spreadsheet* Mike Timperley and ARC.

APPENDIX B - Wastewater Assessment Memo

Opus International Consultants Ltd
Tauranga Office
Gartshore House, Level 3, 116 Cameron Road
PO Box 646, Tauranga 3140
New Zealand

t: +64 7 578 2089
f: +64 7 578 2086
w: www.opus.co.nz

TO	Paul King
COPY	
FROM	Mark Hunter
DATE	20 May 2016
FILE	
SUBJECT	Wayside Road Development – Wastewater Assessment

1 General

This memorandum briefly outlines the design assumptions and details considered for the provision of a new pumping station at Stage 1A of the Wayside Road subdivision as well as the upgrade requirements of the existing Jetco pumping station and rising main system

The concept for providing wastewater infrastructure to the development area is as follows:

- Construction of a new reticulation and wastewater pumping station (PS1) to service the project area;
- Construct emergency storage for the proposed Pumping Station No. 1
- Construction of a new rising main pipeline from PS1 to a discharge point located in the Jetco subdivision, to facilitate drainage of the wastewater to the existing Jetco wastewater pumping station;
- Upgrade the existing Jetco pumping station and rising main to accommodate the increased hydraulic loading.

This memorandum documents the assumptions and design parameters adopted for the above infrastructure.

2 Proposed Pumping Station No. 1

2.1 General

In the sizing of the proposed Pumping Station No. 1 (PS1) the following assumptions have been made:

- The pumping station will service it’s immediate catchment only (18.2ha);
- No provision has been made for increasing the flowrate into the site;
- The rising main design assumes a design flowrate for the immediate catchment only;
- The storage capacity caters for 6hours of ADWF for the immediate drainage catchment only;

- The design of the pumping station and emergency storage chamber is in accordance with the standard details as provided in Part 5 of the Hamilton City Council Infrastructure Technical Specifications.

2.2 Catchment Analysis

The catchment analysis was undertaken in accordance with Part 5 of Volume 2 the Hamilton City Council Development Manual. The Waikato District Council has adopted this document as their design standard.

The catchment flows were calculated based on the following parameters:

2.2.1 Design Parameters

Flow Parameters	
Parameter	**Value**
Catchment Area	18.2 Ha
Population Density	45 People /ha
Flow rates:	
Residential properties	200lt/cap/day
Groundwater Infiltration Allowance	2250 lt/ha/day
Surface water ingress	16500 lt/ha/day
Peak Factor (Table 5.1)	3.1

2.2.2 Design Flows

Based on the parameters indicated above, an assessment of the likely long-term flowrates for the design of the pumping system were made.

It is envisaged that the following flowrates would be generated off the catchment:

Description	ADWF (l/s)	PDWF (l/s)(1)	PWWF (l/s)(2)
Residential catchment	2.37	6.35	9.83

Notes:

1. Peak Dry Weather Flow (PDWF) = ADWF x PF + infiltration allowance
2. Peak Wet Weather flow (PWWF) = ADWF x PF + infiltration allowance + surface water intrusion

2.3 Pumping Station Wet Well

2.3.1 Wet-Well Size

Based on the flowrates calculated above, it is envisaged that a nominal 1800mm diameter wet well will be required for the pumping station.

The depth of the wet-well would be determined by the depth of the proposed gravity reticulation. Information provided by Blue Wallace Surveyors Ltd indicates that the proposed terminal manhole at the pumping station site (WWMH1) has the following characteristics:

- Lid Level: - 23.54m R.L.
- Invert Level: - 19.35m R.L.
- Depth: - 4.19m

It is proposed that the invert of WWMH1 be dropped to 18.98m R.L. to facilitate the gravity connection and operation of the proposed storage chamber.

The finished ground level at the proposed pumping station is assumed to be equivalent to that of the lid level indicated from WWMH1, i.e. 23.54m R.L.

Based on the above and taking into account of manhole losses, pipe grade, pump submergence and proposed operating levels, it is anticipated that the pumping station dimensions would be as follows:

- Lid Level: - 23.54m R.L.
- Invert Level: - 17.84m R.L.
- Depth: - 5.70m
- Pump Stop: - 18.19m R.L.
- Pump Start: - 18.74m R.L. (Pump A)
- Invert of Inlet: - 18.94m R.L.

It is envisaged that the pumping station design would be consistent with the general design details proposed in Part 5 of the Hamilton City Council Infrastructure Technical Specifications.

2.3.2 Geotechnical Conditions

Prior to finalising the design of the pumping station, a geotechnical evaluation will be required at the site to determine ground conditions at the site. The evaluation will also need to consider the potential for liquefiable soils at the site.

2.3.3 Structural Design

The wet-well structure will require detailed structural design prior to finalising construction details.

The structural design will need to consider the geotechnical conditions at the site and will need to comply with the requirements of the Hamilton City Council Design Manual.

2.4 Emergency Storage

2.4.1 Storage Volume Required

Emergency storage at the site is required to cater for 6 hours of average dry weather flow (ADWF); at the calculated design flowrates indicated above, this equates to 51.2m^3.

2.4.2 Critical Storage level

From evaluation of the catchment drawings provided by Blue Wallace Surveyors Ltd, it is apparent that the critical manhole level in the reticulation system is manhole WWMH6.1 which has a lid level of 21.51m R.L.

Assuming a required freeboard of 300mm and allowing an additional 200mm for hydraulic losses in the system, it is proposed that the maximum storage level for the emergency storage system be set at 21.01m R.L.

(Note the actual storage depth will need to be determined once detailed levels of properties are available. Part 5 of the Hamilton City Council Infrastructure Technical Specifications requires that the storage depth be set to at least 500mm below the level of the lowest gulley trap.)

It is proposed that the storage charge/return pipe be set at a level of. 18.98m R.L. and that the pipe be connected to manhole WWMH1. (See attached schematic drawing).

2.4.3 Storage Evaluation

The storage evaluation takes into account the available storage provided by the pumping station wet well and the storage chamber only. In reality, additional storage would be available from the piped storage in the area as well as from manholes.

At the proposed storage level of 21.01m R.L., the proposed pumping station wet well would provide the following storage volume:

- Diameter: - 1.80m
- Area: - 2.54m^2
- Depth available for storage: - 2.82m
- Storage volume available: - 7.16m^3

The size of the emergency storage tank required would therefore be:

- 51.2m^3- 7.16m^3 = 44m^3

Assuming the use of 2.3m diameter flush jointed pipe for the construction of the storage tank, the following levels are proposed:

- Invert Level (lower end): - 19.02m R.L.
- Invert Level (upper end): - 19.14m R.L.
- Grade: - 1%
- Storage charge/return: - 18.94m R.L.

Based on the above and a maximum storage level of 21.01m R.L., a 12m long tank would be required.

The above levels and assumptions are subject to detailed design confirmation of critical spill levels.

The attached drawing provides a concept detail of the proposed pumping station and storage operation.

2.5 Rising Main

To provide adequate conveyance capacity for the calculated peak wet weather flow (PWWF), it is proposed that a DN125 polyethylene pipe be installed for the rising main. If a DN125 PE100 SDR13.6 pipe is considered, the resulting flow velocity would be in the order of 1.10m/s would be achieved.

This would be sufficient for the operation of the system.

It should be noted that a detailed transient analysis of the rising main has not been carried out.

2.6 Pump Selection

2.6.1 General

A preliminary pump selection was undertaken for the proposed pumping station. The following parameters were utilised:

Rising Main Size: - DN125 PE100 SDR 13.6 (I.D.= 106mm)

Rising Main Length: - 240m

2.6.2 Static Head

The static head was based on proposed pumping station operating levels and existing reticulation levels provided by Blue Wallace Surveyors Ltd.

It was assumed that the rising main would discharge into a head manhole in the existing Jetco development (SSMHA11) with an invert level of 29.29m R.L. *(this is to be confirmed prior to finalising pump selection)*

The static head utilised for the preliminary system design is therefore:

- Pump Stop: - 18.19m R.L.
- Discharge level: - 29.29m R.L.
- Static Head: - **11.10m** (maximum)

Cognisance was also made of the difference between the static heads at pump start and pump stop. A static head equivalent to the average between pump start and pump stop was adopted for the hydraulic calculations.

2.6.3 Dynamic Losses

Dynamic losses were calculated assuming a Colebrook White roughness coefficient (ks) of 0.1mm and 1.5mm to cater for both the “new” and “aged” condition of the proposed rising main.

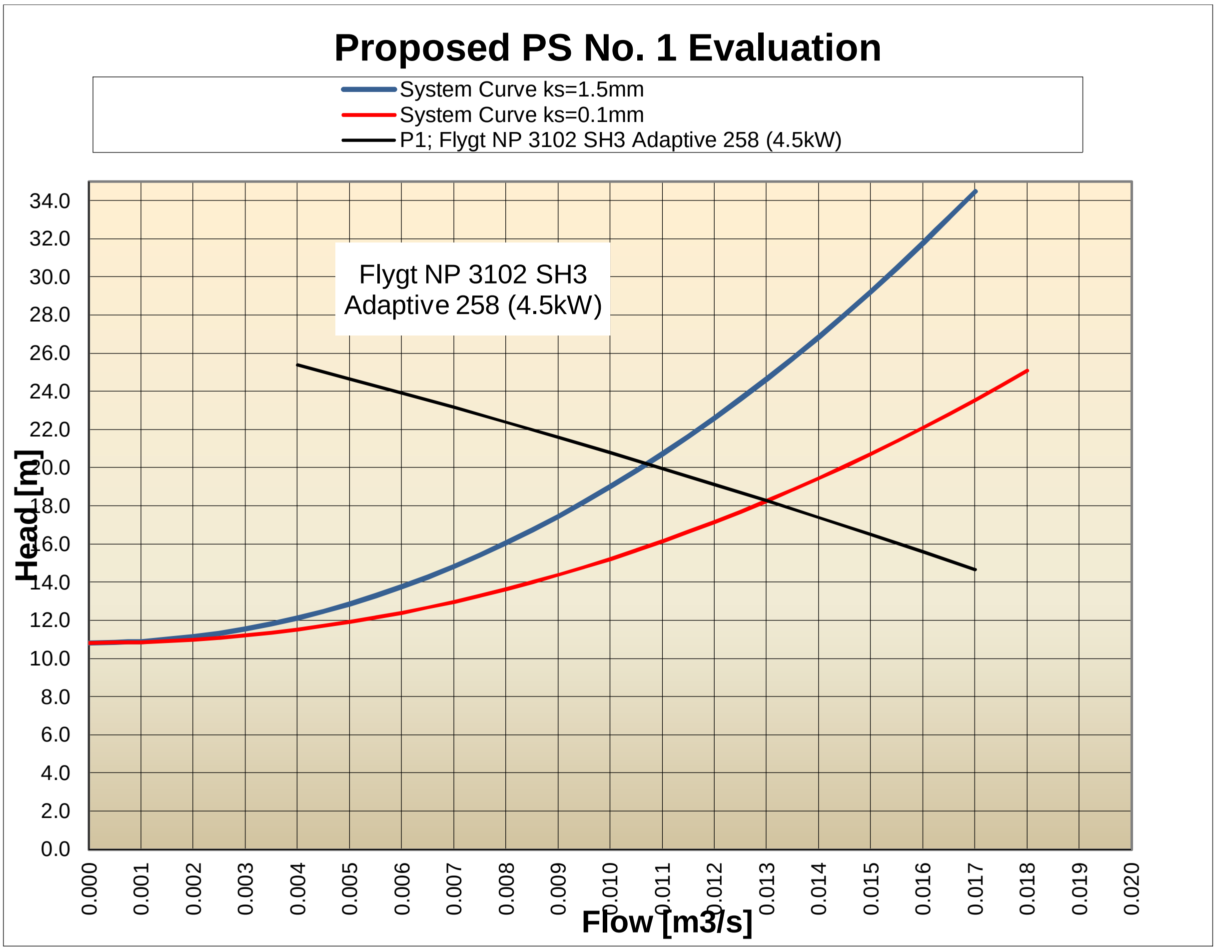
It has been assumed that the pipe riser pipework and valving would be 80mm diameter. Local losses due to bends and valves have also been considered in the headloss calculations.

Based on the above, the duty envelope for pump operation would be between 18.30m and 20.3m (including static head).

2.6.4 Pump Selection

Based on the above, a preliminary pump selection for the pumping station would be a Flygt NP3102 SH3 – Adaptive (258) with a 4.5kW motor.

The curve below depicts the anticipated duty for the pump. It is noted that the flowrate provided by the selected pump is marginally higher than that required, it may be possible to refine the size of the pump impellor selection and this should be looked at in more detail during final pump selection.



It should be noted that Volume 2 Part 5- 5.19.3: of the Hamilton City Council Development Manual states that "*Pumps shall be Flygt MT pumps (medium head performance range) models CP or NP versions 3085, 3102, 3127 or 3153*". The use of an "SH" series pump would need to be discussed with HCC.

2.7 Proposed Pump Station Layout

It is envisaged that the site development for the proposed Pumping Station No. 1 will be set-out and constructed in accordance with the Hamilton City Council Development Manual Standard Drawing No. TS501.

The site layout will however need to take cognisance of the additional space requirements for the provision of the 12m long storage chamber and associated manholes.

A concept layout is attached to this memorandum.

3 Existing Jetco PS – Upgrade Requirements

3.1 General

In determining the upgrade requirements of the existing Jetco pumping station, the following assumptions have been made:

- The pumping station will serve its current catchment, with additional inflow from proposed Pumping Station No. 1 only;
- No provision has been made for increasing the flowrate into the site;
- The rising main design assumes a design flowrate for the catchment as defined above;
- The existing storage capacity caters for 6hours of ADWF for the immediate drainage catchment only (i.e. no upgrade required);
- Assessment has been based on existing wet-well details as provided by Blue Wallace Surveyors Ltd, and are subject to confirmation during detailed design.
- The design of the pumping station and emergency storage chamber is in accordance with the standard details as provided in Part 5 of the Hamilton City Council Infrastructure Technical Specifications.

3.2 Catchment Analysis

The catchment analysis was undertaken in accordance with Part 5 of Volume 2 the Hamilton City Council Development Manual. The Waikato District Council has adopted this document as their design standard.

The catchment flows were calculated based on the following parameters:

3.2.1 Design Parameters

Flow Parameters	
Parameter	**Value**
Catchment Area	12 Ha
Population Density	45 People /ha
Flow rates:	
Residential properties	200lt/cap/day
Groundwater Infiltration Allowance	2250 lt/ha/day
Surface water ingress	16500 lt/ha/day
Peak Factor (Table 5.1)	3.3

3.2.2 Design Flows

Based on the parameters indicated above, an assessment of the likely long-term flowrates for the design of the pumping system were made.

It is envisaged that the following flowrates would be generated off the catchment:

Description	ADWF (l/s)	PDWF (l/s)(1)	PWWF (l/s)(2)
Residential catchment	1.56	4.44	6.73 (3)
Additional Inflow from PS 1	-	-	9.83
Total			**16.56**

Notes:

1. Peak Dry Weather Flow (PDWF) = ADWF x PF + infiltration allowance
2. Peak Wet Weather flow (PWWF) = ADWF x PF + infiltration allowance + surface water intrusion
3. This figure appears to be consistent with the existing pumping station design flow as documented in the Aecom Report titled “Silverstone Wastewater Pump station, Preliminary Design and Options Report, of 17 November 2014”

3.3 Existing Pumping Station Size

3.3.1 Wet-Well Size

The existing drawings provided by Blue Wallace Surveyors Ltd indicates that the existing pumping station has a nominal 1800mm diameter wet well.

The depth of the existing wet well and operating levels provided are as follows:

- Lid Level: - 14.00m R.L.
- Invert Level: - 8.00m R.L.
- Depth: - 6.00m
- Pump Stop: - 8.50m R.L.
- Pump Start: - 8.70 R.L. (Pump A)
- Invert of Inlet: - 9.10m R.L.

It is proposed that the pumping station upgrade be, wherever possible undertaken within the constraints of the existing design and levels of the pumping station.

3.4 Emergency Storage

No changes to the emergency storage system are proposed, it has been assumed that the existing emergency storage available at the pumping station site is adequately sized to cater for the emergency storage needs of the current Jetco development.

3.5 Rising Main

3.5.1 Existing Rising Main

The existing rising main consists of a 700m long DN125 polyethylene pipe. The pressure rating of the existing pipeline is not known.

The existing rising main discharges into a head manhole for the Te Kauwhata wastewater reticulation system located at the intersection of Te Kauwhata Road and Travers Road.

With the increase in flowrate proposed, the existing rising main will require upsizing.

3.5.2 Proposed Rising Main

For the calculated (revised) peak wet weather (PWWF) flowrate, it is proposed that a DN180 polyethylene pipe be installed for the rising main.

If a DN180 PE100 SDR13.6 pipe is considered, the resulting flow velocity would be in the order of 0.90m/s. This velocity is marginally lower than what would be ideal; ideally a velocity of around 1.2m/s is preferred for a rising main pipeline.

3.6 Pumps

3.6.1 General

The existing pumps installed are Flygt NP 3153 SH 11kW. It is our assumption that they are installed in a duty/standby arrangement.

Details of the existing pump riser pipework are not known, and it has been assumed that 100mm diameter pipework was installed at the time of construction – this will require confirmation.

3.6.2 Hydraulic Analysis

A hydraulic analysis and preliminary pump selection was undertaken for the pumping station taking account the increased flow requirements due to the additional pumped inflow from the proposed PS1.

The following parameters were utilised in the evaluation:

Rising Main Size: - DN180 PE100 SDR 13.6 (I.D.= 152.7mm)

Rising Main Length: - 700m

The hydraulic analysis assumes that the discharge pipework in the pumping station wet-well and valve chamber is 100mm diameter.

3.6.3 Static Head

The static head was based on operating levels indicated on Aecom drawing No.C-01-0005 as provided by Blue Wallace Surveyors Ltd.

The existing rising main discharges into a head manhole for the Te Kauwhata wastewater reticulation system located at the intersection of Te Kauwhata Road and Travers Road (WWMH1).

Information obtained from the existing drawings indicates that the manhole has an invert level of 30.42m R.L.

The static head utilised for the preliminary system design is therefore:

- Pump Stop: - 8.40m R.L.
- Discharge level: - 30.42m R.L.
- Static Head: - **22.02m**

The accuracy of the drawings provided and utilised in the determination of the static head for the system is not clear as they are not "as-built" drawings. This will need to be confirmed during detailed design.

3.6.4 Dynamic Losses

Dynamic losses were calculated assuming a Colebrook White roughness coefficient (ks) of 0.1mm and 1.5mm to cater for both the "new" and "aged" condition of the proposed rising main.

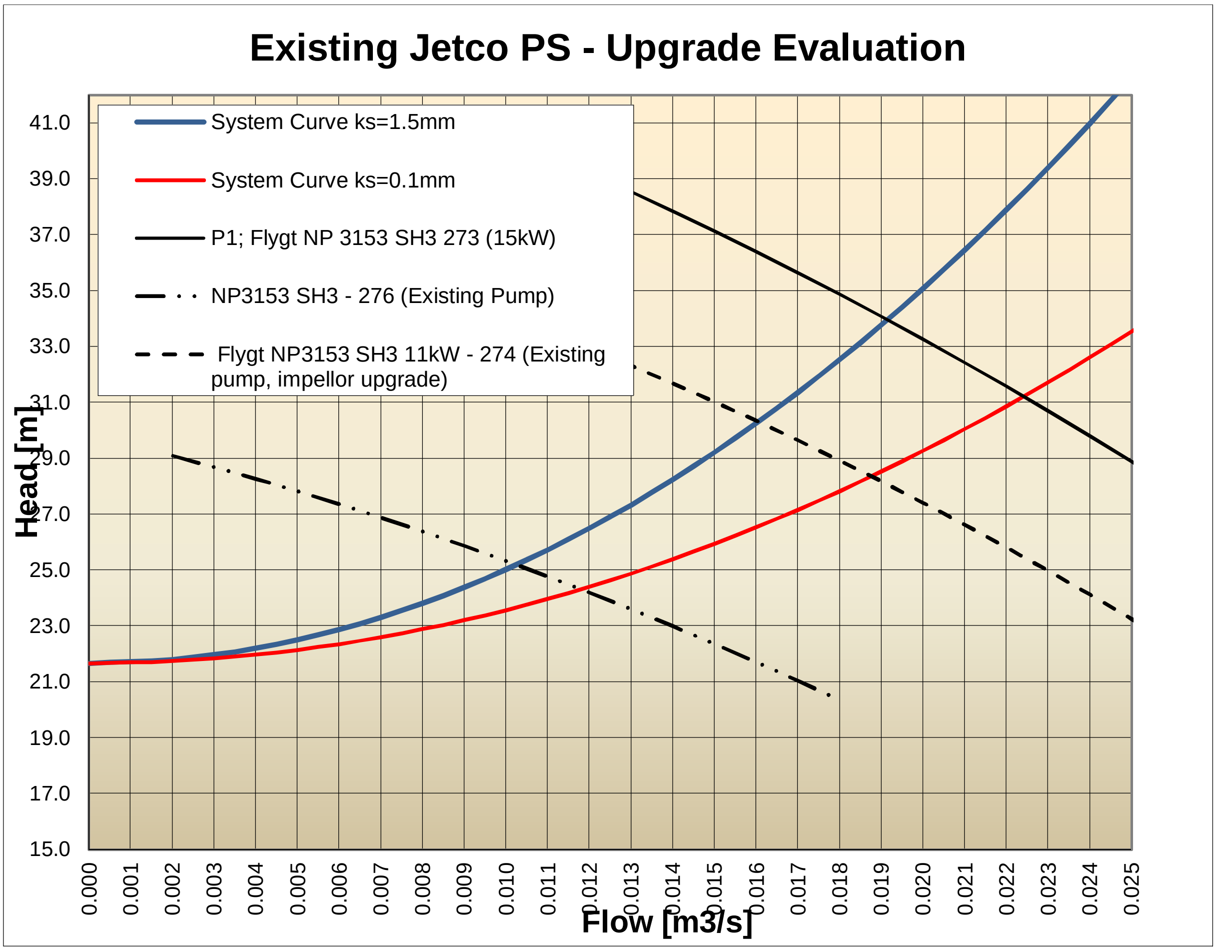
It has been assumed that the pipe riser pipework and valving would be 100mm diameter. Local losses due to bends and valves have also been considered in the headloss calculations.

3.6.5 Pump Selection

In considering the pump selection for upgrade of the Jetco pumping station, consideration was given to the following:

- Capacity of the existing 11 kW pump
- Upgrading the impellor of the existing 11kW pump;
- Replacement of the existing pump.

The following system curves depict the assessment of the above:



Based on the above, the following assessment has been made:

- The existing pump cannot provide the required duty and is limited to between 10l/s and 12l/s (dependent on system roughness);
- Upsizing the impellor of the existing 11kW pump to a 273 (188mm) increases the pumped flowrate to between 16l/s and 18.7l/s (depending on system roughness). The flowrate is marginally lower than that required when utilising a roughness co-efficient of 1.5mm.
- Replacement of the pumps with larger 15kW pumps is slightly oversized for the system.

Consideration could be given to a staged approach to pump upsizing, with the initial pump upgrade being limited to an impellor upgrade. The performance of the pumping station could be monitored and in time the pumps replaced for the slightly larger 15kW units.

The 15kW pump is slightly larger than the existing pumps and the upgrade will have to consider the replacement of switchgear at the motor control centre as well as the possible impact of the larger pump motor on the existing electrical supply at the site.

If this staged approach is favoured, this should be discussed with Waikato District Council before a final decision on the upgrade is made.

It should be noted that Volume 2 Part 5- 5.19.3: of the Hamilton City Council Development Manual states that “Pumps shall be Flygt MT pumps (medium head performance range) models CP or NP versions 3085, 3102, 3127 or 3153”. The use of an “SH” series pump would need to be discussed with Waikato District Council.

3.6.6 Other Upgrade Requirements

As indicated previously, for the purposes of this evaluation, it has been assumed that the existing pumping station discharge riser pipework and valving is sized at 100mm in diameter.

If this is not the case and the current pipework is only 80mm, this would impact on the hydraulic calculations undertaken, and it is likely that this pipework and valving will require upgrading when works on the pump upgrades is undertaken.

This will need to be investigated during detailed design.

4 Limitations of Assessment

4.1 Existing Information

The information utilised to define the design parameters for both the proposed Pumping Station No. 1 and the Jetco pumping station upgrade was obtained from available drawings provided by Blue Wallace Surveyors Ltd.

Should any of the information change (variations in levels, pipe lengths or catchment size etc.), the design parameters will need to be revisited to determine if they are still appropriate.

Notwithstanding the above, it is proposed that a final check of pump selections be made once final scheme drawings for Stage 1A of the Wayside Road sub-division are available.

4.2 Pumping Station Design

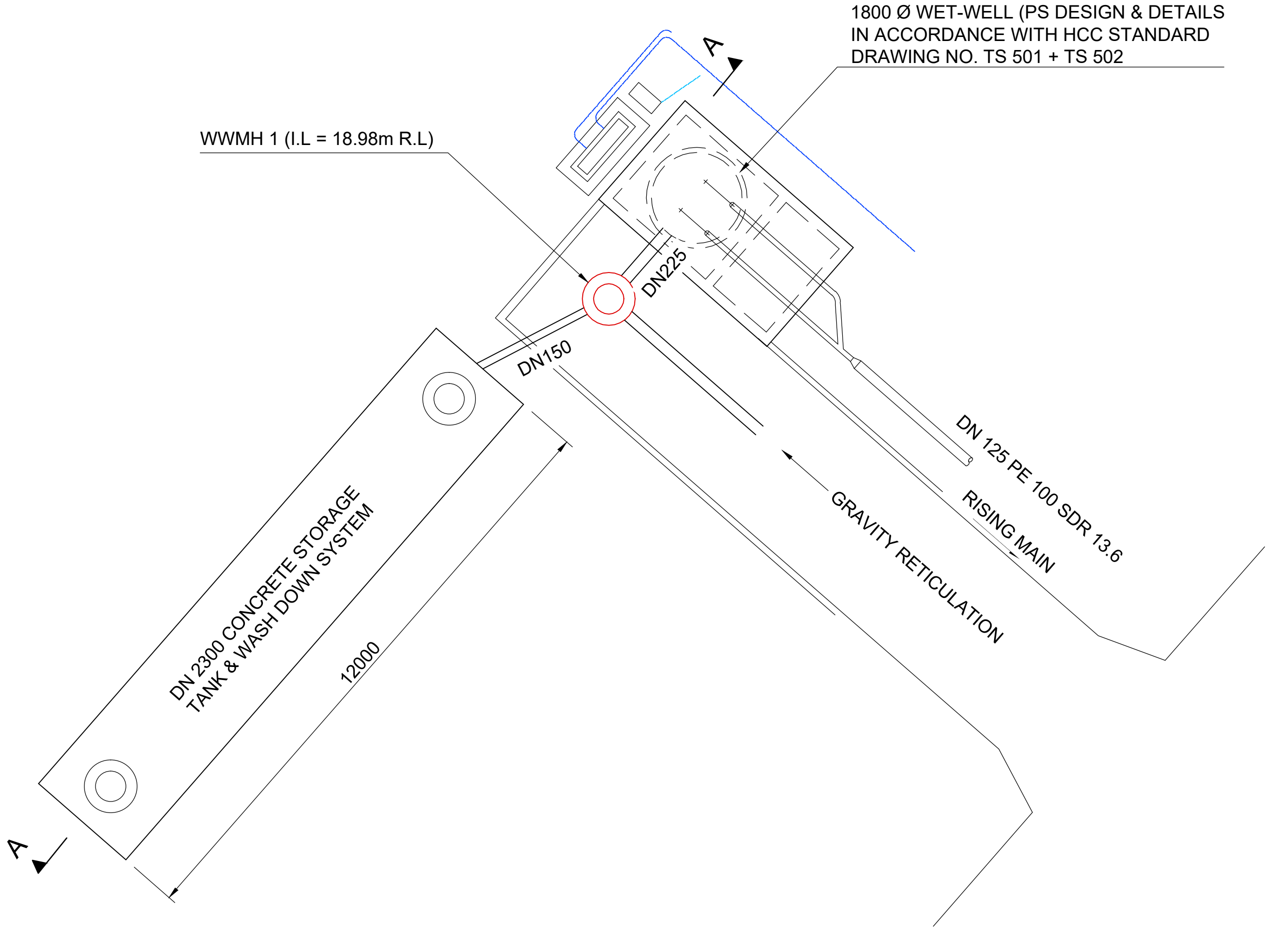
The pumping station design has not considered site specific geotechnical conditions and associated structural design requirements. These will need to be confirmed and appropriate design implemented prior to completion of detailed design of the proposed pumping station.

4.3 Impact on Downstream Wastewater Infrastructure

Provision of additional wastewater infrastructure in the area will result in an increase in the hydraulic loading on downstream infrastructure.

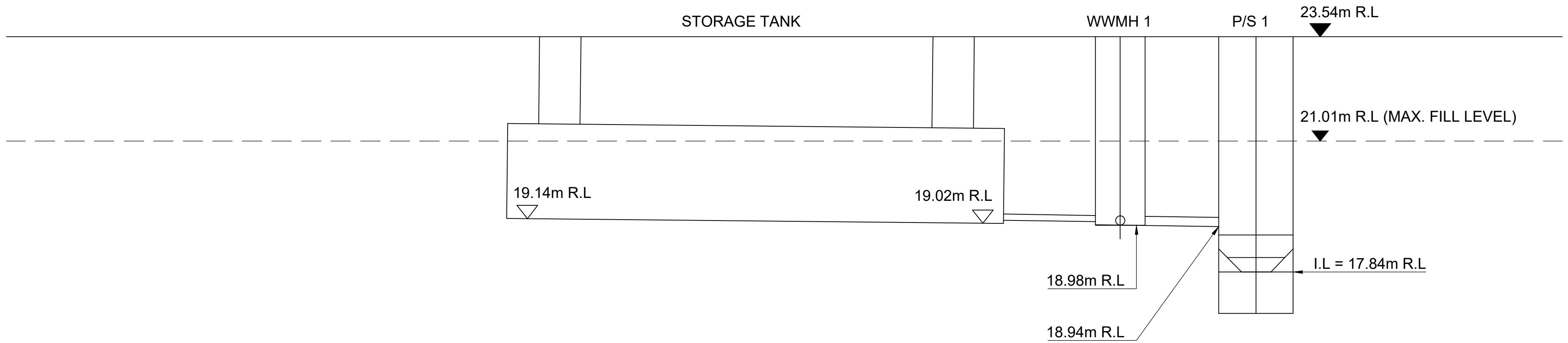
This pumping evaluation has not considered the possible impacts of discharging a larger flow on the existing downstream wastewater reticulation. It has been assumed that the existing reticulation has capacity to convey the increased pump flow from the Jetco pumping station.

Notwithstanding the above, it will be important to check the capacity of the downstream network during detailed design stage for the upgrade works.



PROPOSED PS1 - TYPICAL SITE LAYOUT

SCALE 1:75(A1) 1:150(A3)



TYPICAL SECTION A-A

SCALE 1:75(A1) 1:150(A3)

FOR INFORMATION

Revision	Amendment	Approved	Revision Date
A	FOR INFORMATION	M.H	20/05/2016

Blue Wallace
Surveyors Ltd.

OPUS
Tauranga Office
+64 7 578 2089

PO Box 646
Tauranga 3140
New Zealand

Designed	Approved	Approved Date
M.HUNTER	M.HUNTER	20/05/2016

Drawn	Scales
A.GORDINE	1:75 (A1) 1:150 (A3)

Project
WAYSIDE ROAD DEVELOPMENT
PROPOSED PUMPSTATION 1
CONCEPT LAYOUT

Sheet
TYPICAL SITE LAYOUT & SECTION

Project No.	Sheet. No.	Revision
338720.01	C01	A

1:75 @ A1
1:150 @ A3
0 1 2 3 4 5 6 7 m

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APPENDIX C - Geotechnical Assessment Memo

Opus International
Consultants Ltd
Hamilton Office
Opus House, Princes Street
Private Bag 3057, Waikato Mail
Centre, Hamilton 3240
New Zealand

t: +64 7 838 9344
f: +64 7 838 9324
w: www.opus.co.nz

1 July 2016

Ian McAlley
Director
McAlley Consulting Group Ltd
380 Sunset Rd
Sunnybrook
Rotorua 3015

3-38720.01

Dear Ian,

Updated Stage 1 Geotechnical Assessment for Te Kauwhata Land Limited Development

1 Introduction

Opus International Consultants was originally engaged by Blue Wallace Surveyors Limited in 2014 to undertake a staged geotechnical assessment for a proposed residential development at Lot 2 DP 385781 Wayside Road, Te Kauwhata.

The original proposal was for approximately 17ha of land to be re-zoned to allow residential development at this site. The design comprised the site being divided into approximately 130 residential lots of approximately 800m^2. To access the lots, there will be new road construction with the existing local infrastructure.

In August 2014, Opus conducted a Stage 1 geotechnical investigation and prepared a geotechnical assessment to accompany the development proposal submission. The intention of our original Stage 1 Geotechnical Assessment letter (dated 15 August 2014) was to provide an assessment of any geotechnical constraints on the site and to detail engineering and infrastructure constraints to developing the land.

1.1 Post 2014 Changes to the Proposed Development

Since the original consent application, and following the formation of Te Kauwhata Land Limited, significant changes to the development design have been proposed.

These changes include the removal of up to 7m of in situ material from the top of the ridge which bi-sects the site, and the creation of 35 additional residential lots.

Although the scheme design has changed, the geotechnical issues associated with the site are unchanged.

Therefore the original Stage 1 Geotechnical Assessment report is still applicable, and we have revised this report, presented below, to reference the new residential lot numbers and new scheme plan.

This report includes:

- A description of the site and proposed development,
- A description of the site investigation,
- Assessment of geotechnical constraints,
- Recommendations for possible development strategies and means to achieve them.

2 Site Description

The proposed subdivision is approximately 1.5km west of the Te Kauwhata Township. The surrounding areas consist farmland and lifestyle properties.

Currently the proposed site is being used as an orchard with a small adjoining processing yard. The site is located in the Lower Waikato basin, approximately 1.8km northeast of the Waikato River.

The subdivision area is essentially slightly undulating with occasional shallow depressions.

The site is divided into two portions, east and west, by a north to south trending ridgeline. This ridge is the dominant feature of the development area, with slopes either side of the ridge reaching a maximum slope angle of 30 degrees. In the steeper areas there are areas of soil creep.

East and west of the ridge, each portion of land forms individual “amphitheatre” shapes with grades sloping to the north. These slopes range from level at the base to 10 degrees near the crests.

On the northern site boundary, the lower parts of the basins contain low lying boggy areas with the start of small streams.

There were two springs noted at the site, one on the eastern flank of the ridgeline and one on the western hills of the western amphitheatre. The former being due to localised concentration of surface water within a small basin structure; the latter possibly created by surface run off from the adjacent processing buildings. These have caused small scale localised surface creep of the soil.

3 Geological Setting

The 1:250,000 and 1:63,360 scale geological maps[1] shows the site to be underlain by pumiceous clays with lignite, gravel and some pure pumice silt and sand from Pliocene epoch.

These soils are volcanic in origin and deposited as alluvium with interbedded peat materials and are part of the Whangamarino and Puketoka Formations.

The New Zealand Active Faults Database produced by GNS Sciences shows there are a no known faults in close proximity, with the closest being the Wairoa South normal fault approximately 23km north of the site.

4 Site Investigation

A site walkover and preliminary ground investigation was undertaken on 28th July 2014 to observe topographic and ground conditions across the site.

A combination of Cone Penetrometer Tests (CPTs) and exploratory hand auger holes were specified located by Opus.

The works comprised ten CPTs to depths of up to 29.5m below ground level (bgl) and five hand augured holes to depths of up to 3.6m bgl. These were to investigate the soils for type, thickness, geotechnical properties, liquefaction potential and to determine groundwater levels. The exploratory hole locations of the investigations are shown on Figure 2.

The exploratory hole types and locations were specified by Opus and are detailed in Table 1, copies of all CPT and hand auger data are attached to this memo.

Investigation Identity	Depth Investigated (m BGL)	Location and Feature Investigated
CPT1	16.0	Western boundary. General ground conditions on top of slope.
CPT2	13.0	Northern boundary. General ground conditions on mid slope.
CPT3	17.0	Northern boundary. General ground conditions on mid slope.
CPT4	27.0	Top of ridgeline. General ground conditions.
CPT5	17.0	Eastern half of site. Soft ground near stream head.

---

[1] Edbrooke, S.W. (compiler) 2001: Geology of the Auckland Area. Institute of Geological and Nuclear Sciences 1:250,000 geological map 3. 1 sheet + 74p. Lower Hutt, New Zealand. Institute of Geological and Nuclear Sciences Limited.
Kear, D, Schofield, J.C, N52 Te Kauwhata (1st Edition) Geological Map of New Zealand, 1:63,360, Department of Scientific and Industrial Research. Wellington New Zealand.

CPT6	20.0	Southern boundary. General ground conditions on top of slope.
CPT7	29.5	Eastern boundary. General ground conditions on top of slope.
CPT8	9.0	Eastern half of site. General ground conditions on mid slope.
CPT9	7.5	Western half of site. Soft ground near stream head.
CPT10	14.5	Western half of site. General ground conditions on mid slope.
HA1	3.6	Northern boundary. General ground conditions on base of slope.
HA2	2.0	Top of ridgeline. General ground conditions.
HA3	1.9	Northern boundary, western half of site. General ground conditions on base of slope (stream head).
HA4	3.5	Northern boundary, eastern half of site. General ground conditions on base of slope (stream head).
HA5	2.0	Western half of site. General ground conditions on mid slope.

Table 1. Details of ground investigation.

The hand auger did not reach the prescribed depth of 4.0m due to unrecoverable materials.

Groundwater levels were measured in CPTs holes, hand auger holes and inferred from CPT results.

Ground water levels vary across the site. In the lower elevations of the site ground water was observed between ground level and 1m depth.

Further uphill we consider the ground water to be between 4 to 8m below ground level. At the top of the ridgeline we consider the water level to be much deeper than this at approximately 16m below ground level.

5 Geotechnical Constraints Assessment

Our geotechnical assessment has identified a number of potential constraints to the site.

In this section we discuss these constraints, potential risks and then make recommendations to manage these constraints.

Where appropriate we present possible means of overcoming or managing any risks or threats posed by the constraints:

- Geomorphology/ Topography,
- Ground Conditions,
- Ground Water,
- Liquefaction Risk,
- Slope Stability,
- Foundation conditions,
- Earthworks.

5.1 Geomorphology

This section relates to physical topographical features that reflect the geological environment in which they were formed.

Using aerial photos and a site visit we have identified a number of features including unstable areas such as landslips, soft ground, gullies and stream channels.

The choice of landform for the development should avoid these features or employ measures to minimize or remove the risks they pose.

Figure 3 and 4 show the geomorphological features that pose a potential constraint to the current plan. These features are summarised in Table 2 below.

Feature	Threat	Development Options
Landslips or soil creep	Movement of houses and infrastructure	Regrade slopes
Soft soils	Excessive settlement, bearing capacity failure	Appropriate foundations, replace/import soils, ground treatment
Artesian water	Flooding	Avoid area, drain area, build up levels
Springs	Soft soil, flooding and soil creep/erosion	Collect and channel water

Table 2 Features Identified at the Site

The location of these features and our recommendations for the development are detailed in Table 3 below.

Feature	Location	Development Options
Potential landslips or soil creep	Lots 41-44, 66-70, 81-87, 104-110	Slope is currently at 25 degrees in cohesive soils. We recommend that this slope is regraded to a shallower slope angle. This angle can be determined by further ground investigation and slope stability analysis.
Soft soils	Lots 4-6, 10-12, 54-58, 71-73, 80-87, 110-116, 126-136	Artesian water may cause flooding to properties in this area and the soft soils will require additional engineering input.
Artesian water	Lots 132-134	See above
Springs	Lots 33-46, 66-70, 81-87	Collect and channel water to storm water drain.

Table 3 Recommendations for Development

5.2 Ground Conditions

The investigation generally confirmed the soil types shown on the geological maps.

Some CPTs (2, 4, and 10) proved very weak soils at depths of 3 to 12m below ground level with cone resistances less than 1MPa.

The two CPTs undertaken in the lowest lying parts of the site (5 and 9) showed approximately 4m of very soft ground immediately below ground level.

In general, the CPTs and hand augers proved three main soil units at the site:

- Upper silt and clay (soft to firm) although this unit is missing in CPT8 and CPT10 over,
- Middle sandy silt (very soft to firm) over,
- Lower silt and clay (generally firm, although very soft at CPT10.

These three consistently identifiable soils units are discussed below.

5.2.1 Upper Silt and clay

The thickness of this soil unit ranges from 0.5-6.0m. CPT5 and CPT9 encountered very weak soil with organic material content within this layer.

The silty clay soils are described as soft to firm in the hand augers and show a CPT cone resistance (qc) of 2-5 MPa (approximately 30 to 75kPa undrained shear strength).

5.2.2 Middle Sandy silt

This soil unit lies between 4m and 10m depth and ranges from 2.0 to 7.0m thick.

In hand auger 3 this soil was described as a brown silty sand with traces of gravel. The soil was dilatant and released moisture when reworked.

Strength of these soils is highly variable across the site.

5.2.3 Lower Silt and Clay

The thickness of this soil unit ranges from 3.0 to >19.0m.

CPT6 and CPT7 proved sensitive or organic soils at depth which were extremely weak.

As the silt content increases in this unit, the strength appears to decrease.

5.3 Ground Water

Ground water was encountered between ground level and 16m below ground level.

Given the nature of the soils and the results of the investigation we consider that on most of the lots soakage to ground will not be the most appropriate method for onsite stormwater management.

The vast majority of soils at the site contain soft clay and silt which are likely to result in low permeabilities.

Springs are present at the locations shown on Figures 3 and 4. There was also a strong flow at the surface from HA4, suggesting artesian ground water at that location. The source of these spring and flows is uncertain.

The ground water levels have been plotted and interpreted as a piezometric surface, shown as Figure 5.

We have interpreted the ground water levels for each investigation location, these levels are presented in Table 4. Elevations have been measured by handheld GPS in the field and inferred from the Blue Wallace survey.

Investigation Identity	Hole Elevation	Depth to Ground Water (m BGL)	Ground Water Reduced Level (m RL)
CPT1	70	4	66
CPT2	60	2	58
CPT3	65	3	62
CPT4	74	16	58
CPT5	57	0	57
CPT6	72	6	66
CPT7	66	5	61
CPT8	64	5	59

CPT9	62	1	61
CPT10	66	8	58
HA1	63	1	62
HA2	77	Dry	-
HA3	55	2	53
HA4	57	0	57
HA5	66	Dry	-

Table 4. Details of ground water observations.

We note that groundwater levels can vary significantly across the site and are likely to experience a seasonal variation also. Consideration needs to be given to the season rise in the groundwater table when designing soakage systems.

5.4 Liquefaction Risk

Soils at the site have the potential to liquefy during a significant seismic event due to their grain size, density, strength and the high water table.

We determined Soil Class D (deep soft soils) for the site, design life of 50 years and importance level of 2 for the structures.

We have calculated the design peak ground acceleration (PGA) for a magnitude 7.5 earthquake using NZS1170.5[2].

For the ultimate limit state (ULS) 1:500yr event we have determined a PGA of 0.17g.

Data from the five CPTs was used for the liquefaction assessment using Cliq software. This program determines the risk of liquefaction and the potential vertical liquefaction induced settlement.

Data for the CPTs shows that there is potential for liquefaction beneath the site with the highest potential being below the eastern side.

Estimated potential liquefaction induced vertical settlements in the ULS case are shown in Table 5.

Exploratory Hole	CPT1	CPT2	CPT3	CPT4	CPT5	CPT6	CPT7	CPT8	CPT9	CPT10
Estimated Liquefaction induced settlement (mm)	153	60	29	0	138	11	51	2	40	8

Table 5: ULS case: estimated liquefaction induced settlement over whole CPT depth

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[2] Structural Design Actions NZS1170.5 2004.

The CPT traces used are for the total depth of the CPT test. Some of these tests did not reach to depths of up to 20m, therefore liquefaction settlements at those locations may be higher may be higher than the values quoted above.

On Figure 6 we show the areas of the site that may be affected by liquefaction induced settlements.

Liquefaction risk can be re-assessed in detailed design following completion of the earthworks design plan and earthworks and foundation designs selected to minimise potential impact.

5.5 Slope Stability

Some slopes to the east of the ridge may have marginal stability. Signs of instability included hummocky surfaces, crescent-shaped depressions, trees leaning uphill and a spring.

Relatively minor disturbance such as excavation for roads and building platforms may lead to failure. Careful design of cut slopes will be necessary or use of retaining structures.

5.6 Foundation and Bearing Capacity Conditions

This site has noticeably different foundation conditions between the higher and lower areas of the site.

The lower elevations have generally softer soils which may reflect higher ground water in these areas.

Away from these lower elevations there is a stronger ‘crust’ of drier cohesive soils on top of softer materials.

5.6.1 General Site Observation

CPT and hand auger results indicate that a design ultimate bearing capacity (UBC) of 300kPa is likely to be available at some locations, particularly in areas of deeper cut.

Areas that do not achieve this will require localised undercut and replacement with compacted fill.

At this stage we anticipate that foundations supported on the natural soils and controlled fill may be designed and constructed in accordance with NZS 3604, but with varying depths of excavation to remove soft soils at some of the lots.

Expected excavation depths range from 0.5 to 2.0 metres below ground level are likely to be required.

Given the variability of the foundation materials on the site, we recommended that geotechnical testing is undertaken as part of the house design/building process on each lot to comply with NZS3604:2011 to confirm the general recommendations contained in this report and to enable specific foundation recommendations to be provided.

5.6.2 Soft Soil Areas

Soft soil was generally proved in the lower parts of the site, specifically in the proximity of hand auger 3, CPT 9, CPT5. Hand auger 4 encountered 3-4m of soft, wet and organic soils.

Specific engineer designed foundations will be needed in these areas, designed in accordance with NZS 3604:2011 as. The following foundation options will need to be considered:

- Timber piles extending though the soft soils into suitable bearing soils,
- Excavate and replacement of soft materials,
- Surcharging/preloading the soils to reduce settlements and consolidate soils to improve bearing capacity
- Rib raft foundations

At CPT10 very soft soils were encountered beneath the surface and specific foundation/earthworks design will be required to provide suitable building platforms.

All options will require specific engineering design and the most suitable option on each lot will depend on the final specific building, ground levels, location and landscaping proposals.

5.6.3 Faults

The Ministry for the Environment document, "*Planning for Development of Land on or Close to Active Faults*"[3], defines a Fault Avoidance Zone for buildings. There were no signs of faulting at the site. The published geological data shows that the nearest fault is 23km north of the site.

5.6.4 Geothermal

At the time of site inspection there were no geothermal vents present at the ground surface, nor were there any shown on the published geological maps.

5.6.5 Earthworks

Overall we recommend earthworks and excavations across the site are carefully designed and minimised as far as possible in some areas.

This based on the following observations:

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[3] Kerr, J. et al. 2003. Planning for Development of Land on or Close to Active Faults. A guideline to assist resource management planners in New Zealand. Ministry for the Environment, Wellington, New Zealand.

- Shallow ground water levels in the lower lying parts of the site and on the eastern flank of the ridgeline. Cuttings in these areas may require drainage to ensure stability.

- In some areas the upper 2-4m of soils present are generally the better soils for foundation properties and cutting below these soils increases foundation costs,

- The soils at the site are all silt rich and are sensitive to reworking and changes in moisture content. Some of the sandier parts of the soil were observed to breakdown on remoulding by hand, releasing moisture and softening. It is likely that a high proportion of the excavated material will need drying or conditioning on excavation before it can be placed and reused as structural fill.

- Fills placed over the softer more compressible soils in the lower lying areas will have to be carefully designed and timed to ensure stability and manage settlements.

- Due to the silt content of the soils, good erosion and sediment control will be necessary during site works.

- The CBR of the natural silt rich soils is likely to be of the order of 2%.

6 Conclusions and Recommendations

We have investigated the soils at the site using CPTs and hand augers. The soils encountered are consistent with published geological data.

Three soils units have been identified for the site with softer organic soils at lower elevations.

The three soil units are generally firm silts and clay, over soft sandy silts, over soft to stiff silty clays.

We consider that the upper firm silts and clays are the best option for foundations of houses and roads. Soils beneath this are weaker and may contain excessive moisture making the difficult to use as fill. These weaker materials are also likely to require specifically engineered foundations.

The soil conditions encountered were noticeably different between the higher and lower elevations of the site with softer and more compressible soils at shallow depth in the low lying areas.

Generally the majority of site soils are expected to have the desired bearing capacity for residential development. However the low lying and soft soils will not achieve required bearing capacity. Individual lot geotechnical investigations will be required to comply with building standards and localised ground treatment may be required.

The lowest elevations have soft soils that will need to be avoided for construction or engineered to improve the ground conditions.

The area directly east of the central ridge has potentially unstable slopes. These will need measures to improve the stability and allow construction in this area. This could be achieved by regarding the slope or retaining structures. This can be confirmed at the detailed design stage.

Liquefaction poses a threat to the site and this needs to be considered during the individual foundation design phases by using ground improvement or reinforcing measures. We recommend that rib raft type foundations are used for the construction.

Following the completion of an earthworks plan we recommend that further stages of ground investigation are undertaken to provide information for the following to enable detailed design:

- Delineate the extent of the soft soils at the CPT10 location,
- Founding properties beneath fills,
- Cut slope properties (stability and drainage),
- Cut material properties (for re-use as structural fill),
- Foundation properties beneath structures,
- Ground water levels,
- CBR values for pavement design.

Further stages of investigation and analysis have been carried out to address these requirements since the preparation of the initial Stage 1 Geotechnical Assessment, however the conclusions are dependent on the updated earthworks plan, and will be reported on separately.

7 Limitations

The recommendations and opinions contained in this report are based upon on site observations and data from the ground investigation undertaken by Opus International Consultants as described above. Inferences about the nature and continuity of ground conditions across the site are made on the basis of the site observations, sound geological principles and engineering judgement; however continuity of ground conditions cannot be guaranteed.

This report has been prepared for the particular project described in the brief to us and no responsibility is accepted for the use of any part of this report in any other context or for any other purpose.

DRAFT

SITE AREA	170,145.5m²
NUMBER OF LOTS	165
GROSS AVERAGE YIELD	1,031m²
NET AREA	116,029m²
NET AVERAGE YIELD	703m²
① DRAINAGE RESERVE	2,497m²
② OPEN SPACE	2,599m²
③ DRAINAGE RESERVE	991m²
TOTAL RESERVE/OPEN SPACE	6,087m²
SMALLEST LOT SIZE	550m²
LARGEST LOT SIZE	1,091m²

WAYSIDE ROAD SUBDIVISION DEVELOPMENT, TE KAUWHATA 1

RESOURCE CONSENT PLAN | CLIENT | TE KAUWHATA LAND LTD | PROJECT | 2016-018 | DATE | 30/05/2016 | REVISION | R12
SCALE 1:1,250 (A1) 1:2,500 (A3)

The purpose of this plan is to show the general intent of the design and may not be complete in every detail. This plan is not intended as a construction drawing and should not be used as such.

mansergh graham
LANDSCAPE ARCHITECTS

23 NAYLOR STREET | PO BOX 542 | HAMILTON | NEW ZEALAND

Blue Wallace
Surveyors Ltd.
25 Harwood Street, P O Box 38,
Hamilton Central, HAMILTON.
Phone (07) 839 7799, Fax (07) 839 4455

OPUS

WAYSIDE ROAD SUBDIVISION, TE KAUWHATA– SCHEME PLAN		
01/07/2016	*3-38720.01*	FIGURE 1

Key

↑ North

△ CPT

○ Hand Auger

Blue Wallace
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25 Harwood Street, P O Box 38,
Hamilton Central, HAMILTON.
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WAYSIDE ROAD, TE KAUWHATA- SITE LOCATION PLAN– CPTS AND HAND AUGERS		
01/07/2016	*3-38720.01*	FIGURE 2

Approximately 100m

Key

North

Convex Break of Slope

Concave Break of Slope

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Surveyors Ltd.
25 Harwood Street, P O Box 38,
Hamilton Central, HAMILTON.
Phone (07) 839 7799, Fax (07) 839 4455

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WAYSIDE ROAD, TE KAUWHATA- GEOMORPHOLIGICAL PLAN

01/07/2016	*3-38720.01*	FIGURE 3

Key

North ↑

Spring ↗

Blue Wallace
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Hamilton Central, HAMILTON.
Phone (07) 839 7799, Fax (07) 839 4455

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WAYSIDE ROAD, TE KAUWHATA- GEOTECHNICAL HAZARD PLAN

01/07/2016	*3-38720.01*	FIGURE 4

Key

North

Levels are reduced level
(m RL)

Approximately 100m

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Surveyors Ltd.
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Hamilton Central, HAMILTON.
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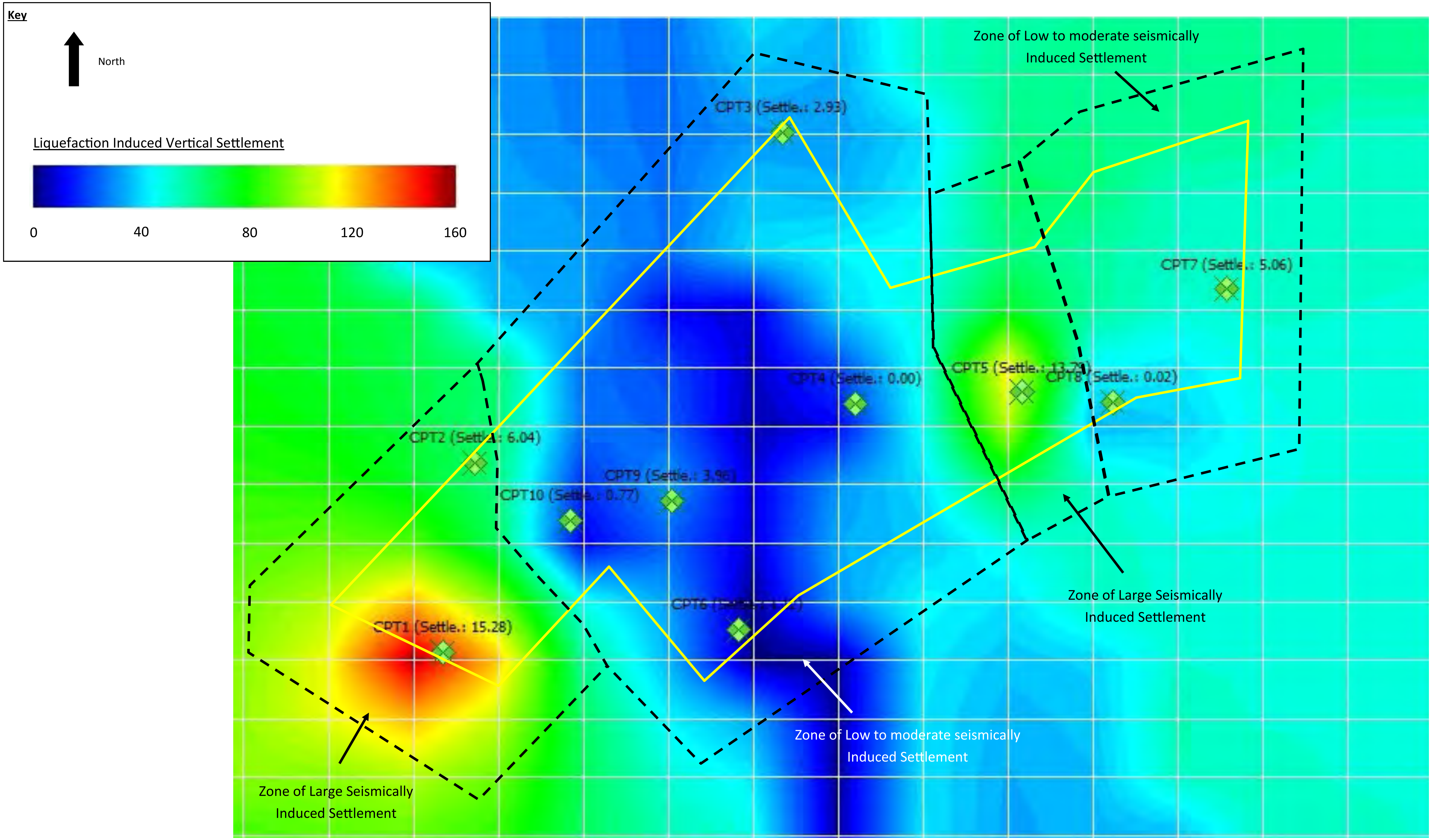
OPUS

WAYSIDE ROAD, TE KAUWHATA- PRELIMINARY GROUND WATER PROFILE

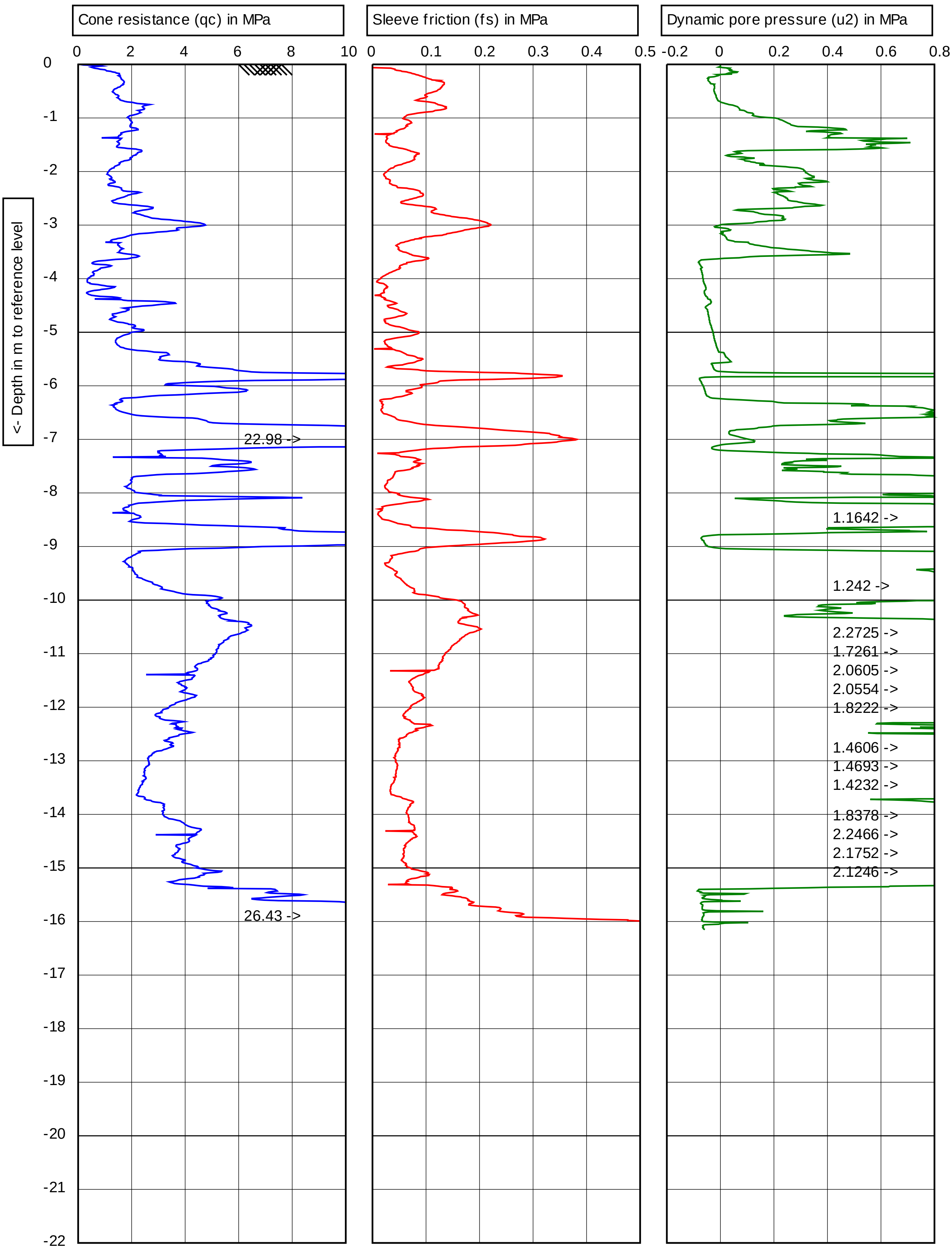
01/07/2016	*3-38720.01*	FIGURE 5



Blue Wallace
Surveyors Ltd.
25 Harwood Street, P O Box 38,
Hamilton Central, HAMILTON.
Phone (07) 839 7799, Fax (07) 839 4455

OPUS

WAYSIDE ROAD, TE KAUWHATA- POTENTIAL LIQUEFACTION VERTICAL SETTLEMENTS (ULS)		
01/07/2016	***3-38720.01***	FIGURE 6



Refusal (Tonnage)

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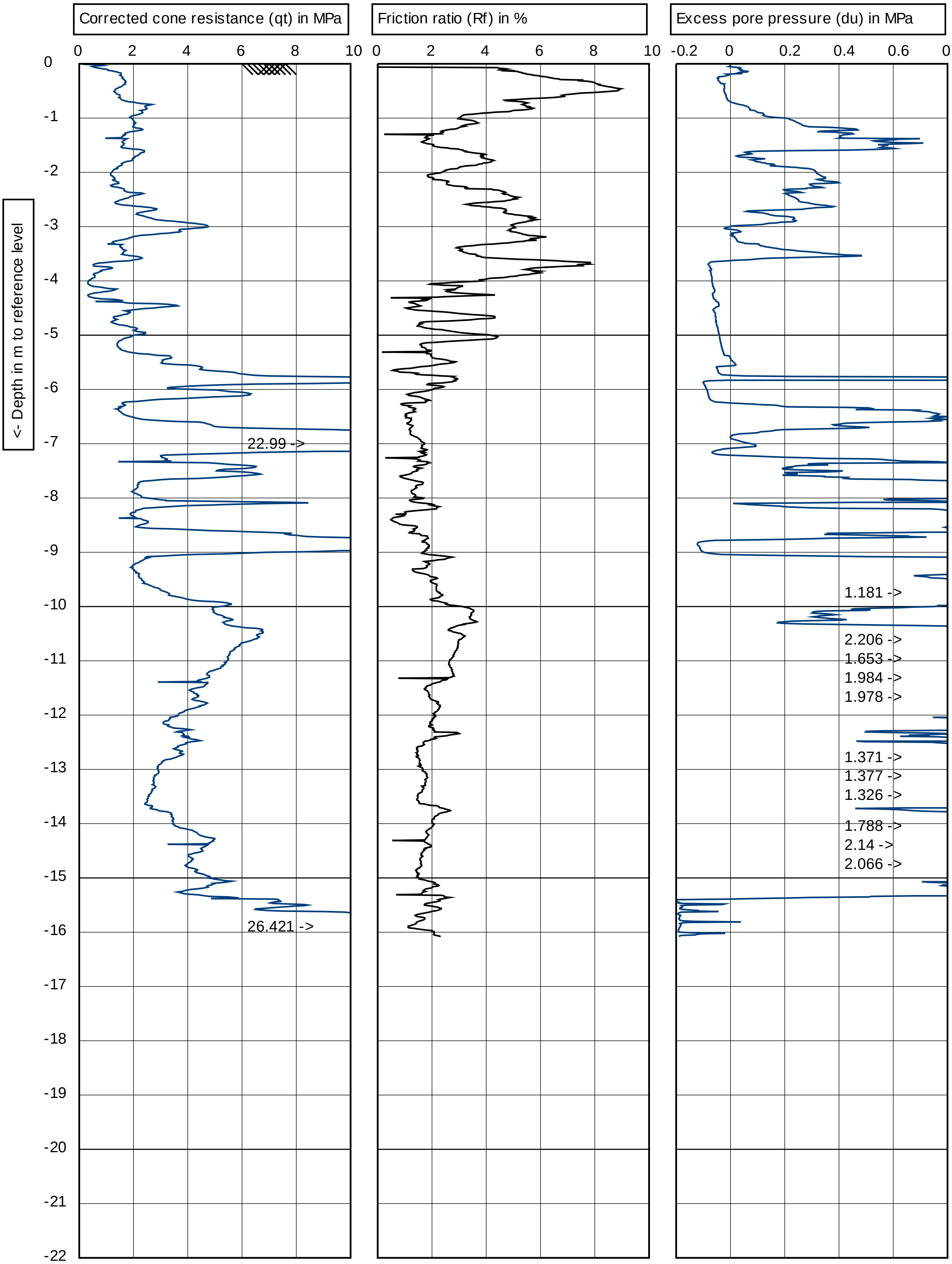
	G.L. 0 MSL / W.L.: **-3.7**	Date:	**4/08/2014**
		Cone no.:	**C10CFIPT.C11306**
		Project no.:	**338720.00**
		CPT no.:	**01** **1/6**

Project: **Blue Wallace 1**
Location: **Wayside Rd - Te Kauwhata**
Position: **1788342, 5857238 NZTM**

1.40



Refusal (Tonnage)

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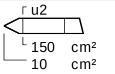
Graphs on this page are not IANZ accredited

1.40



Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL

W.L.: **-3.7**

Predrill : **0 m Predrilled**

Date: **4/08/2014**

Project: **Blue Wallace 1**

Location: **Wayside Rd - Te Kauwhata**

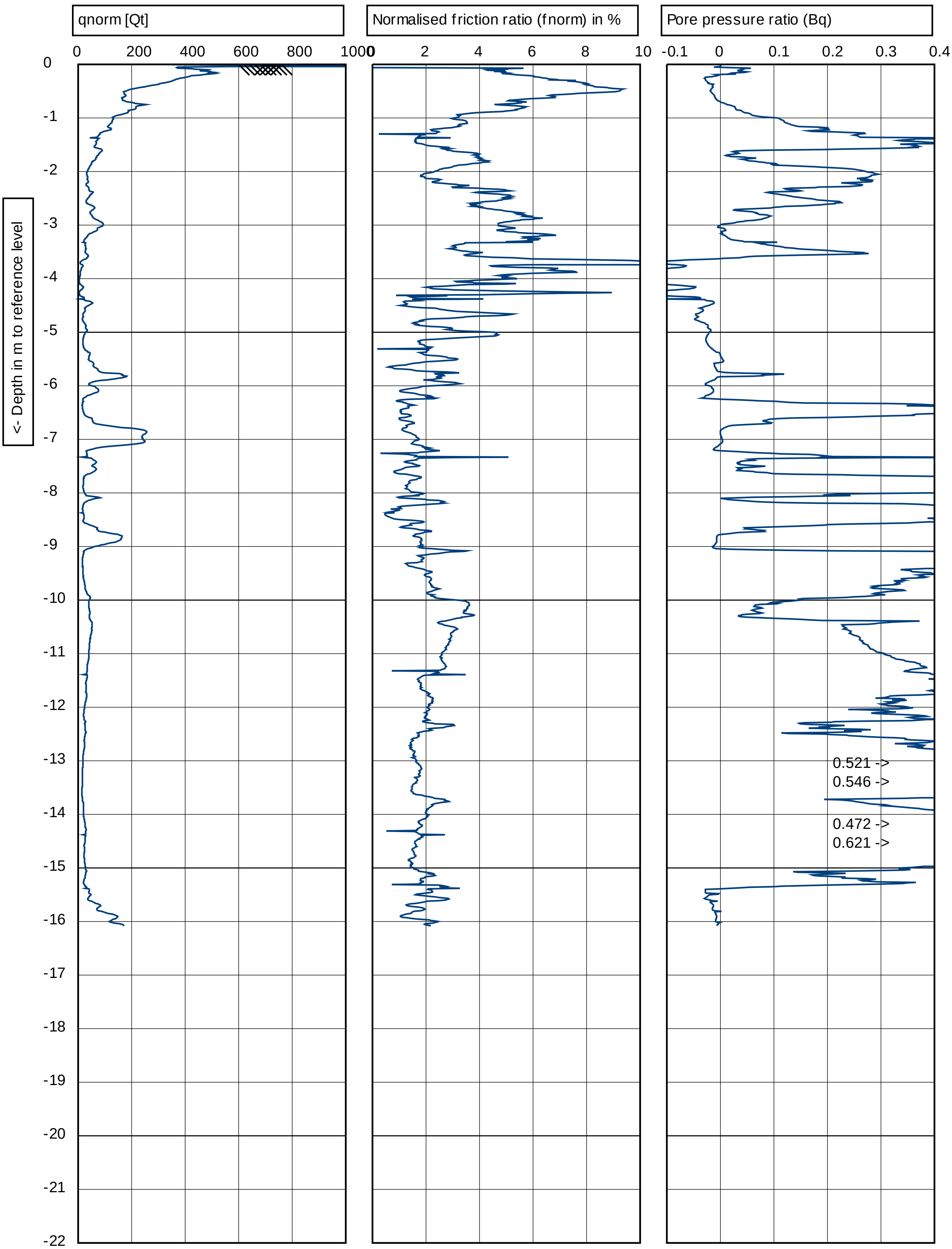
Position: **1788342, 5857238 NZTM**

Cone no.: **C10CFIPT.C11306**

Project no.: **338720.00**

CPT no.: **01**

2/6



Refusal (Tonnage)

EOH - Dipped - Collapsed dry @ 3.7m

Graphs on this page are not IANZ accredited

u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL

W.L.: **-3.7**

Project: **Blue Wallace 1**

Location: **Wayside Rd - Te Kauwhata**

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Predrill : **0 m Predrilled**

Date: **4/08/2014**

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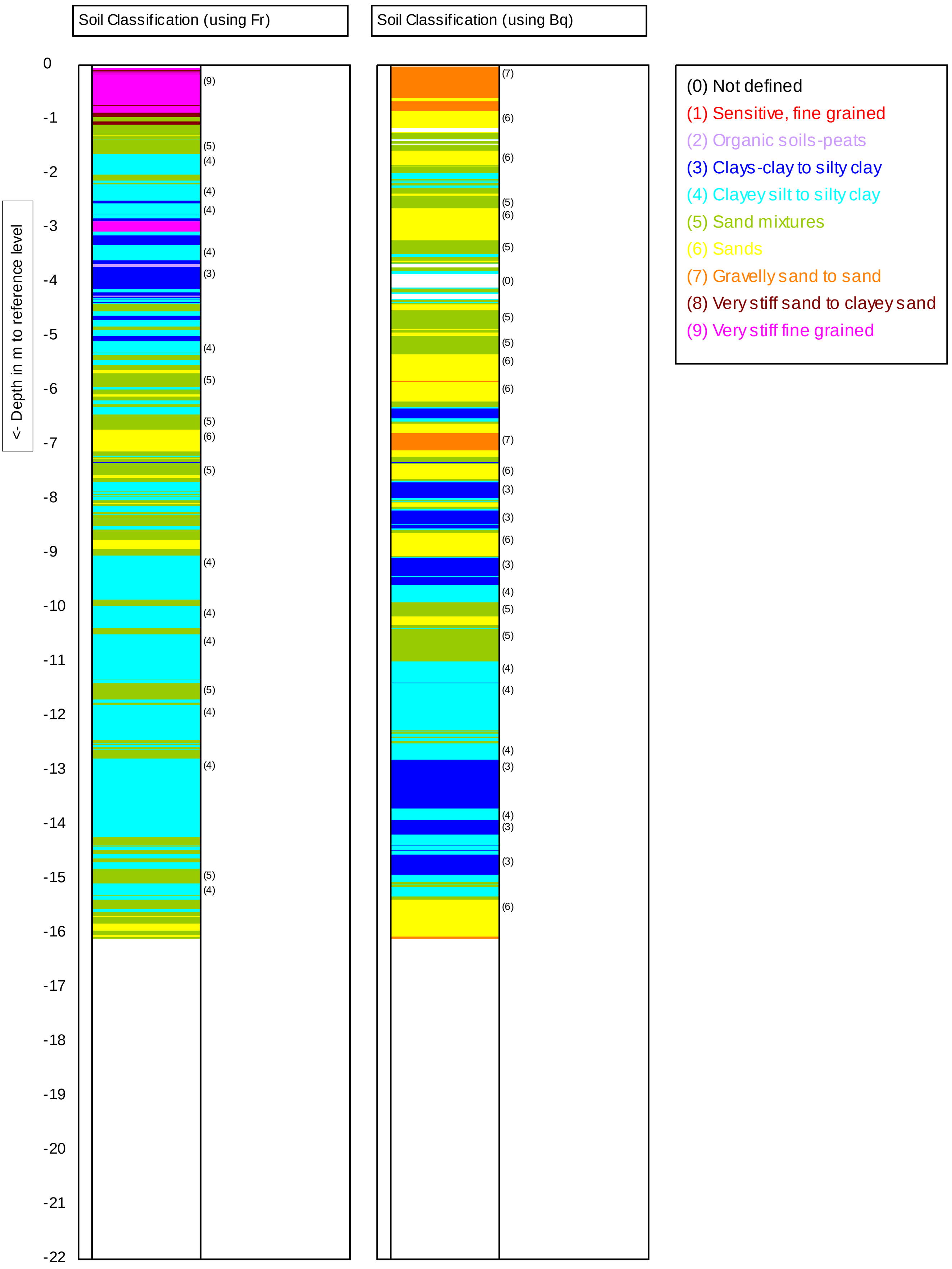
Project no.: **338720.00**

CPT no.: **01**



OPUS

Graphs on this page are not IANZ accredited

1.40

u2
150 cm²
10 cm²

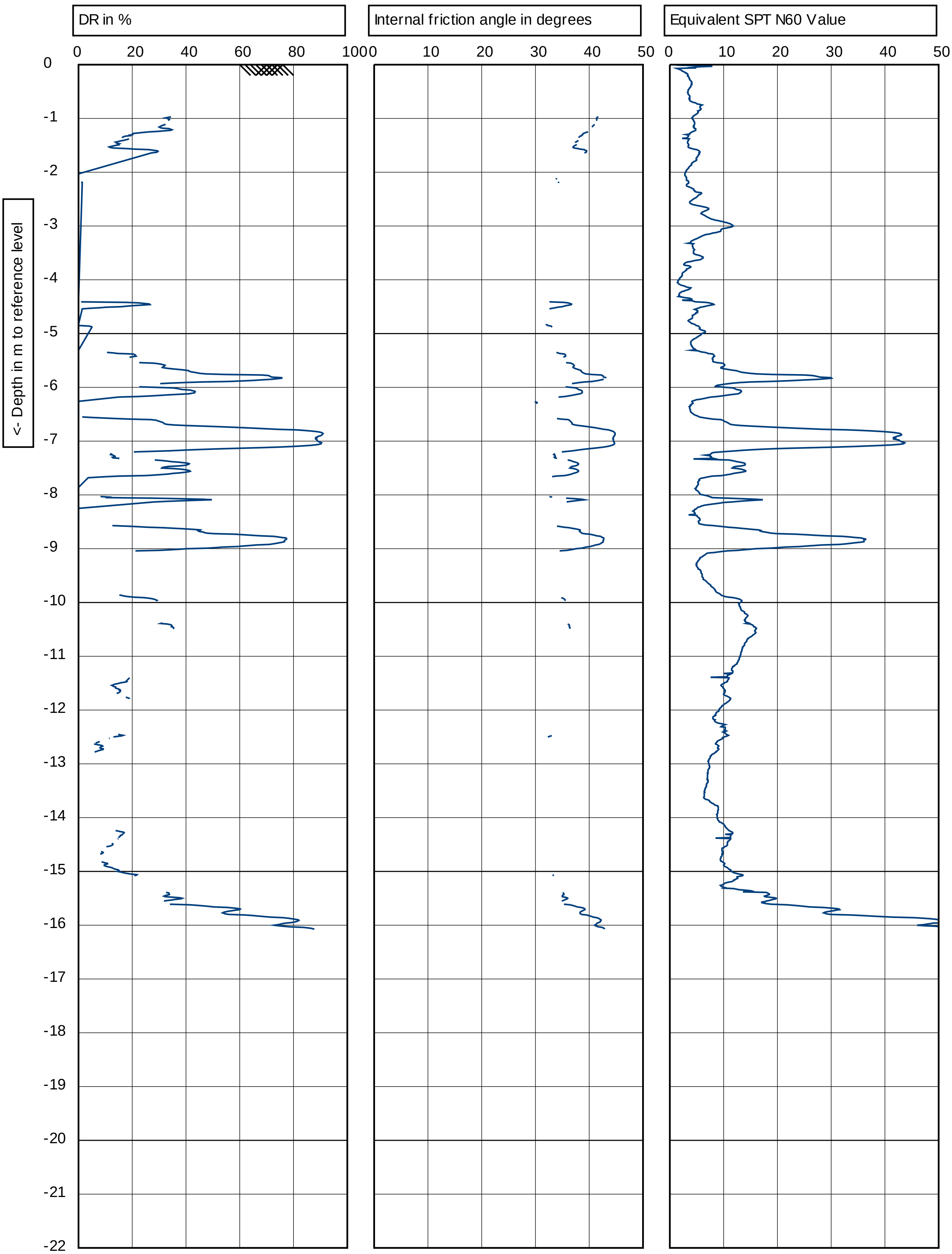
Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL

W.L.: **-3.7**

Project:	**Blue Wallace 1**
Location:	**Wayside Rd - Te Kauwhata**
Position:	**1788342, 5857238 NZTM**

Predrill :	**0 m Predrilled**
Date:	**4/08/2014**
Cone no.:	**C10CFIPT.C11306**
Project no.:	**338720.00**
CPT no.:	**01**



Refusal (Tonnage)

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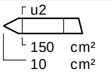
Graphs on this page are not IANZ accredited

1.40



Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL

W.L.: **-3.7**

Project: **Blue Wallace 1**

Location: **Wayside Rd - Te Kauwhata**

Position: **1788342, 5857238 NZTM**

Predrill : **0 m Predrilled**

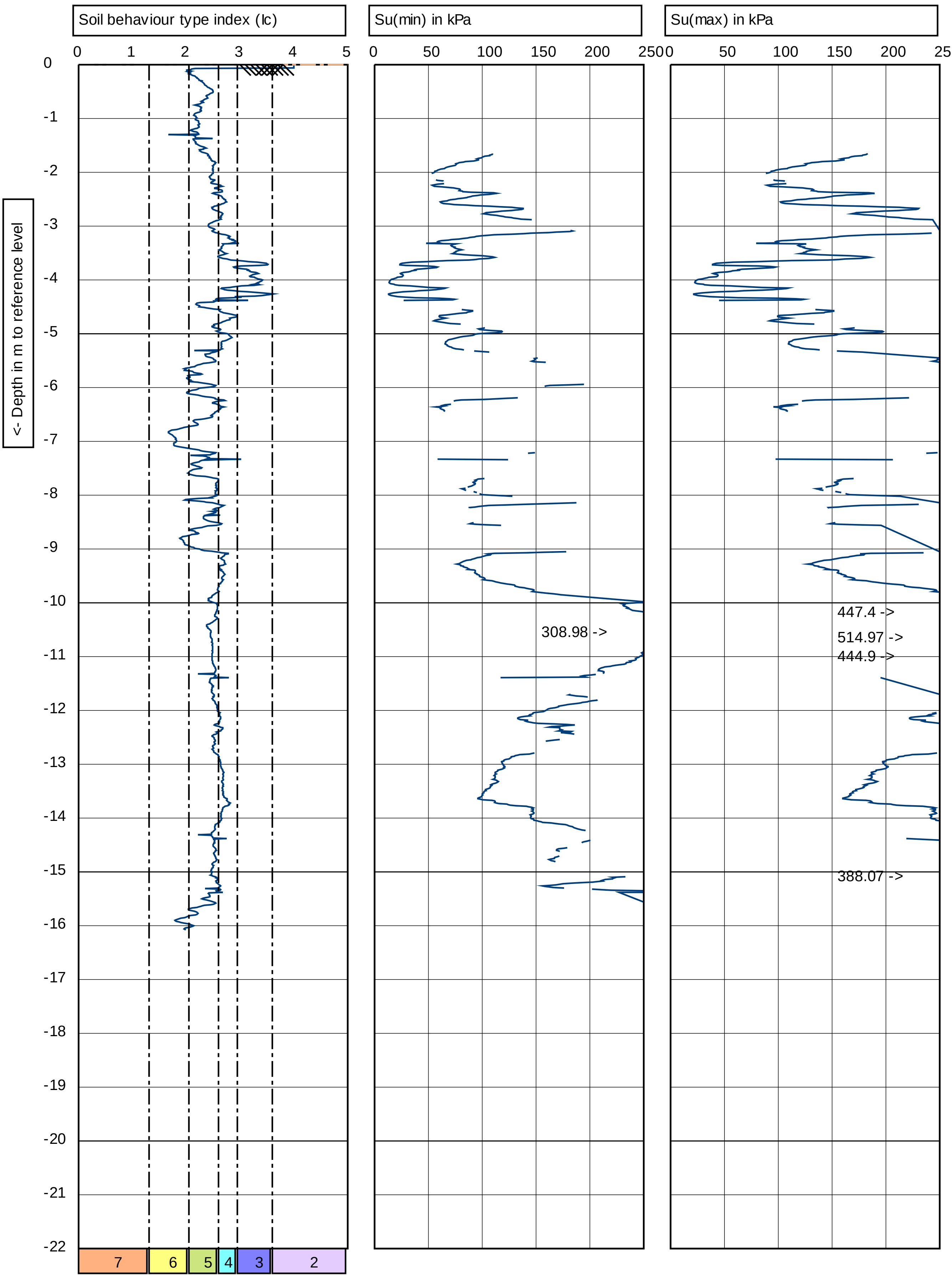
Date: **4/08/2014**

Cone no.: **C10CFIPT.C11306**

Project no.: **338720.00**

CPT no.: **01**

5/6



Refusal (Tonnage)

EOH - Dipped - Collapsed dry @ 3.7m

OPUS

Graphs on this page are not IANZ accredited

1.40

u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL

W.L.: **-3.7**

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Location: **Wayside Rd - Te Kauwhata**

Position: **1788342, 5857238 NZTM**

Predrill : **0 m Predrilled**

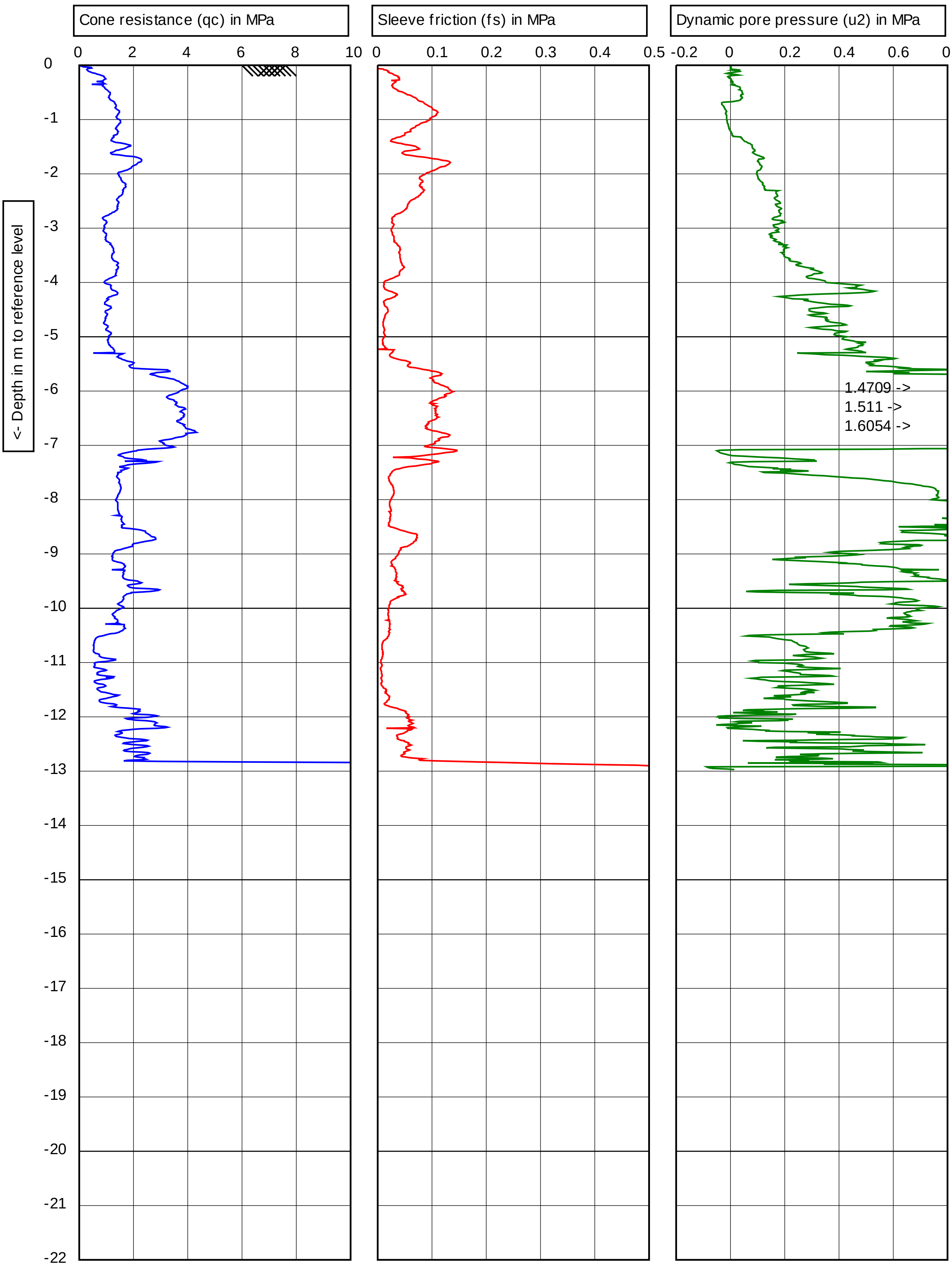
Date: **4/08/2014**

Cone no.: **C10CFIPT.C11306**

Project no.: **338720.00**

CPT no.: **01**

6/6



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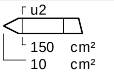


Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL

W.L.: **-1.7**

Project: **Blue Wallace 1**

Location: **Wayside Rd - Te Kauwhata**

Position: **1788369, 5857394 NZTM**

Predrill : **0 m Predrilled**

Date: **4/08/2014**

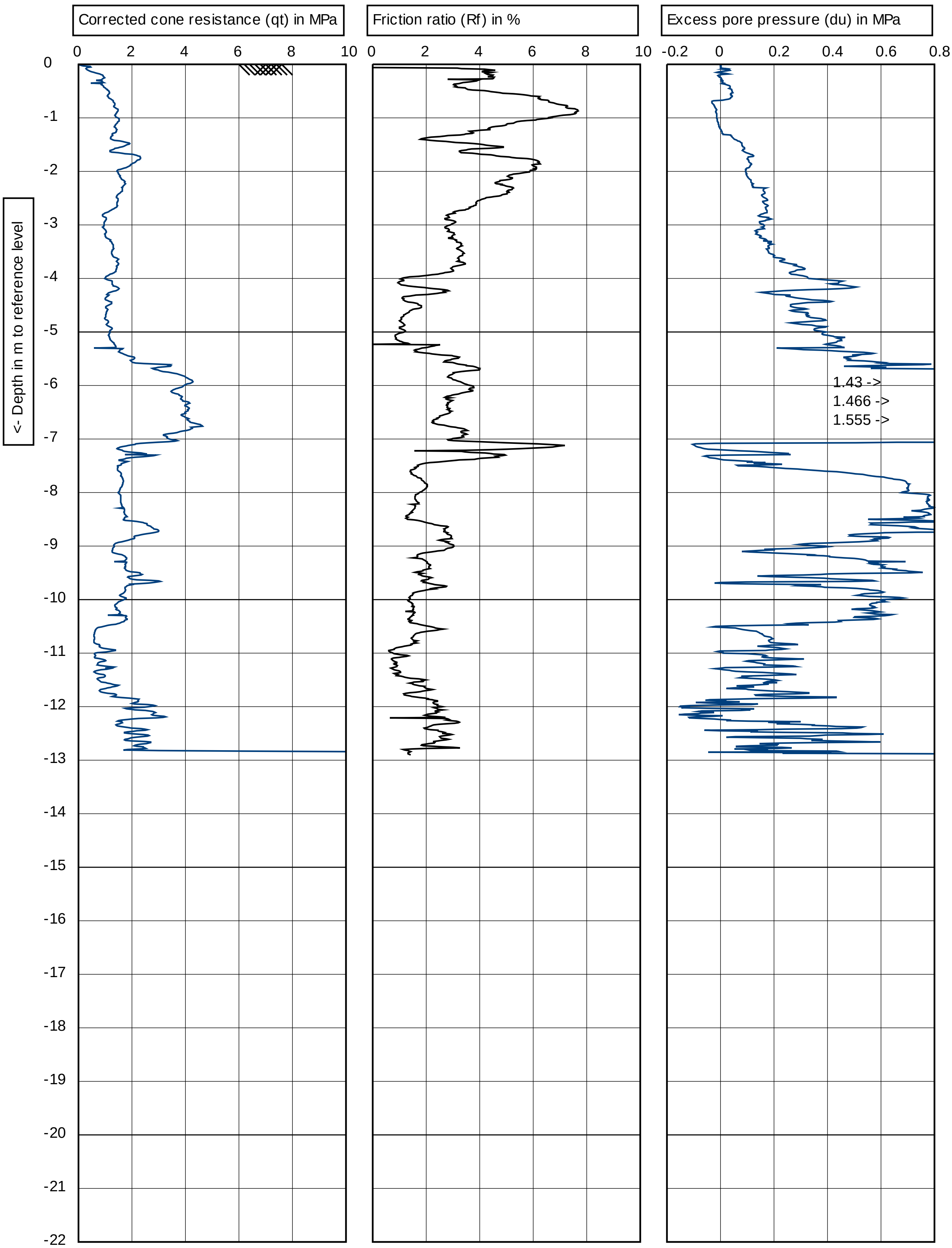
Cone no.: **C10CFIPT.C11306**

Project no.: **338720.00**

CPT no.: **02**

1/6

1.40



Refusal (qc / tonnage)

EOH - Dipped - Collapsed dry @ 1.7m

Graphs on this page are not IANZ accredited

1.40

u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL

W.L.: **-1.7**

Project: **Blue Wallace 1**

Location: **Wayside Rd - Te Kauwhata**

Position: **1788369, 5857394 NZTM**

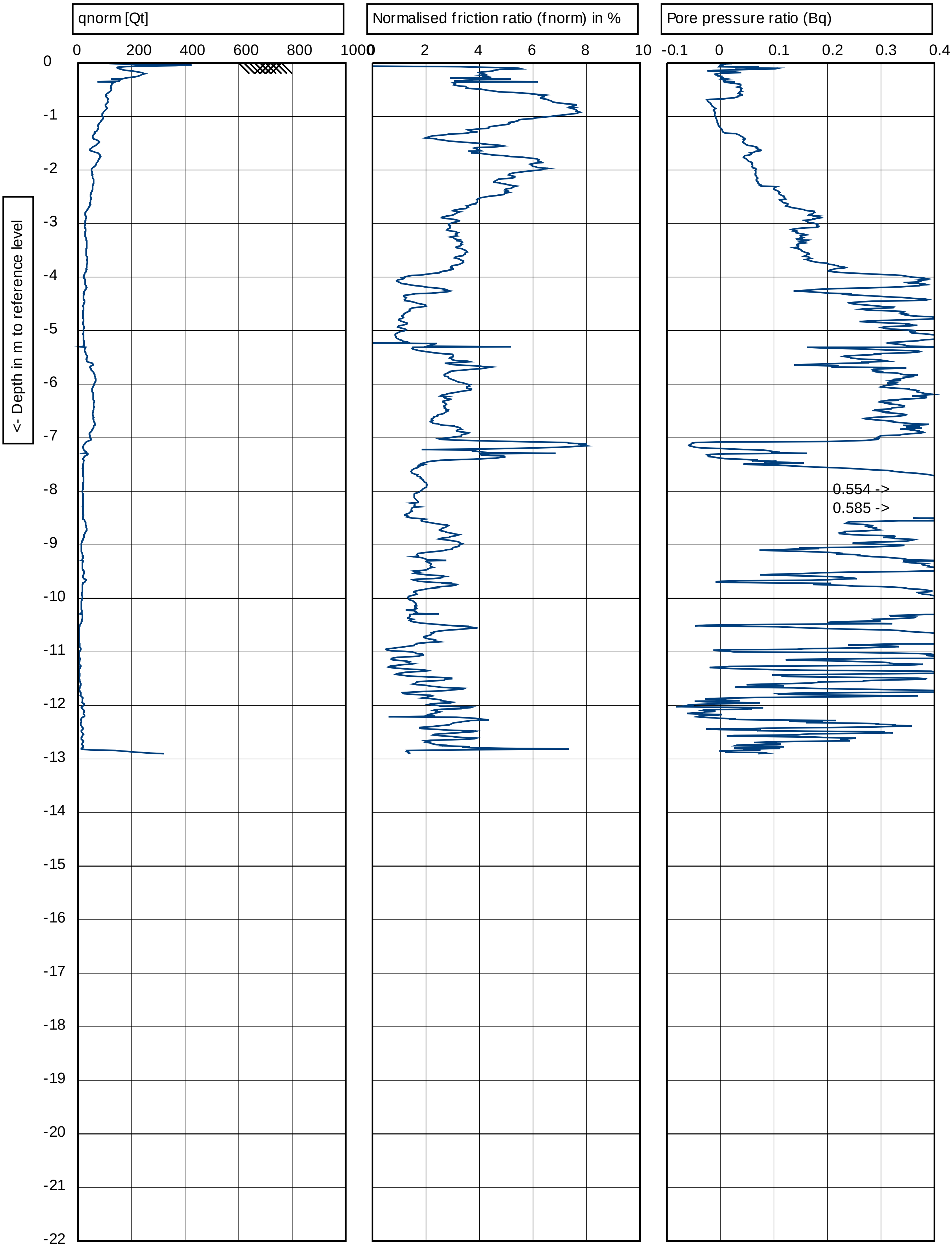
Predrill : **0 m Predrilled**

Date: **4/08/2014**

Cone no.: **C10CFIPT.C11306**

Project no.: **338720.00**

CPT no.: **02** **2/6**



Refusal (qc / tonnage)

EOH - Dipped - Collapsed dry @ 1.7m

OPUS

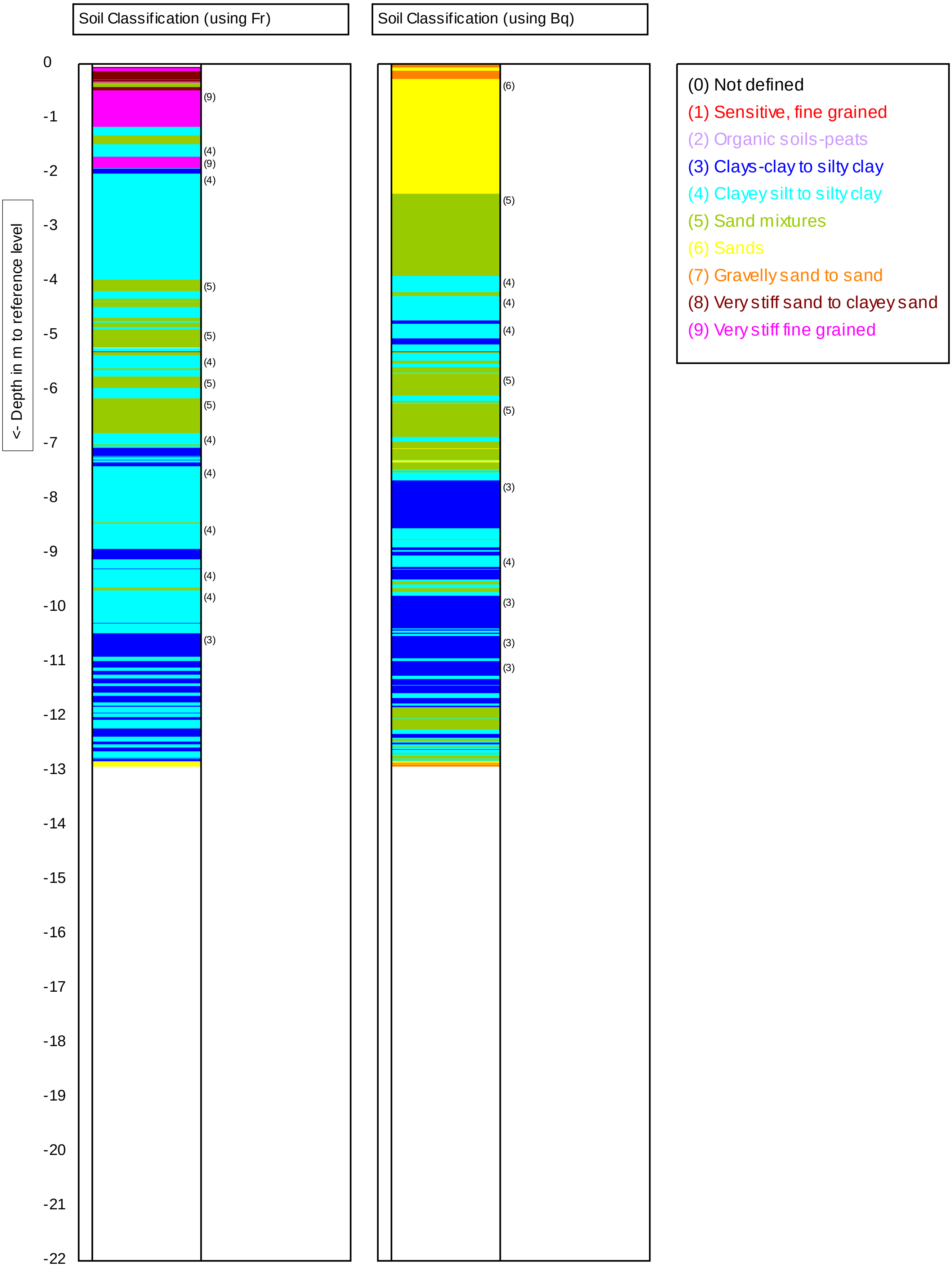
Graphs on this page are not IANZ accredited

u2 150 cm² 10 cm²	Test according ASTM D5778-12 & ISO 22476-1:2012		Predrill :	**0 m Predrilled**
	G.L. 0 MSL	W.L.: **-1.7**	Date:	**4/08/2014**

Project: **Blue Wallace 1**
Location: **Wayside Rd - Te Kauwhata**
Position: **1788369, 5857394 NZTM**

Cone no.:	**C10CFIPT.C11306**
Project no.:	**338720.00**
CPT no.:	**02**

1.40



OPUS

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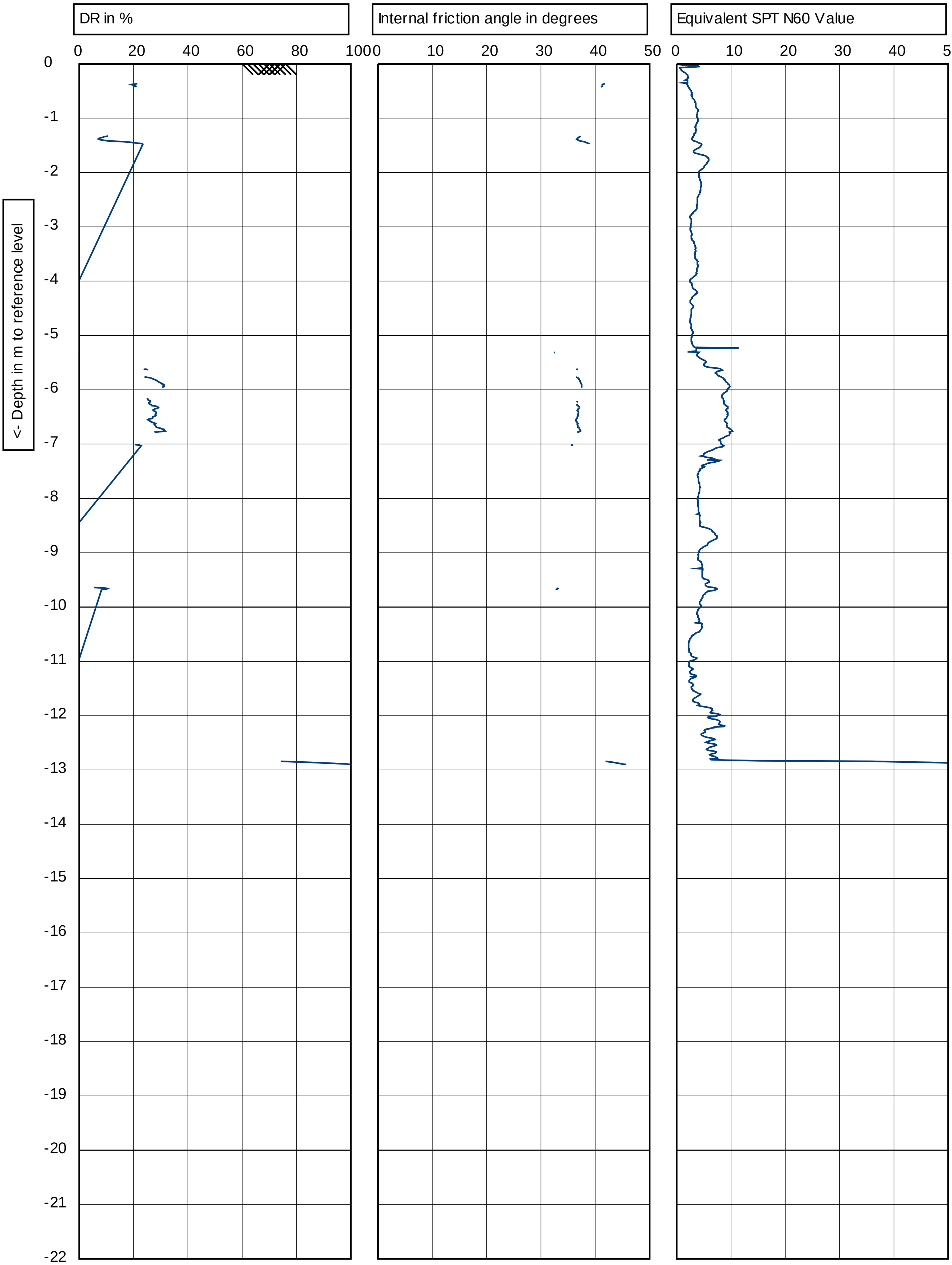
u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012		Predrill :	**0 m Predrilled**
G.L. 0 MSL	W.L.: **-1.7**	Date:	**4/08/2014**
Project: **Blue Wallace 1**		Cone no.:	**C10CFIPT.C11306**
Location: **Wayside Rd - Te Kauwhata**		Project no.:	**338720.00**
Position: **1788369, 5857394 NZTM**		CPT no.:	**02** 4/6

1.40

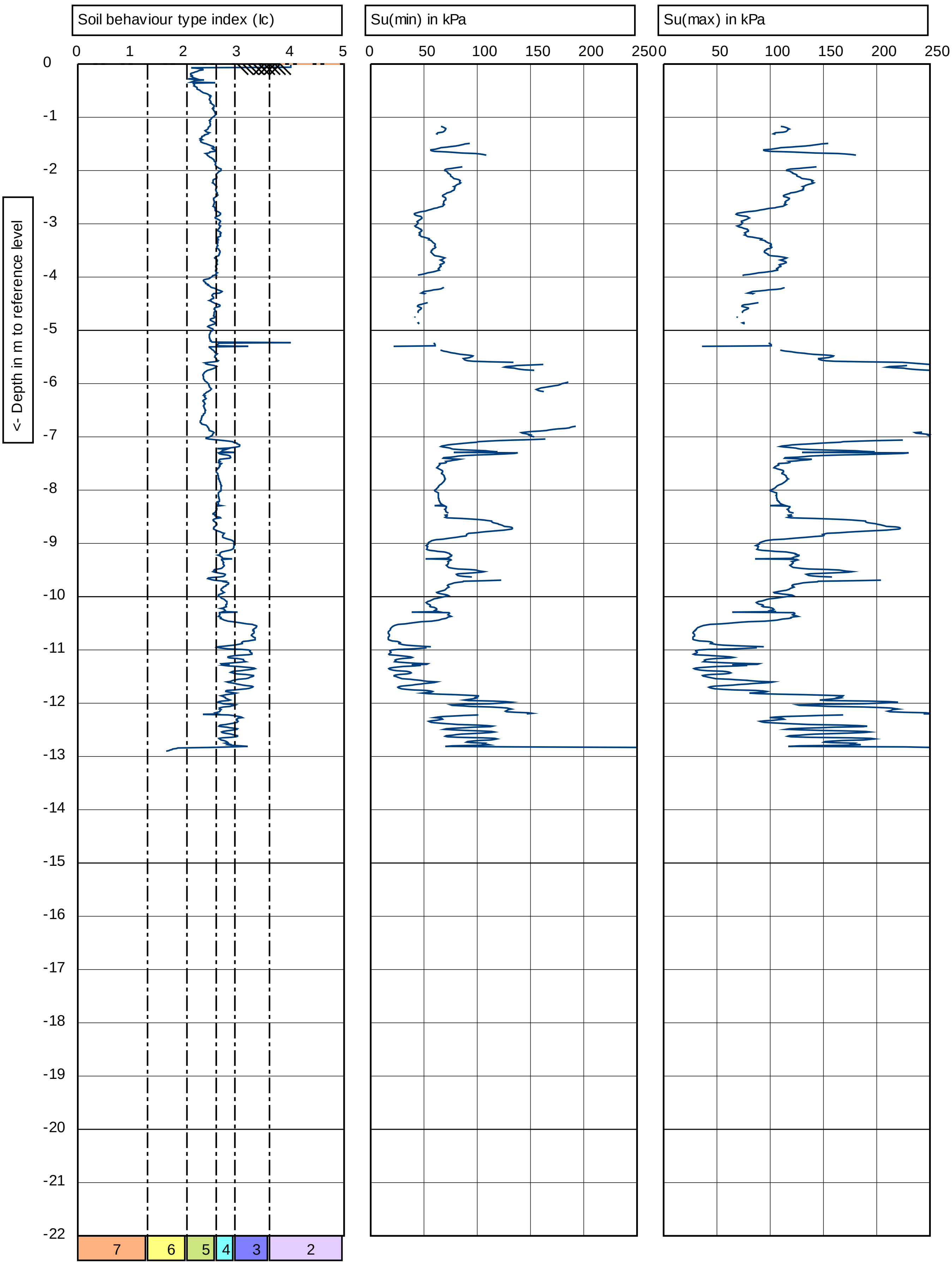


Refusal (qc / tonnage)

EOH - Dipped - Collapsed dry @ 1.7m

u2 150 cm² 10 cm²	Test according ASTM D5778-12 & ISO 22476-1:2012	Predrill :	**0 m Predrilled**
	G.L. 0 MSL / W.L.: **-1.7**	Date:	**4/08/2014**
	Project: **Blue Wallace 1**	Cone no.:	**C10CFIPT.C11306**
	Location: **Wayside Rd - Te Kauwhata**	Project no.:	**338720.00**
	Position: **1788369, 5857394 NZTM**	CPT no.:	**02** 5/6

1.40



Refusal (qc / tonnage)

EOH - Dipped - Collapsed dry @ 1.7m

OPUS

Graphs on this page are not IANZ accredited

1.40

u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012

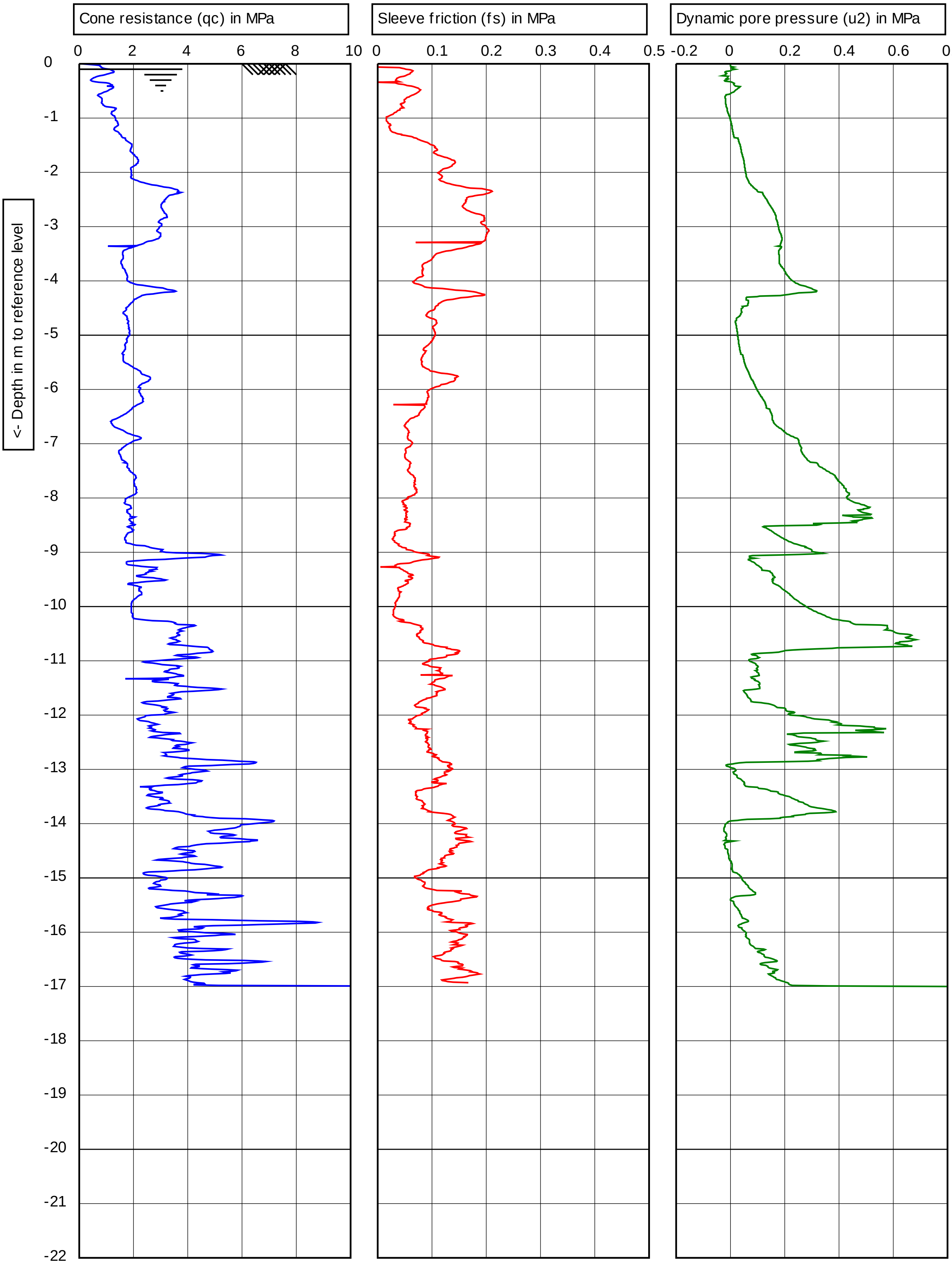
G.L. 0 MSL

W.L.: **-1.7**

Project: **Blue Wallace 1**
Location: **Wayside Rd - Te Kauwhata**
Position: **1788369, 5857394 NZTM**

Predrill : **0 m Predrilled**
Date: **4/08/2014**
Cone no.: **C10CFIPT.C11306**
Project no.: **338720.00**
CPT no.: **02**

6/6



Refusal (Tonnage)

EOH - Dipped - GWL @ 0.1m

u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL

W.L.: **-0.1**

Project: **Blue Wallace 1**

Location: **Wayside Rd - Te Kauwhata**

Position: **1788622, 5857666 NZTM**

Predrill : **0 m Predrilled**

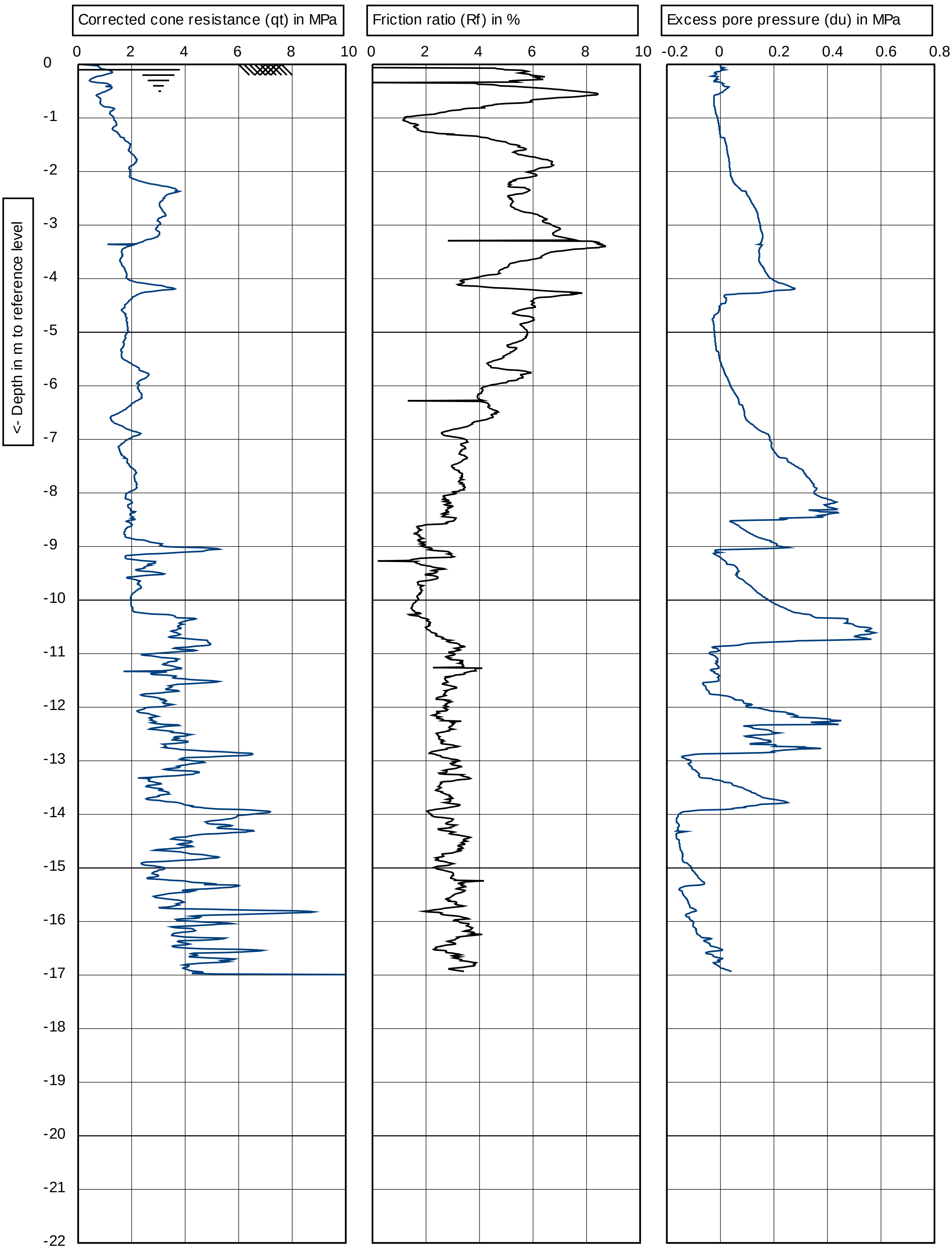
Date: **4/08/2014**

Cone no.: **C10CFIPT.C11306**

Project no.: **338720.00**

CPT no.: **03** **1/6**

1.40



Refusal (Tonnage)

EOH - Dipped - GWL @ 0.1m

Graphs on this page are not IANZ accredited

1.40

u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL

W.L.: **-0.1**

Project: **Blue Wallace 1**

Location: **Wayside Rd - Te Kauwhata**

Position: **1788622, 5857666 NZTM**

Predrill : **0 m Predrilled**

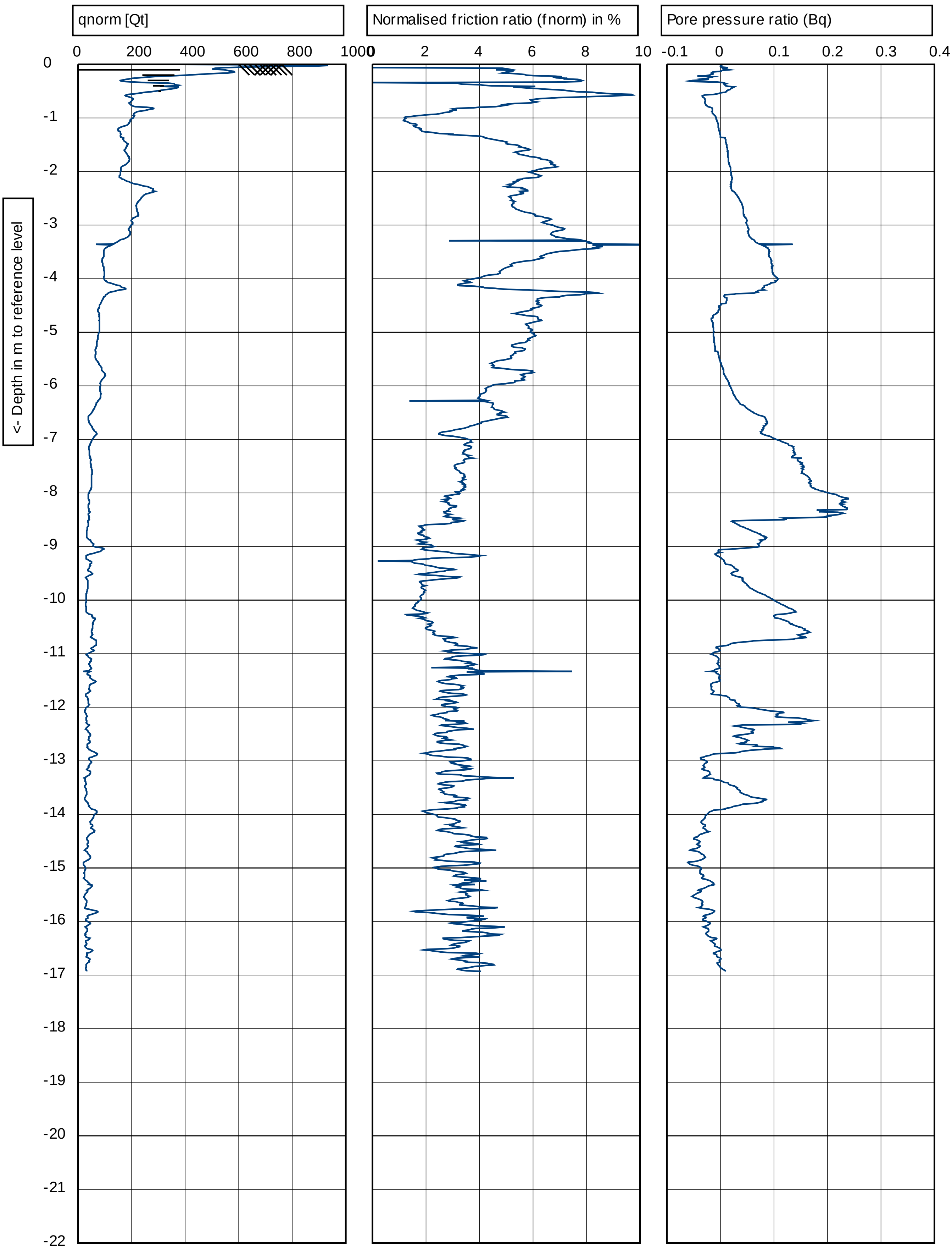
Date: **4/08/2014**

Cone no.: **C10CFIPT.C11306**

Project no.: **338720.00**

CPT no.: **03**

2/6



Refusal (Tonnage)

EOH - Dipped - GWL @ 0.1m

OPUS

Graphs on this page are not IANZ accredited

1.40

u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL

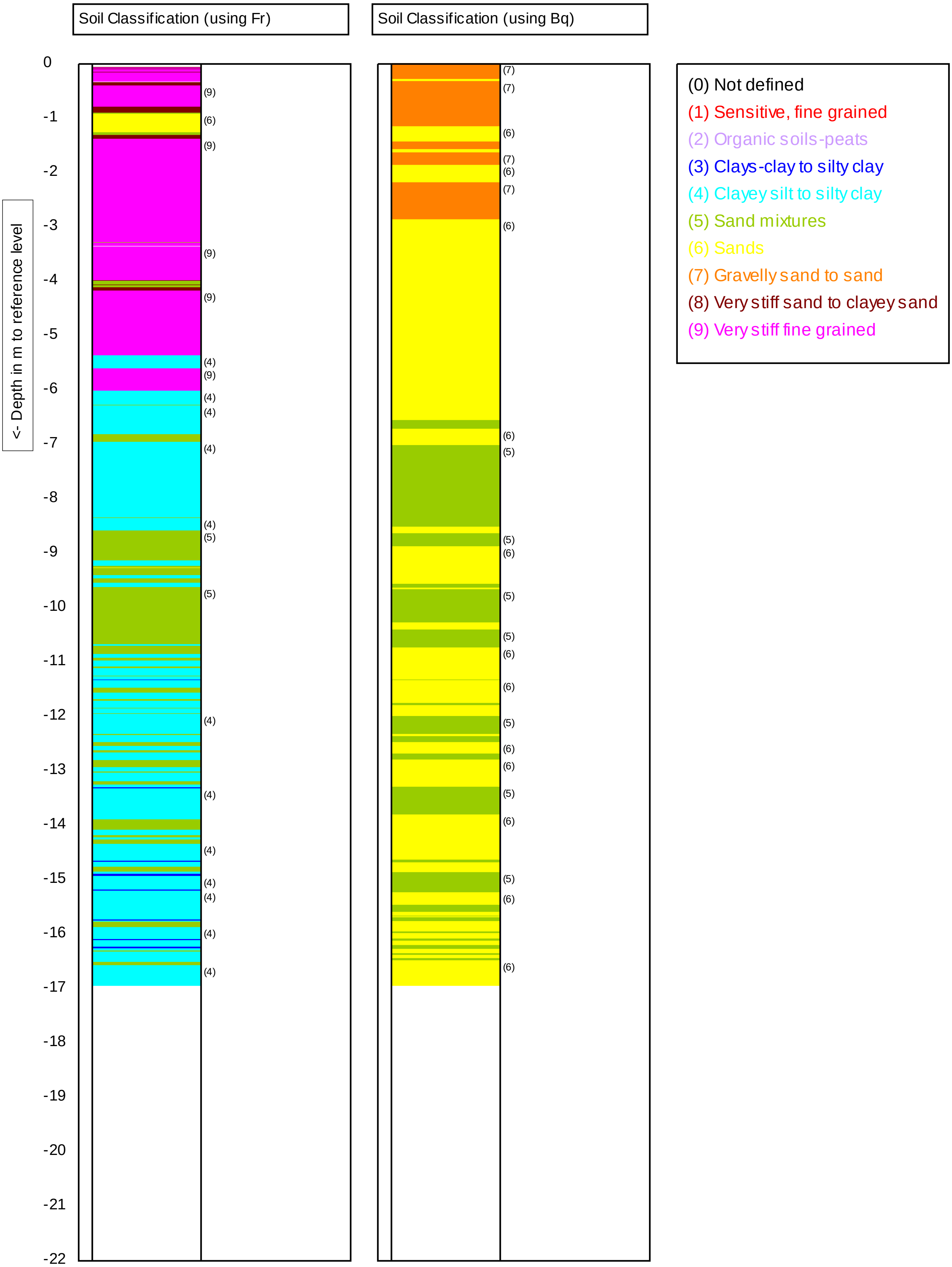
W.L.: **-0.1**

Project: **Blue Wallace 1**

Location: **Wayside Rd - Te Kauwhata**

Position: **1788622, 5857666 NZTM**

Predrill :	**0 m Predrilled**
Date:	**4/08/2014**
Cone no.:	**C10CFIPT.C11306**
Project no.:	**338720.00**
CPT no.:	**03**



OPUS

Graphs on this page are not IANZ accredited

1.40

u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL

W.L.: **-0.1**

Project: **Blue Wallace 1**

Location: **Wayside Rd - Te Kauwhata**

Position: **1788622, 5857666 NZTM**

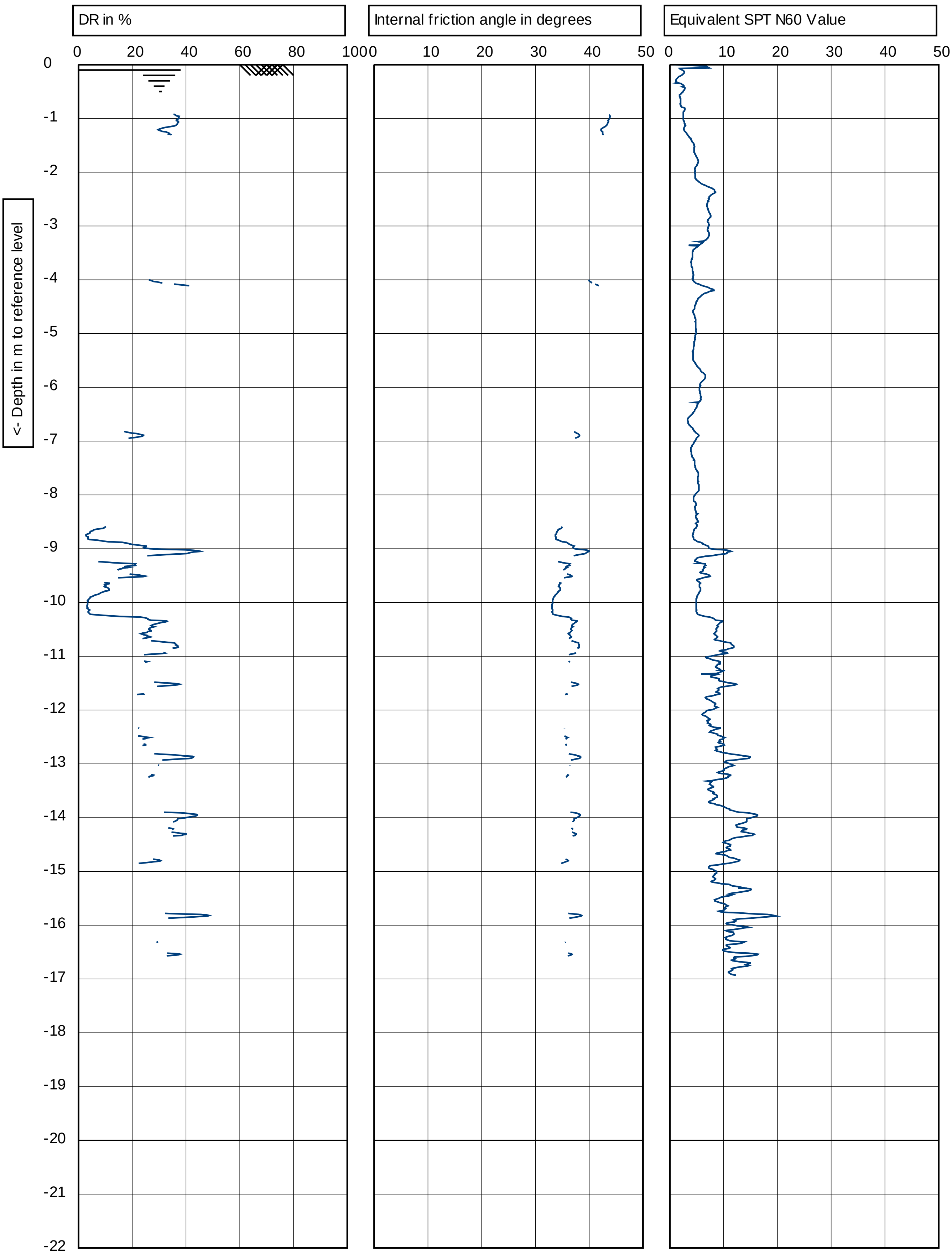
Predrill : **0 m Predrilled**

Date: **4/08/2014**

Cone no.: **C10CFIPT.C11306**

Project no.: **338720.00**

CPT no.: **03**



Refusal (Tonnage)

EOH - Dipped - GWL @ 0.1m

OPUS

Graphs on this page are not IANZ accredited

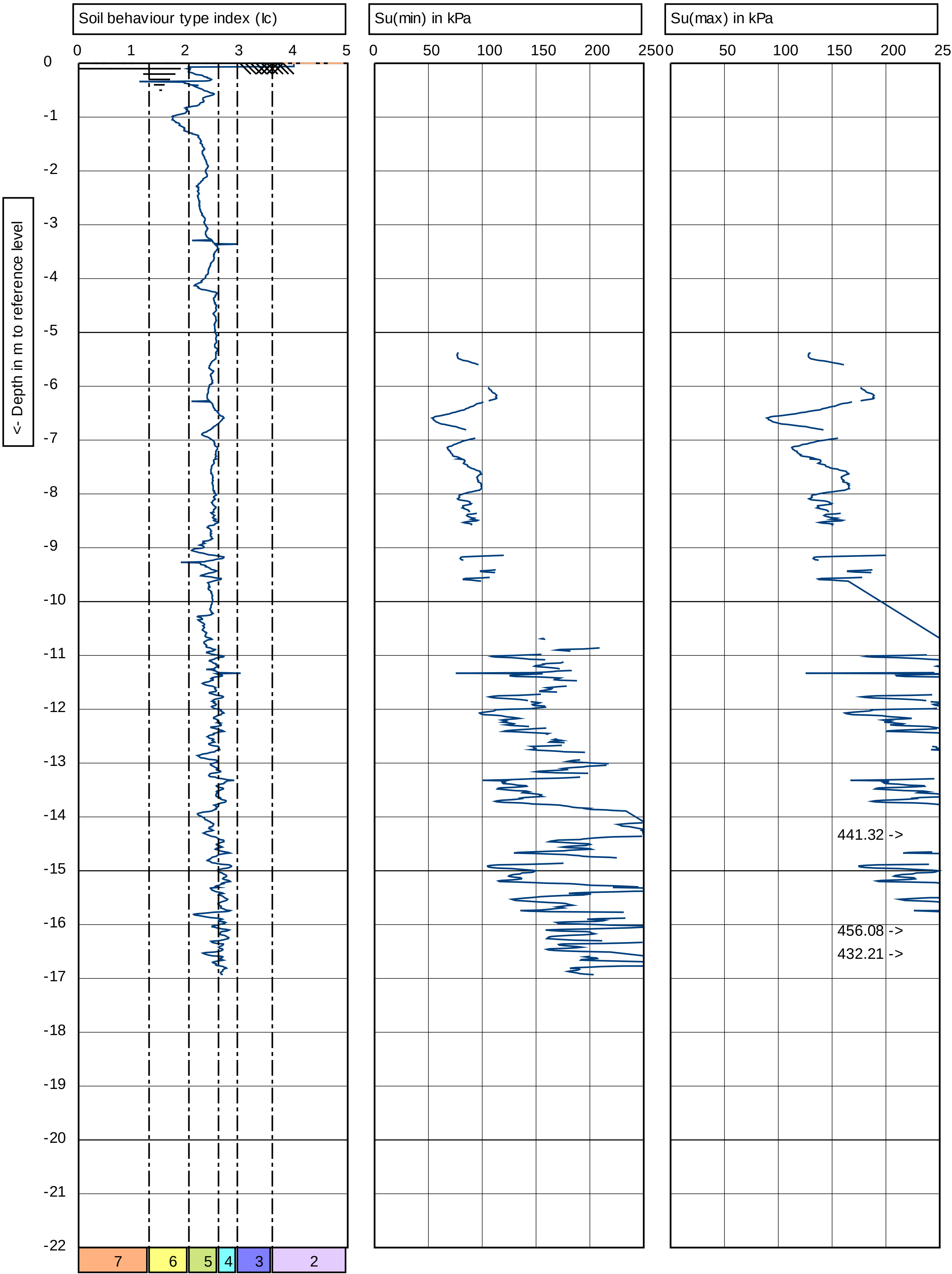
1.40

u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012		Predrill :	**0 m Predrilled**
G.L. 0 MSL	W.L.: **-0.1**	Date:	**4/08/2014**

Project: **Blue Wallace 1**
Location: **Wayside Rd - Te Kauwhata**
Position: **1788622, 5857666 NZTM**

Cone no.:	**C10CFIPT.C11306**
Project no.:	**338720.00**
CPT no.:	**03**



Refusal (Tonnage)

EOH - Dipped - GWL @ 0.1m

Graphs on this page are not IANZ accredited

1.40

u2
150 cm²
10 cm²

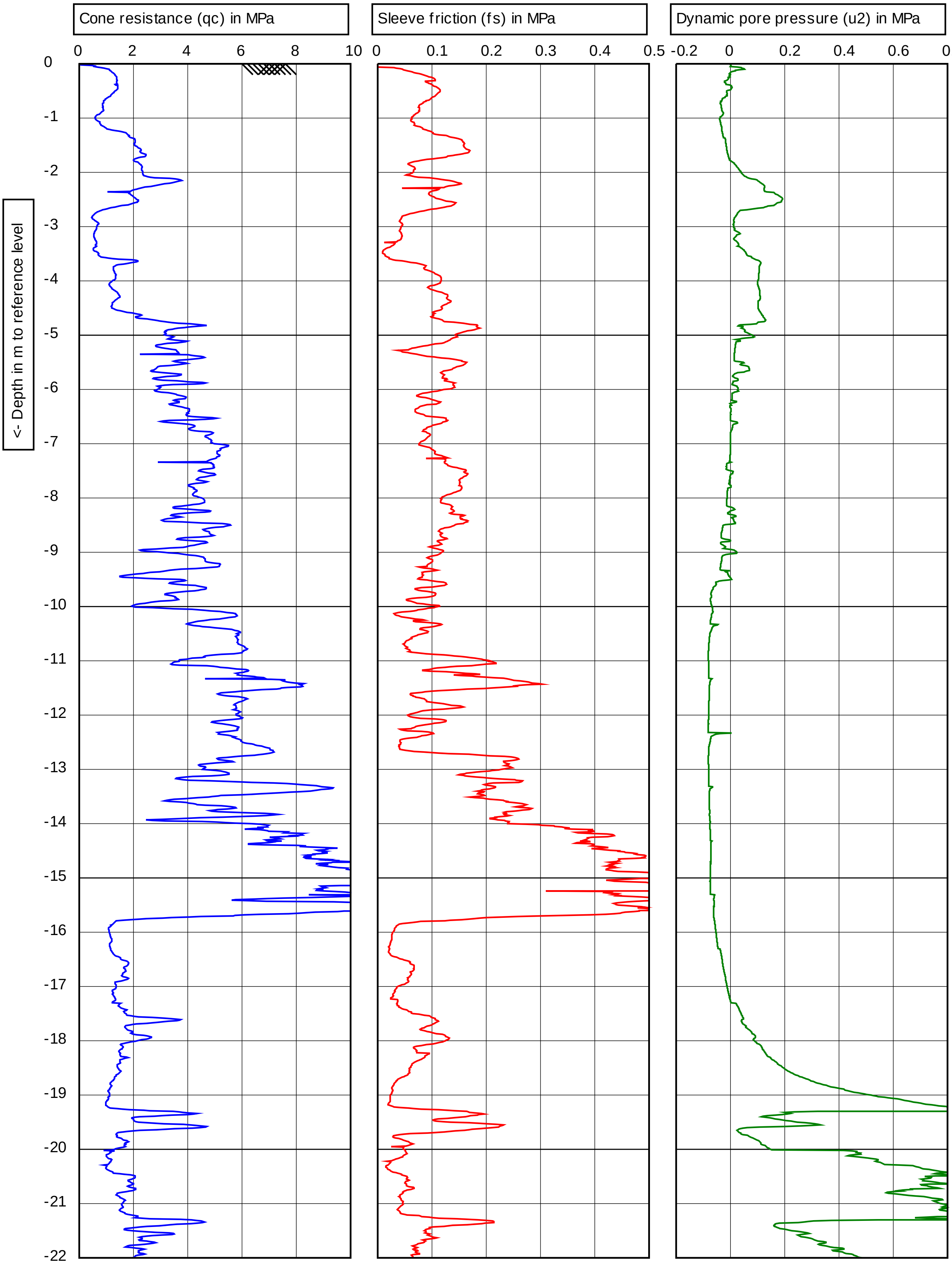
Test according ASTM D5778-12 & ISO 22476-1:2012

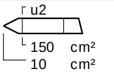
G.L. 0 MSL

W.L.: **-0.1**

Project: **Blue Wallace 1**
Location: **Wayside Rd - Te Kauwhata**
Position: **1788622, 5857666 NZTM**

Predrill : **0 m Predrilled**
Date: **4/08/2014**
Cone no.: **C10CFIPT.C11306**
Project no.: **338720.00**
CPT no.: **03**





Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL

W.L.: **-1.5**

Predrill : **0 m Predrilled**

Date: **4/08/2014**

Project: **Blue Wallace 1**

Location: **Wayside Rd - Te Kauwhata**

Position: **1788683, 5857443 NZTM**

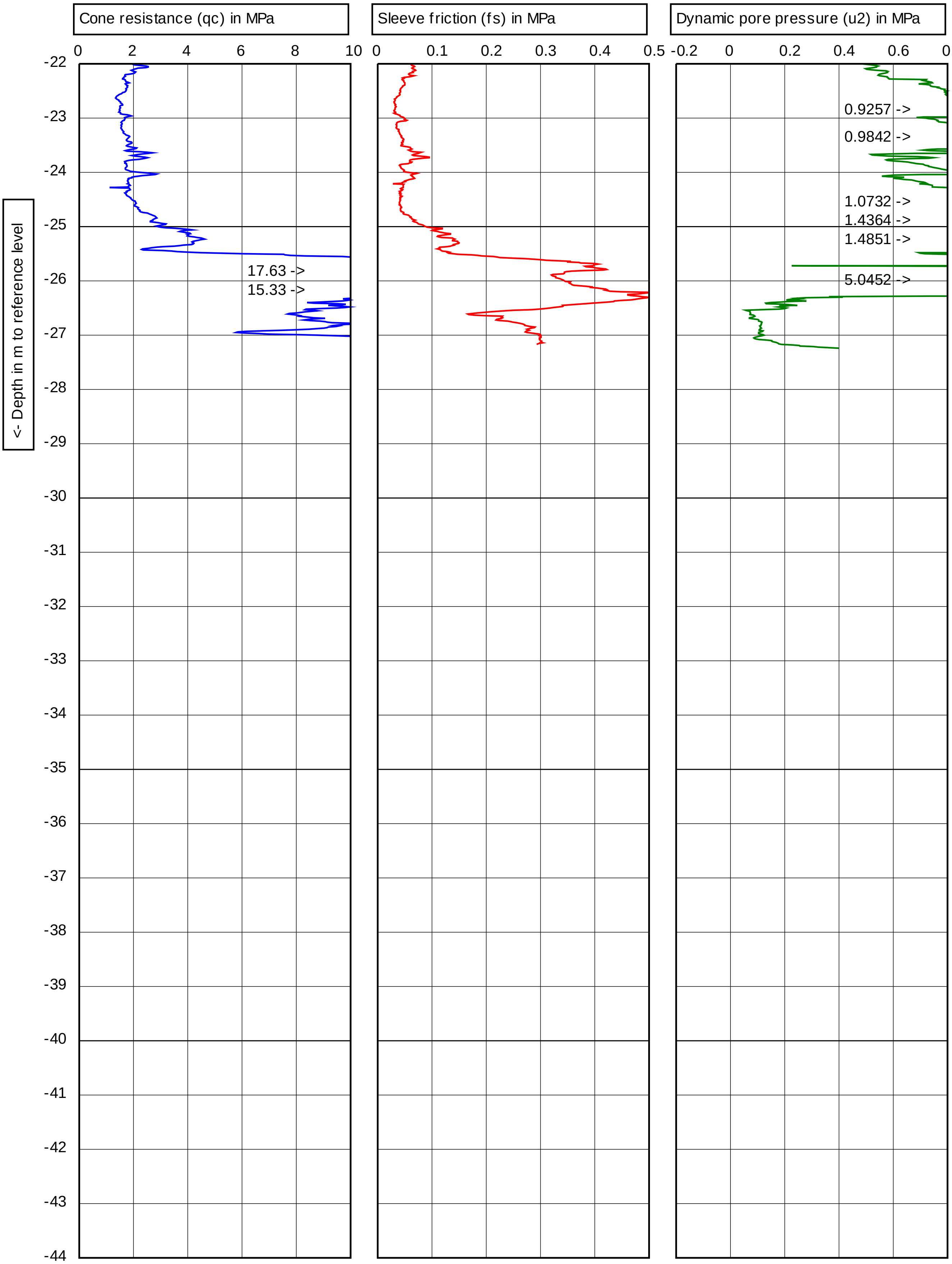
Cone no.: **C10CFIPT.C11306**

Project no.: **338720.00**

CPT no.: **04**

1/12

1.40



Refusal (Tonnage)

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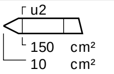


Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL

W.L.: **-1.5**

Predrill : **0 m Predrilled**

Date: **4/08/2014**

Project: **Blue Wallace 1**

Location: **Wayside Rd - Te Kauwhata**

Position: **1788683, 5857443 NZTM**

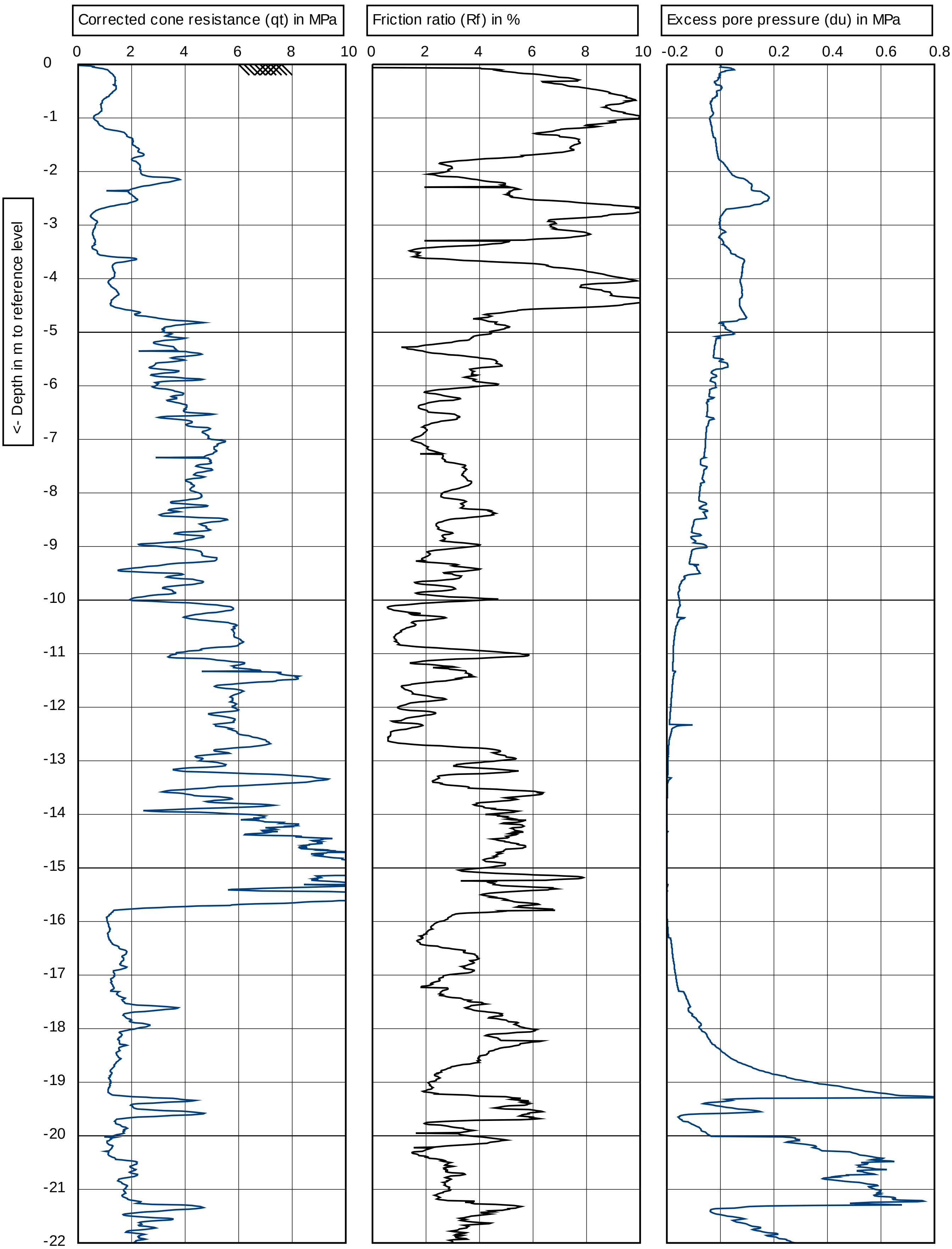
Cone no.: **C10CFIPT.C11306**

Project no.: **338720.00**

CPT no.: **04**

2/12

1.40



OPUS

Graphs on this page are not IANZ accredited

u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL

W.L.: **-1.5**

Predrill : **0 m Predrilled**

Date: **4/08/2014**

Project: **Blue Wallace 1**

Location: **Wayside Rd - Te Kauwhata**

Position: **1788683, 5857443 NZTM**

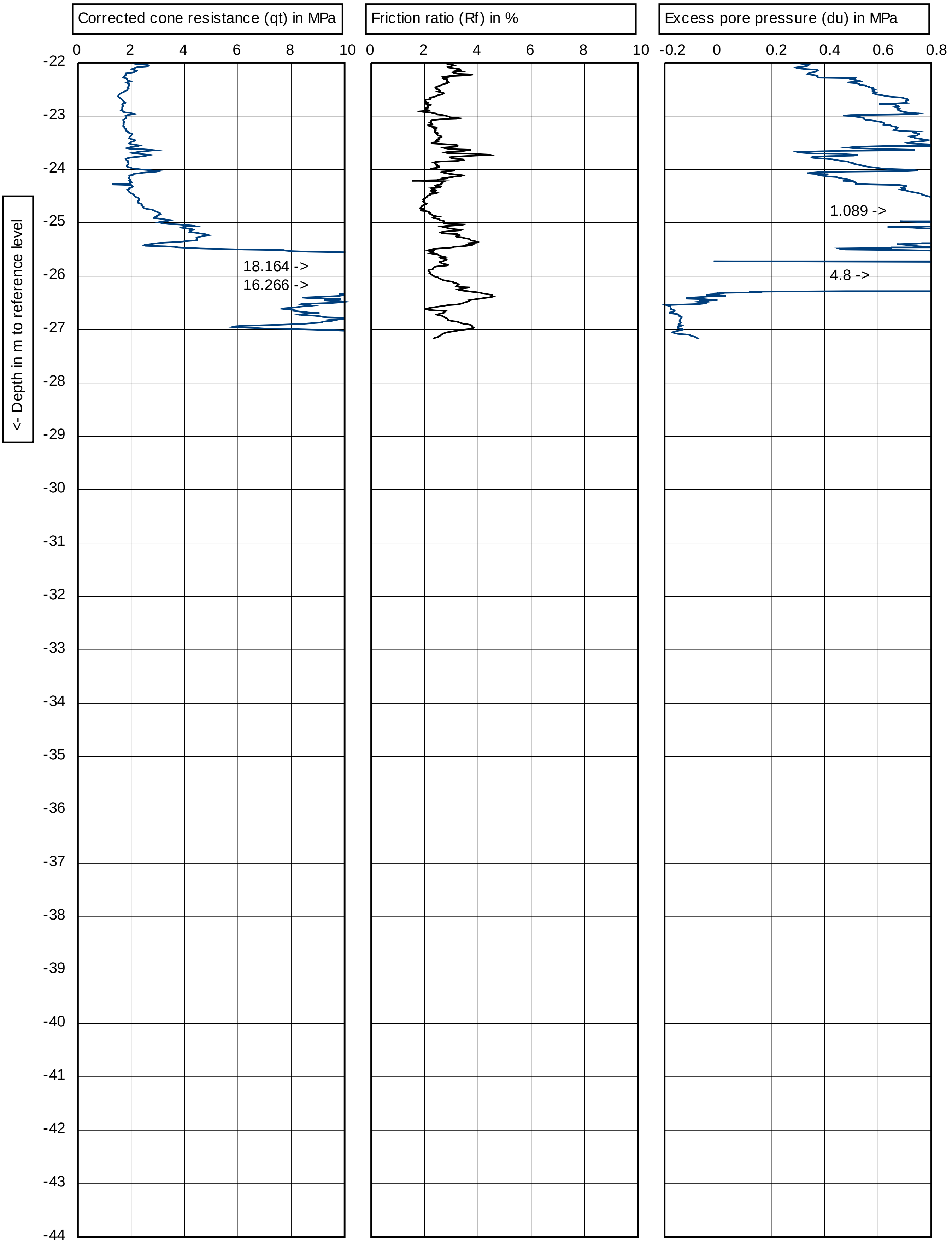
Cone no.: **C10CFIPT.C11306**

Project no.: **338720.00**

CPT no.: **04**

3/12

1.40



Refusal (Tonnage)

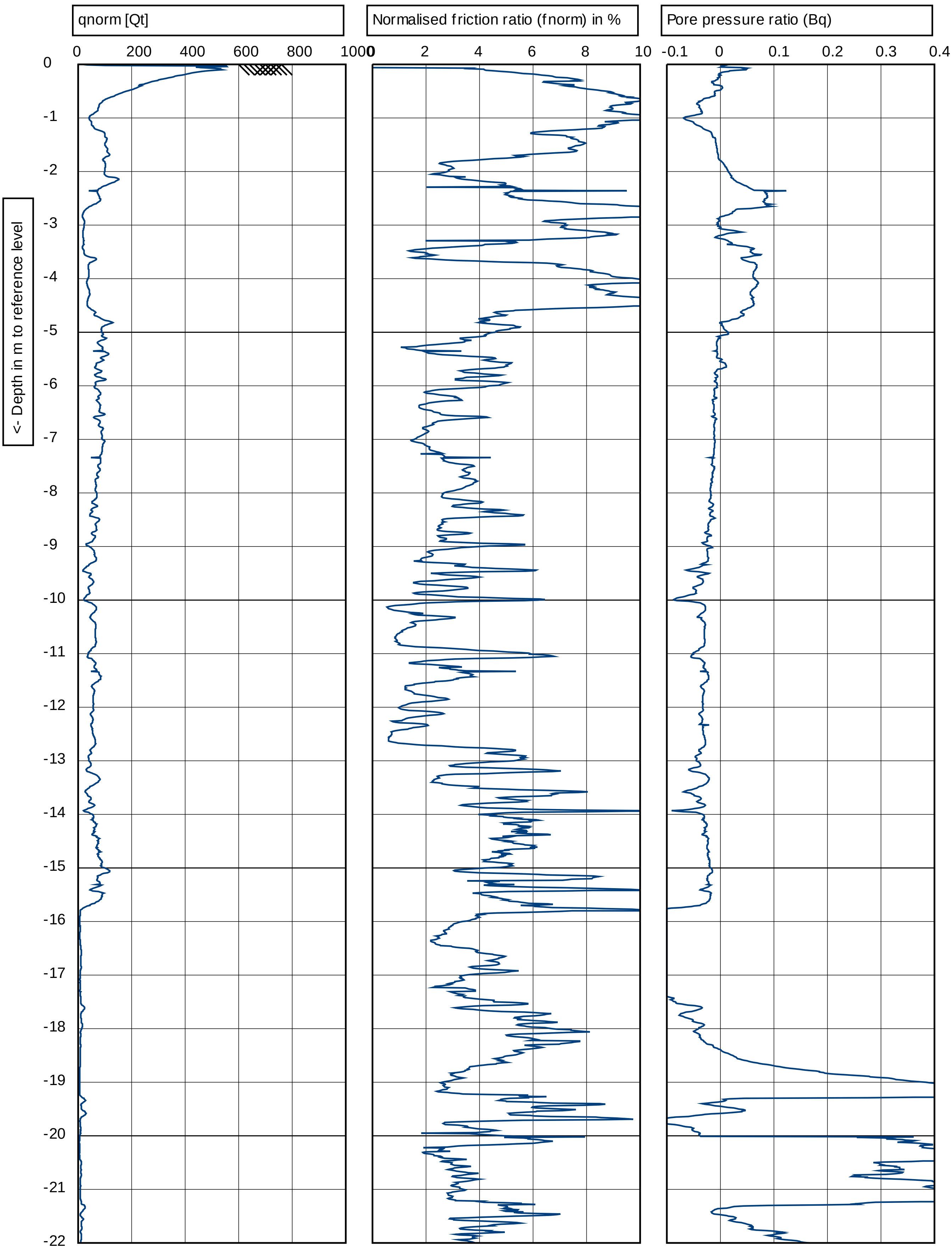
EOH - Dipped - Collapsed dry @ 1.5m

OPUS

Graphs on this page are not IANZ accredited

u2 150 cm² 10 cm²	Test according ASTM D5778-12 & ISO 22476-1:2012		Predrill :	**0 m Predrilled**
	G.L. 0 MSL	W.L.: **-1.5**	Date:	**4/08/2014**
Project:	**Blue Wallace 1**		Cone no.:	**C10CFIPT.C11306**
Location:	**Wayside Rd - Te Kauwhata**		Project no.:	**338720.00**
Position:	**1788683, 5857443 NZTM**		CPT no.:	**04** **4/12**

1.40



OPUS

Graphs on this page are not IANZ accredited

1.40

u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL

W.L.: **-1.5**

Predrill : **0 m Predrilled**

Date: **4/08/2014**

Cone no.: **C10CFIPT.C11306**

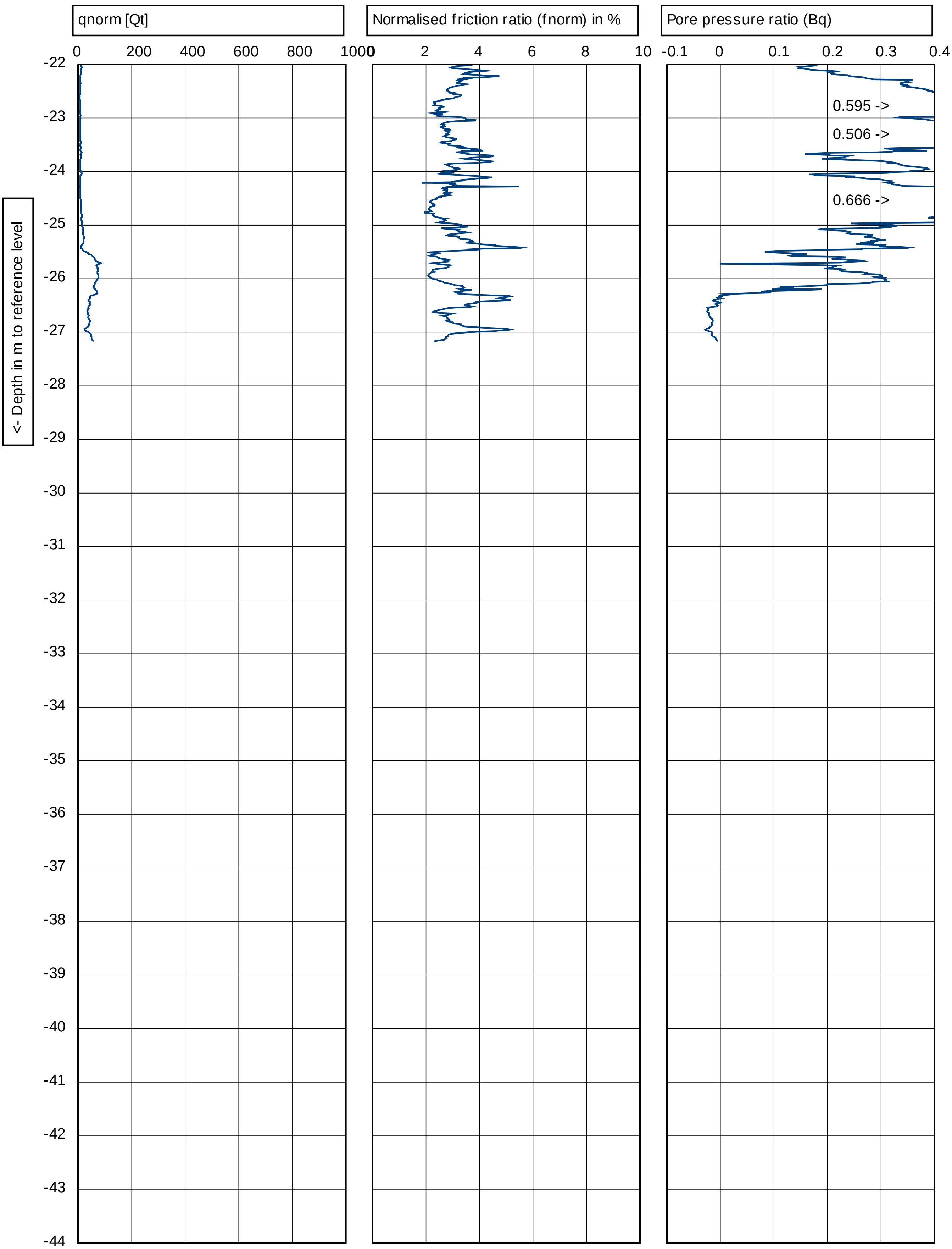
Project no.: **338720.00**

CPT no.: **04**

Project: **Blue Wallace 1**

Location: **Wayside Rd - Te Kauwhata**

Position: **1788683, 5857443 NZTM**



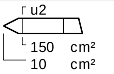
Refusal (Tonnage)

EOH - Dipped - Collapsed dry @ 1.5m

OPUS

Graphs on this page are not IANZ accredited

1.40



Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL

W.L.: **-1.5**

Project: **Blue Wallace 1**

Location: **Wayside Rd - Te Kauwhata**

Position: **1788683, 5857443 NZTM**

Predrill : **0 m Predrilled**

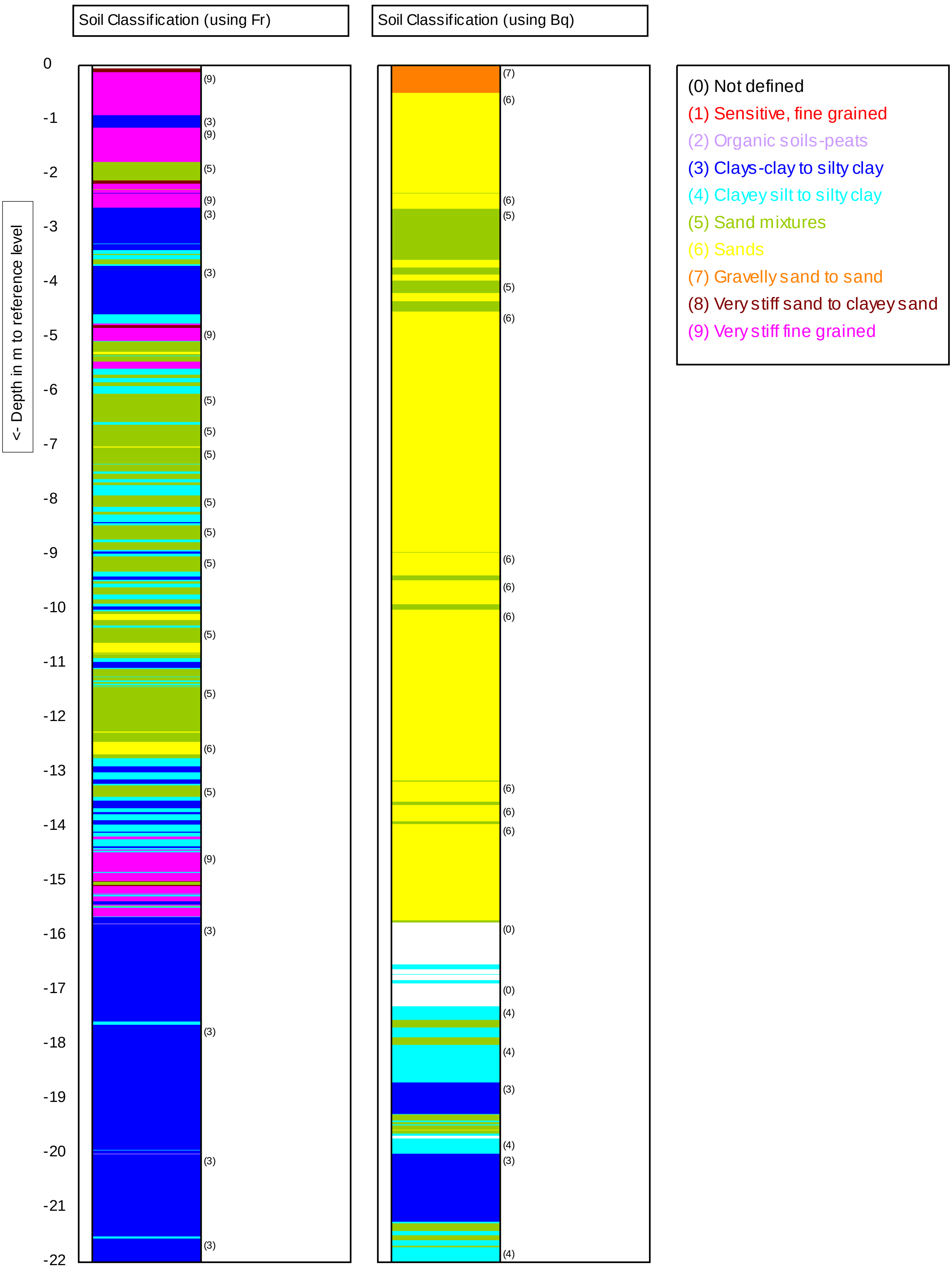
Date: **4/08/2014**

Cone no.: **C10CFIPT.C11306**

Project no.: **338720.00**

CPT no.: **04**

6/12



OPUS

Graphs on this page are not IANZ accredited

1.40

u2
150 cm²
10 cm²

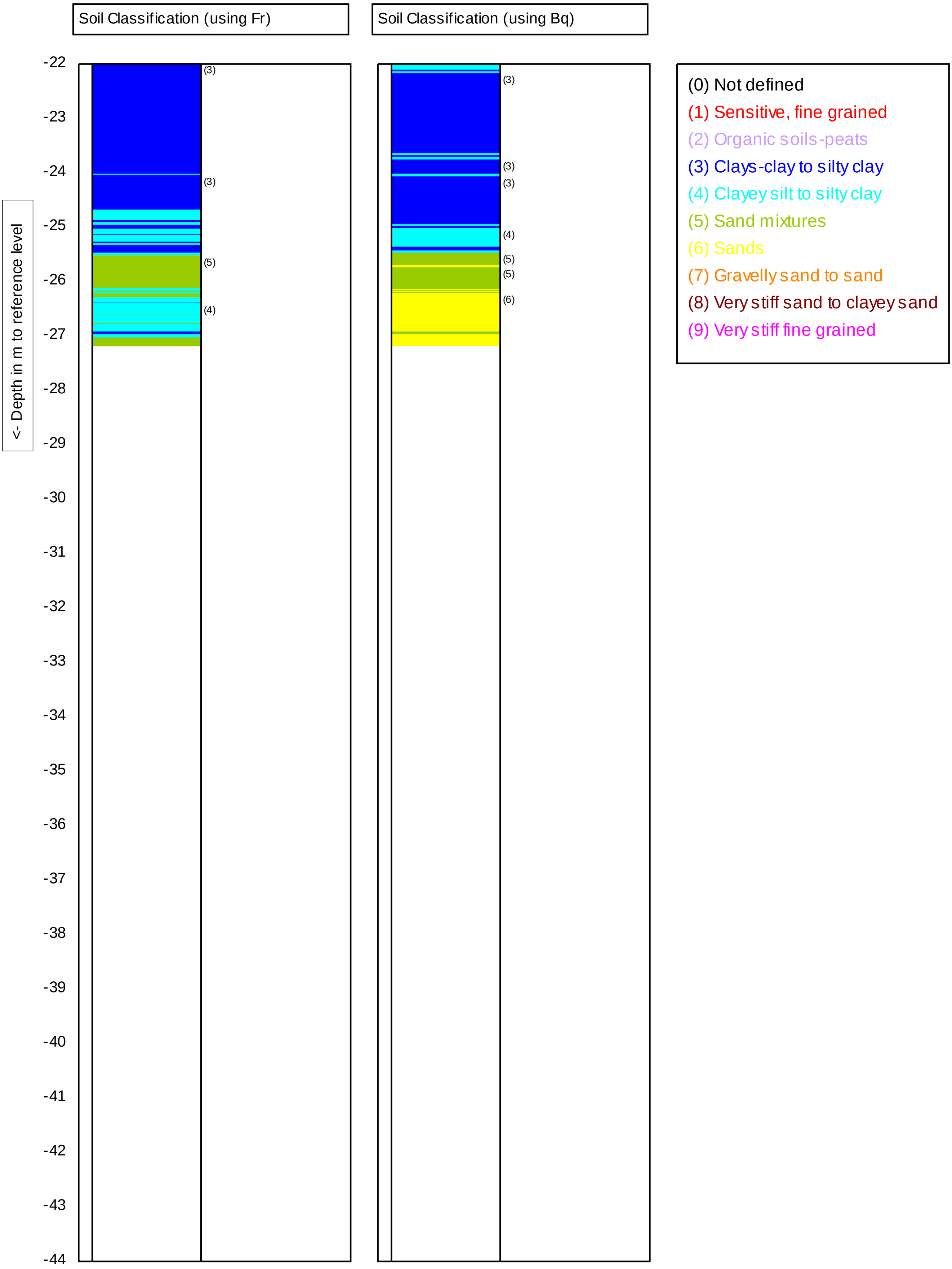
Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL

W.L.: **-1.5**

Project: **Blue Wallace 1**
Location: **Wayside Rd - Te Kauwhata**
Position: **1788683, 5857443 NZTM**

Predrill : **0 m Predrilled**
Date: **4/08/2014**
Cone no.: **C10CFIPT.C11306**
Project no.: **338720.00**
CPT no.: **04**



OPUS

Graphs on this page are not IANZ accredited

1.40

u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL

W.L.: **-1.5**

Project: **Blue Wallace 1**

Location: **Wayside Rd - Te Kauwhata**

Position: **1788683, 5857443 NZTM**

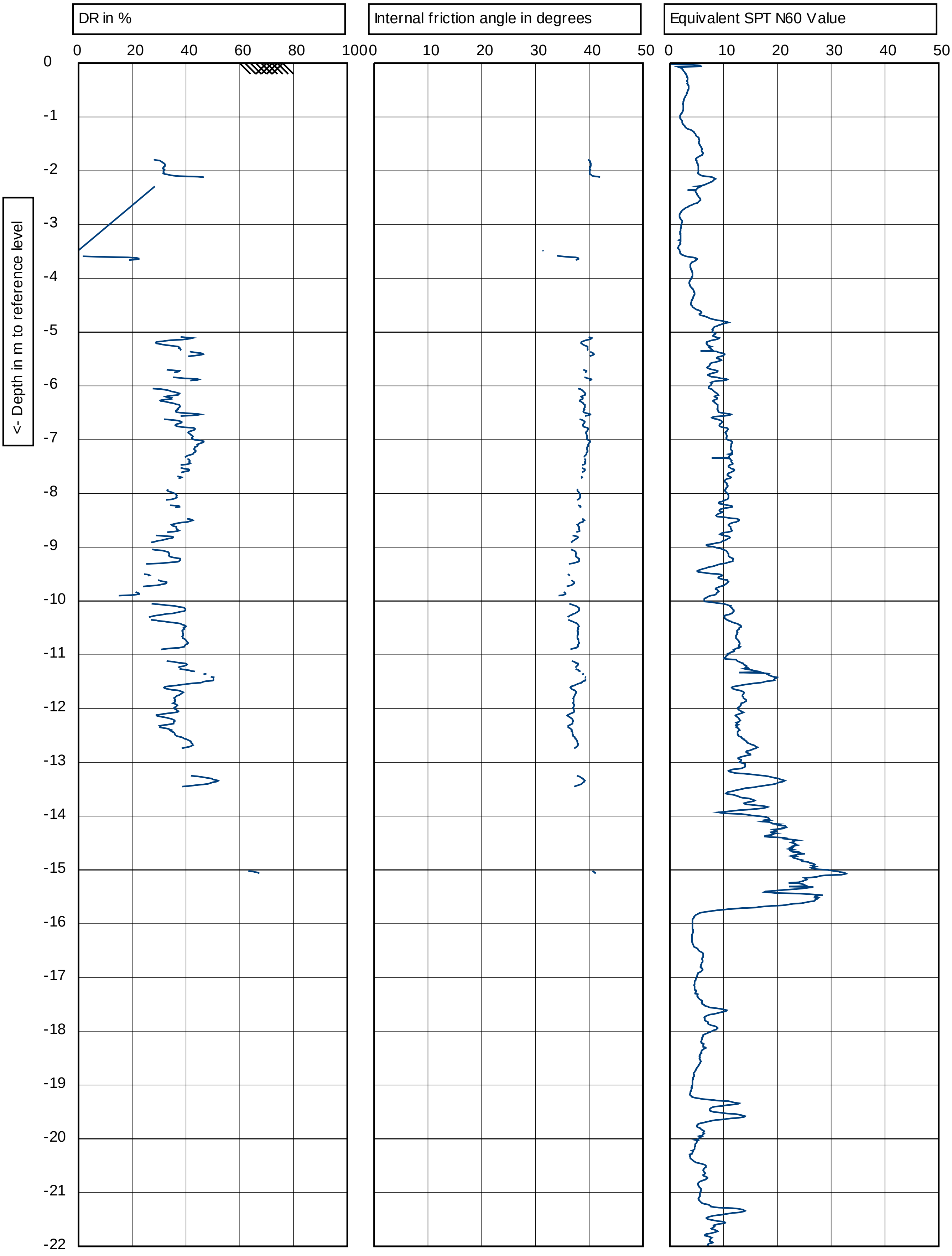
Predrill : **0 m Predrilled**

Date: **4/08/2014**

Cone no.: **C10CFIPT.C11306**

Project no.: **338720.00**

CPT no.: **04**



Graphs on this page are not IANZ accredited

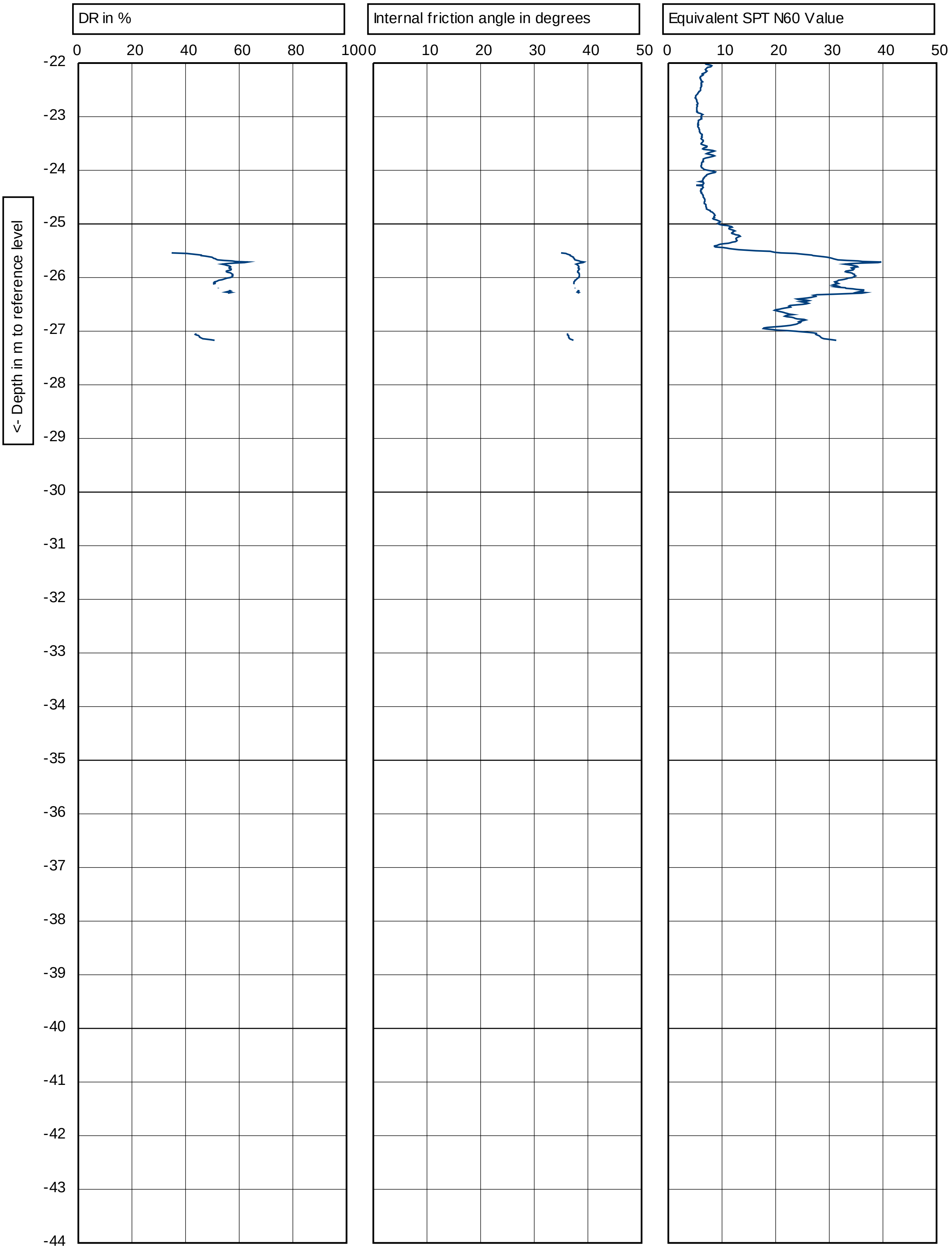
u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012		Predrill :	**0 m Predrilled**
G.L. 0 MSL	W.L.: **-1.5**	Date:	**4/08/2014**

Project: **Blue Wallace 1**
Location: **Wayside Rd - Te Kauwhata**
Position: **1788683, 5857443 NZTM**

Cone no.:	**C10CFIPT.C11306**	
Project no.:	**338720.00**	
CPT no.:	**04**	**9/12**

1.40



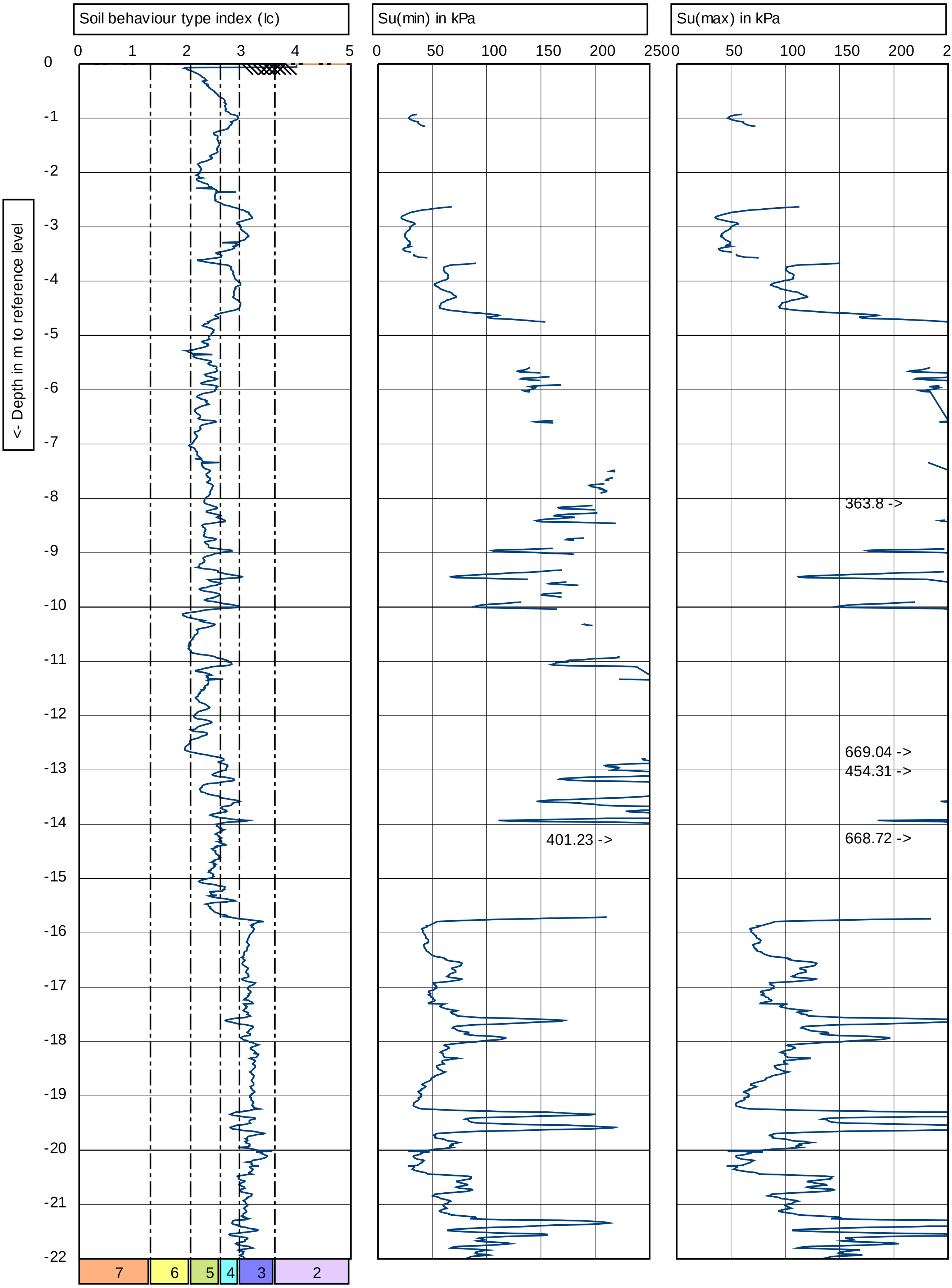
Refusal (Tonnage)

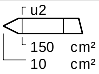
EOH - Dipped - Collapsed dry @ 1.5m

Graphs on this page are not IANZ accredited

u2 150 cm² 10 cm²	Test according ASTM D5778-12 & ISO 22476-1:2012	Predrill :	**0 m Predrilled**
	G.L. 0 MSL W.L.: **-1.5**	Date:	**4/08/2014**
Project:	**Blue Wallace 1**	Cone no.:	**C10CFIPT.C11306**
Location:	**Wayside Rd - Te Kauwhata**	Project no.:	**338720.00**
Position:	**1788683, 5857443 NZTM**	CPT no.:	**04**

1.40





OPUS

Graphs on this page are not IANZ accredited

Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL

W.L.: **-1.5**

Project: **Blue Wallace 1**

Location: **Wayside Rd - Te Kauwhata**

Position: **1788683, 5857443 NZTM**

Predrill : **0 m Predrilled**

Date: **4/08/2014**

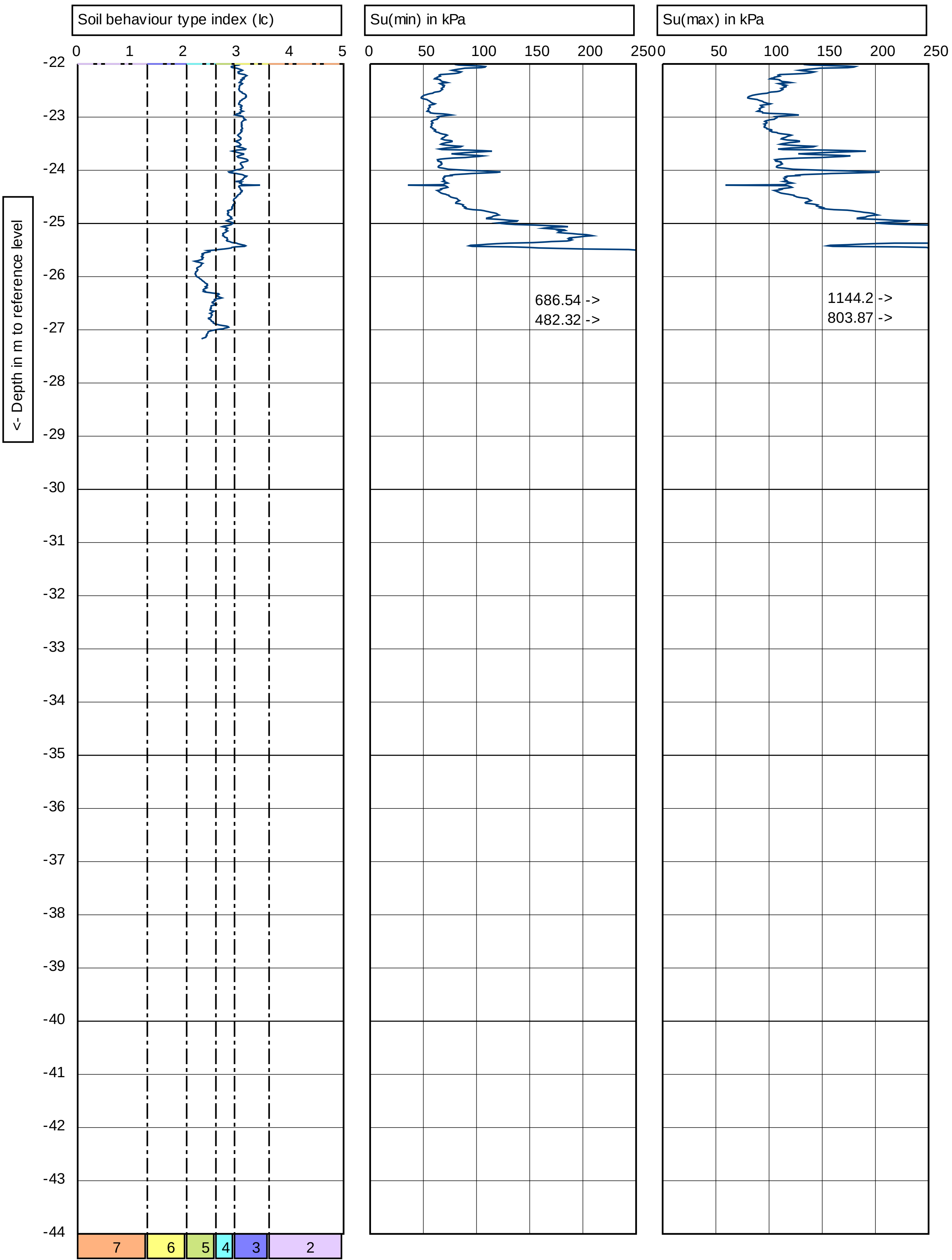
Cone no.: **C10CFIPT.C11306**

Project no.: **338720.00**

CPT no.: **04**

11/12

1.40



Refusal (Tonnage)

EOH - Dipped - Collapsed dry @ 1.5m

OPUS

Graphs on this page are not IANZ accredited

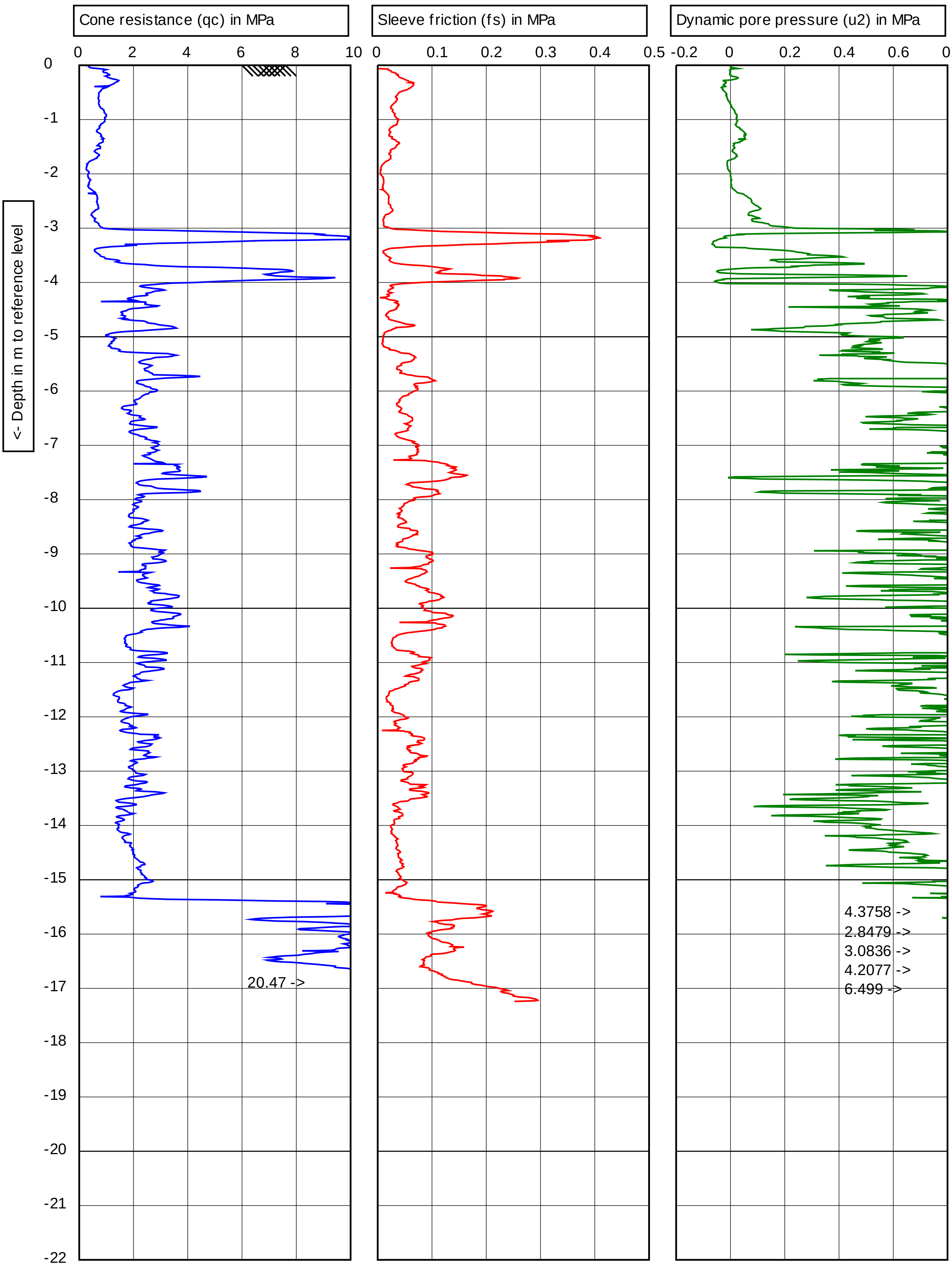
1.40

u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012		Predrill :	**0 m Predrilled**
G.L. 0 MSL	W.L.: **-1.5**	Date:	**4/08/2014**

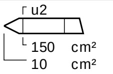
Project: **Blue Wallace 1**
Location: **Wayside Rd - Te Kauwhata**
Position: **1788683, 5857443 NZTM**

Cone no.: **C10CFIPT.C11306**
Project no.: **338720.00**
CPT no.: **04**



Refusal (Tonnage)

EOH - Dipped - Collapsed dry @ 1.7m



Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL

W.L.: **-1.7**

Predrill : **0 m Predrilled**

Date: **4/08/2014**

Cone no.: **C10CFIPT.C11306**

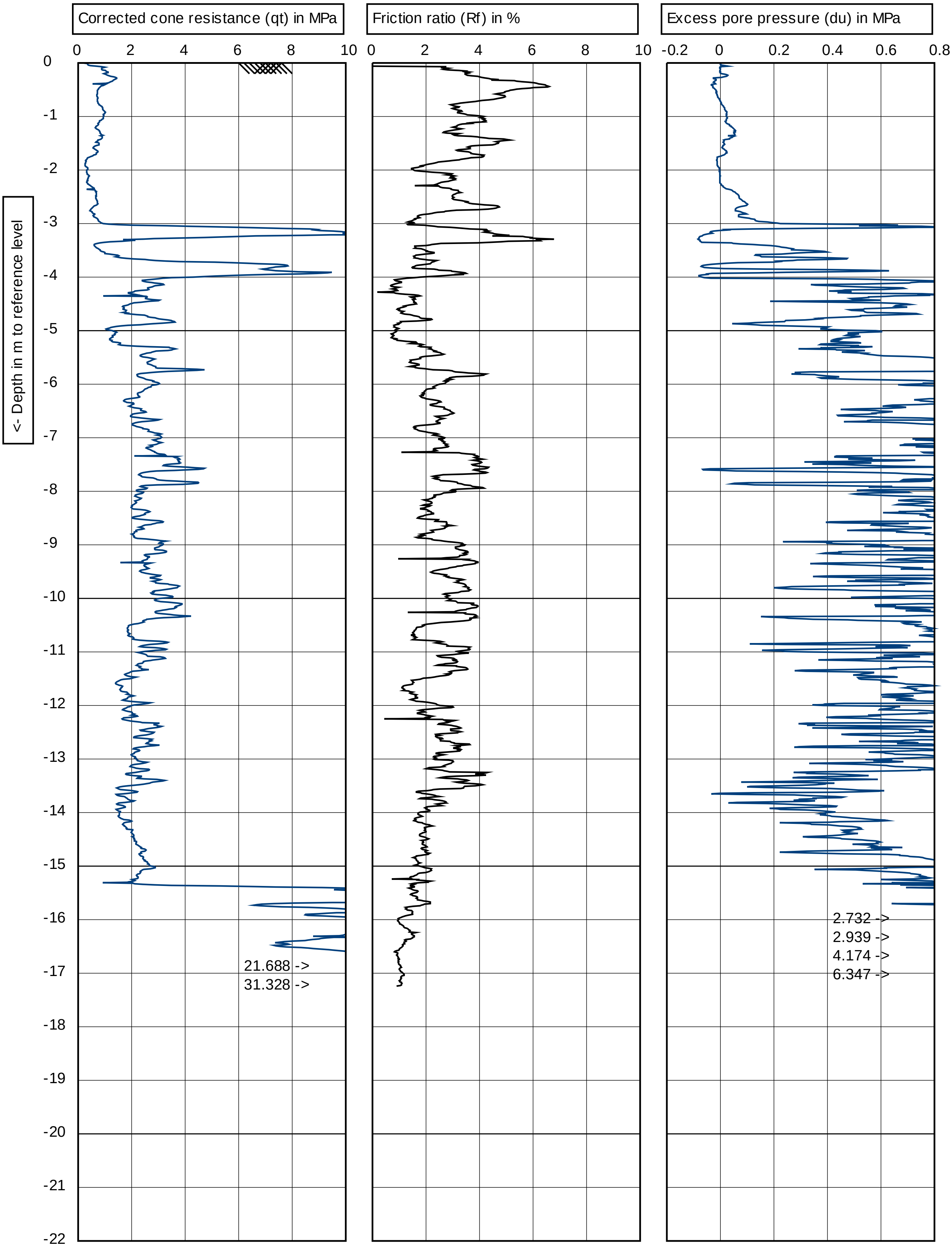
Project no.: **338720.00**

CPT no.: **05**

1/6

Project: **Blue Wallace 1**
Location: **Wayside Rd - Te Kauwhata**
Position: **1788820, 5857452 NZTM**

1.40



Refusal (Tonnage)

EOH - Dipped - Collapsed dry @ 1.7m

Graphs on this page are not IANZ accredited

1.40

u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL

W.L.: **-1.7**

Predrill : **0 m Predrilled**

Date: **4/08/2014**

Cone no.: **C10CFIPT.C11306**

Project no.: **338720.00**

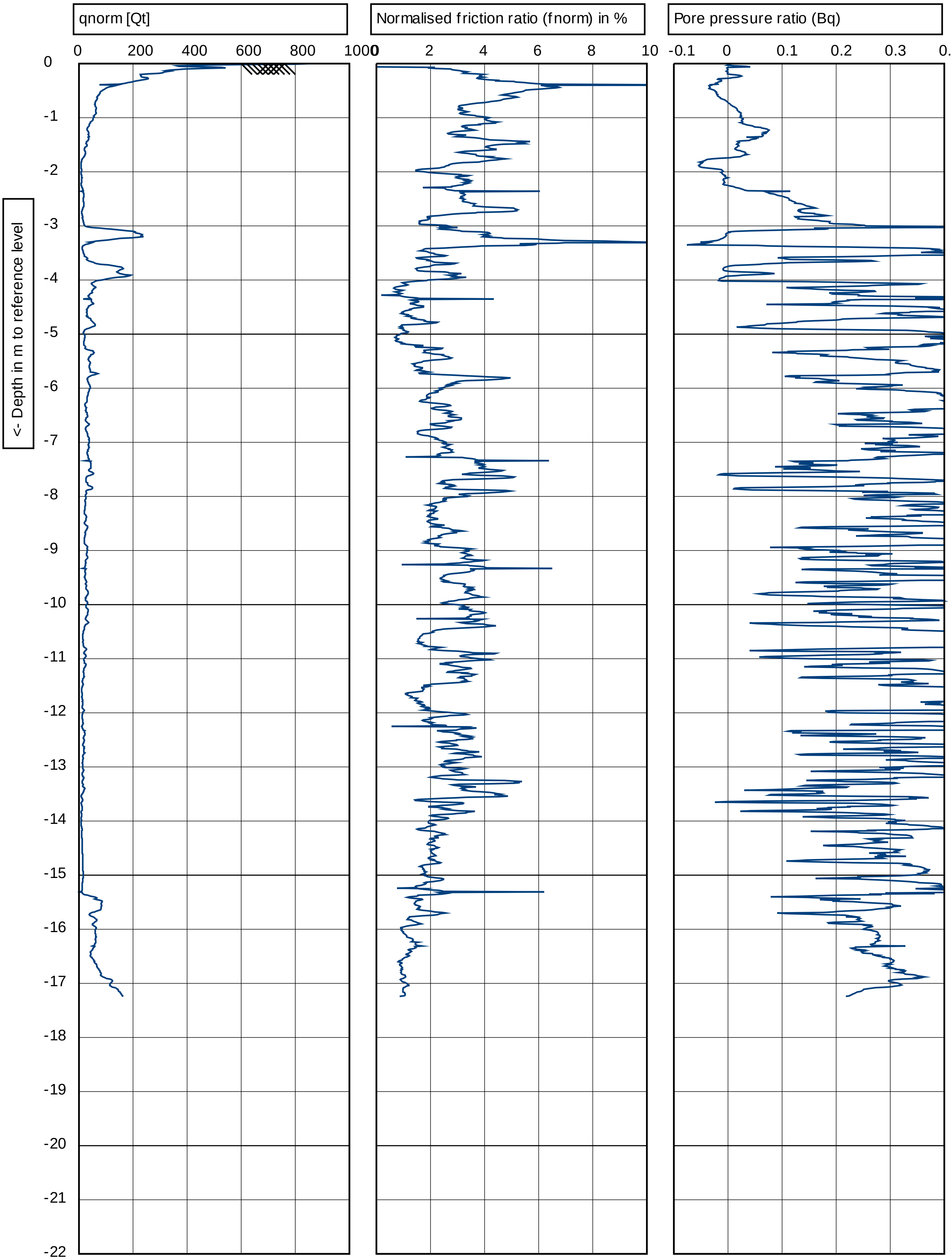
CPT no.: **05**

2/6

Project: **Blue Wallace 1**

Location: **Wayside Rd - Te Kauwhata**

Position: **1788820, 5857452 NZTM**



Refusal (Tonnage)

EOH - Dipped - Collapsed dry @ 1.7m

OPUS

Graphs on this page are not IANZ accredited

1.40

u2
150 cm²
10 cm²

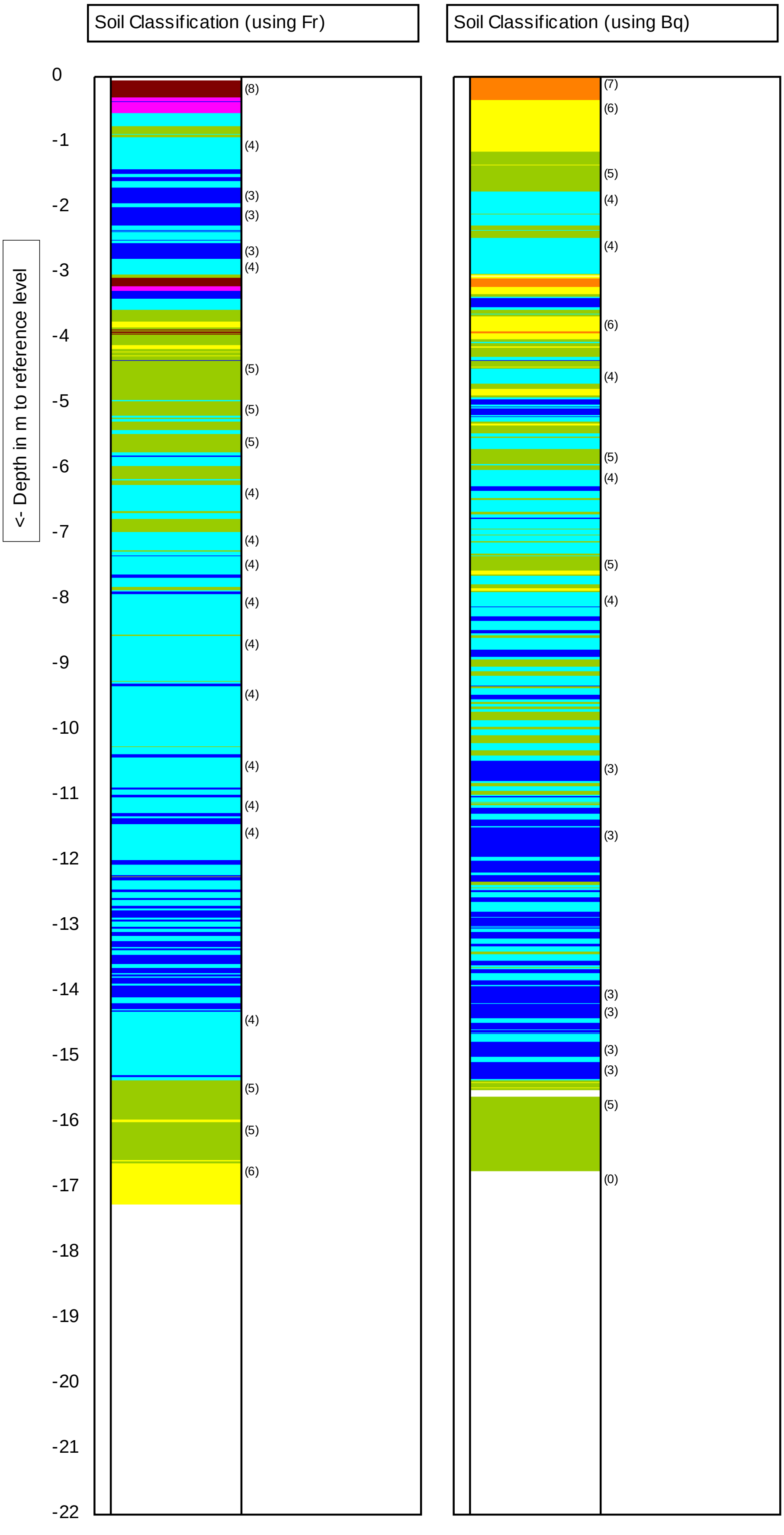
Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL

W.L.: **-1.7**

Project: **Blue Wallace 1**
Location: **Wayside Rd - Te Kauwhata**
Position: **1788820, 5857452 NZTM**

Predrill : **0 m Predrilled**
Date: **4/08/2014**
Cone no.: **C10CFIPT.C11306**
Project no.: **338720.00**
CPT no.: **05**



(0) Not defined
(1) Sensitive, fine grained
(2) Organic soils-peats
(3) Clays-clay to silty clay
(4) Clayey silt to silty clay
(5) Sand mixtures
(6) Sands
(7) Gravelly sand to sand
(8) Very stiff sand to clayey sand
(9) Very stiff fine grained

OPUS

Graphs on this page are not IANZ accredited

1.40

u2
150 cm²
10 cm²

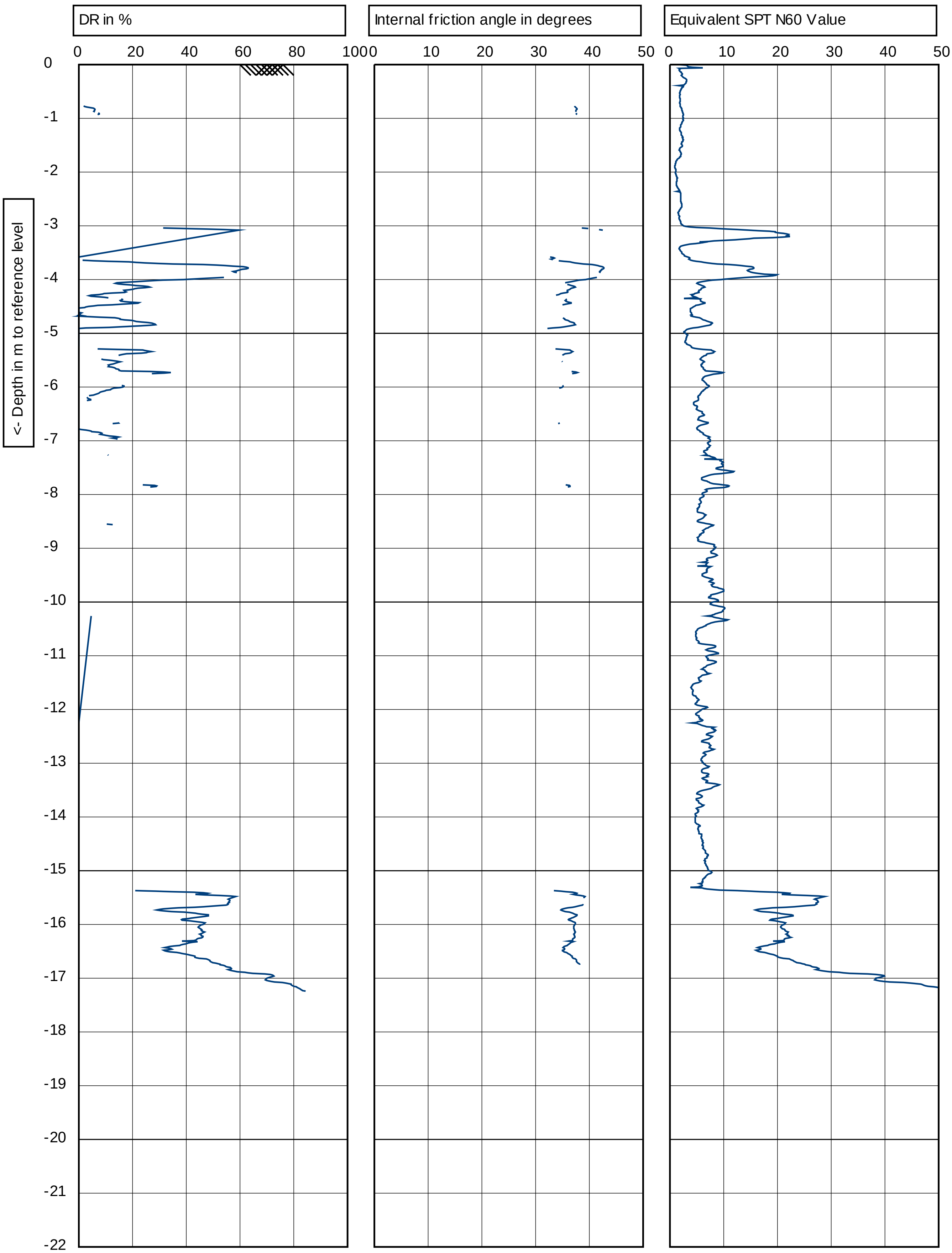
Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL

W.L.: **-1.7**

Project: **Blue Wallace 1**
Location: **Wayside Rd - Te Kauwhata**
Position: **1788820, 5857452 NZTM**

Predrill :	**0 m Predrilled**
Date:	**4/08/2014**
Cone no.:	**C10CFIPT.C11306**
Project no.:	**338720.00**
CPT no.:	**05**



Refusal (Tonnage)

EOH - Dipped - Collapsed dry @ 1.7m

Graphs on this page are not IANZ accredited

u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL

W.L.: **-1.7**

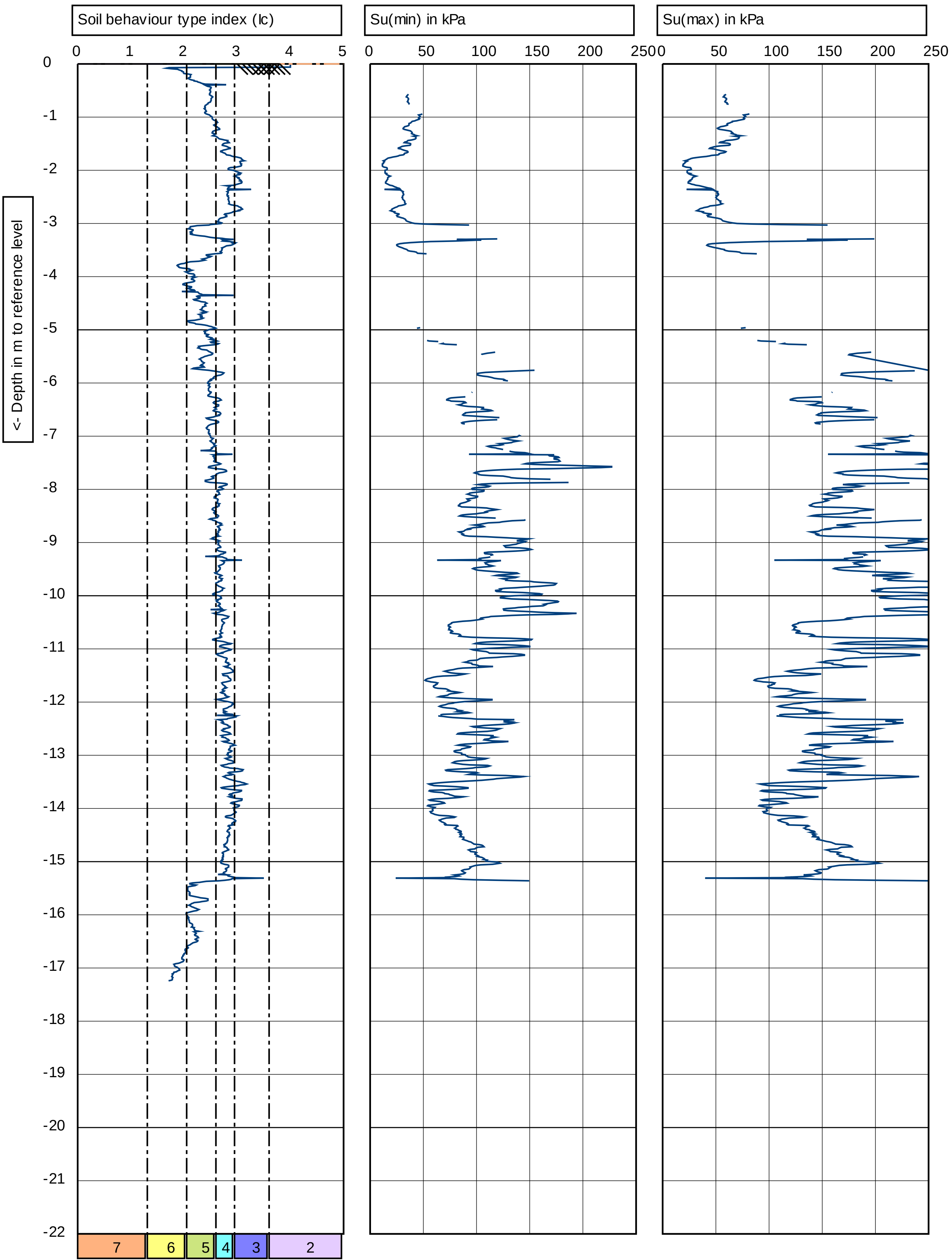
Project: **Blue Wallace 1**

Location: **Wayside Rd - Te Kauwhata**

Position: **1788820, 5857452 NZTM**

Predrill :	**0 m Predrilled**
Date:	**4/08/2014**
Cone no.:	**C10CFIPT.C11306**
Project no.:	**338720.00**
CPT no.:	**05**

1.40

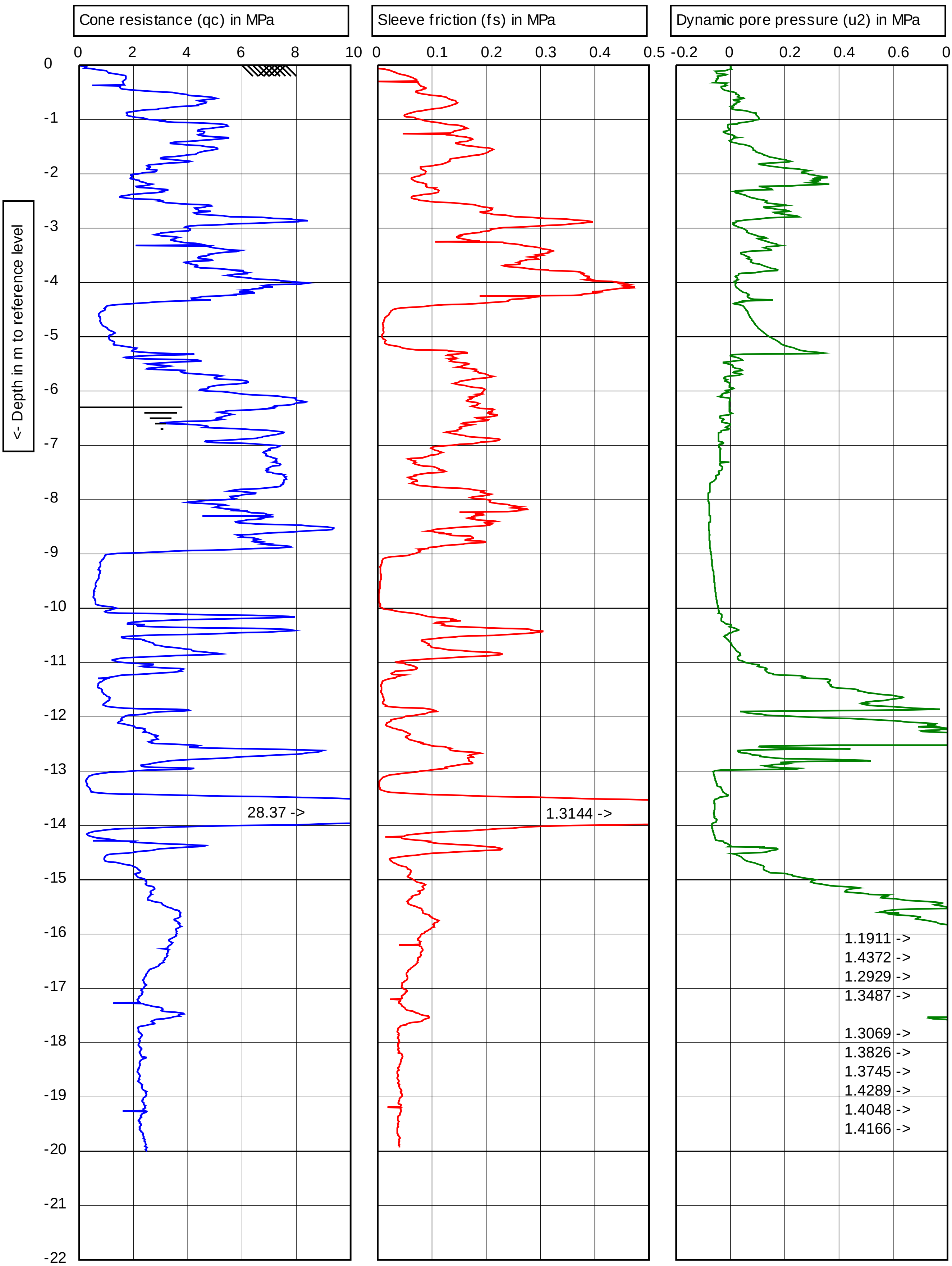


Refusal (Tonnage)

EOH - Dipped - Collapsed dry @ 1.7m

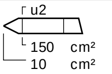
OPUS Graphs on this page are not IANZ accredited	u2 150 cm² 10 cm²	Test according ASTM D5778-12 & ISO 22476-1:2012	Predrill :	**0 m Predrilled**
		G.L. 0 MSL W.L.: **-1.7**	Date:	**4/08/2014**
		Project: **Blue Wallace 1**	Cone no.:	**C10CFIPT.C11306**
		Location: **Wayside Rd - Te Kauwhata**	Project no.:	**338720.00**
		Position: **1788820, 5857452 NZTM**	CPT no.:	**05** **6/6**

1.40



Target Depth

EOH - Dipped - GWL @ 6.3m



Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL

W.L.: **-6.3**

Predrill : **0 m Predrilled**

Date: **4/08/2014**

Cone no.: **C10CFIPT.C11306**

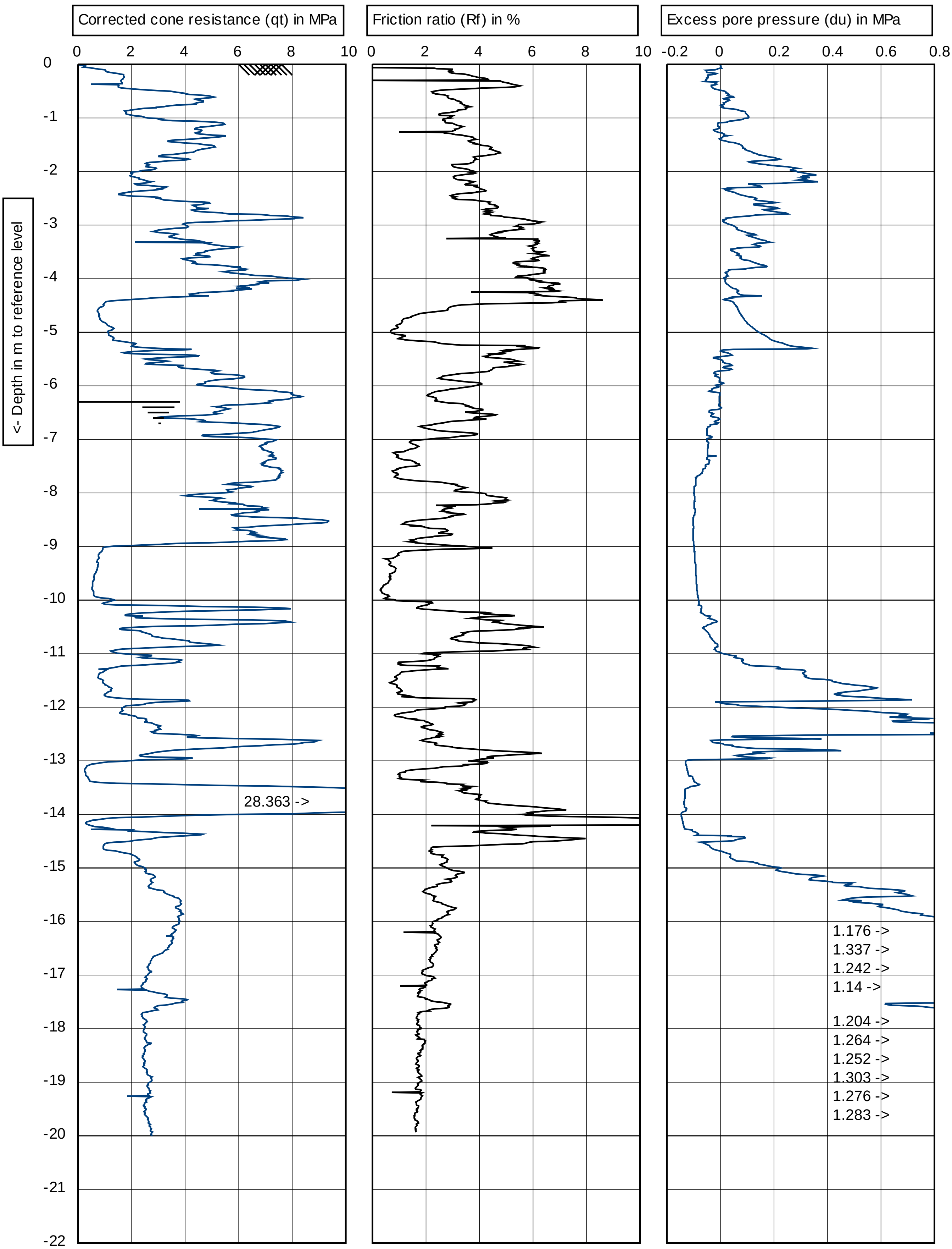
Project no.: **338720.00**

CPT no.: **06**

1/6

Project: **Blue Wallace 1**
Location: **Wayside Rd - Te Kauwhata**
Position: **1788586, 5857256 NZTM**

1.40



Target Depth

EOH - Dipped - GWL @ 6.3m

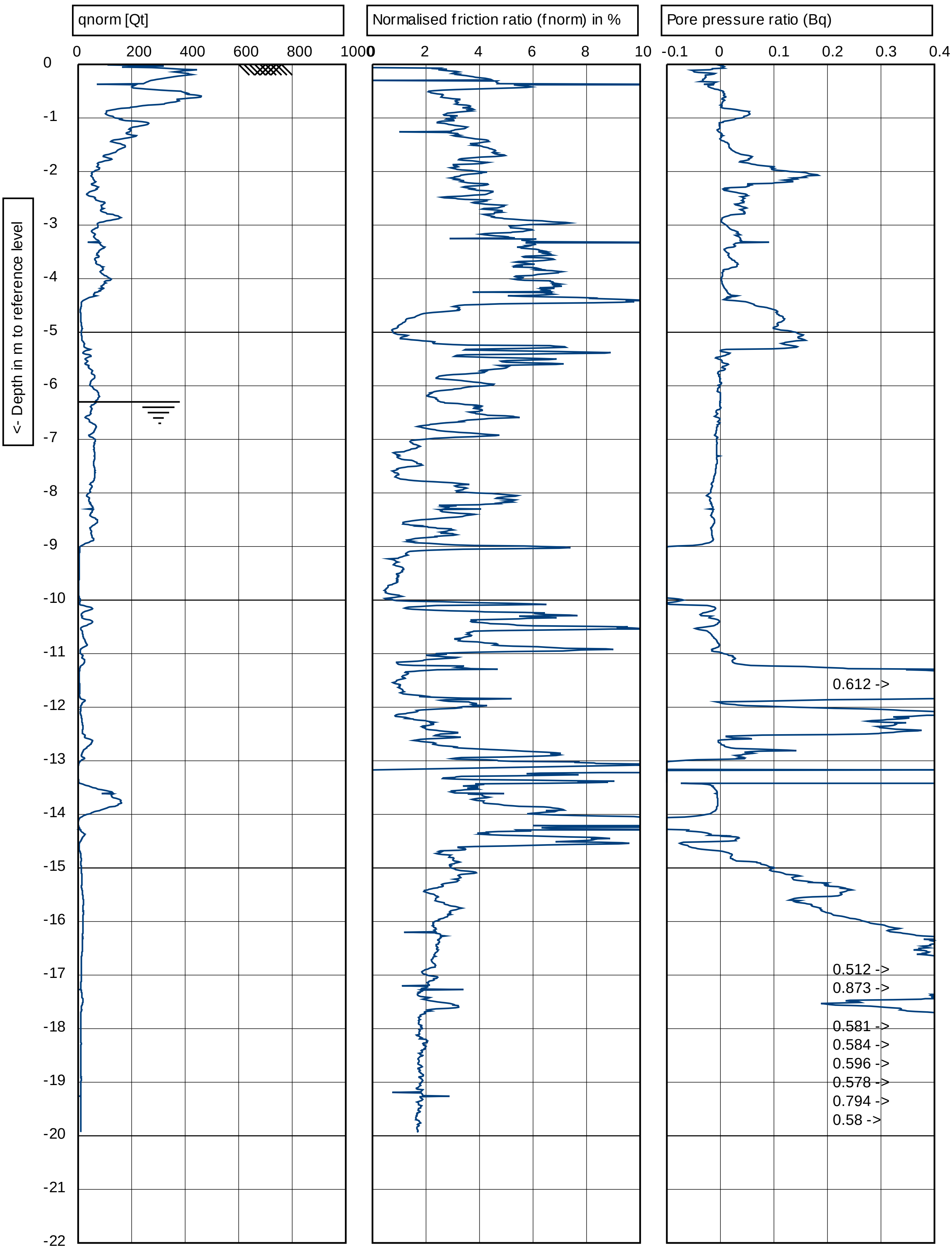
Graphs on this page are not IANZ accredited

1.40

u2	Test according ASTM D5778-12 & ISO 22476-1:2012		Predrill :	**0 m Predrilled**
150 cm² 10 cm²	G.L. 0 MSL	W.L.: **-6.3**	Date:	**4/08/2014**

Project: **Blue Wallace 1**
Location: **Wayside Rd - Te Kauwhata**
Position: **1788586, 5857256 NZTM**

Cone no.: **C10CFIPT.C11306**
Project no.: **338720.00**
CPT no.: **06** **2/6**

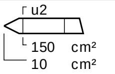


Target Depth

EOH - Dipped - GWL @ 6.3m

Graphs on this page are not IANZ accredited

1.40



Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL

W.L.: **-6.3**

Project: **Blue Wallace 1**

Location: **Wayside Rd - Te Kauwhata**

Position: **1788586, 5857256 NZTM**

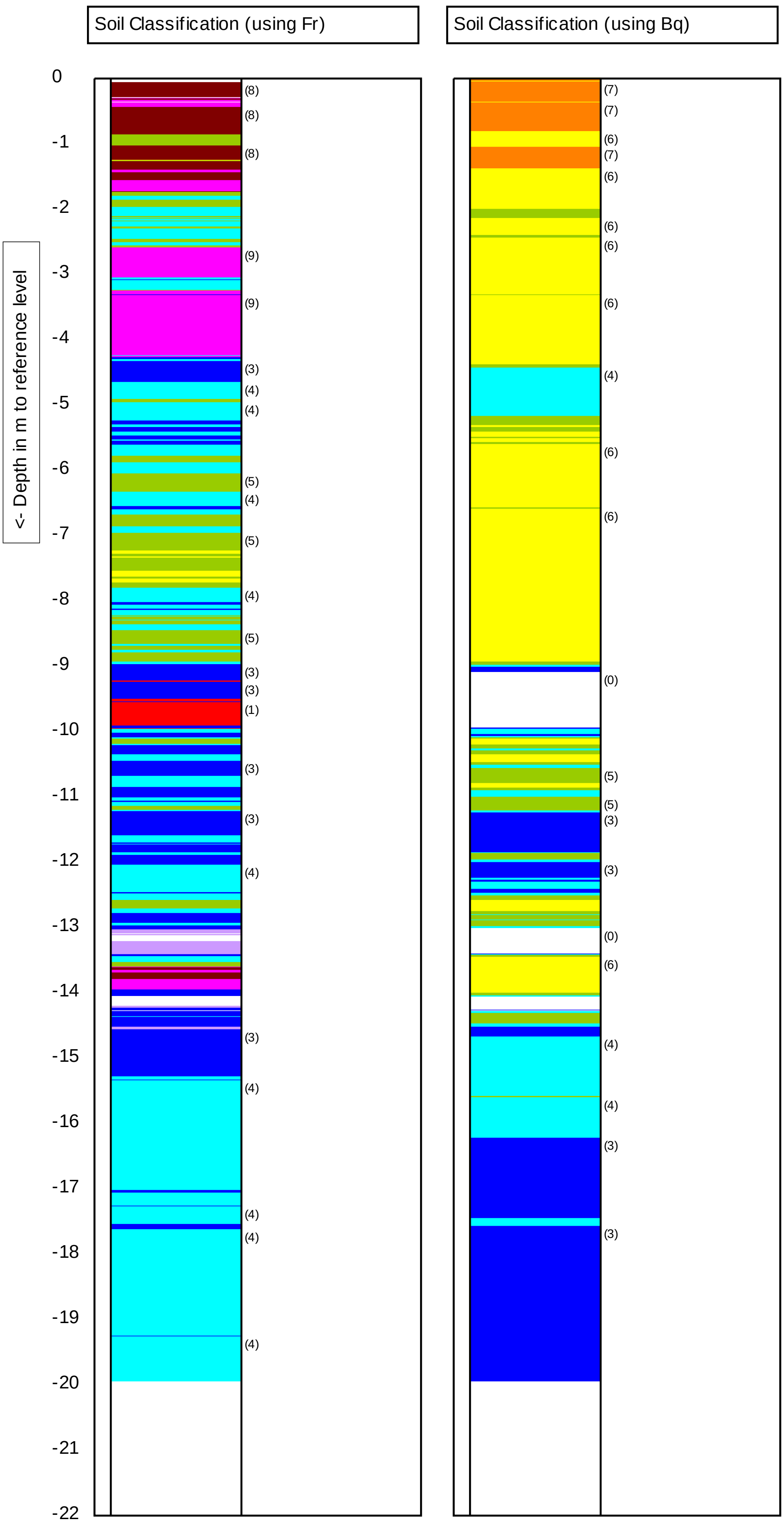
Predrill : **0 m Predrilled**

Date: **4/08/2014**

Cone no.: **C10CFIPT.C11306**

Project no.: **338720.00**

CPT no.: **06**



(0) Not defined
(1) Sensitive, fine grained
(2) Organic soils-peats
(3) Clays-clay to silty clay
(4) Clayey silt to silty clay
(5) Sand mixtures
(6) Sands
(7) Gravelly sand to sand
(8) Very stiff sand to clayey sand
(9) Very stiff fine grained

OPUS

Graphs on this page are not IANZ accredited

1.40

u2
150 cm^2
10 cm^2

Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL

W.L.: **-6.3**

Predrill : **0 m Predrilled**

Date: **4/08/2014**

Cone no.: **C10CFIPT.C11306**

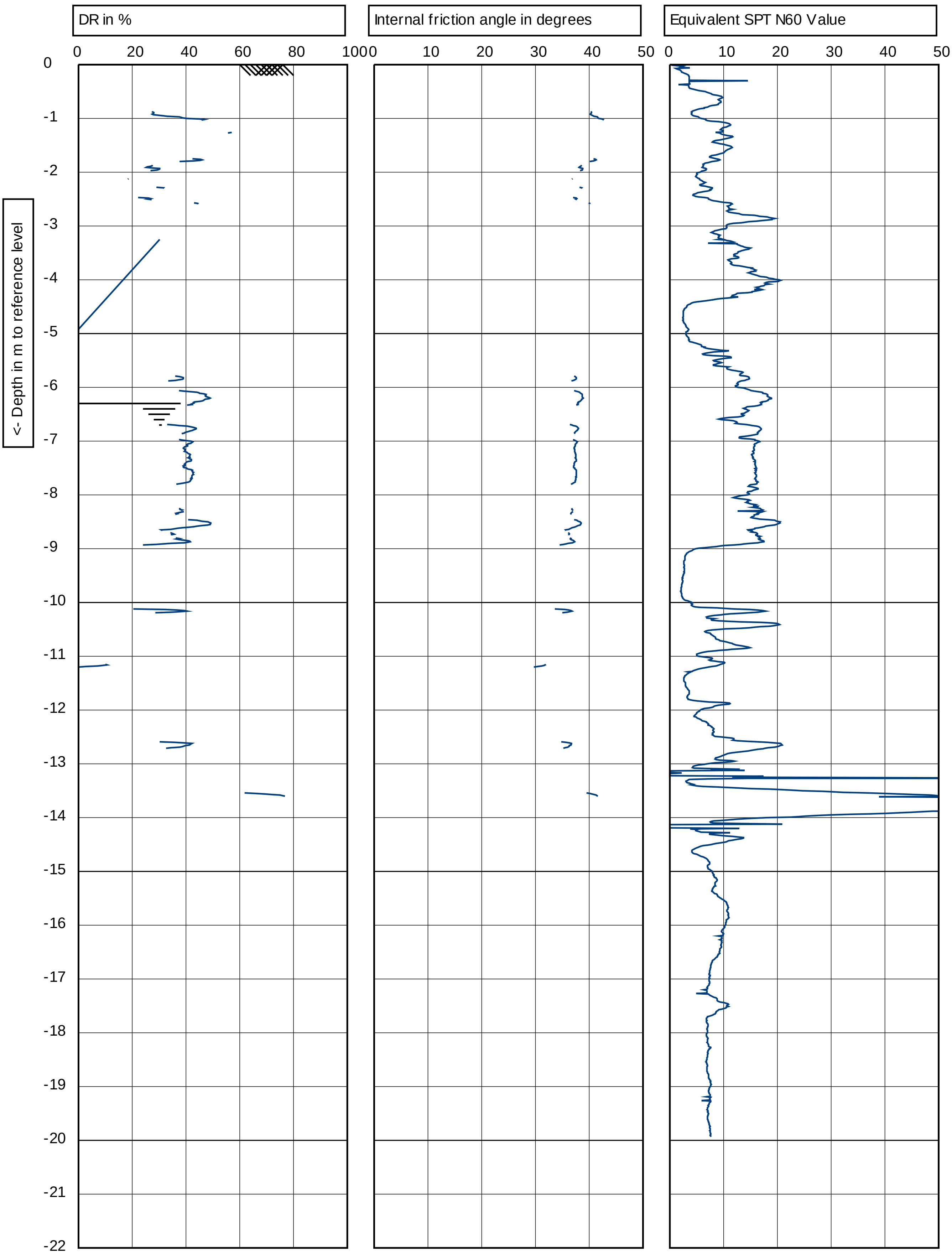
Project no.: **338720.00**

CPT no.: **06** **4/6**

Project: **Blue Wallace 1**

Location: **Wayside Rd - Te Kauwhata**

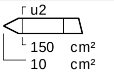
Position: **1788586, 5857256 NZTM**



Target Depth

EOH - Dipped - GWL @ 6.3m

Graphs on this page are not IANZ accredited



Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL

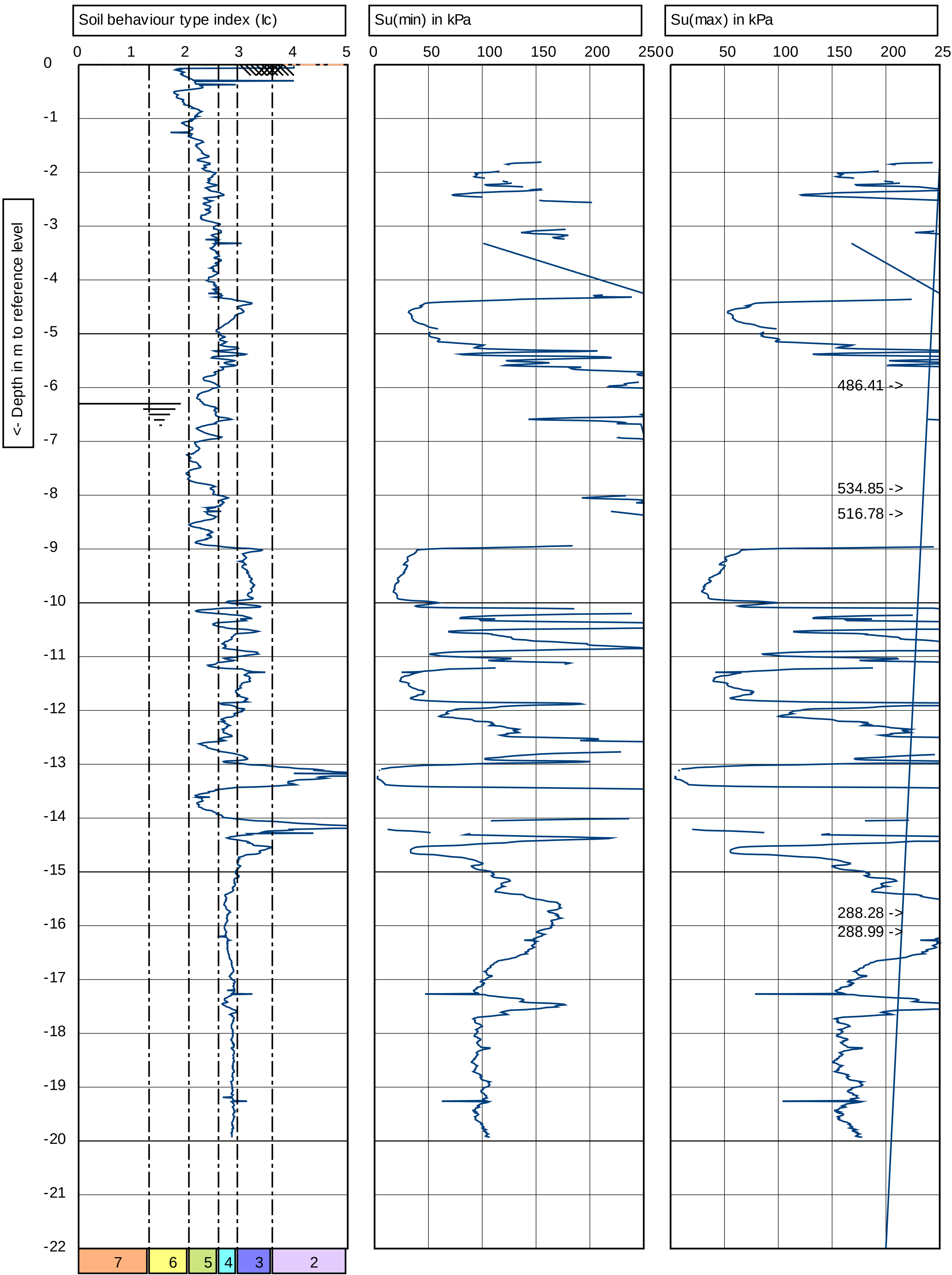
W.L.: **-6.3**

Project: **Blue Wallace 1**

Location: **Wayside Rd - Te Kauwhata**

Position: **1788586, 5857256 NZTM**

Predrill :	**0 m Predrilled**
Date:	**4/08/2014**
Cone no.:	**C10CFIPT.C11306**
Project no.:	**338720.00**
CPT no.:	**06**



Target Depth

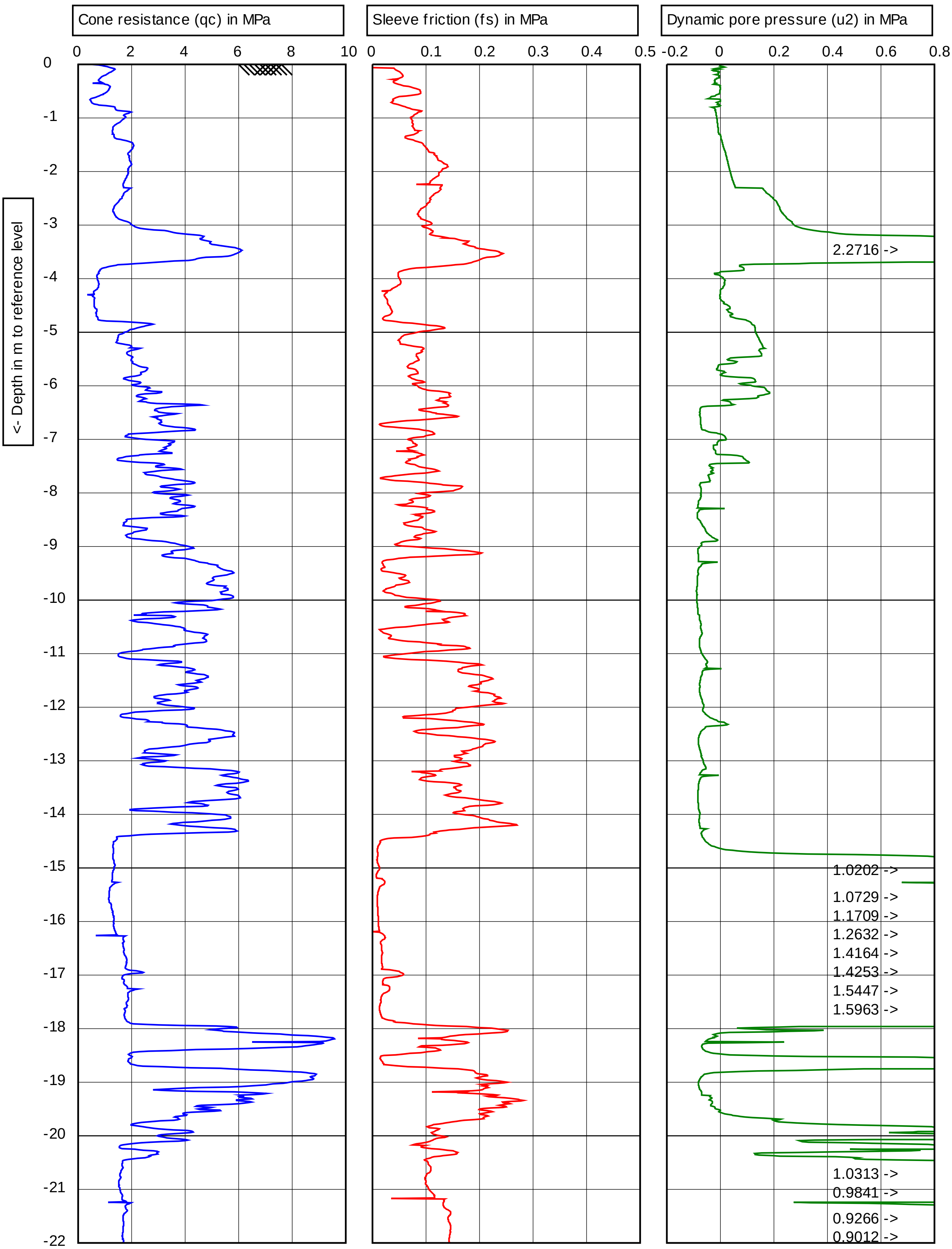
EOH - Dipped - GWL @ 6.3m

Graphs on this page are not IANZ accredited

1.40

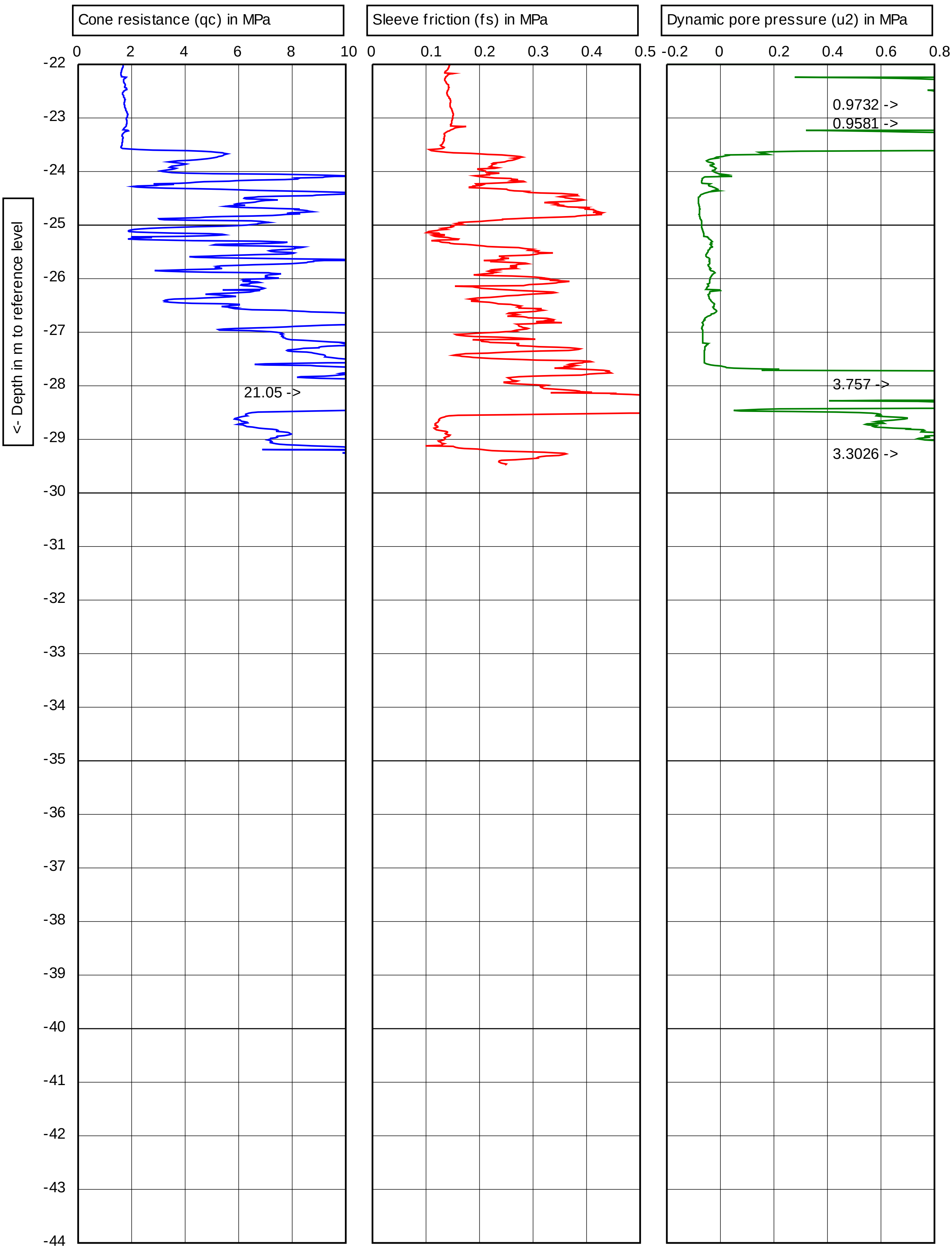
u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012		Predrill :	**0 m Predrilled**
G.L. 0 MSL	W.L.: **-6.3**	Date:	**4/08/2014**
Project: **Blue Wallace 1**		Cone no.:	**C10CFIPT.C11306**
Location: **Wayside Rd - Te Kauwhata**		Project no.:	**338720.00**
Position: **1788586, 5857256 NZTM**		CPT no.:	**06** 6/6



u2 150 cm² 10 cm²	Test according ASTM D5778-12 & ISO 22476-1:2012	Predrill :	**0 m Predrilled**
	G.L. 0 MSL / W.L.: **-5.2**	Date:	**4/08/2014**
Project:	**Blue Wallace 1**	Cone no.:	**C10CFIPT.C11306**
Location:	**Wayside Rd - Te Kauwhata**	Project no.:	**338720.00**
Position:	**1788989, 5857537 NZTM**	CPT no.:	**07** **1/12**

1.40

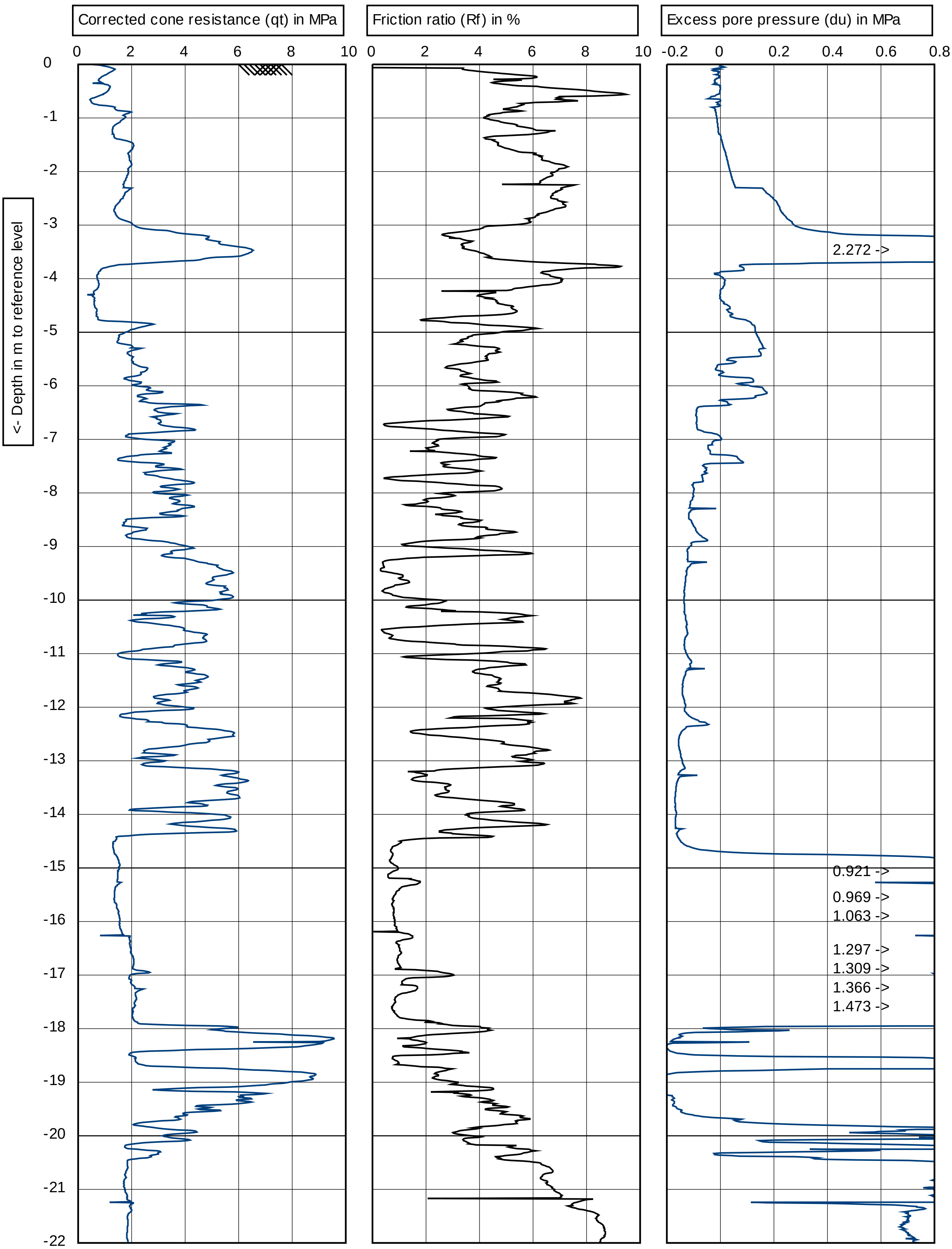


Refusal (Tonnage)

EOH - Dipped - Collapsed dry @ 5.2m

u2 150 cm² 10 cm²	Test according ASTM D5778-12 & ISO 22476-1:2012		Predrill :	**0 m Predrilled**
	G.L. 0 MSL	W.L.: **-5.2**	Date:	**4/08/2014**
Project:	**Blue Wallace 1**		Cone no.:	**C10CFIPT.C11306**
Location:	**Wayside Rd - Te Kauwhata**		Project no.:	**338720.00**
Position:	**1788989, 5857537 NZTM**		CPT no.:	**07** **2/12**

1.40



OPUS

Graphs on this page are not IANZ accredited

1.40

u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012

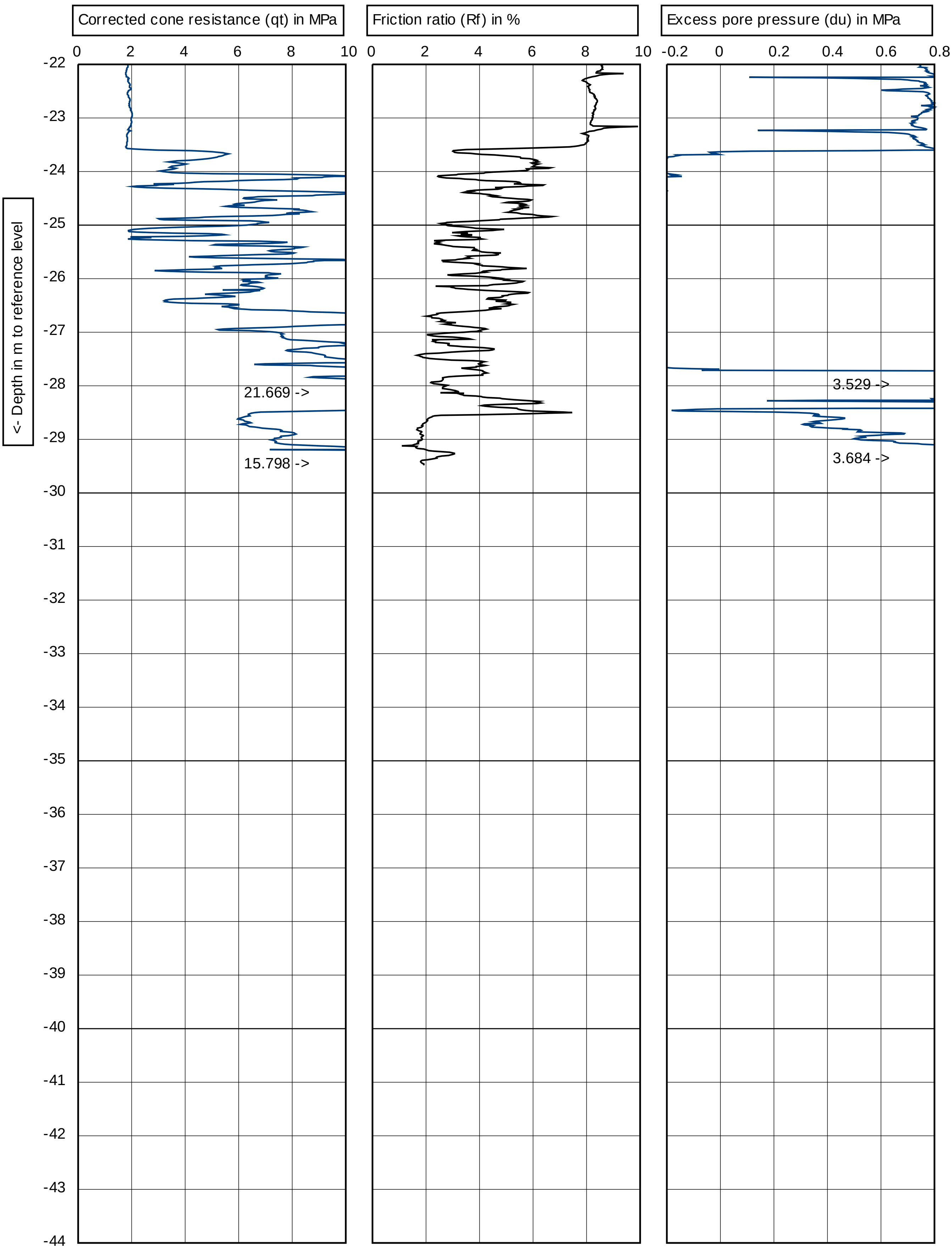
G.L. 0 MSL

W.L.: **-5.2**

Project: **Blue Wallace 1**
Location: **Wayside Rd - Te Kauwhata**
Position: **1788989, 5857537 NZTM**

Predrill :	**0 m Predrilled**
Date:	**4/08/2014**
Cone no.:	**C10CFIPT.C11306**
Project no.:	**338720.00**
CPT no.:	**07**

3/12



Refusal (Tonnage)

EOH - Dipped - Collapsed dry @ 5.2m

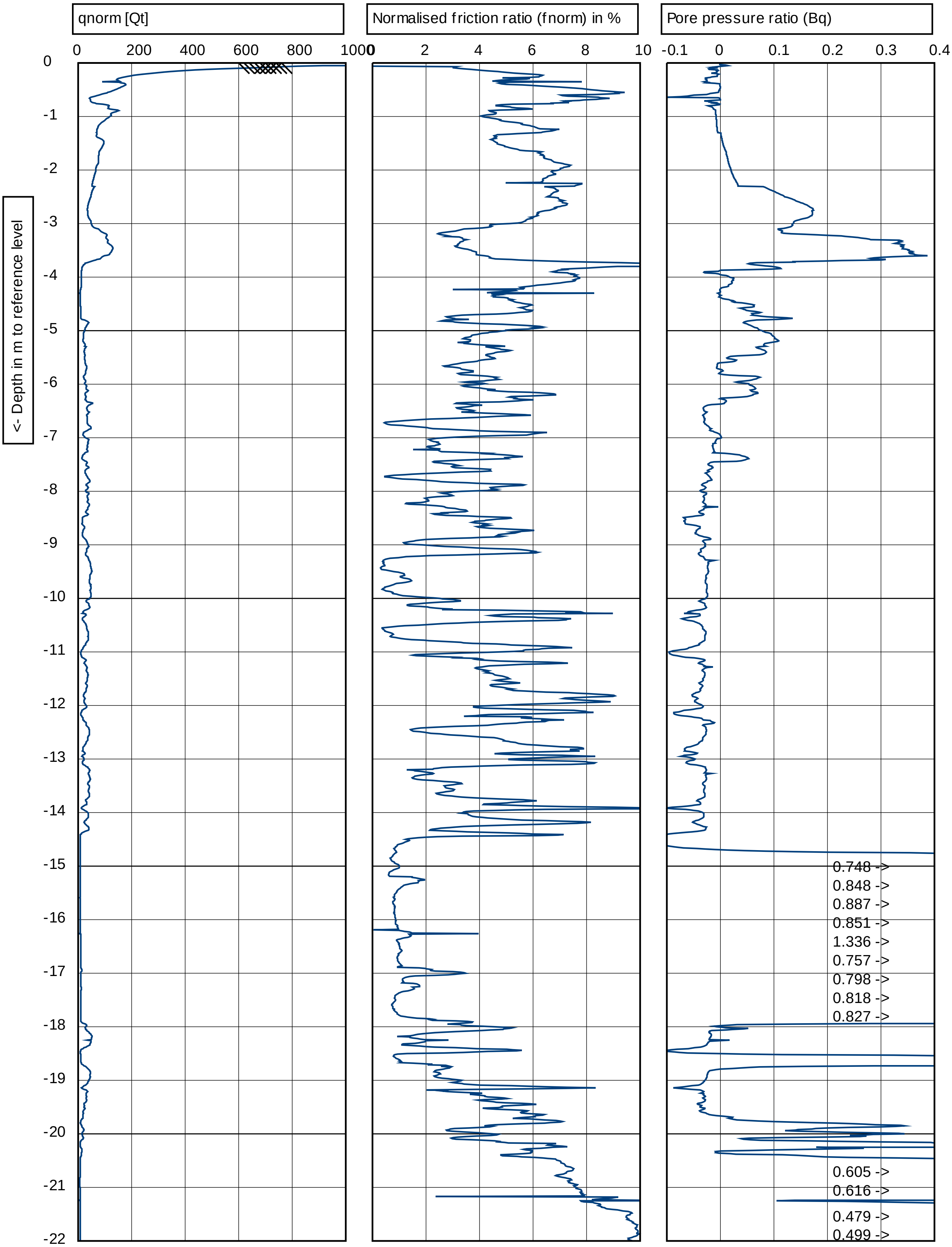
OPUS

Graphs on this page are not IANZ accredited

1.40

u2
150 cm²
10 cm²

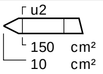
Test according ASTM D5778-12 & ISO 22476-1:2012		Predrill :	**0 m Predrilled**
G.L. 0 MSL	W.L.: **-5.2**	Date:	**4/08/2014**
Project: **Blue Wallace 1**		Cone no.:	**C10CFIPT.C11306**
Location: **Wayside Rd - Te Kauwhata**		Project no.:	**338720.00**
Position: **1788989, 5857537 NZTM**		CPT no.:	**07** 4/12



OPUS

Graphs on this page are not IANZ accredited

1.40



Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL

W.L.: **-5.2**

Project: **Blue Wallace 1**

Location: **Wayside Rd - Te Kauwhata**

Position: **1788989, 5857537 NZTM**

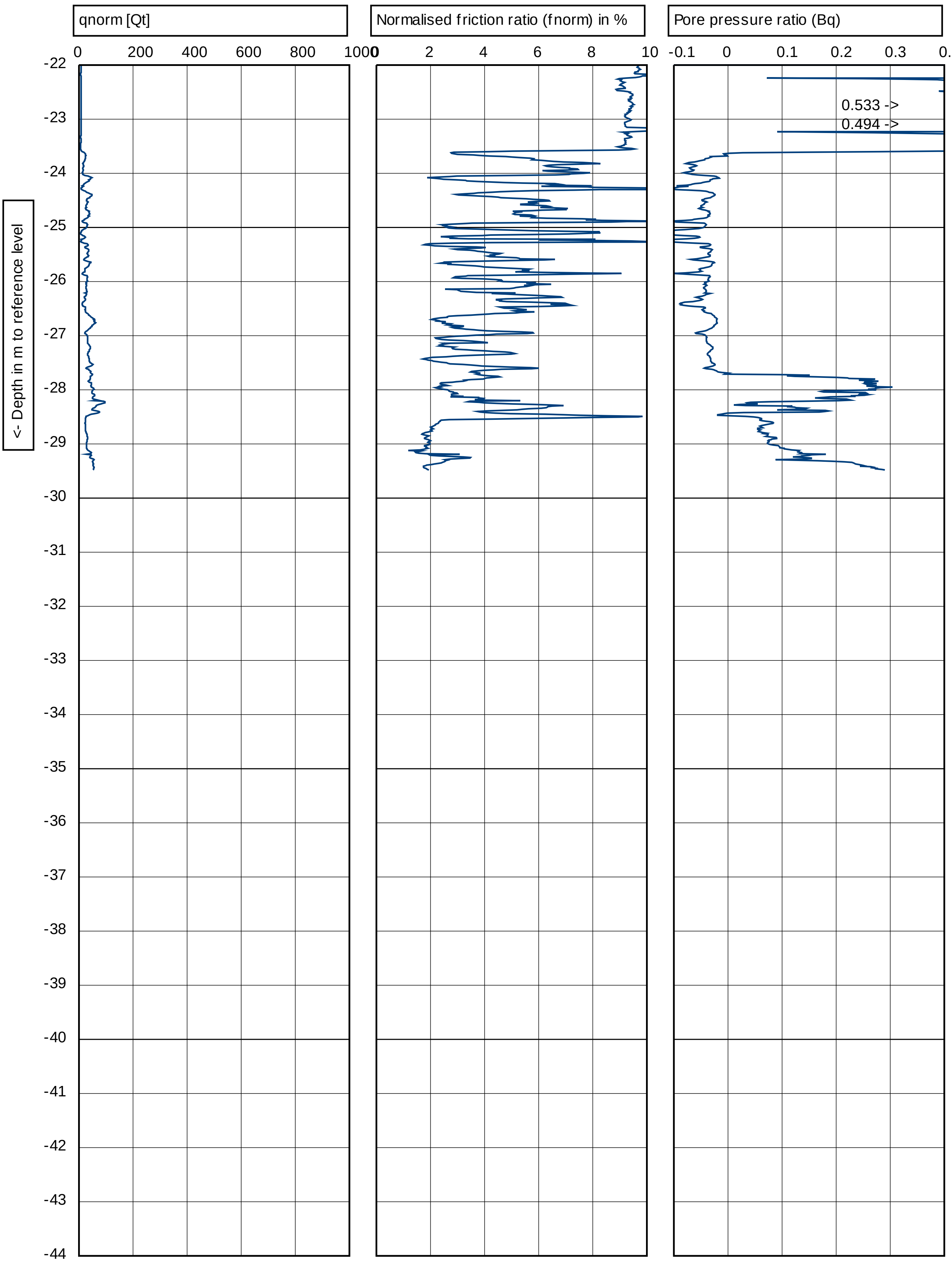
Predrill : **0 m Predrilled**

Date: **4/08/2014**

Cone no.: **C10CFIPT.C11306**

Project no.: **338720.00**

CPT no.: **07**



Refusal (Tonnage)

EOH - Dipped - Collapsed dry @ 5.2m

OPUS

Graphs on this page are not IANZ accredited

u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012

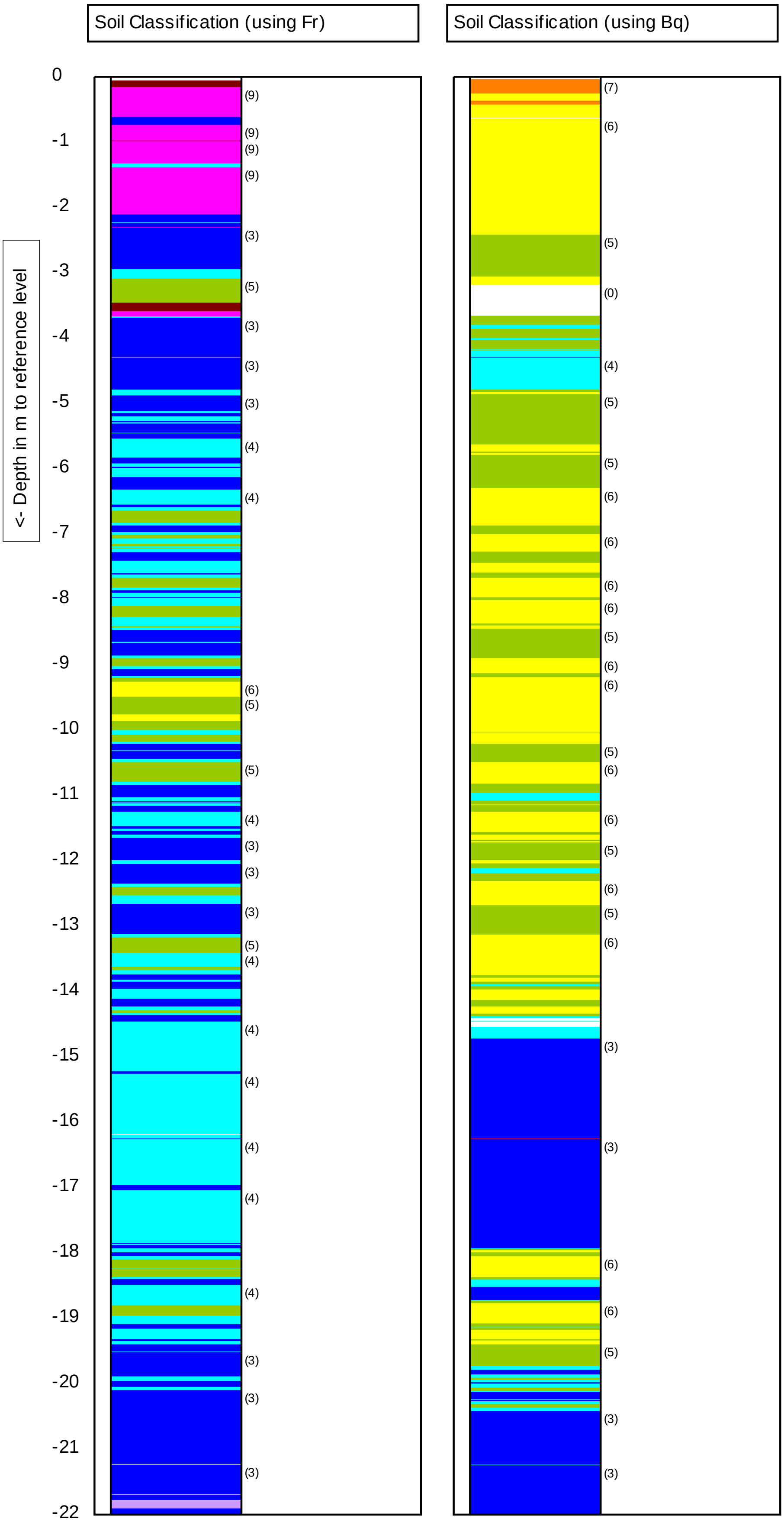
G.L. 0 MSL

W.L.: **-5.2**

Project: **Blue Wallace 1**
Location: **Wayside Rd - Te Kauwhata**
Position: **1788989, 5857537 NZTM**

Predrill : **0 m Predrilled**
Date: **4/08/2014**
Cone no.: **C10CFIPT.C11306**
Project no.: **338720.00**
CPT no.: **07**

1.40



(0) Not defined
(1) Sensitive, fine grained
(2) Organic soils-peats
(3) Clays-clay to silty clay
(4) Clayey silt to silty clay
(5) Sand mixtures
(6) Sands
(7) Gravelly sand to sand
(8) Very stiff sand to clayey sand
(9) Very stiff fine grained

OPUS

Graphs on this page are not IANZ accredited

1.40

u2
150 cm²
10 cm²

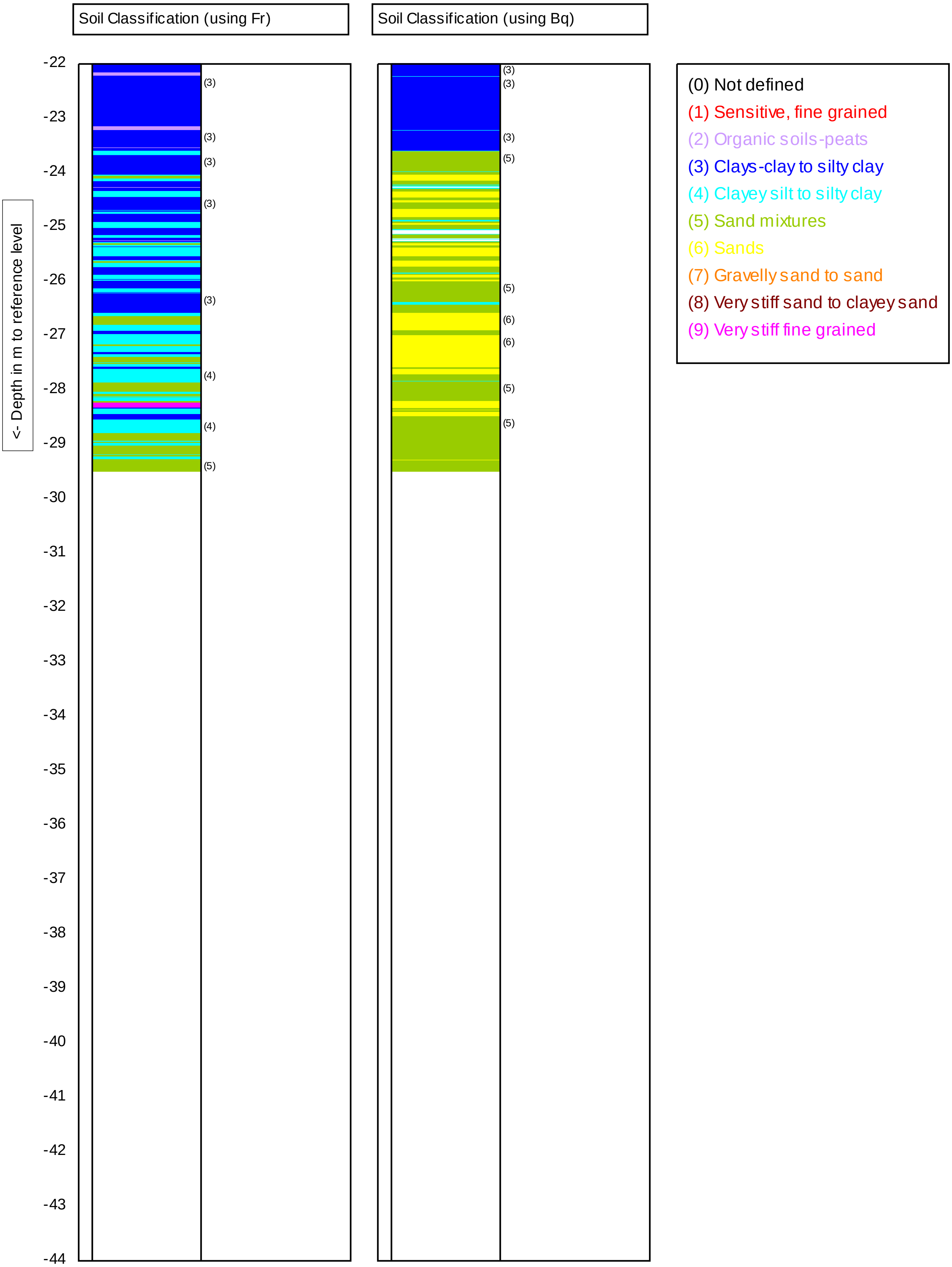
Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL

W.L.: **-5.2**

Project: **Blue Wallace 1**
Location: **Wayside Rd - Te Kauwhata**
Position: **1788989, 5857537 NZTM**

Predrill : **0 m Predrilled**
Date: **4/08/2014**
Cone no.: **C10CFIPT.C11306**
Project no.: **338720.00**
CPT no.: **07**



OPUS

Graphs on this page are not IANZ accredited

u2
150 cm²
10 cm²

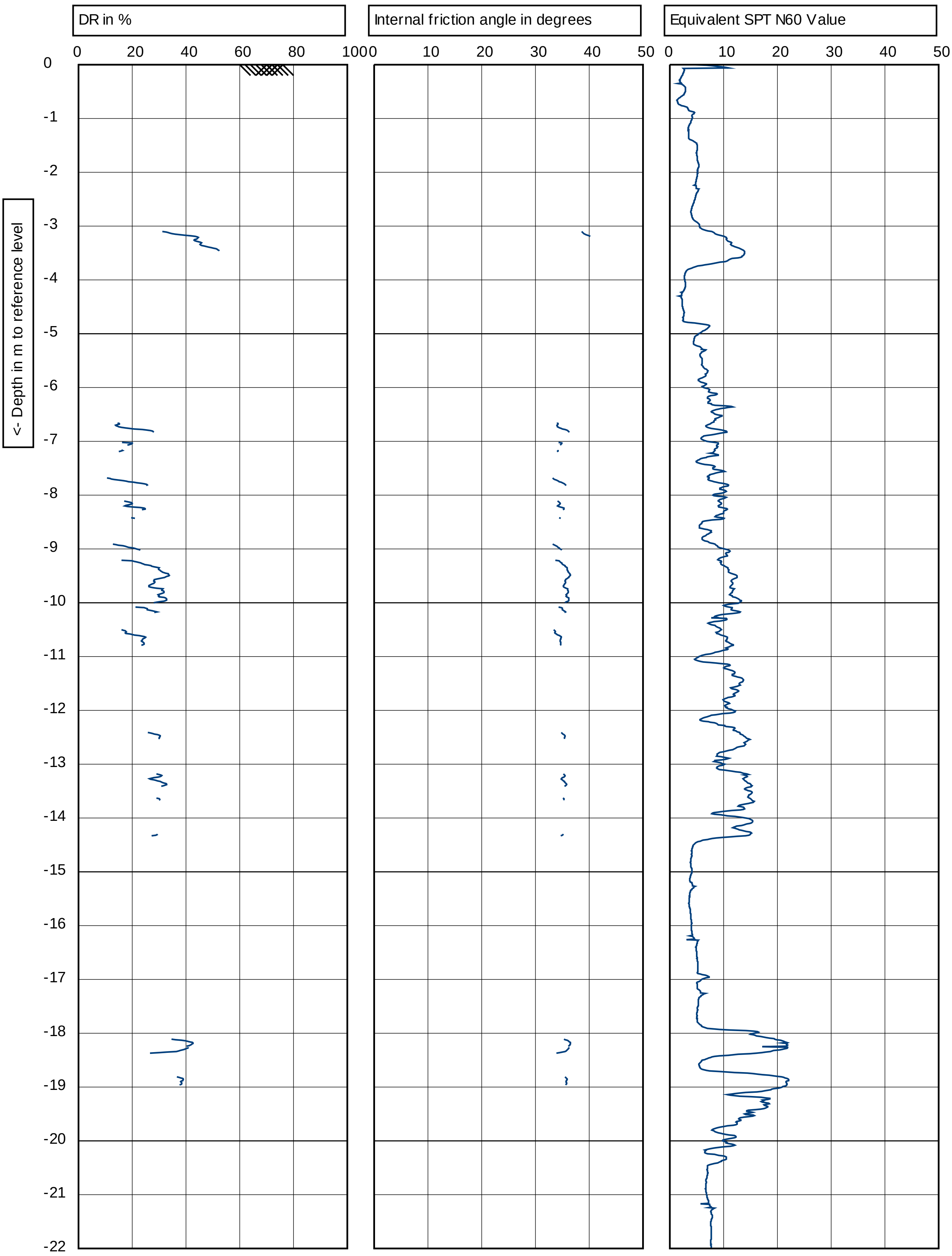
Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL

W.L.: **-5.2**

Project: **Blue Wallace 1**
Location: **Wayside Rd - Te Kauwhata**
Position: **1788989, 5857537 NZTM**

Predrill : **0 m Predrilled**
Date: **4/08/2014**
Cone no.: **C10CFIPT.C11306**
Project no.: **338720.00**
CPT no.: **07**



OPUS

Graphs on this page are not IANZ accredited

u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL

W.L.: **-5.2**

Project: **Blue Wallace 1**

Location: **Wayside Rd - Te Kauwhata**

Position: **1788989, 5857537 NZTM**

Predrill : **0 m Predrilled**

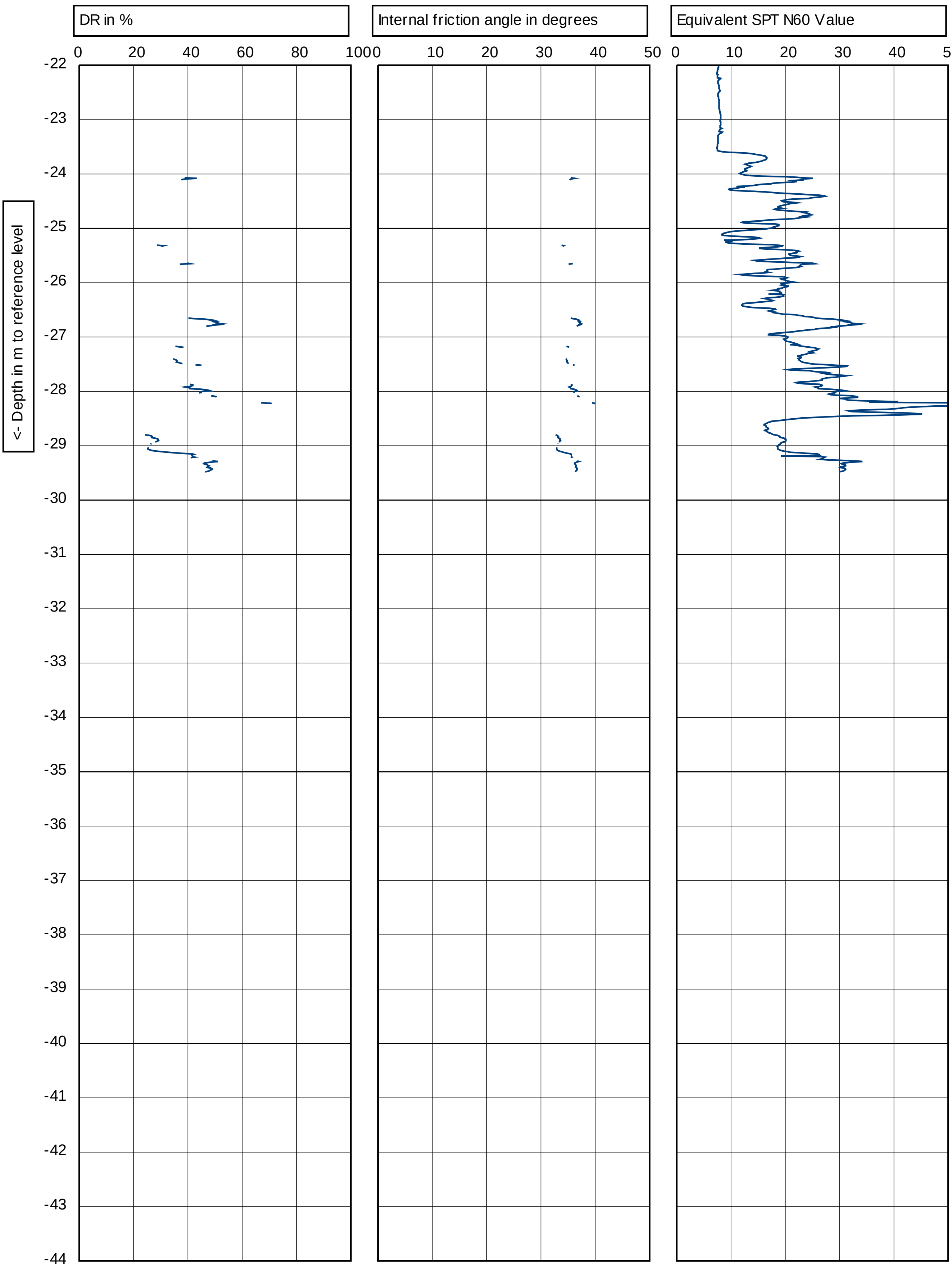
Date: **4/08/2014**

Cone no.: **C10CFIPT.C11306**

Project no.: **338720.00**

CPT no.: **07**

1.40



Refusal (Tonnage)

EOH - Dipped - Collapsed dry @ 5.2m

Graphs on this page are not IANZ accredited

u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012

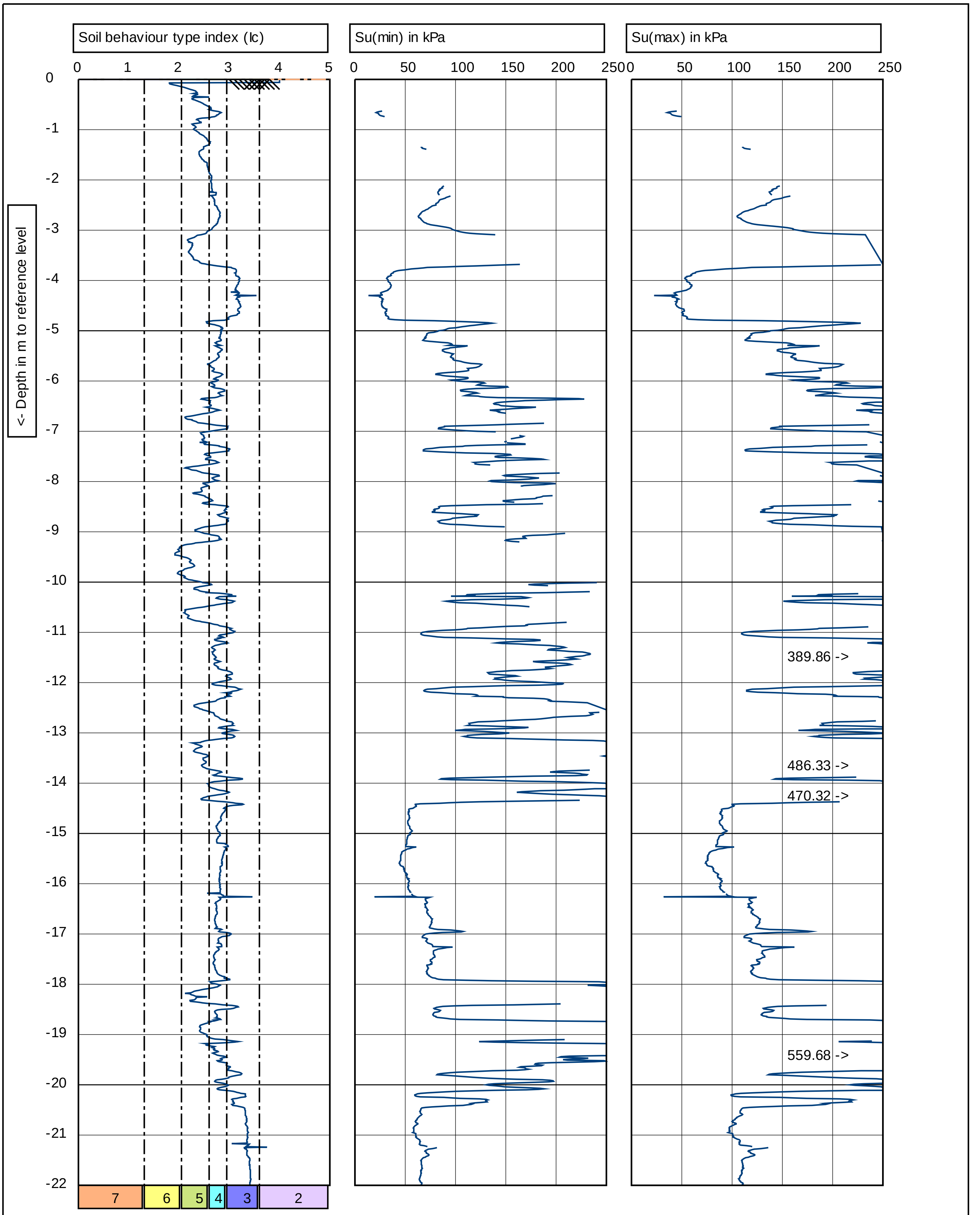
G.L. 0 MSL

W.L.: **-5.2**

Project: **Blue Wallace 1**
Location: **Wayside Rd - Te Kauwhata**
Position: **1788989, 5857537 NZTM**

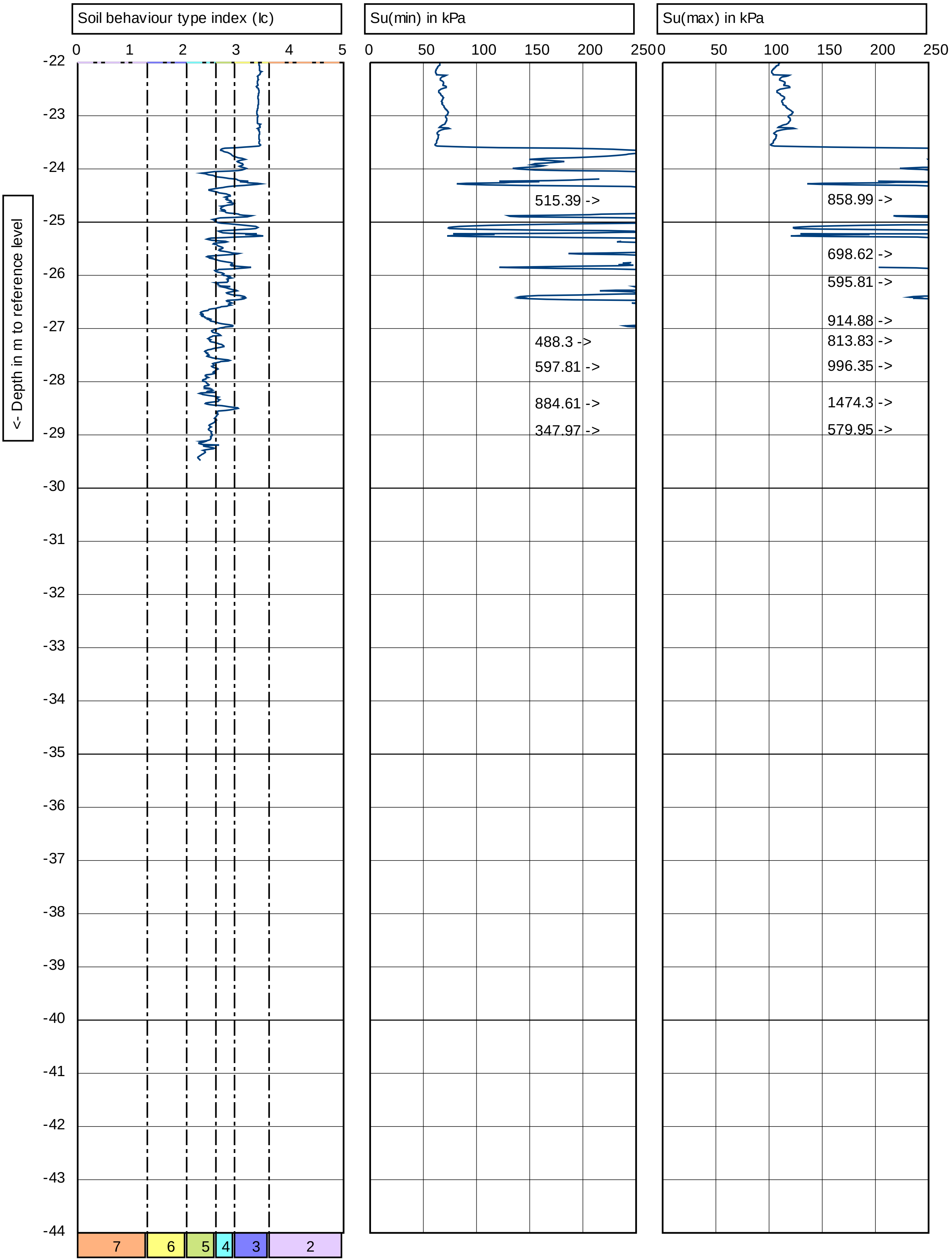
Predrill : **0 m Predrilled**
Date: **4/08/2014**
Cone no.: **C10CFIPT.C11306**
Project no.: **338720.00**
CPT no.: **07**

1.40



OPUS Graphs on this page are not IANZ accredited	u2 150 cm² 10 cm²	Test according ASTM D5778-12 & ISO 22476-1:2012	Predrill : **0 m Predrilled**
		G.L. 0 MSL W.L.: **-5.2**	Date: **4/08/2014**
	Project: **Blue Wallace 1**		Cone no.: **C10CFIPT.C11306**
	Location: **Wayside Rd - Te Kauwhata**		Project no.: **338720.00**
	Position: **1788989, 5857537 NZTM**		CPT no.: **07** **11/12**

1.40



Refusal (Tonnage)

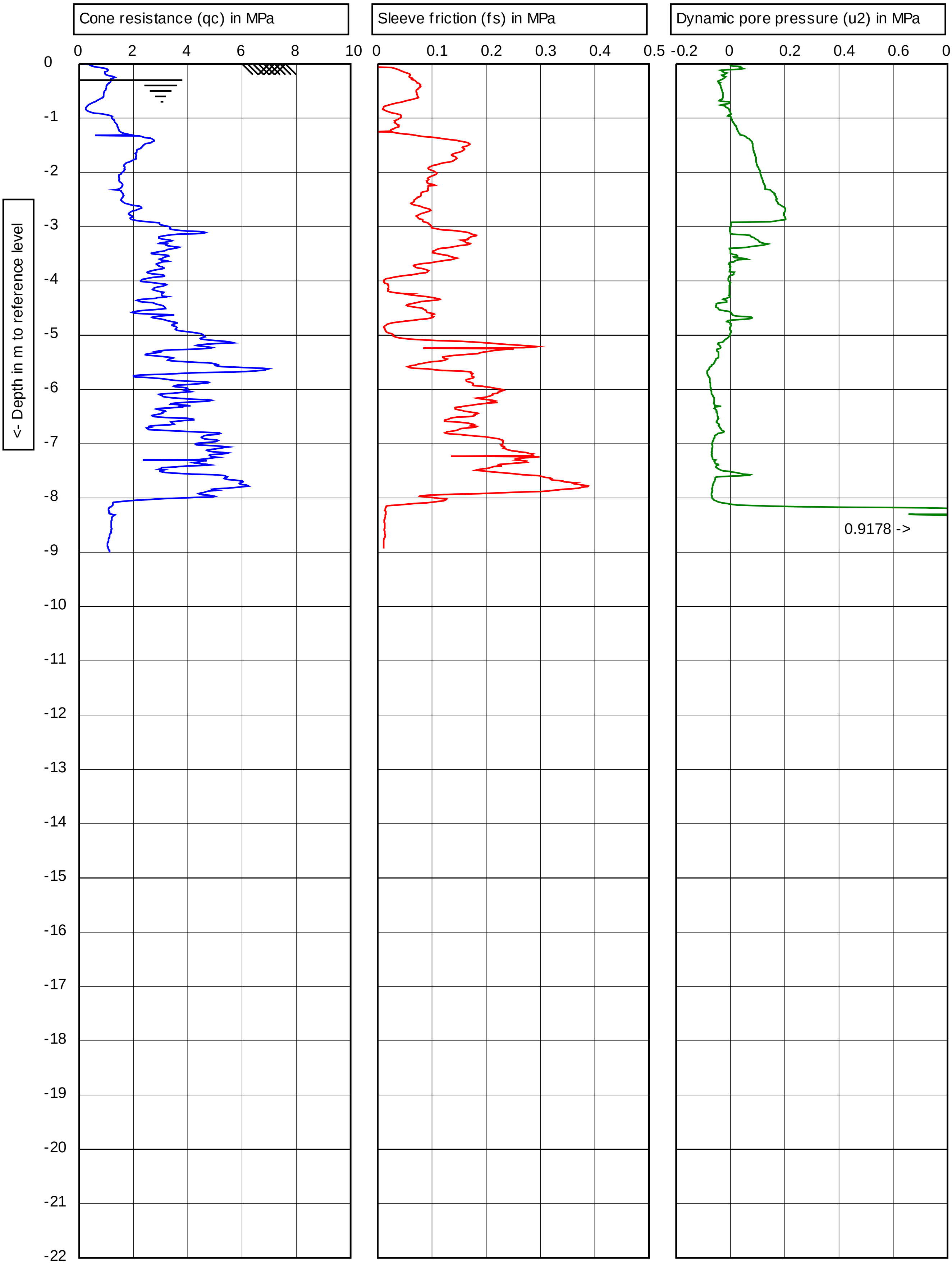
EOH - Dipped - Collapsed dry @ 5.2m

OPUS

Graphs on this page are not IANZ accredited

u2 150 cm² 10 cm²	Test according ASTM D5778-12 & ISO 22476-1:2012	Predrill :	**0 m Predrilled**
	G.L. 0 MSL W.L.: **-5.2**	Date:	**4/08/2014**
Project:	**Blue Wallace 1**	Cone no.:	**C10CFIPT.C11306**
Location:	**Wayside Rd - Te Kauwhata**	Project no.:	**338720.00**
Position:	**1788989, 5857537 NZTM**	CPT no.:	**07**

1.40



Target Depth

EOH - Dipped - GWL @ 0.3m

u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL

W.L.: **-0.3**

Predrill : **0 m Predrilled**

Date: **4/08/2014**

Project: **Blue Wallace 1**
Location: **Wayside Rd - Te Kauwhata**
Position: **1788895, 5857444 NZTM**

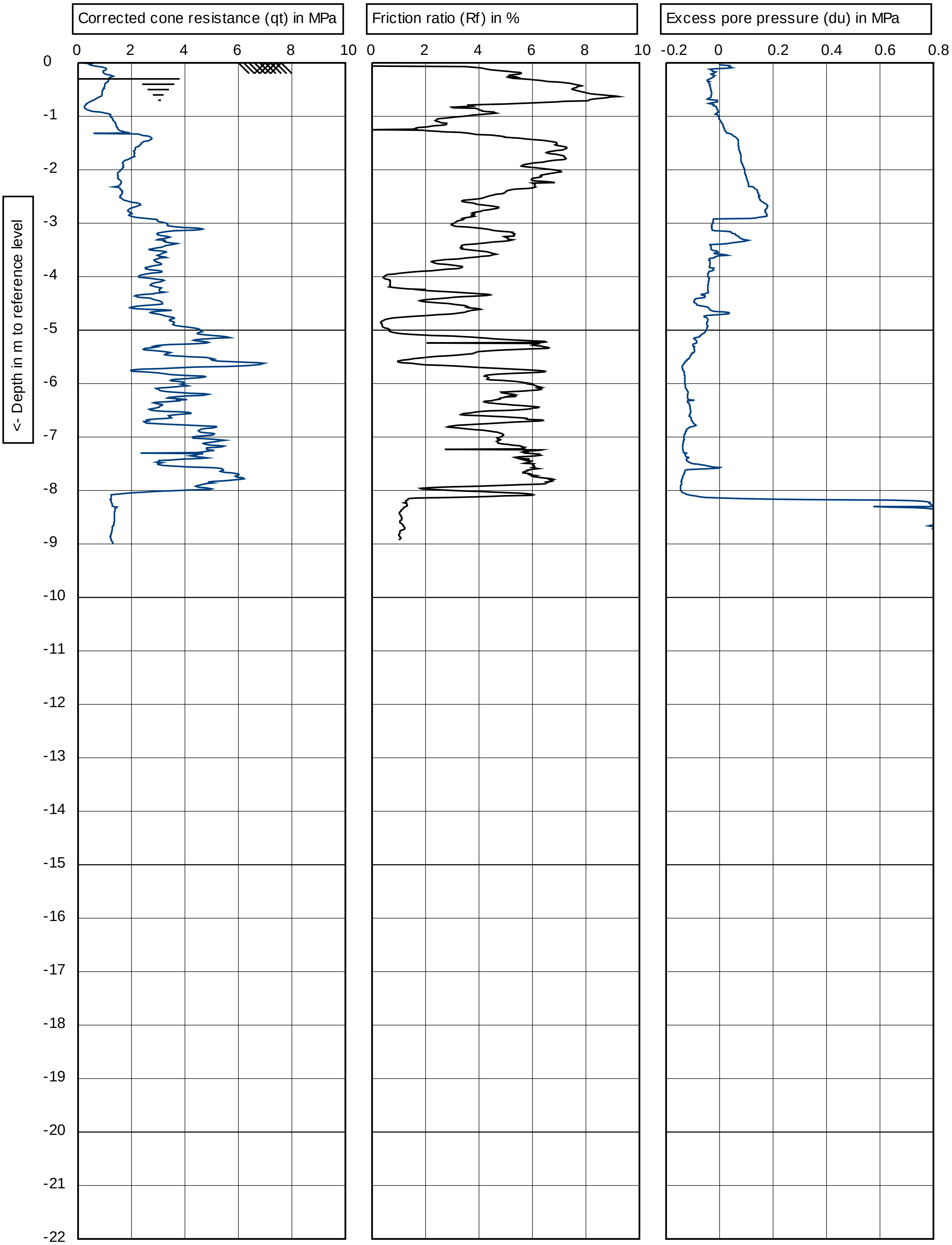
Cone no.: **C10CFIPT.C11306**

Project no.: **338720.00**

CPT no.: **08**

1/6

1.40



Target Depth

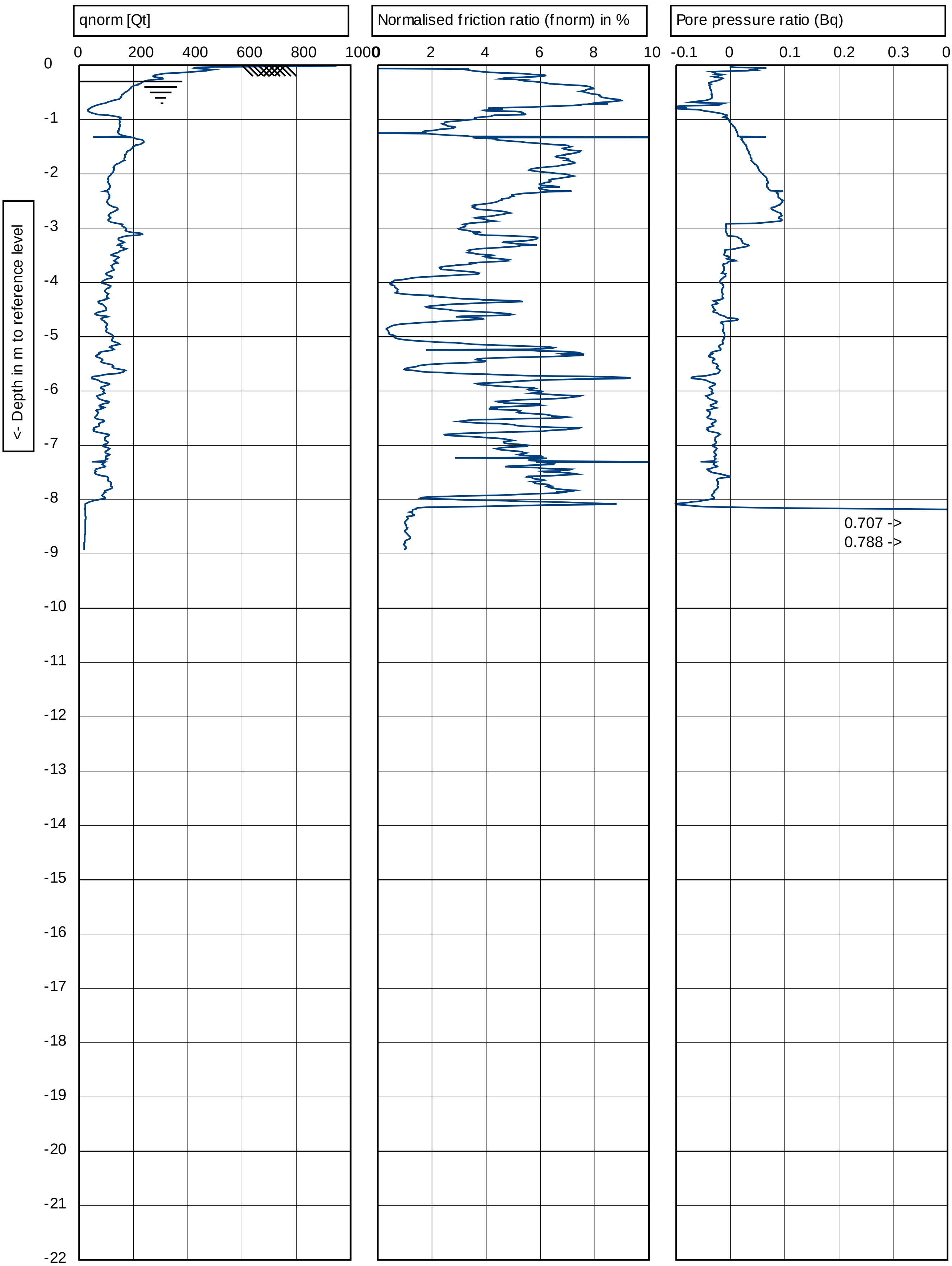
EOH - Dipped - GWL @ 0.3m

Graphs on this page are not IANZ accredited

1.40

u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012		Predrill :	**0 m Predrilled**
G.L. 0 MSL	W.L.: **-0.3**	Date:	**4/08/2014**
Project:	**Blue Wallace 1**	Cone no.:	**C10CFIPT.C11306**
Location:	**Wayside Rd - Te Kauwhata**	Project no.:	**338720.00**
Position:	**1788895, 5857444 NZTM**	CPT no.:	**08** 2/6



Target Depth

EOH - Dipped - GWL @ 0.3m

OPUS

Graphs on this page are not IANZ accredited

u2
150 cm²
10 cm²

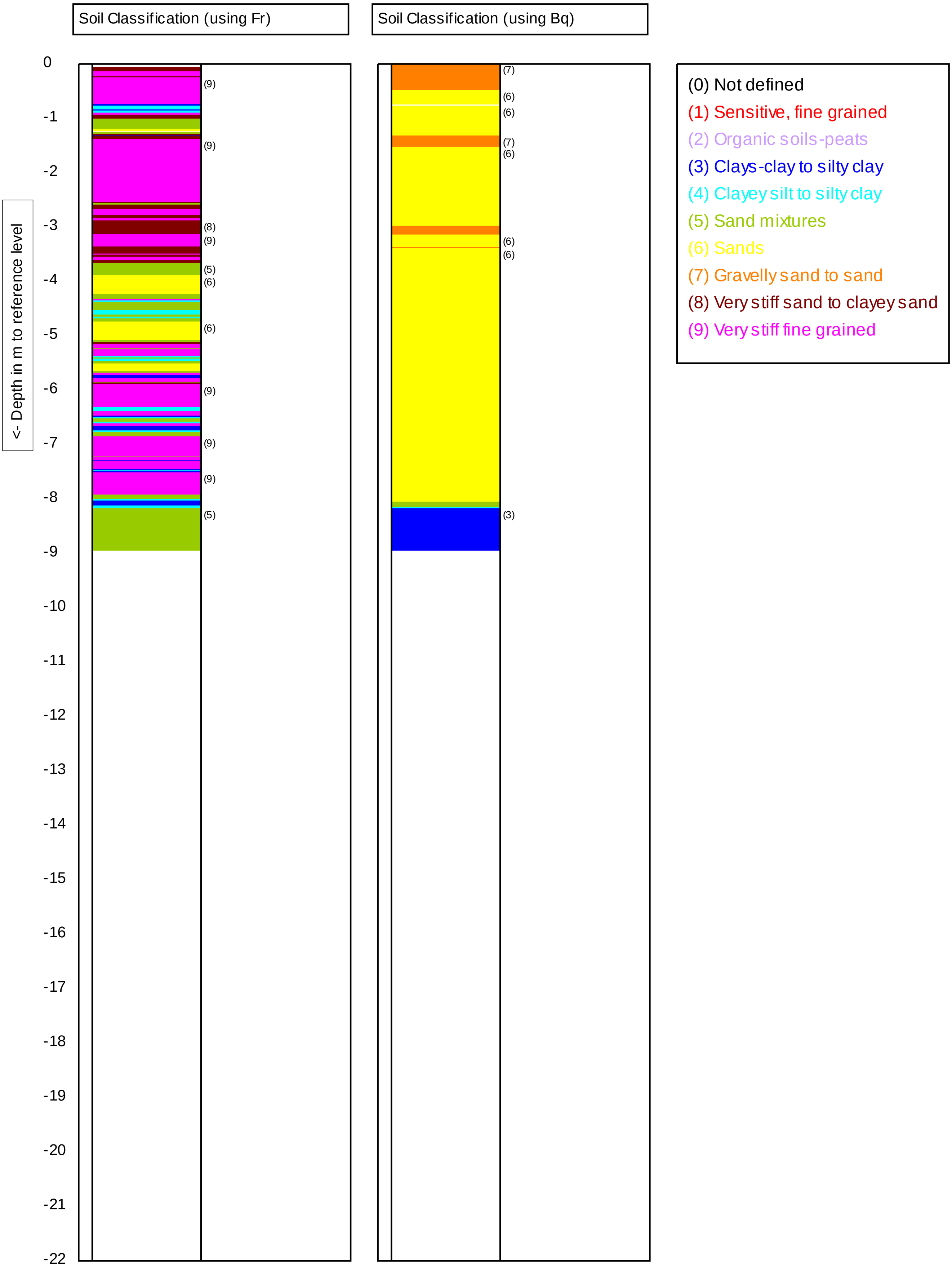
Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL

W.L.: **-0.3**

Project: **Blue Wallace 1**
Location: **Wayside Rd - Te Kauwhata**
Position: **1788895, 5857444 NZTM**

Predrill :	**0 m Predrilled**
Date:	**4/08/2014**
Cone no.:	**C10CFIPT.C11306**
Project no.:	**338720.00**
CPT no.:	**08**

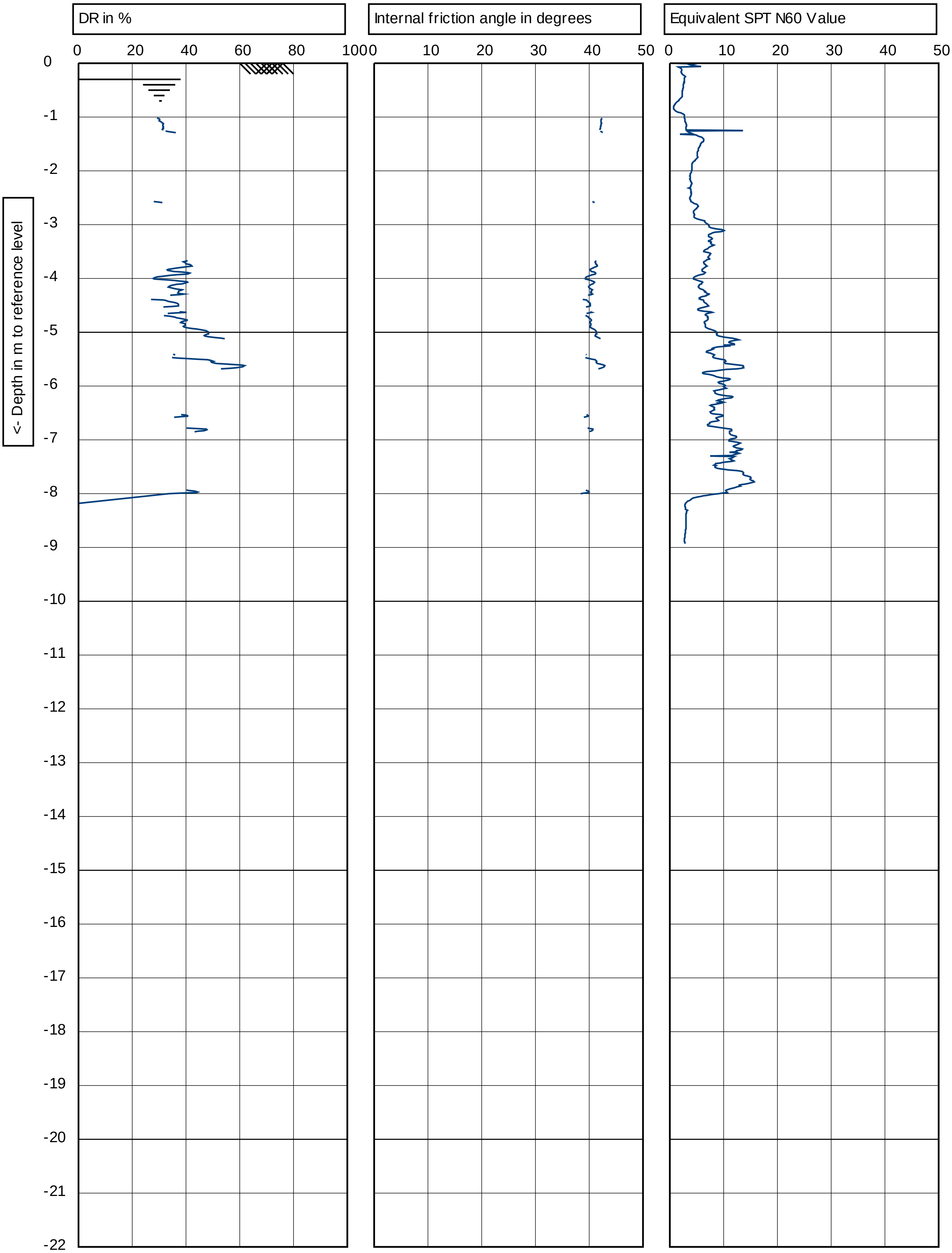


Graphs on this page are not IANZ accredited

u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012		Predrill :	**0 m Predrilled**
G.L. 0 MSL	W.L.: **-0.3**	Date:	**4/08/2014**
Project:	**Blue Wallace 1**	Cone no.:	**C10CFIPT.C11306**
Location:	**Wayside Rd - Te Kauwhata**	Project no.:	**338720.00**
Position:	**1788895, 5857444 NZTM**	CPT no.:	**08** **4/6**

1.40



Target Depth

EOH - Dipped - GWL @ 0.3m

OPUS

Graphs on this page are not IANZ accredited

u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL

W.L.: **-0.3**

Project: **Blue Wallace 1**

Location: **Wayside Rd - Te Kauwhata**

Position: **1788895, 5857444 NZTM**

Predrill : **0 m Predrilled**

Date: **4/08/2014**

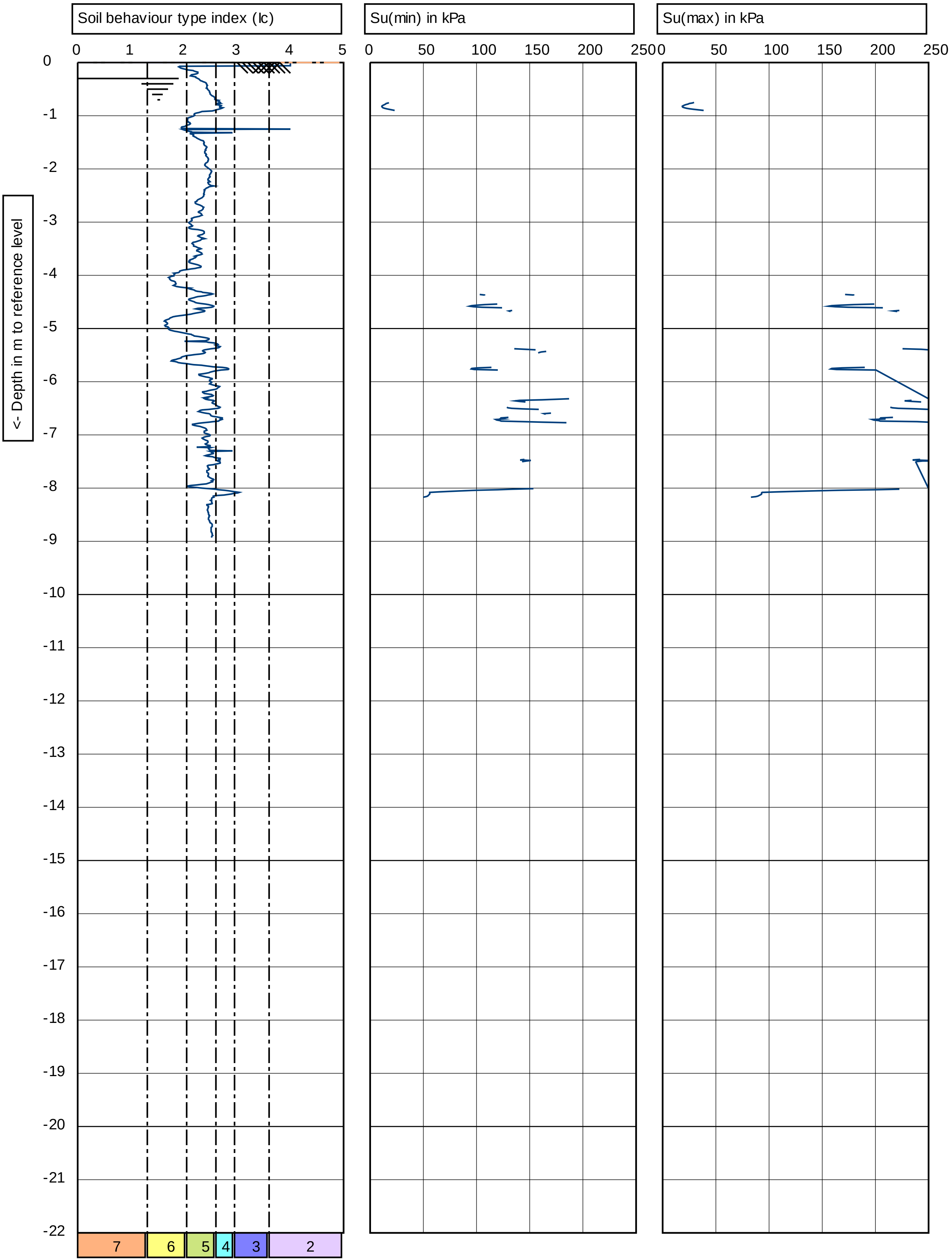
Cone no.: **C10CFIPT.C11306**

Project no.: **338720.00**

CPT no.: **08**

5/6

1.40



Target Depth

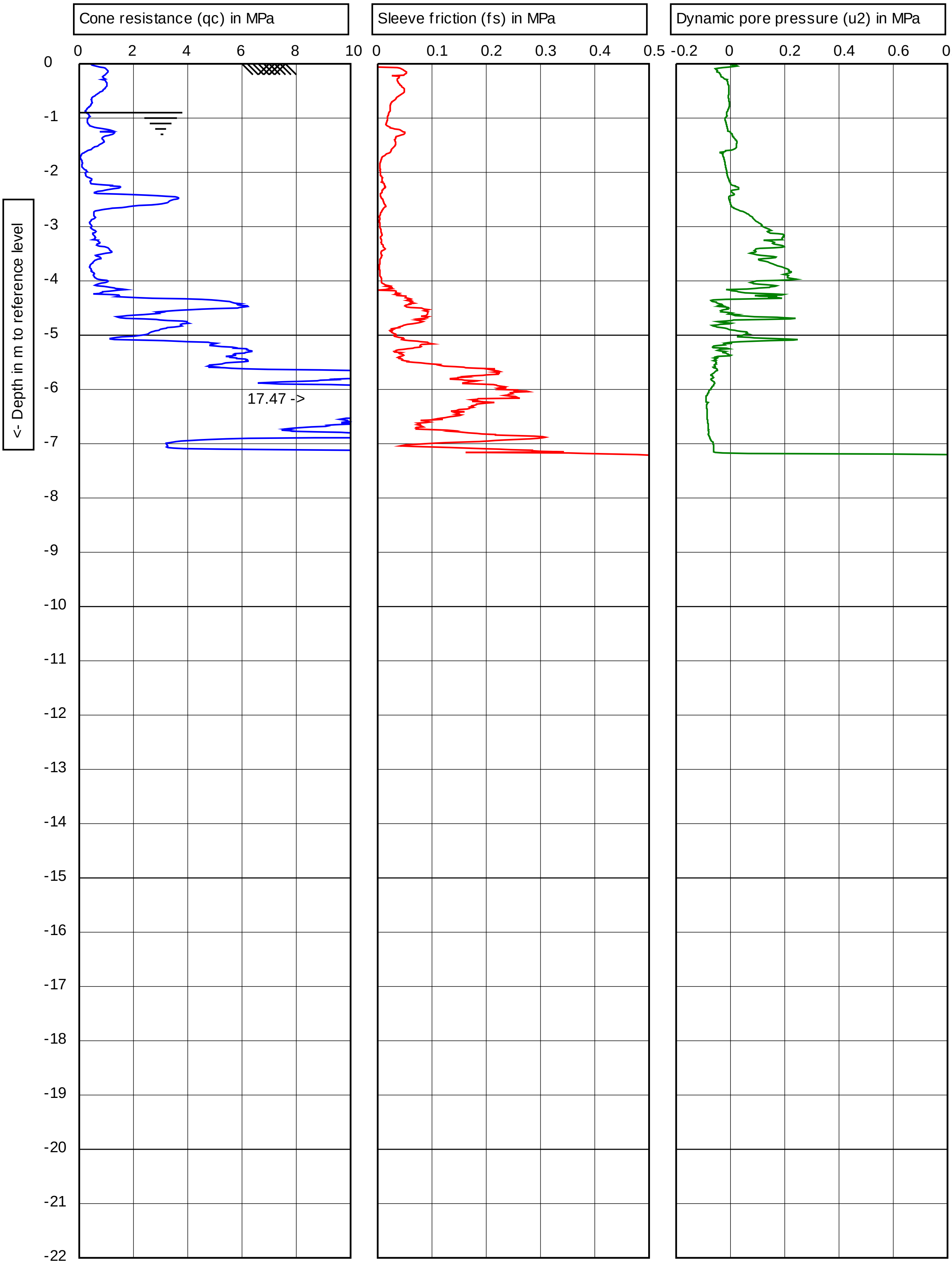
EOH - Dipped - GWL @ 0.3m

Graphs on this page are not IANZ accredited

u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012		Predrill :	**0 m Predrilled**
G.L. 0 MSL	W.L.: **-0.3**	Date:	**4/08/2014**
Project:	**Blue Wallace 1**	Cone no.:	**C10CFIPT.C11306**
Location:	**Wayside Rd - Te Kauwhata**	Project no.:	**338720.00**
Position:	**1788895, 5857444 NZTM**	CPT no.:	**08** **6/6**

1.40



Refusal (qc / tonnage)

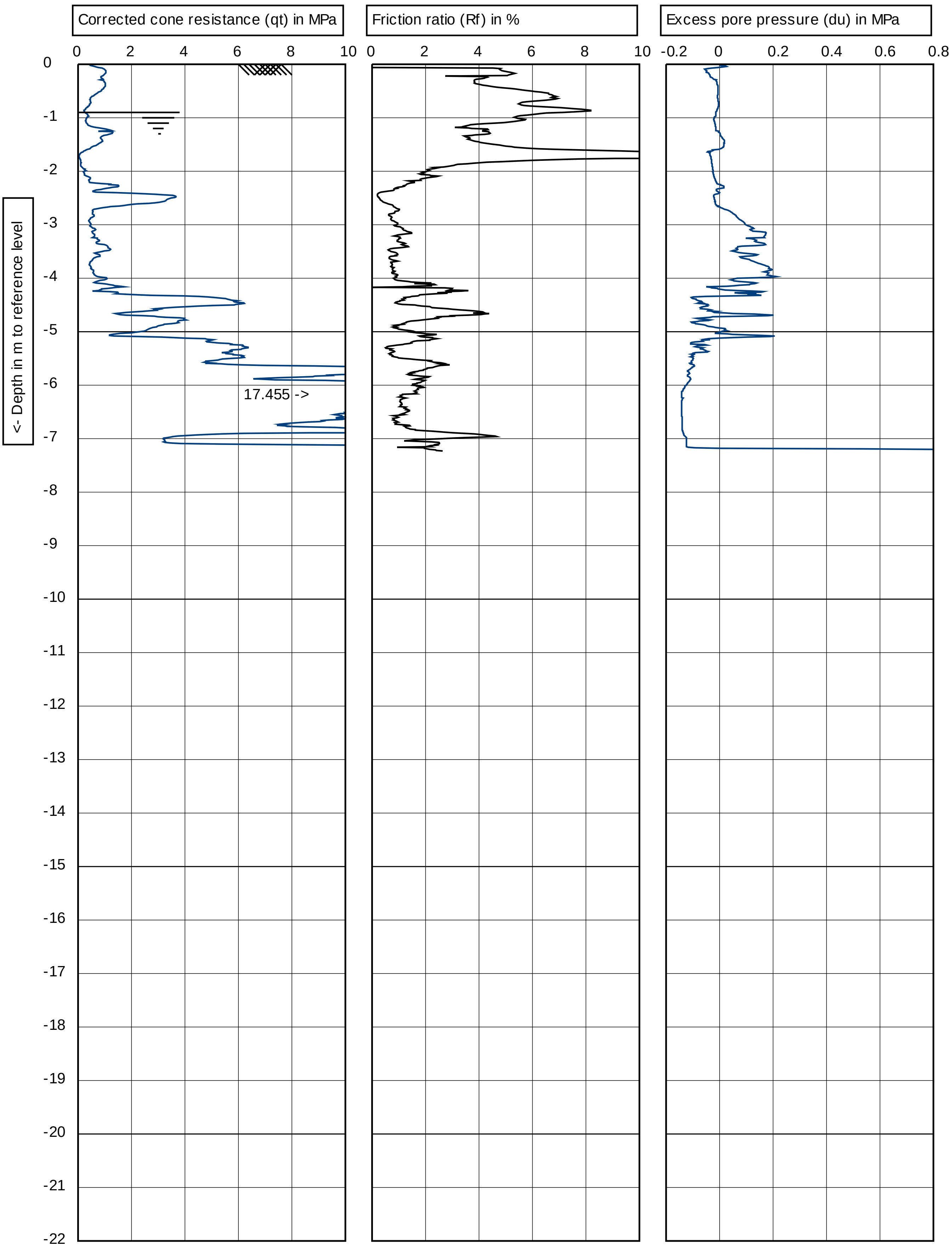
EOH - Dipped - GWL @ 0.9m

Test according ASTM D5778-12 & ISO 22476-1:2012		Predrill :	**0 m Predrilled**
G.L. 0 MSL	W.L.: **-0.9**	Date:	**4/08/2014**

Project: **Blue Wallace 1**
Location: **Wayside Rd - Te Kauwhata**
Position: **1788531, 5857363 NZTM**

Cone no.: **C10CFIPT.C11306**
Project no.: **338720.00**
CPT no.: **09** **1/6**

1.40



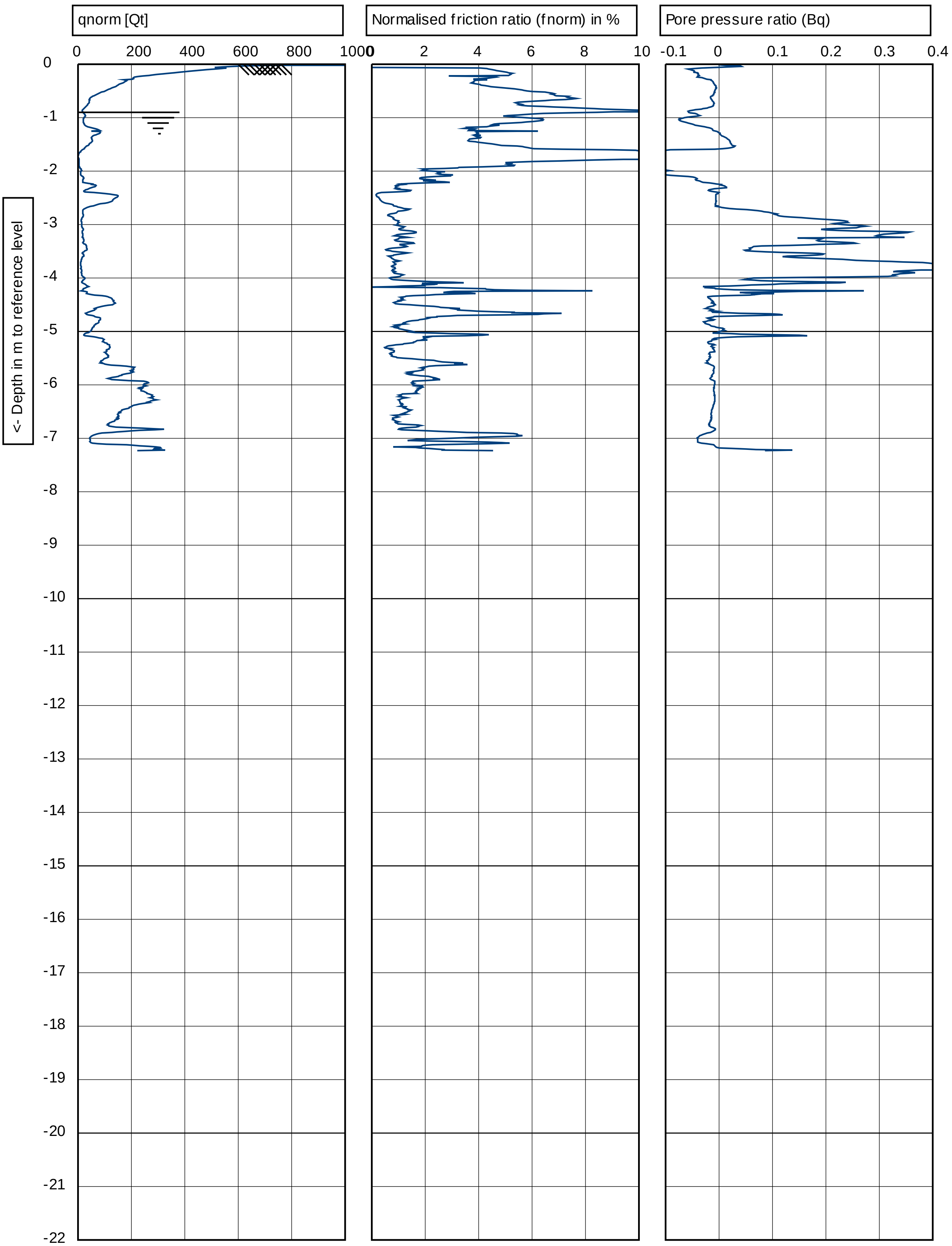
Refusal (qc / tonnage)

EOH - Dipped - GWL @ 0.9m

u2 150 cm² 10 cm²	Test according ASTM D5778-12 & ISO 22476-1:2012		Predrill :	**0 m Predrilled**
	G.L. 0 MSL	W.L.: **-0.9**	Date:	**4/08/2014**
Project:	**Blue Wallace 1**		Cone no.:	**C10CFIPT.C11306**
Location:	**Wayside Rd - Te Kauwhata**		Project no.:	**338720.00**
Position:	**1788531, 5857363 NZTM**		CPT no.:	**09** **2/6**

Graphs on this page are not IANZ accredited

1.40

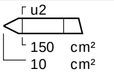


Refusal (qc / tonnage)

EOH - Dipped - GWL @ 0.9m

Graphs on this page are not IANZ accredited

1.40



Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL

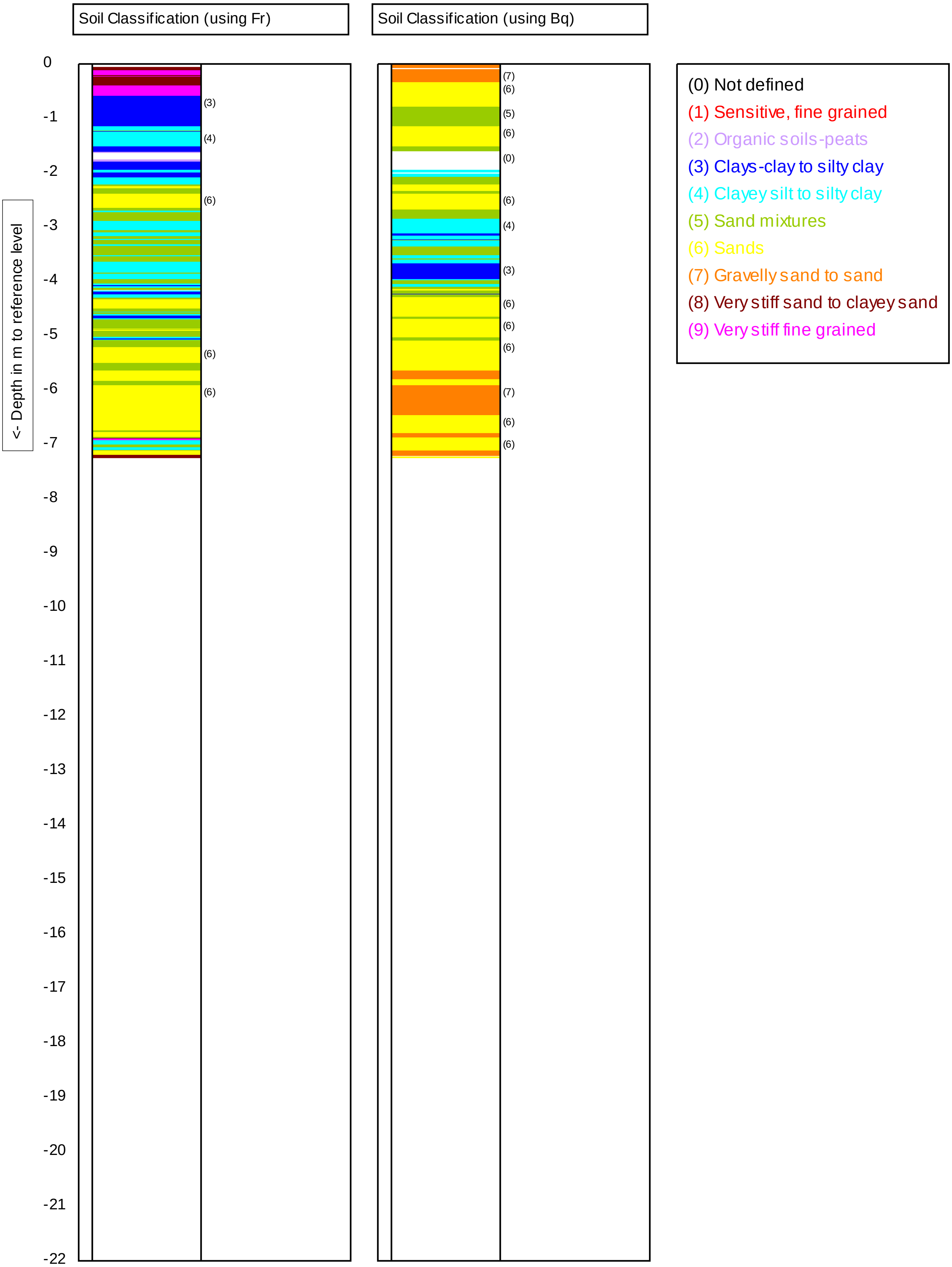
W.L.: **-0.9**

Project: **Blue Wallace 1**

Location: **Wayside Rd - Te Kauwhata**

Position: **1788531, 5857363 NZTM**

Predrill :	**0 m Predrilled**
Date:	**4/08/2014**
Cone no.:	**C10CFIPT.C11306**
Project no.:	**338720.00**
CPT no.:	**09**



OPUS

Graphs on this page are not IANZ accredited

1.40

u2
150 cm²
10 cm²

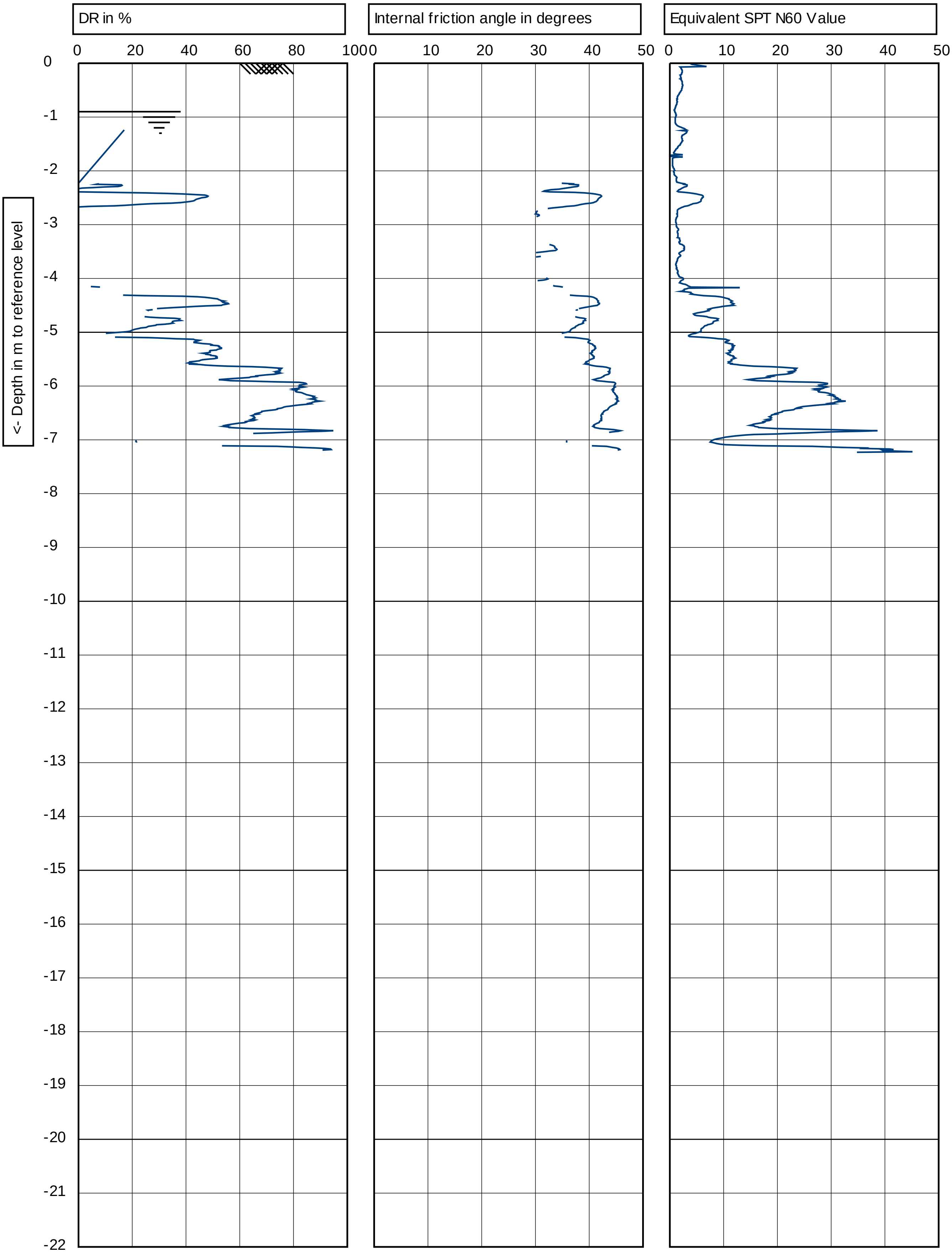
Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL

W.L.: **-0.9**

Project: **Blue Wallace 1**
Location: **Wayside Rd - Te Kauwhata**
Position: **1788531, 5857363 NZTM**

Predrill : **0 m Predrilled**
Date: **4/08/2014**
Cone no.: **C10CFIPT.C11306**
Project no.: **338720.00**
CPT no.: **09**



Refusal (qc / tonnage)

EOH - Dipped - GWL @ 0.9m

OPUS

Graphs on this page are not IANZ accredited

1.40

u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL

W.L.: **-0.9**

Project: **Blue Wallace 1**

Location: **Wayside Rd - Te Kauwhata**

Position: **1788531, 5857363 NZTM**

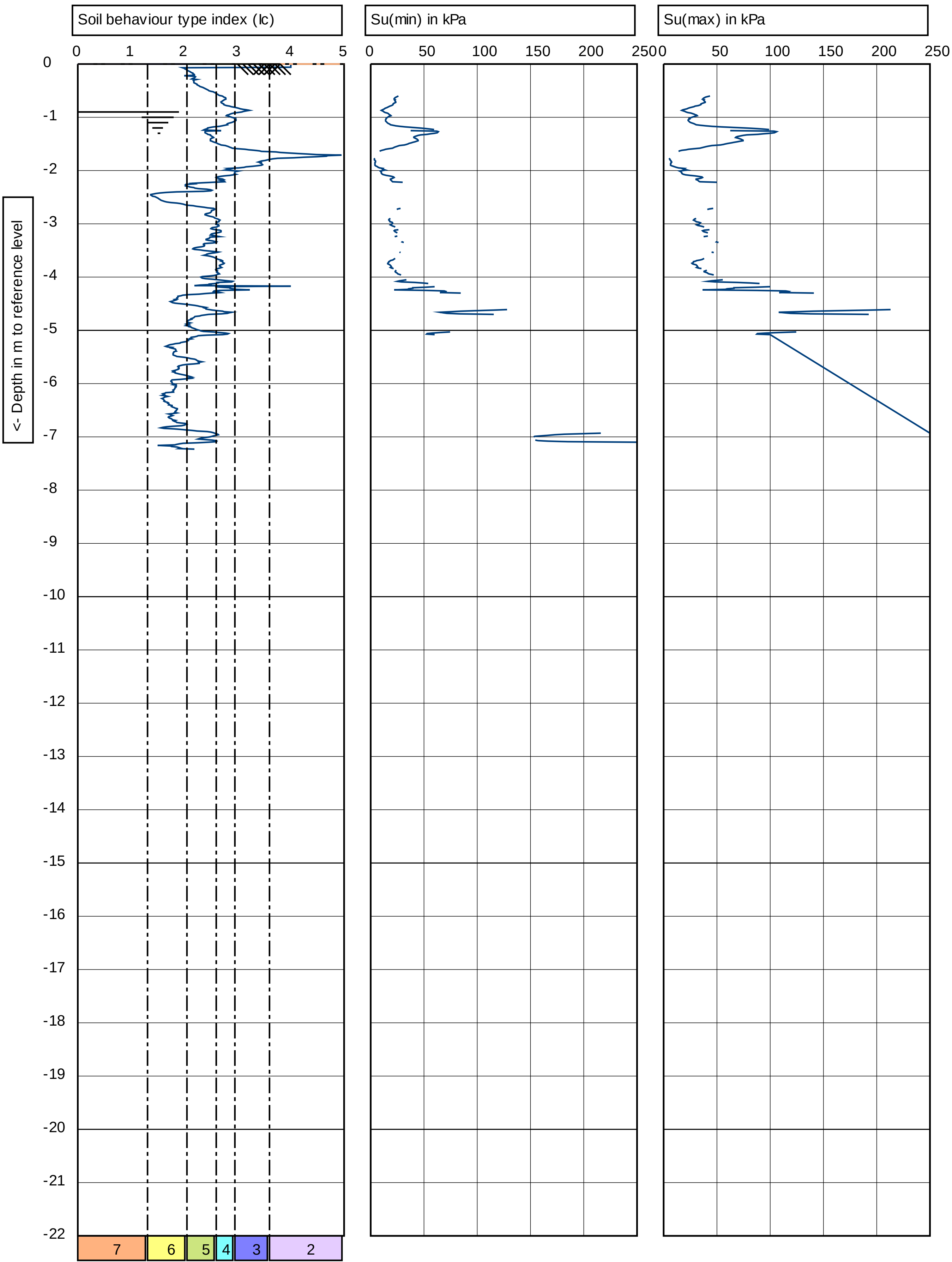
Predrill : **0 m Predrilled**

Date: **4/08/2014**

Cone no.: **C10CFIPT.C11306**

Project no.: **338720.00**

CPT no.: **09**



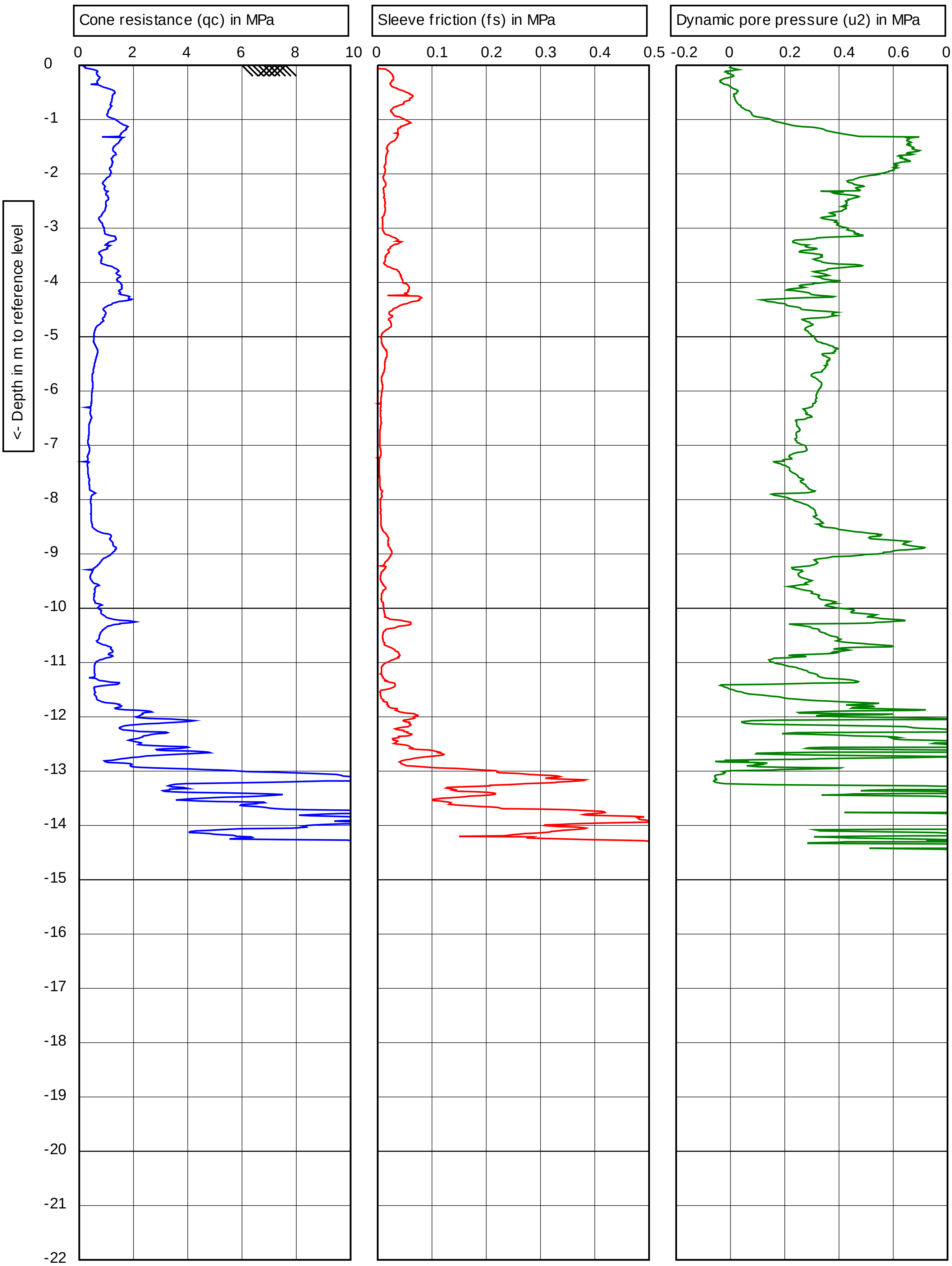
Refusal (qc / tonnage)

EOH - Dipped - GWL @ 0.9m

u2 150 cm² 10 cm²	Test according ASTM D5778-12 & ISO 22476-1:2012	Predrill :	**0 m Predrilled**
	G.L. 0 MSL W.L.: **-0.9**	Date:	**4/08/2014**
Project:	**Blue Wallace 1**	Cone no.:	**C10CFIPT.C11306**
Location:	**Wayside Rd - Te Kauwhata**	Project no.:	**338720.00**
Position:	**1788531, 5857363 NZTM**	CPT no.:	**09** 6/6

Graphs on this page are not IANZ accredited

1.40



Refusal (qc / tonnage)

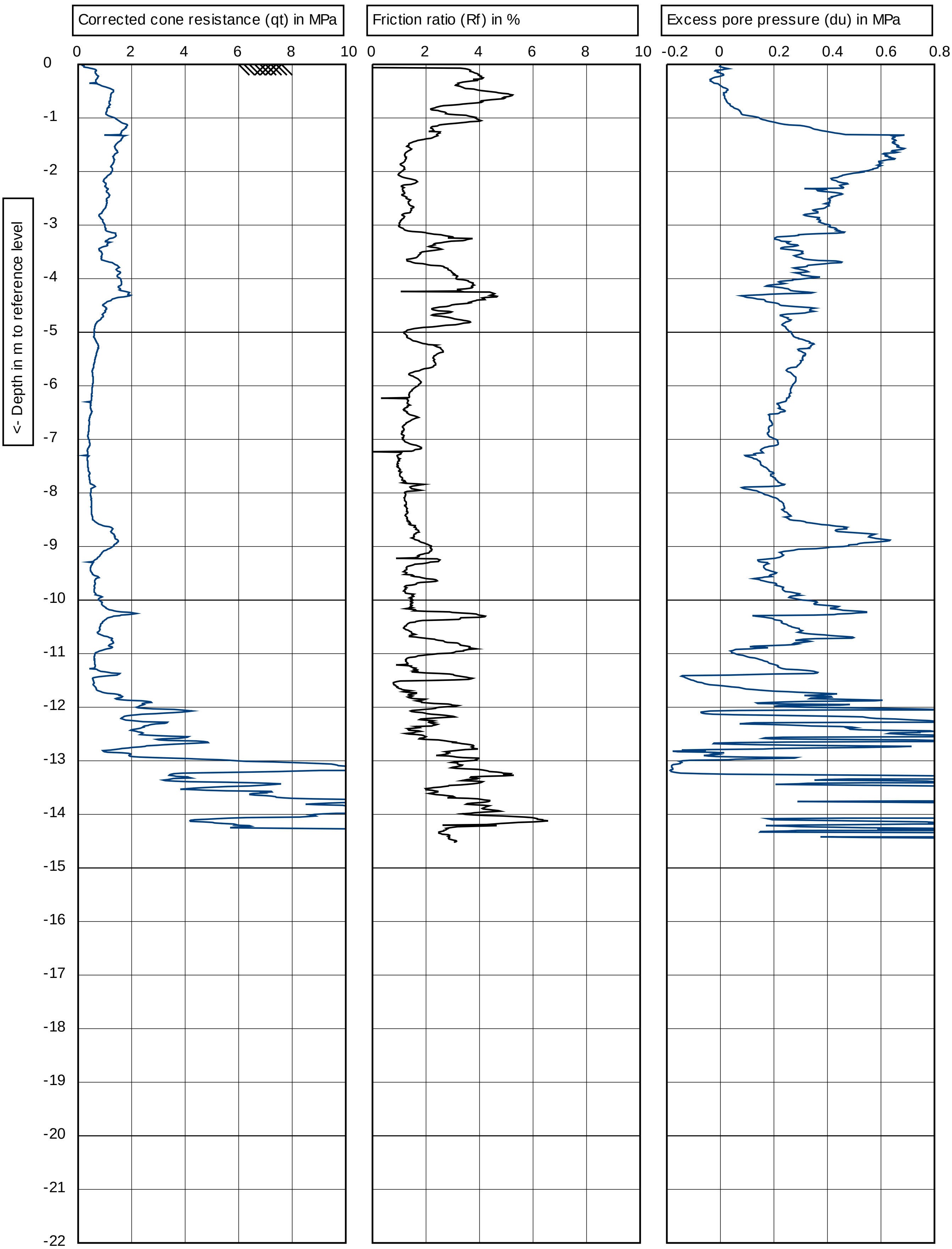
EOH - Dipped - Collapsed dry @ 0.6m

u2 150 cm² 10 cm²	Test according ASTM D5778-12 & ISO 22476-1:2012		Predrill :	**0 m Predrilled**
	G.L. 0 MSL	W.L.: **-0.6**	Date:	**4/08/2014**

Project: **Blue Wallace 1**
Location: **Wayside Rd - Te Kauwhata**
Position: **1788448, 5857346 NZTM**

Cone no.:	**C10CFIPT.C11306**
Project no.:	**338720.00**
CPT no.:	**10**

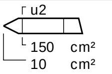
1.40



Refusal (qc / tonnage)

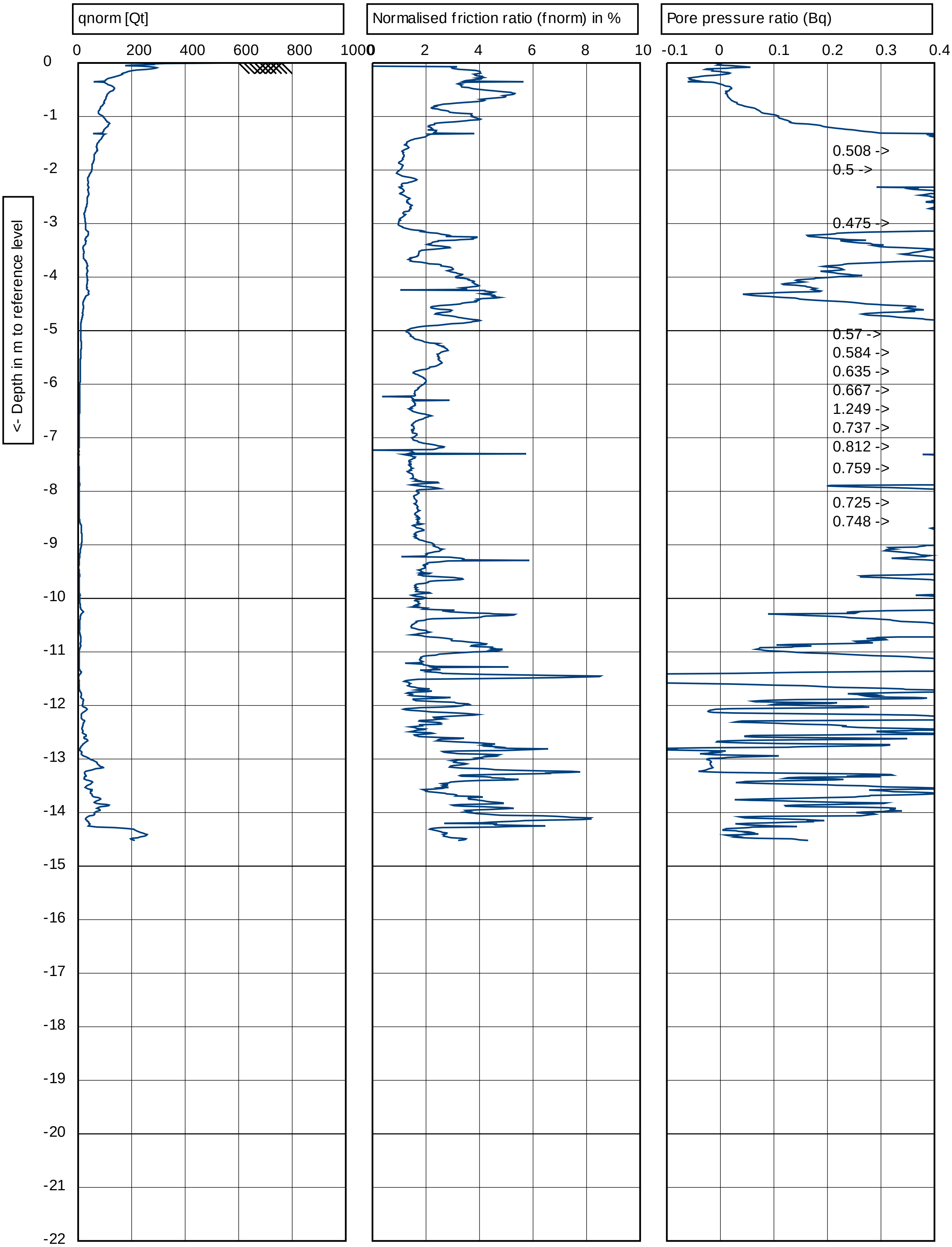
EOH - Dipped - Collapsed dry @ 0.6m

Graphs on this page are not IANZ accredited



Test according ASTM D5778-12 & ISO 22476-1:2012		Predrill :	**0 m Predrilled**
G.L. 0 MSL	W.L.: **-0.6**	Date:	**4/08/2014**
Project: **Blue Wallace 1**		Cone no.:	**C10CFIPT.C11306**
Location: **Wayside Rd - Te Kauwhata**		Project no.:	**338720.00**
Position: **1788448, 5857346 NZTM**		CPT no.:	**10** 2/6

1.40



Refusal (qc / tonnage)

EOH - Dipped - Collapsed dry @ 0.6m

OPUS

Graphs on this page are not IANZ accredited

1.40

u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012

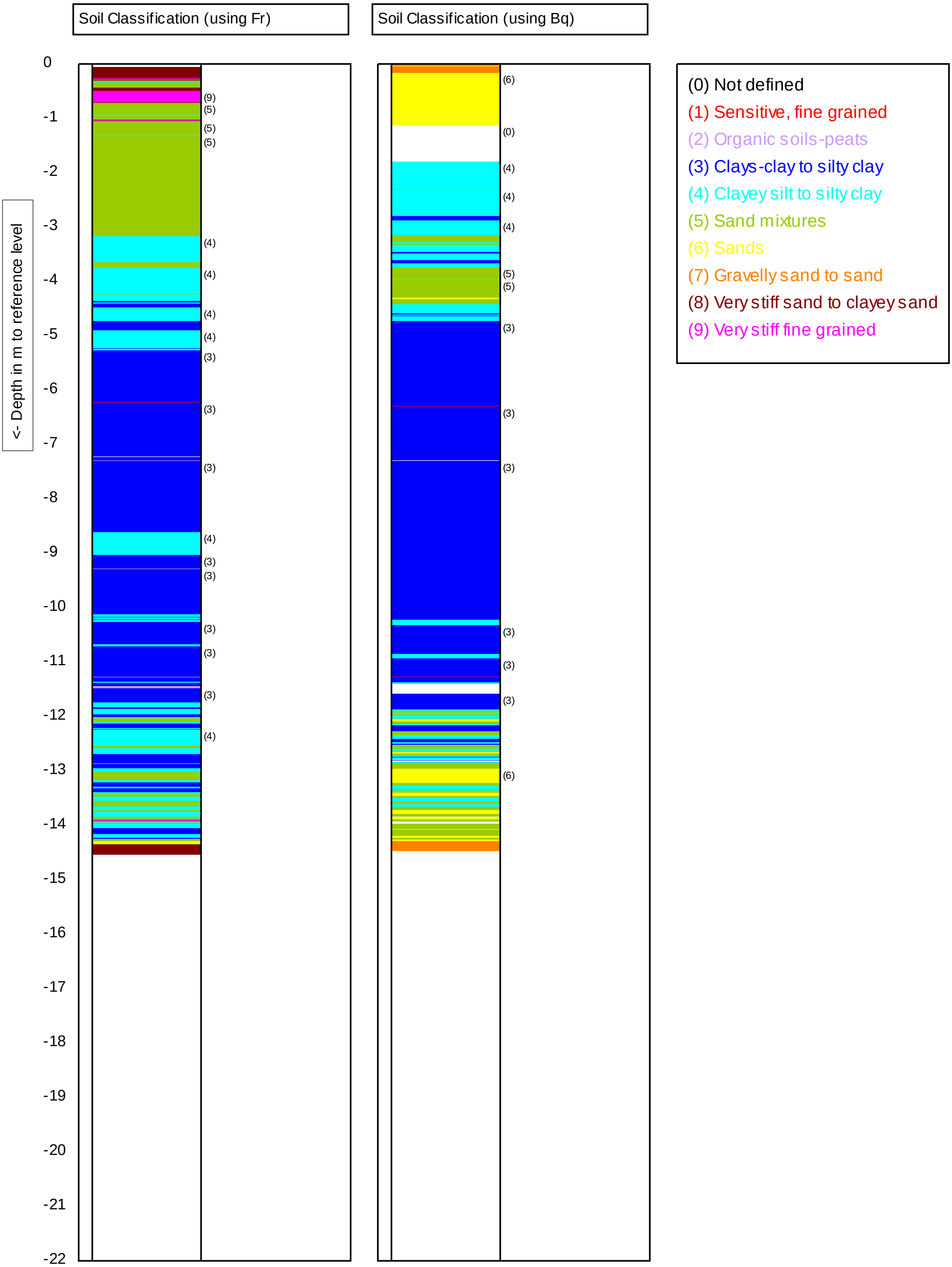
G.L. 0 MSL

W.L.: **-0.6**

Project: **Blue Wallace 1**
Location: **Wayside Rd - Te Kauwhata**
Position: **1788448, 5857346 NZTM**

Predrill :	**0 m Predrilled**
Date:	**4/08/2014**
Cone no.:	**C10CFIPT.C11306**
Project no.:	**338720.00**
CPT no.:	**10**

3/6

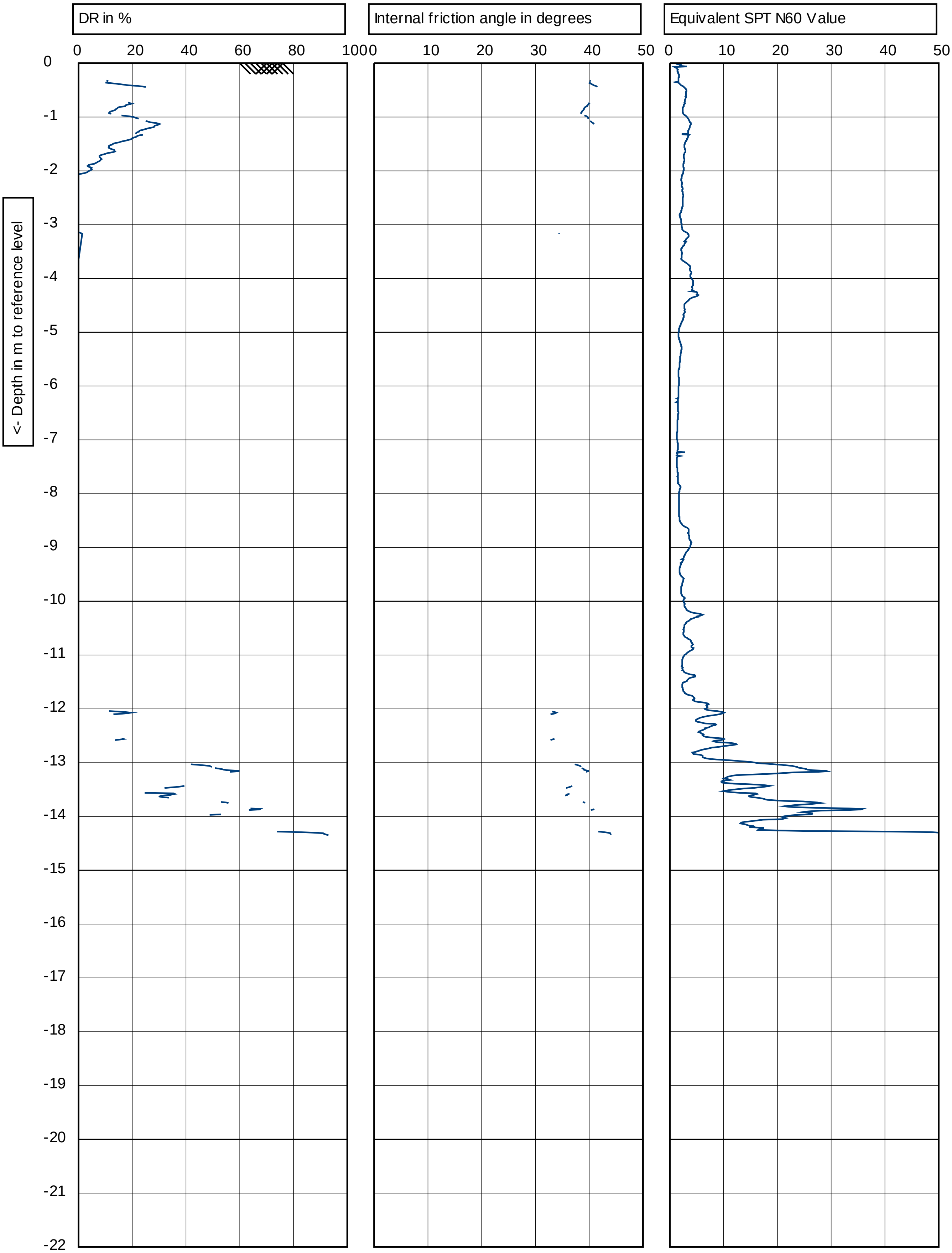


1.40

OPUS

Graphs on this page are not IANZ accredited

u2 150 cm² 10 cm²	Test according ASTM D5778-12 & ISO 22476-1:2012		Predrill :	**0 m Predrilled**
	G.L. 0 MSL	W.L.: **-0.6**	Date:	**4/08/2014**
Project:	**Blue Wallace 1**		Cone no.:	**C10CFIPT.C11306**
Location:	**Wayside Rd - Te Kauwhata**		Project no.:	**338720.00**
Position:	**1788448, 5857346 NZTM**		CPT no.:	**10** **4/6**



Refusal (qc / tonnage)

EOH - Dipped - Collapsed dry @ 0.6m

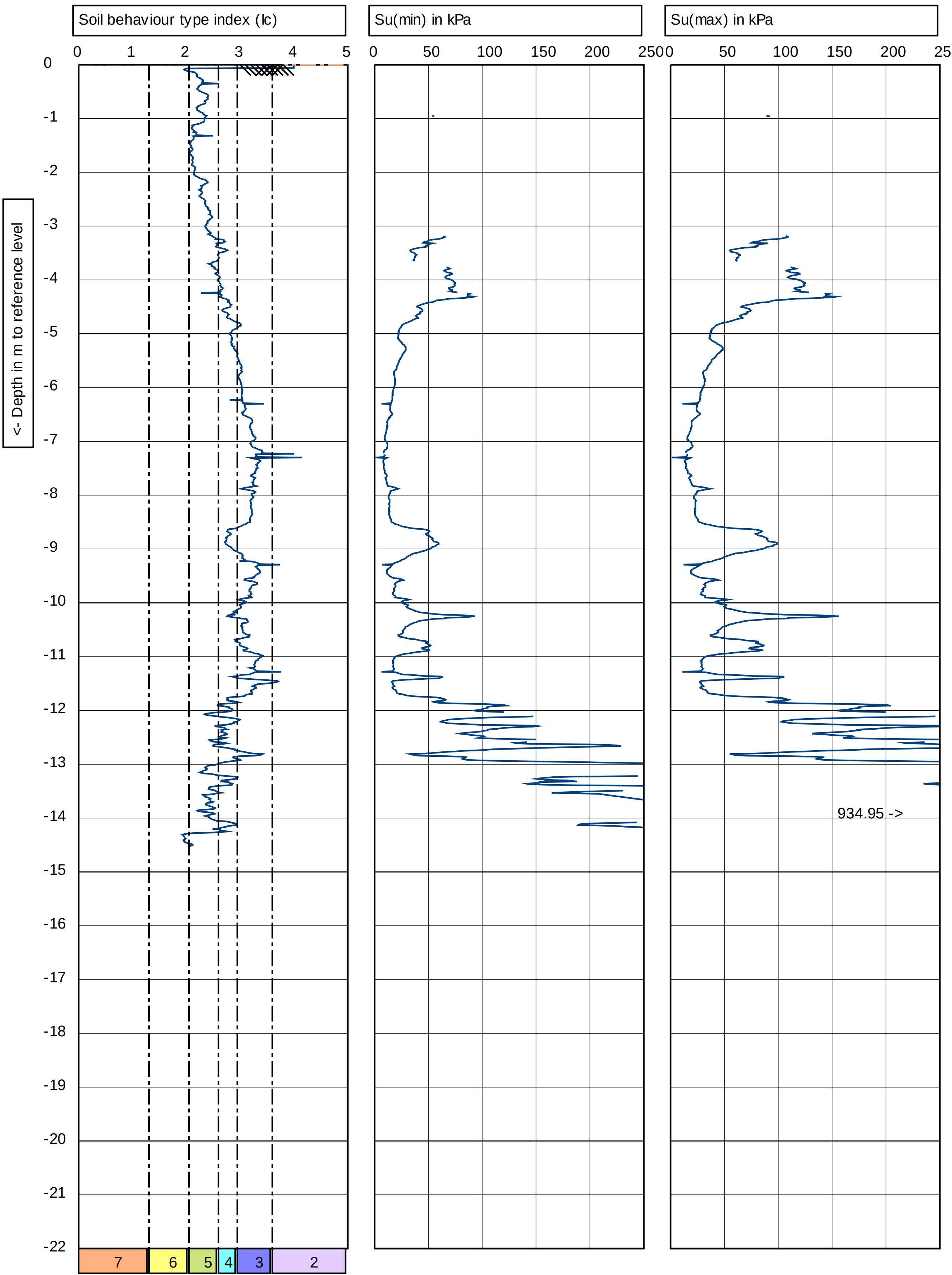
OPUS

Graphs on this page are not IANZ accredited

u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012		Predrill :	**0 m Predrilled**
G.L. 0 MSL	W.L.: **-0.6**	Date:	**4/08/2014**
Project: **Blue Wallace 1**		Cone no.:	**C10CFIPT.C11306**
Location: **Wayside Rd - Te Kauwhata**		Project no.:	**338720.00**
Position: **1788448, 5857346 NZTM**		CPT no.:	**10** 5/6

1.40



Refusal (qc / tonnage)

EOH - Dipped - Collapsed dry @ 0.6m

OPUS

Graphs on this page are not IANZ accredited

1.40

u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012

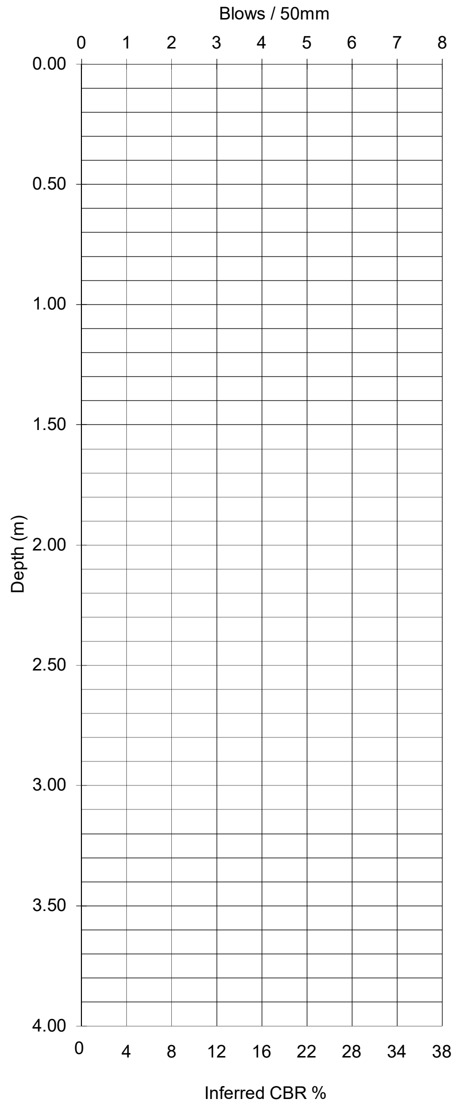
G.L. 0 MSL	W.L.: **-0.6**	Predrill :	**0 m Predrilled**
		Date:	**4/08/2014**
Project:	**Blue Wallace 1**	Cone no.:	**C10CFIPT.C11306**
Location:	**Wayside Rd - Te Kauwhata**	Project no.:	**338720.00**
Position:	**1788448, 5857346 NZTM**	CPT no.:	**10**

AUGER / SCALA PENETROMETER
TEST REPORT

Project : **Wayside Road, Te Kauwhata**
Location : **Wayside Road, Te Kauwhata**
Client : **Blue Wallace Surveyors Ltd**
Contractor : **-**
Test number : **HA1**
Shear vane number : **-**
Shear vane correction : **-**
Water level (m): **1**
Reduced level (m):

Project No : **3-38720.0**
Lab Ref No : **-**
Client Ref No : **-**

Scala Penetrometer



Test Results

Depth (m)	Shear Strength (kPa)	Soil Description
		TOPSOIL. Silty organic CLAY; dark brown; very soft to soft; moist; highly plastic.
0.40		Silty CLAY; Brown; soft; moist; highly plastic.
0.70		Silty CLAY some sand; greyish brown; very soft to soft; moist highly plastic Sand is fine to coarse of pumice and charcoal.
1.60		Clayey SILT some sand; yellowish light brown mottled light grey; firm; moist highly plastic. Sand is fine and grey from weathering.
2.30		Becoming light grey mottled brown
3.60		End of Hole

Test Methods

Determination of Penetration Resistance of a Soil, NZS 4402 : 1988, Test 6.5.2
Shear Strength using a Hand Held Shear Vane: NZ Geotechnical Soc Inc 8/2001
Inferred CBR values taken from Austroads Pavement Design Manual 2004

Field Descriptions of Soils and Rocks by
NZ Geotechnical Society Dec 2005

Date tested :
Date reported : 15/08/14

This report may only be reproduced in full

Approved

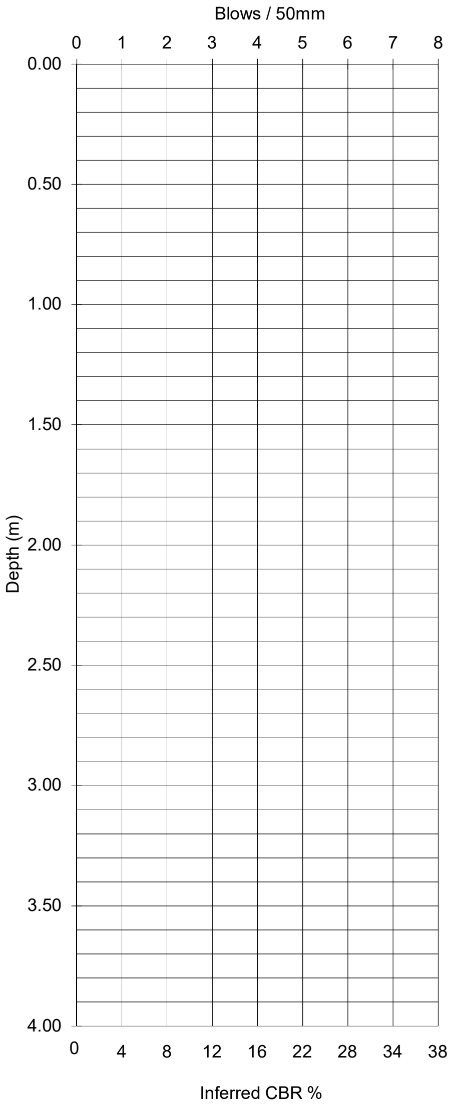
Designation : *Laboratory Manager*
Date : 15/08/14

AUGER / SCALA PENETROMETER
TEST REPORT

Project :	**Wayside Road, Te Kauwhata**
Location :	**Wayside Road, Te Kauwhata**
Client :	**Blue Wallace Surveyors Ltd**
Contractor :	**-**
Test number :	**HA2**
Shear vane number :	**-**
Shear vane correction :	**-**
Water level (m):	**Dry**
Reduced level (m):	

Project No :	**3-38720.0**
Lab Ref No :	**-**
Client Ref No :	**-**

Scala Penetrometer



Test Results

Depth (m)	Shear Strength (kPa)	Soil Description
		TOPSOIL. Silty CLAY; dark brown; firm to stiff; dry to moist; highly plastic.
0.10		Silty CLAY; Brownish orange; firm to stiff; moist; highly plastic
2.00		End of Hole

Test Methods	
Determination of Penetration Resistance of a Soil, NZS 4402 : 1988, Test 6.5.2	Field Descriptions of Soils and Rocks by
Shear Strength using a Hand Held Shear Vane: NZ Geotechnical Soc Inc 8/2001	NZ Geotechnical Society Dec 2005
Inferred CBR values taken from Austroads Pavement Design Manual 2004	

Date tested :
Date reported : 15/08/14

This report may only be reproduced in full

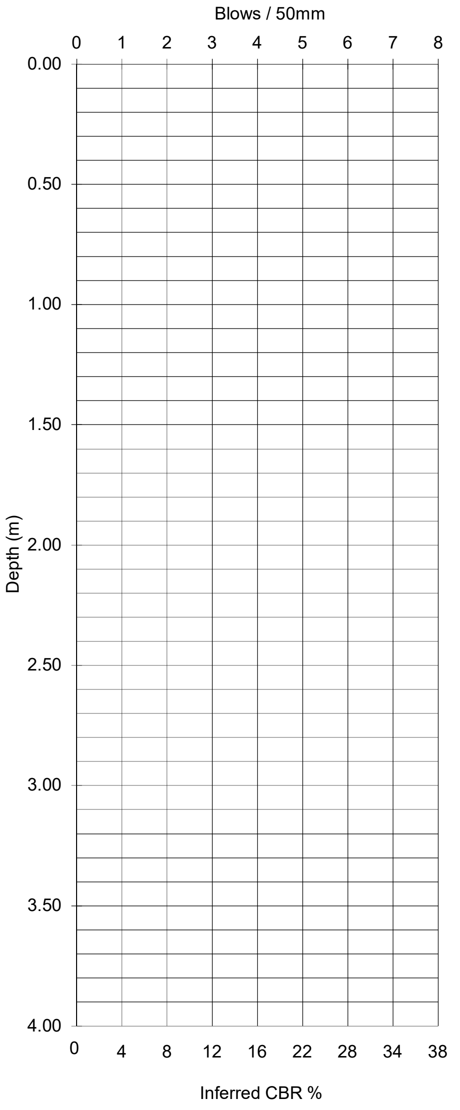
Approved

AUGER / SCALA PENETROMETER
TEST REPORT

Project :	**Wayside Road, Te Kauwhata**
Location :	**Wayside Road, Te Kauwhata**
Client :	**Blue Wallace Surveyors Ltd**
Contractor :	**-**
Test number :	**HA3**
Shear vane number :	**-**
Shear vane correction :	**-**
Water level (m):	**1.9**
Reduced level (m):	

Project No :	**3-38720.0**
Lab Ref No :	**-**
Client Ref No :	**-**

Scala Penetrometer



Test Results

Depth (m)	Shear Strength (kPa)	Soil Description
0.10		TOPSOIL. Silty organic CLAY; dark brown; very soft; wet; highly plastic Clayey SILT trace fine sand; Brown mottled grey; sift to stiff; moist highly plastic.
1.20		No sand, stiff
1.40		Organic SILT; dark brown; very soft to soft; moist to wet; highly plastic Trace gravel. Silty fine to medium SAND; brown; moist to wet; dilatant. Trace fine gravel
1.90		End of Hole

Test Methods	
Determination of Penetration Resistance of a Soil, NZS 4402 : 1988, Test 6.5.2 Shear Strength using a Hand Held Shear Vane: NZ Geotechnical Soc Inc 8/2001 Inferred CBR values taken from Austroads Pavement Design Manual 2004	Field Descriptions of Soils and Rocks by NZ Geotechnical Society Dec 2005

Date tested :

Date reported : 15/08/14

This report may only be reproduced in full

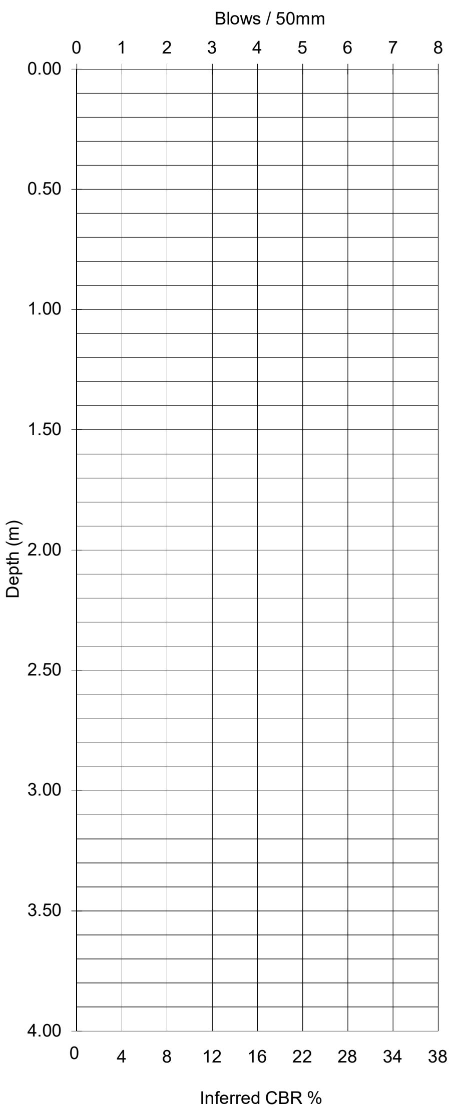
Approved

AUGER / SCALA PENETROMETER
TEST REPORT

Project :	**Wayside Road, Te Kauwhata**
Location :	**Wayside Road, Te Kauwhata**
Client :	**Blue Wallace Surveyors Ltd**
Contractor :	**-**
Test number :	**HA4**
Shear vane number :	**-**
Shear vane correction :	**-**
Water level (m):	**-0.05**
Reduced level (m):	

Project No :	**3-38720.0**
Lab Ref No :	**-**
Client Ref No :	**-**

Scala Penetrometer



Test Results

Depth (m)	Shear Strength (kPa)	Soil Description
		TOPSOIL. Silty organic CLAY; dark brown; very soft; wet; highly plastic
0.10		Gravelly sandy SILT; reddish brown; very soft; moist; low plasticity
0.40		Clayey SILT; grey; very soft to soft; moist; highly plastic. Slightly organic
1.20		Clayey sandy SILT; grey; soft; moist; low plasticity
1.60		Clayey SILT; grey mottled brown; soft; moist; highly plastic
2.30		Clayey SILT; white; soft to firm; moist; highly plastic
3.50		End of Hole

Test Methods

Determination of Penetration Resistance of a Soil, NZS 4402 : 1988, Test 6.5.2	Field Descriptions of Soils and Rocks by
Shear Strength using a Hand Held Shear Vane: NZ Geotechnical Soc Inc 8/2001	NZ Geotechnical Society Dec 2005
Inferred CBR values taken from Austroads Pavement Design Manual 2004	

Date tested :
Date reported : 15/08/14

This report may only be reproduced in full

Approved

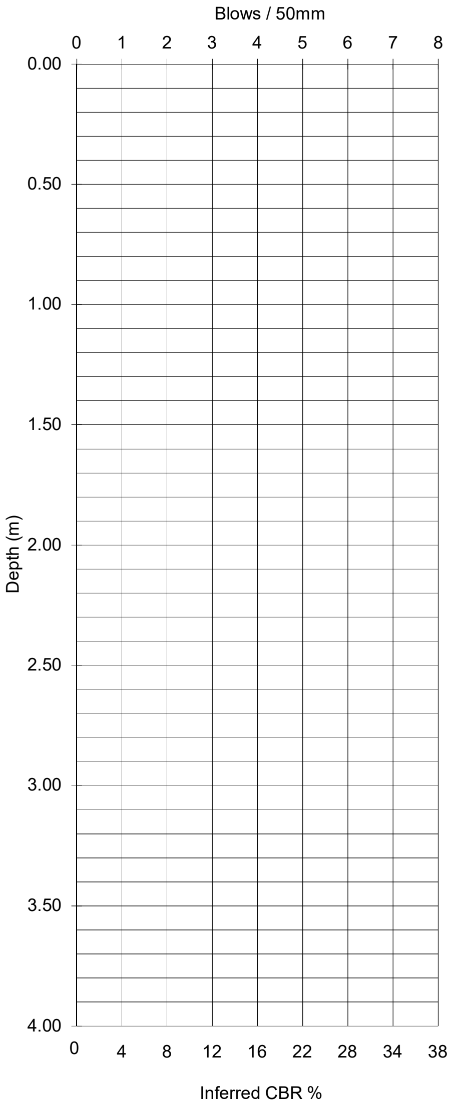
AUGER / SCALA PENETROMETER TEST REPORT

OPUS

Project : **Wayside Road, Te Kauwhata**
Location : **Wayside Road, Te Kauwhata**
Client : **Blue Wallace Surveyors Ltd**
Contractor : **-**
Test number : **HA5**
Shear vane number : **-**
Shear vane correction : **-**
Water level (m): **Dry**
Reduced level (m):

Project No : **3-38720.0**
Lab Ref No : **-**
Client Ref No : **-**

Scala Penetrometer



Test Results

Depth (m)	Shear Strength (kPa)	Soil Description
		TOPSOIL. Clayey SILT; dark brown; very soft; moist; highly plastic
0.10		Clayey SILT; creamish white mottled orange; firm; moist; highly plastic Slightly dilatant.
2.00		End of Hole

Test Methods

Determination of Penetration Resistance of a Soil, NZS 4402 : 1988, Test 6.5.2
Shear Strength using a Hand Held Shear Vane: NZ Geotechnical Soc Inc 8/2001
Inferred CBR values taken from Austroads Pavement Design Manual 2004

Field Descriptions of Soils and Rocks by
NZ Geotechnical Society Dec 2005

Date tested :
Date reported : 15/08/14

This report may only be reproduced in full

Approved

APPENDIX D – Revised Scheme Plans

SCHEME PLANS

LOTS 1 - 165 RESIDENTIAL SUBDIVISION OF
LOT 306 DP 495940 - STAGES 1 - 4
WAYSIDE ROAD - TE KAUWHATA
PREPARED FOR: TE KAUWHATA LAND LTD

WDC REF: SUB0163/14
BLUE WALLACE REF: 14/012
REVISION #10
DATE: 7 JULY 2016

S:\2014\14012 - SILVERSPUR\CAD\FOR RC APPROVAL\14012
APPLICATION SCHEME #10 17-06-16.DWG

NOMINATED SUPERVISIOR

NAME: MURRAY WALLACE - REGISTERED PROFESSIONAL SURVEYOR
ADDRESS: 25 HARWOOD STREET, HAMILTON
E-MAIL: murray@bluewallace.co.nz
PHONE: Wk. (07) 839 7799 Mob. 021 823 768

Blue Wallace
Surveyors Ltd.
25 Harwood Street, P O Box 38,
Hamilton.
Phone (07) 8397799, Fax (07) 8394455

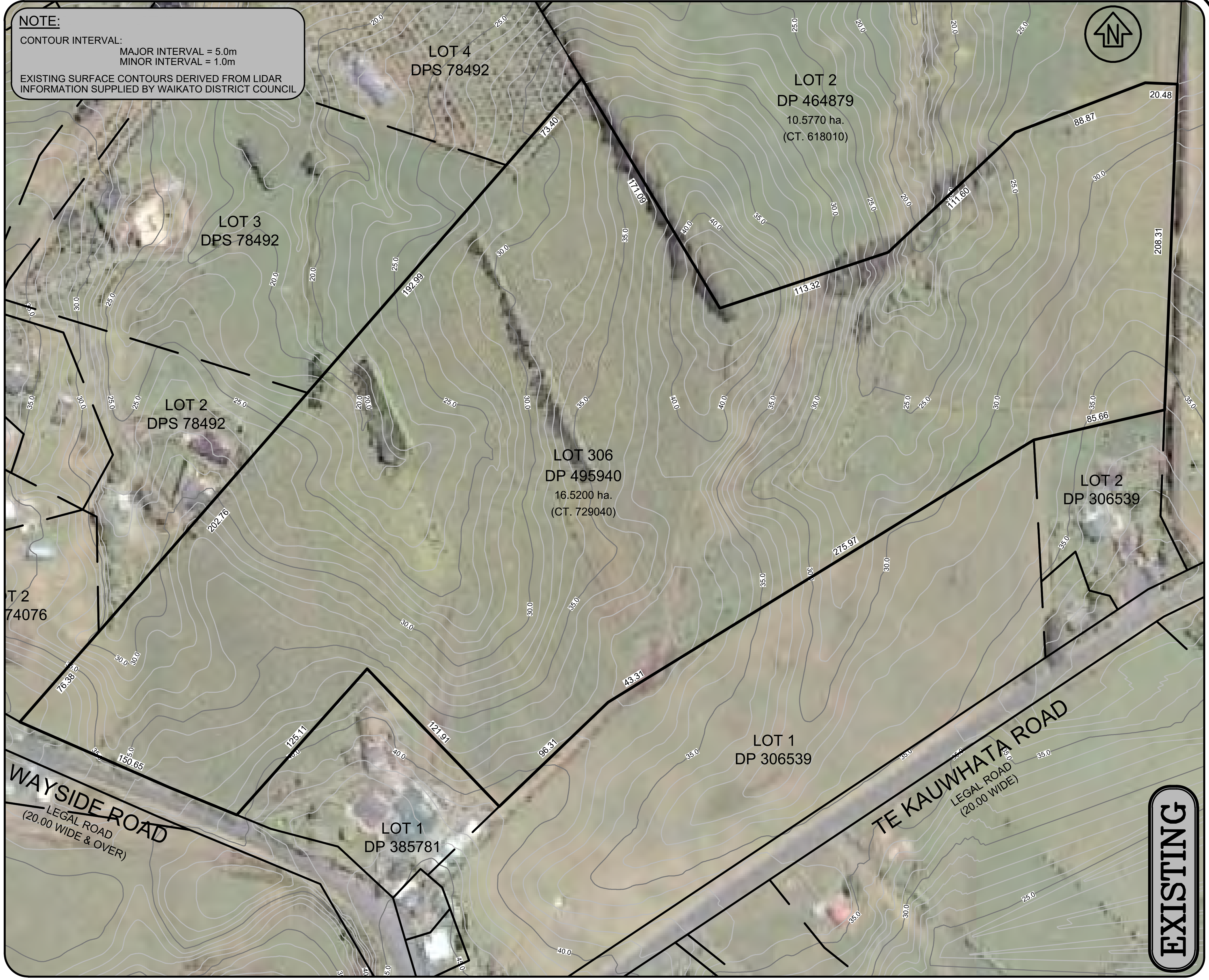
SCHEME PLANS

INDEX TO SHEETS

LOTS 1 - 165 RESIDENTIAL SUBDIVISION OF
LOT 306 DP 495940 - STAGES 1 - 4
WAYSIDE ROAD - TE KAUWHATA
PREPARED FOR: TE KAUWHATA LAND LTD

Blue Wallace
Surveyors Ltd.
25 Harwood Street, P O Box 38,
Hamilton Central, HAMILTON.
Phone (07) 839 7799, Fax (07) 839 4455

LOCATION DIAGRAM
Scale 1:15000



NOTE:

CONTOUR INTERVAL:
MAJOR INTERVAL = 5.0m
MINOR INTERVAL = 1.0m

EXISTING SURFACE CONTOURS DERIVED FROM LIDAR INFORMATION SUPPLIED BY WAIKATO DISTRICT COUNCIL

NOTE:

1) ALL AREAS AND DIMENSIONS SUBJECT TO FINAL SURVEY AND APPROVAL FROM THE WAIKATO DISTRICT COUNCIL

2) LEGAL DESCRIPTION: LOT 306
DP 495940

(CT. 729040)

3) TOTAL AREA: 16.5200 ha.

4) ZONE: LIVING ZONE TE KAUWHATA WEST

5) AERIAL PHOTO SUBJECT TO DISTORTION

6) ALL LEVELS ARE IN TERMS OF MOTURIKI DATUM

SCALE: 1:2500 @A3, 1:1250 @A1

DATE: JULY 2016

No.	Amendment	Init.	Date.	
1	APPLICATION SCHEME PLAN #10 17-6-16	WAB	07/16	Designed. WAB Drawn. WAB 7 JULY 2016
2				Checked.
3				Approved.

S:\2014\14012 - SILVERSPUR\CAD\FOR RC APPROVAL\14012 APPLICATION SCHEME #10 17-06-16.DWG

LOTS 1 - 165 BEING A SUBDIVISION OF LOT 306 DP 495940 WAYSIDE ROAD - TE KAUWHATA PREPARED FOR: TE KAUWHATA LAND LTD

Version #10

Blue Wallace
Surveyors Ltd.
25 Harwood Street, P O Box 38,
Hamilton Central, HAMILTON.
Phone (07) 839 7799, Fax (07) 839 4455

File Reference
14/012

Drawing No.
1 of 12

MEMORANDUM OF EASEMENT

PURPOSE	SERV. TENE.	SHOWN	DOM. TENE.
RIGHT OF WAY RIGHT TO CONVEY ELECTRICITY, TELECOMMUNICATIONS AND COMPUTER MEDIA & WATER RIGHT TO DRAIN STORMWATER SEWAGE	LOT 200 HEREON	A	LOTS 7 - 12 HEREON
	LOT 203 HEREON	C	LOTS 32 & 33 HEREON
	LOT 204 HEREON	D	LOT 38 & 39 HEREON
	LOT 206 HEREON	E	LOT 50 & 51 HEREON
	LOT 207 HEREON	F	LOT 56 & 57 HEREON
	LOT 208 HEREON	G	LOT 60 - 62 HEREON
	LOT 209 HEREON	H	LOT 65 & 66 HEREON
	LOT 210 HEREON	I	LOT 71 & 72 HEREON
	LOT 211 HEREON	J	LOT 75 & 76 HEREON
	LOT 213 HEREON	K	LOTS 88 & 89 HEREON
	LOT 217 HEREON	L	LOTS 95 - 98 HEREON
	LOT 218 HEREON	M	LOTS 138 & 139 HEREON
	LOT 219 HEREON	N	LOTS 143 & 144 HEREON
	LOT 222 HEREON	O	LOTS 109 & 110 HEREON
	LOT 223 HEREON	P	LOTS 113 & 114 HEREON
	LOT 224 HEREON	Q	LOTS 122 & 123 HEREON
	LOT 225 HEREON	R	LOTS 127 - 132 HEREON
RIGHT OF WAY	LOT 300 HEREON	B	LOT 202 HEREON

NOTE:

1) ALL AREAS AND DIMENSIONS SUBJECT TO FINAL SURVEY AND APPROVAL FROM THE WAIKATO DISTRICT COUNCIL

2) LEGAL DESCRIPTION: LOT 306
DP 495940

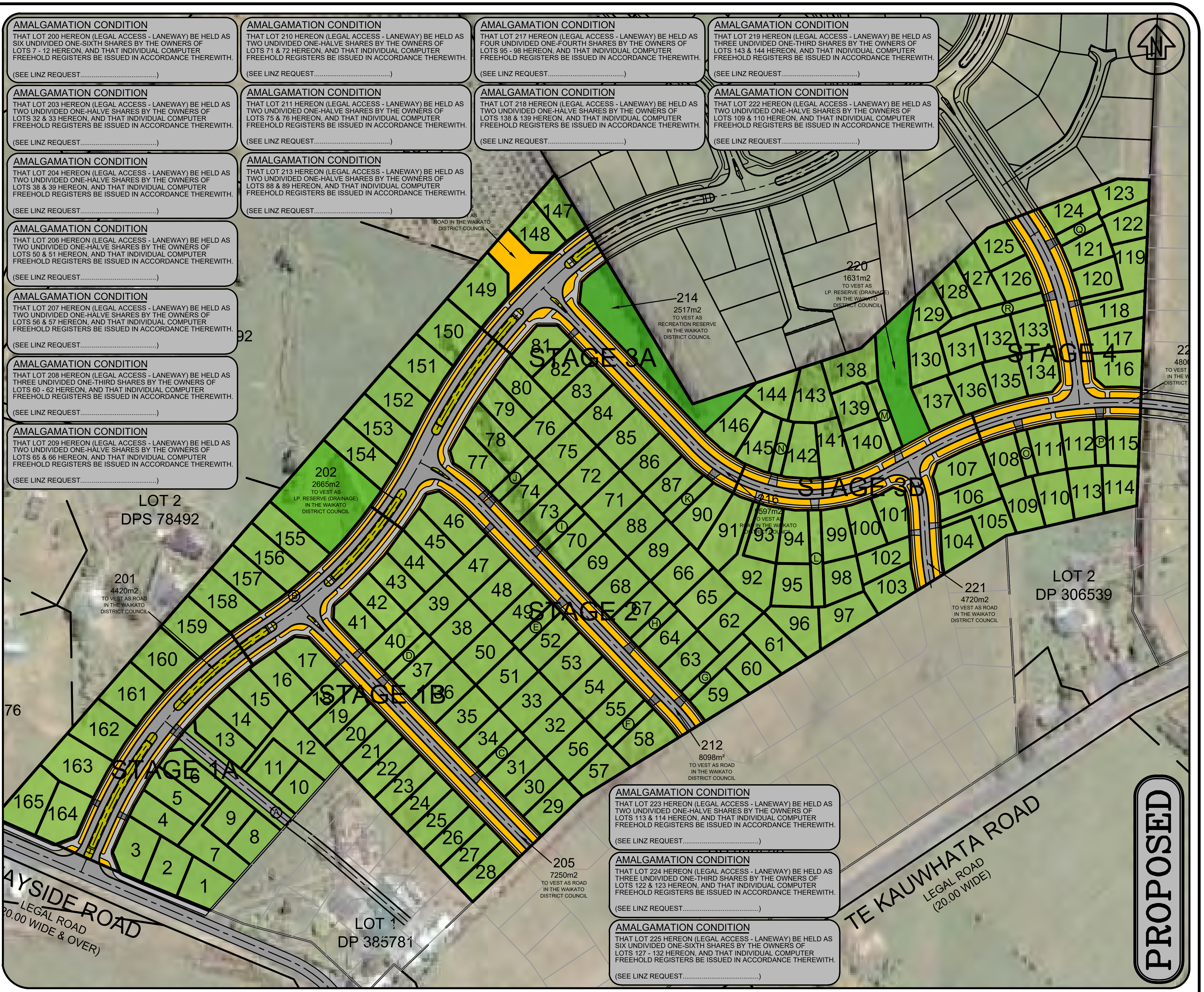
(CT. 729040)

3) TOTAL AREA: 16.5200 ha.

4) ZONE: LIVING ZONE TE KAUWHATA WEST

5) AERIAL PHOTO SUBJECT TO DISTORTION

6) ALL LEVELS ARE IN TERMS OF MOTURIKI DATUM



AMALGAMATION CONDITION
THAT LOT 200 HEREON (LEGAL ACCESS - LANEWAY) BE HELD AS SIX UNDIVIDED ONE-SIXTH SHARES BY THE OWNERS OF LOTS 7 - 12 HEREON, AND THAT INDIVIDUAL COMPUTER FREEHOLD REGISTERS BE ISSUED IN ACCORDANCE THEREWITH.
(SEE LINZ REQUEST..)

AMALGAMATION CONDITION
THAT LOT 210 HEREON (LEGAL ACCESS - LANEWAY) BE HELD AS TWO UNDIVIDED ONE-HALVE SHARES BY THE OWNERS OF LOTS 71 & 72 HEREON, AND THAT INDIVIDUAL COMPUTER FREEHOLD REGISTERS BE ISSUED IN ACCORDANCE THEREWITH.
(SEE LINZ REQUEST..)

AMALGAMATION CONDITION
THAT LOT 217 HEREON (LEGAL ACCESS - LANEWAY) BE HELD AS FOUR UNDIVIDED ONE-FOURTH SHARES BY THE OWNERS OF LOTS 95 - 98 HEREON, AND THAT INDIVIDUAL COMPUTER FREEHOLD REGISTERS BE ISSUED IN ACCORDANCE THEREWITH.
(SEE LINZ REQUEST..)

AMALGAMATION CONDITION
THAT LOT 219 HEREON (LEGAL ACCESS - LANEWAY) BE HELD AS THREE UNDIVIDED ONE-THIRD SHARES BY THE OWNERS OF LOTS 143 & 144 HEREON, AND THAT INDIVIDUAL COMPUTER FREEHOLD REGISTERS BE ISSUED IN ACCORDANCE THEREWITH.
(SEE LINZ REQUEST..)

AMALGAMATION CONDITION
THAT LOT 203 HEREON (LEGAL ACCESS - LANEWAY) BE HELD AS TWO UNDIVIDED ONE-HALVE SHARES BY THE OWNERS OF LOTS 32 & 33 HEREON, AND THAT INDIVIDUAL COMPUTER FREEHOLD REGISTERS BE ISSUED IN ACCORDANCE THEREWITH.
(SEE LINZ REQUEST..)

AMALGAMATION CONDITION
THAT LOT 211 HEREON (LEGAL ACCESS - LANEWAY) BE HELD AS TWO UNDIVIDED ONE-HALVE SHARES BY THE OWNERS OF LOTS 75 & 76 HEREON, AND THAT INDIVIDUAL COMPUTER FREEHOLD REGISTERS BE ISSUED IN ACCORDANCE THEREWITH.
(SEE LINZ REQUEST..)

AMALGAMATION CONDITION
THAT LOT 218 HEREON (LEGAL ACCESS - LANEWAY) BE HELD AS TWO UNDIVIDED ONE-HALVE SHARES BY THE OWNERS OF LOTS 138 & 139 HEREON, AND THAT INDIVIDUAL COMPUTER FREEHOLD REGISTERS BE ISSUED IN ACCORDANCE THEREWITH.
(SEE LINZ REQUEST..)

AMALGAMATION CONDITION
THAT LOT 222 HEREON (LEGAL ACCESS - LANEWAY) BE HELD AS TWO UNDIVIDED ONE-HALVE SHARES BY THE OWNERS OF LOTS 109 & 110 HEREON, AND THAT INDIVIDUAL COMPUTER FREEHOLD REGISTERS BE ISSUED IN ACCORDANCE THEREWITH.
(SEE LINZ REQUEST..)

AMALGAMATION CONDITION
THAT LOT 204 HEREON (LEGAL ACCESS - LANEWAY) BE HELD AS TWO UNDIVIDED ONE-HALVE SHARES BY THE OWNERS OF LOTS 38 & 39 HEREON, AND THAT INDIVIDUAL COMPUTER FREEHOLD REGISTERS BE ISSUED IN ACCORDANCE THEREWITH.
(SEE LINZ REQUEST..)

AMALGAMATION CONDITION
THAT LOT 213 HEREON (LEGAL ACCESS - LANEWAY) BE HELD AS TWO UNDIVIDED ONE-HALVE SHARES BY THE OWNERS OF LOTS 88 & 89 HEREON, AND THAT INDIVIDUAL COMPUTER FREEHOLD REGISTERS BE ISSUED IN ACCORDANCE THEREWITH.
(SEE LINZ REQUEST..)

AMALGAMATION CONDITION
THAT LOT 206 HEREON (LEGAL ACCESS - LANEWAY) BE HELD AS TWO UNDIVIDED ONE-HALVE SHARES BY THE OWNERS OF LOTS 50 & 51 HEREON, AND THAT INDIVIDUAL COMPUTER FREEHOLD REGISTERS BE ISSUED IN ACCORDANCE THEREWITH.
(SEE LINZ REQUEST..)

AMALGAMATION CONDITION
THAT LOT 207 HEREON (LEGAL ACCESS - LANEWAY) BE HELD AS TWO UNDIVIDED ONE-HALVE SHARES BY THE OWNERS OF LOTS 56 & 57 HEREON, AND THAT INDIVIDUAL COMPUTER FREEHOLD REGISTERS BE ISSUED IN ACCORDANCE THEREWITH.
(SEE LINZ REQUEST..)

AMALGAMATION CONDITION
THAT LOT 208 HEREON (LEGAL ACCESS - LANEWAY) BE HELD AS THREE UNDIVIDED ONE-THIRD SHARES BY THE OWNERS OF LOTS 60 - 62 HEREON, AND THAT INDIVIDUAL COMPUTER FREEHOLD REGISTERS BE ISSUED IN ACCORDANCE THEREWITH.
(SEE LINZ REQUEST..)

AMALGAMATION CONDITION
THAT LOT 209 HEREON (LEGAL ACCESS - LANEWAY) BE HELD AS TWO UNDIVIDED ONE-HALVE SHARES BY THE OWNERS OF LOTS 65 & 66 HEREON, AND THAT INDIVIDUAL COMPUTER FREEHOLD REGISTERS BE ISSUED IN ACCORDANCE THEREWITH.
(SEE LINZ REQUEST..)

AMALGAMATION CONDITION
THAT LOT 223 HEREON (LEGAL ACCESS - LANEWAY) BE HELD AS TWO UNDIVIDED ONE-HALVE SHARES BY THE OWNERS OF LOTS 113 & 114 HEREON, AND THAT INDIVIDUAL COMPUTER FREEHOLD REGISTERS BE ISSUED IN ACCORDANCE THEREWITH.
(SEE LINZ REQUEST..)

AMALGAMATION CONDITION
THAT LOT 224 HEREON (LEGAL ACCESS - LANEWAY) BE HELD AS THREE UNDIVIDED ONE-THIRD SHARES BY THE OWNERS OF LOTS 122 & 123 HEREON, AND THAT INDIVIDUAL COMPUTER FREEHOLD REGISTERS BE ISSUED IN ACCORDANCE THEREWITH.
(SEE LINZ REQUEST..)

AMALGAMATION CONDITION
THAT LOT 225 HEREON (LEGAL ACCESS - LANEWAY) BE HELD AS SIX UNDIVIDED ONE-SIXTH SHARES BY THE OWNERS OF LOTS 127 - 132 HEREON, AND THAT INDIVIDUAL COMPUTER FREEHOLD REGISTERS BE ISSUED IN ACCORDANCE THEREWITH.
(SEE LINZ REQUEST..)

SCALE: 1:2500 @A3, 1:1250 @A1
DATE: JULY 2016

No.	Amendment	Init.	Date.	
1	APPLICATION SCHEME PLAN #10 17-6-16	WAB	07/16	Designed. WAB
2				Drawn. WAB 7 JULY 2016
3				Checked.
				Approved.

S:\2014\14012 - SILVERSPUR\CAD\FOR RC APPROVAL\14012 APPLICATION SCHEME #10 17-06-16.DWG

LOTS 1 - 165 BEING A SUBDIVISION OF
LOT 306 DP 495940
WAYSIDE ROAD - TE KAUWHATA
PREPARED FOR: TE KAUWHATA LAND LTD

Version #10

Firm's Name

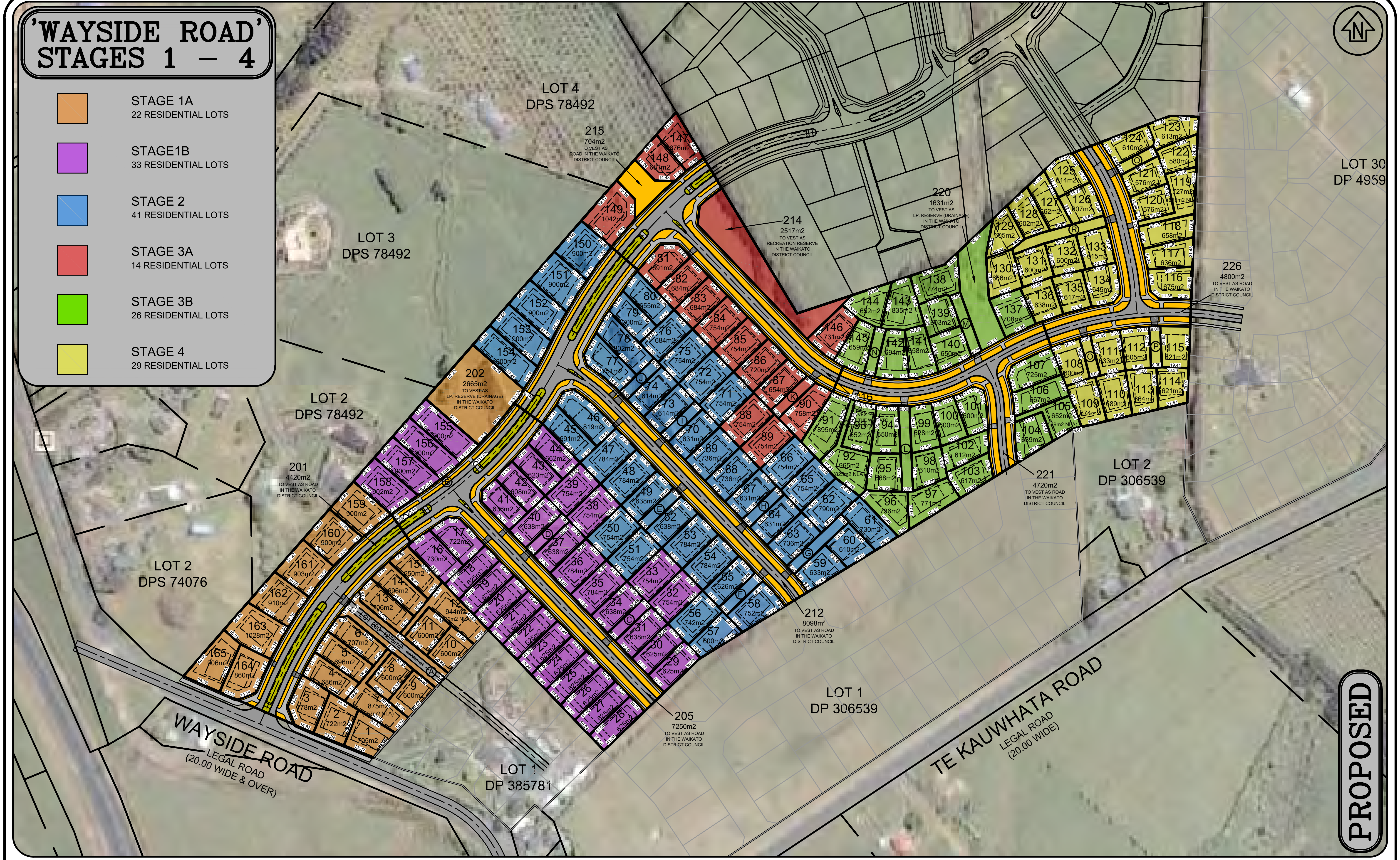
Blue Wallace
Surveyors Ltd.
25 Harwood Street, P O Box 38,
Hamilton Central, HAMILTON.
Phone (07) 839 7799, Fax (07) 839 4455

File Reference
14/012

Drawing No.
2 of 12

'WAYSIDE ROAD' STAGES 1 – 4

🟧	STAGE 1A 22 RESIDENTIAL LOTS
🟪	STAGE1B 33 RESIDENTIAL LOTS
🟦	STAGE 2 41 RESIDENTIAL LOTS
🟥	STAGE 3A 14 RESIDENTIAL LOTS
🟩	STAGE 3B 26 RESIDENTIAL LOTS
🟨	STAGE 4 29 RESIDENTIAL LOTS



SCALE: 1:2500 @A3, 1:1250 @A1 DATE: JULY 2016

No.	Amendment	Init.	Date.	
				Designed. WAB
1	APPLICATION SCHEME PLAN #10 17-6-16	WAB	07/16	Drawn. WAB 7 JULY 2016
2				Checked.
3				Approved.

S:\2014\14012 - SILVERSPUR\CAD\FOR RC APPROVAL\14012 APPLICATION SCHEME #10 17-06-16.DWG

LOTS 1 - 165 BEING A SUBDIVISION OF
LOT 306 DP 495940
WAYSIDE ROAD - TE KAUWHATA
PREPARED FOR: TE KAUWHATA LAND LTD

Version #10

Firm's Name

Blue Wallace
Surveyors Ltd.
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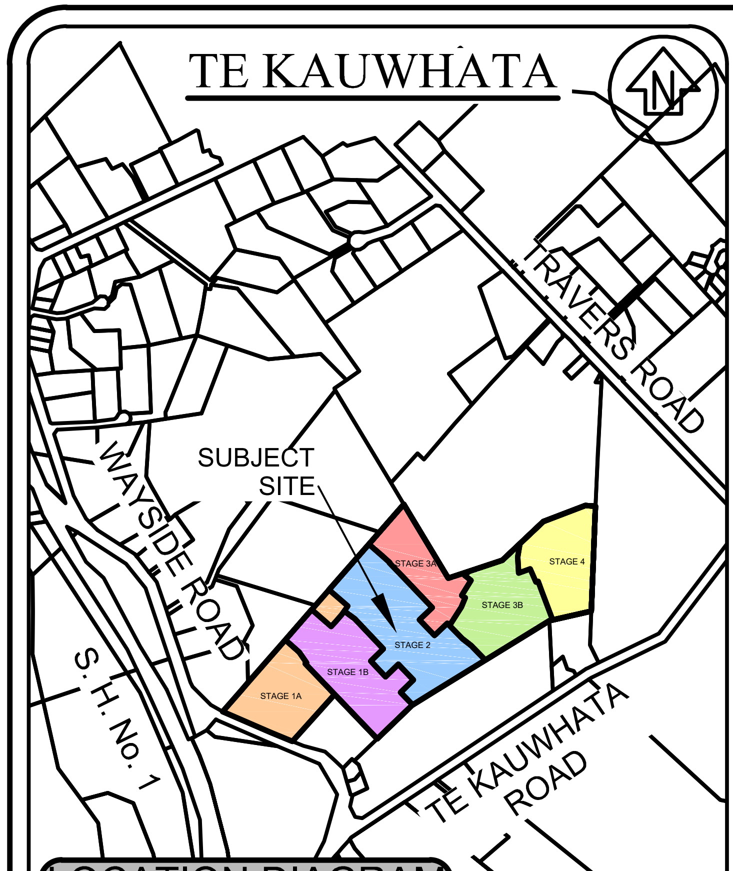
Phone (07) 839 7799, Fax (07) 839 4455

File Reference
14/012

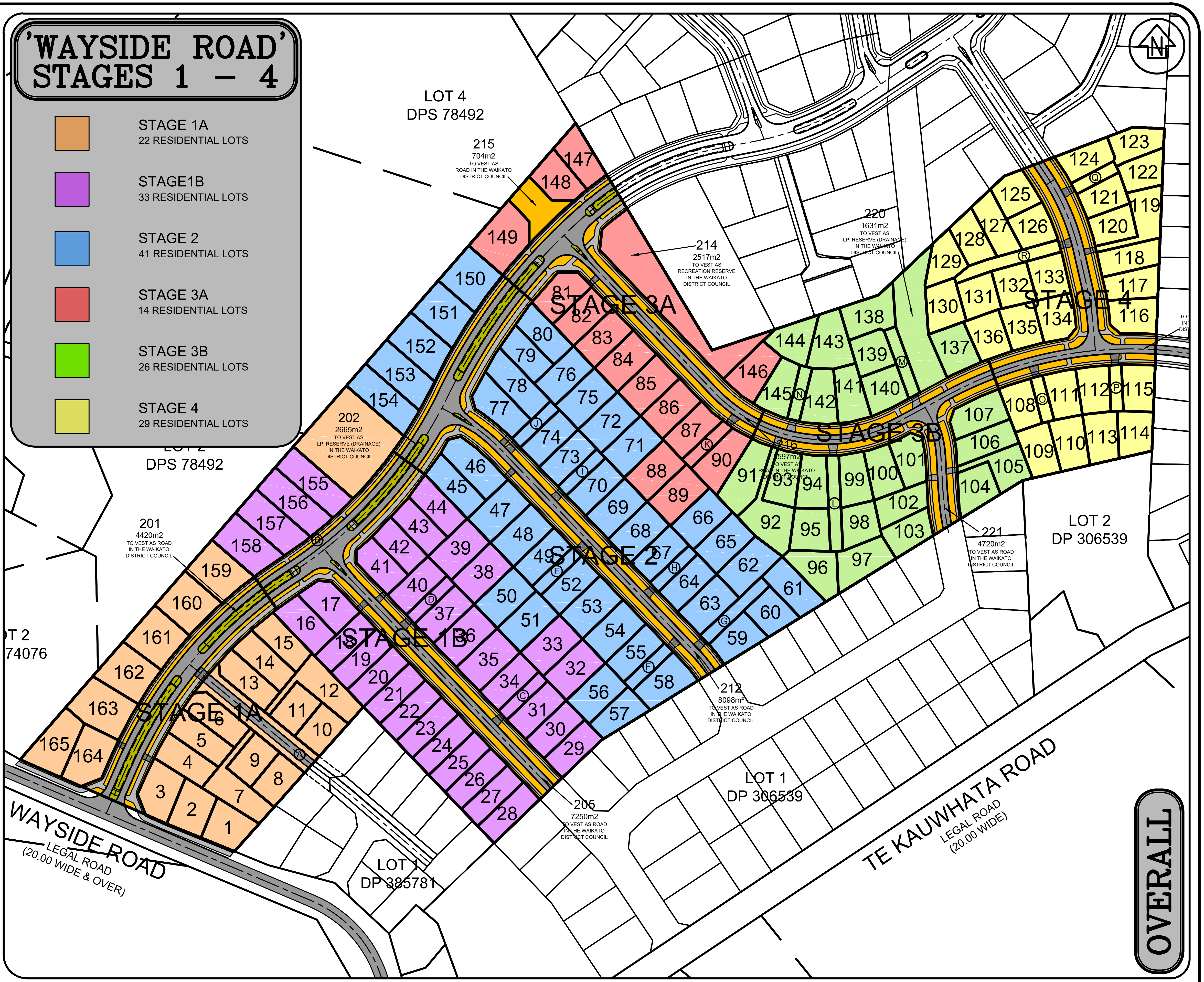
Drawing No.
3 of 12



LOCATION DIAGRAM
Scale 1:15000

'WAYSIDE ROAD' STAGES 1 – 4

🟧	STAGE 1A 22 RESIDENTIAL LOTS
🟪	STAGE1B 33 RESIDENTIAL LOTS
🟦	STAGE 2 41 RESIDENTIAL LOTS
🟥	STAGE 3A 14 RESIDENTIAL LOTS
🟩	STAGE 3B 26 RESIDENTIAL LOTS
🟨	STAGE 4 29 RESIDENTIAL LOTS



OVERALL

NOTE:

1) ALL AREAS AND DIMENSIONS SUBJECT TO FINAL SURVEY AND APPROVAL FROM THE WAIKATO DISTRICT COUNCIL

2) LEGAL DESCRIPTION: LOT 306
DP 495940

(CT. 729040)

3) TOTAL AREA: 16.5200 ha.

4) ZONE: LIVING ZONE TE KAUWHATA WEST

5) AERIAL PHOTO SUBJECT TO DISTORTION

6) ALL LEVELS ARE IN TERMS OF MOTURIKI DATUM

SCALE: 1:2500 @A3
DATE: JULY 2016

No.	Amendment	Init.	Date.
1	APPLICATION STAGING PLAN - OVERALL	WAB	07/16
2			
3			

Designed. WAB
Drawn. WAB 7 JULY 2016
Checked.
Approved.

S:\2014\14012 - SILVERSPUR\CAD\FOR RC APPROVAL\14012 APPLICATION SCHEME #10 17-06-16.DWG

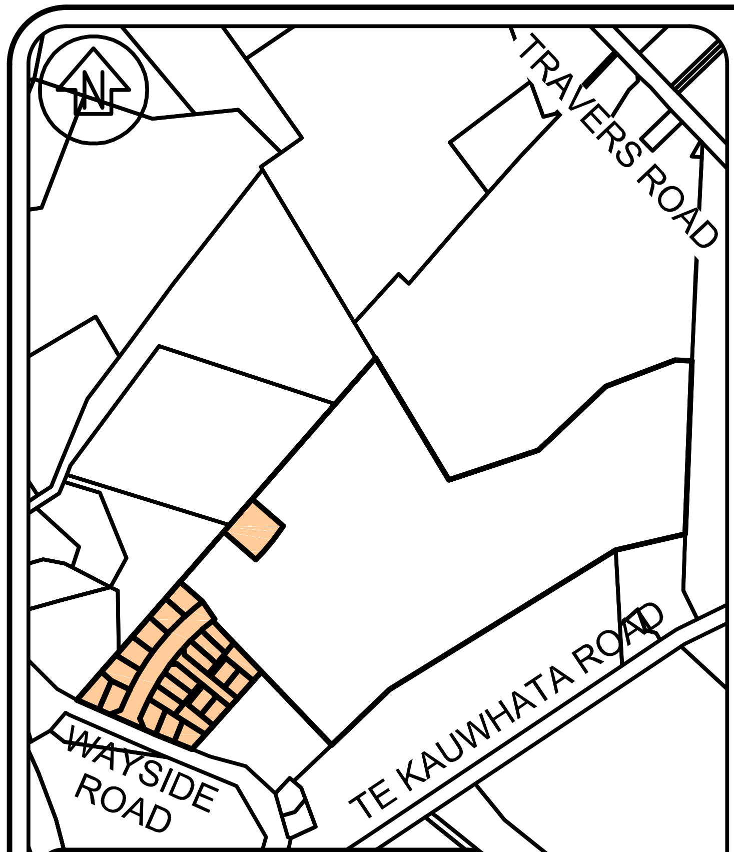
STAGING PLAN - OVERALL STAGING PLAN
LOT 306 DP 495940
WAYSIDE ROAD - TE KAUWHATA
PREPARED FOR: TE KAUWHATA LAND LTD

Version #10

Firm's Name
Blue Wallace
Surveyors Ltd.
25 Harwood Street, P O Box 38,
Hamilton Central, HAMILTON.
Phone (07) 839 7799, Fax (07) 839 4455

File Reference
14/012

Drawing No.
4 of 12



LOCATION DIAGRAM
Scale 1:10000

MEMORANDUM OF EASEMENT

PURPOSE	SERV. TENE.	SHOWN	DOM. TENE.
RIGHT OF WAY RIGHT TO CONVEY ELECTRICITY, TELECOMMUNICATIONS AND COMPUTER MEDIA, WATER RIGHT TO DRAIN SEWER & STORMWATER	LOT 200 HEREON	A	LOTS 7 - 12 HEREON
RIGHT OF WAY	LOT 300 HEREON	B	LOT 202 HEREON

NOTE:

1) ALL AREAS AND DIMENSIONS SUBJECT TO FINAL SURVEY AND APPROVAL FROM THE WAIKATO DISTRICT COUNCIL

2) LEGAL DESCRIPTION: LOT 306
DP 495940

(CT. 729040)

3) TOTAL AREA: 16.5200 ha.

4) ZONE: LIVING ZONE TE KAUWHATA WEST

5) AERIAL PHOTO SUBJECT TO DISTORTION

6) ALL LEVELS ARE IN TERMS OF MOTURIKI DATUM

'WAYSIDE ROAD' STAGE 1A

1) RESIDENTIAL LOTS = 22 LOTS (LOTS 1 - 15, 159 - 165)
TOTAL AREA: 1.6973 ha.

2) ROAD RESERVE TO VEST = 1 LOT (LOT 201)
TOTAL AREA: 0.4420 ha.

3) ACCESS LOTS (LANEWAY) = 1 LOT (LOT 200)
TOTAL AREA: 0.1275 ha.

4) LP. RESERVE TO VEST (DRAINAGE) = 1 LOT (LOT 202)
TOTAL AREA: 0.2665 ha.

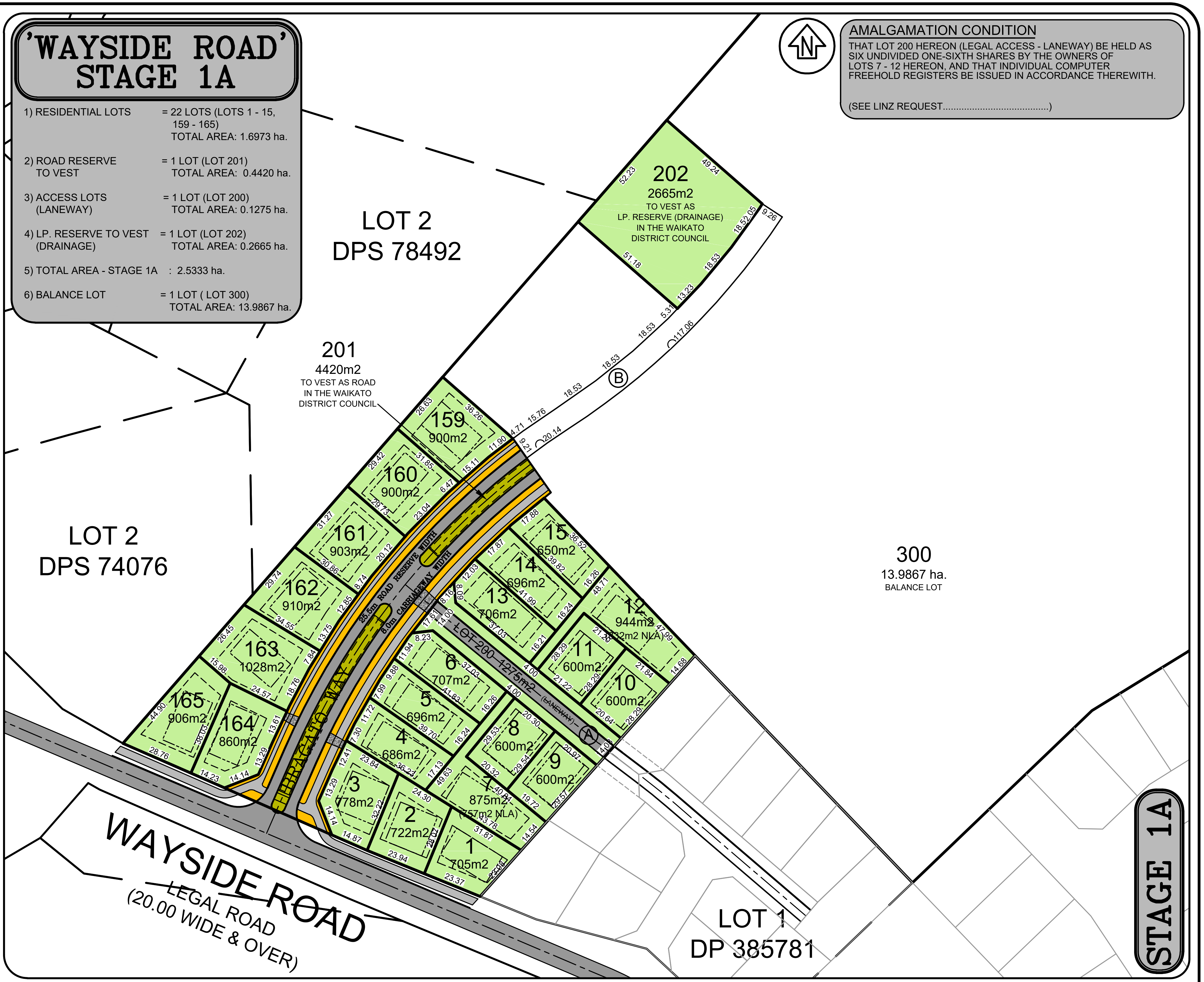
5) TOTAL AREA - STAGE 1A : 2.5333 ha.

6) BALANCE LOT = 1 LOT (LOT 300)
TOTAL AREA: 13.9867 ha.

AMALGAMATION CONDITION

THAT LOT 200 HEREON (LEGAL ACCESS - LANEWAY) BE HELD AS SIX UNDIVIDED ONE-SIXTH SHARES BY THE OWNERS OF LOTS 7 - 12 HEREON, AND THAT INDIVIDUAL COMPUTER FREEHOLD REGISTERS BE ISSUED IN ACCORDANCE THEREWITH.

(SEE LINZ REQUEST..)



SCALE: 1:1500 @A3			DATE: JULY 2016	
No.	Amendment	Init.	Date.	Designed. WAB
1	APPLICATION STAGING PLAN - STAGE 1	WAB	07/16	Drawn. WAB 7 JULY 2016
2				Checked.
3				Approved.

S:\2014\14012 - SILVERSPUR\CAD\FOR RC APPROVAL\14012 APPLICATION SCHEME #10 17-06-16.DWG

STAGING PLAN - STAGE 1A DETAIL PLAN
LOT 306 DP 495940
WAYSIDE ROAD - TE KAUWHATA
PREPARED FOR: TE KAUWHATA LAND LTD

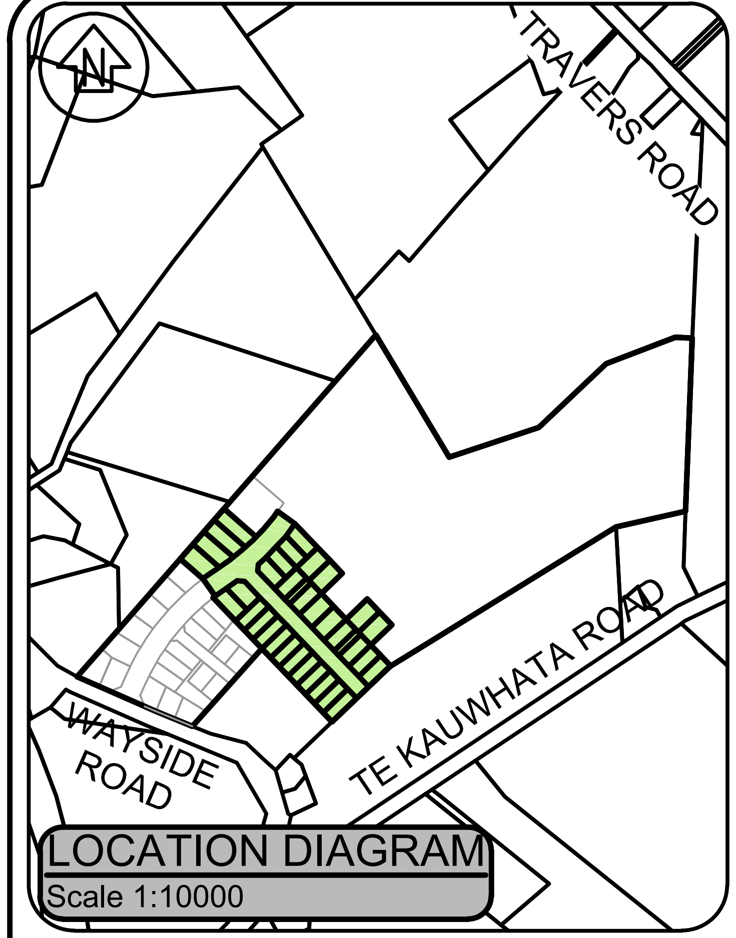
Version #10

Firm's Name

Blue Wallace
Surveyors Ltd.
25 Harwood Street, P O Box 38,
Hamilton Central, HAMILTON.
Phone (07) 839 7799, Fax (07) 839 4455

File Reference
14/012

Drawing No.
5 of 12



LOCATION DIAGRAM
Scale 1:10000

MEMORANDUM OF EASEMENT

PURPOSE	SERV. TENE.	SHOWN	DOM. TENE.
RIGHT OF WAY RIGHT TO CONVEY ELECTRICITY, TELECOMMUNI-CATIONS AND COMPUTER MEDIA, WATER	LOT 203 HEREON	C	LOTS 32 & 33 HEREON
RIGHT TO DRAIN SEWER & STORMWATER	LOT 204 HEREON	D	LOT 38 & 39 HEREON

NOTE:

1) ALL AREAS AND DIMENSIONS SUBJECT TO FINAL SURVEY AND APPROVAL FROM THE WAIKATO DISTRICT COUNCIL

2) LEGAL DESCRIPTION: LOT 300
DP ??????
(CT. ??????)

3) TOTAL AREA: 13.9867 ha.

4) ZONE: LIVING ZONE TE KAUWHATA WEST

5) AERIAL PHOTO SUBJECT TO DISTORTION

6) ALL LEVELS ARE IN TERMS OF MOTURIKI DATUM

'WAYSIDE ROAD' STAGE 1B

1) RESIDENTIAL LOTS = 33 LOTS (LOTS 16 - 44, 155 - 158)
TOTAL AREA: 2.2841 ha.

2) ROAD RESERVE TO VEST = 1 LOT (LOT 205)
TOTAL AREA: 0.7250 ha.

3) ACCESS LOTS (LANEWAY) = 2 LOTS (LOT 203 & 204)
TOTAL AREA: 0.0584 ha.

4) TOTAL AREA - STAGE 1B : 3.0675ha.

5) BALANCE LOT = 1 LOT (LOT 301)
TOTAL AREA: 10.9192 ha.

AMALGAMATION CONDITION

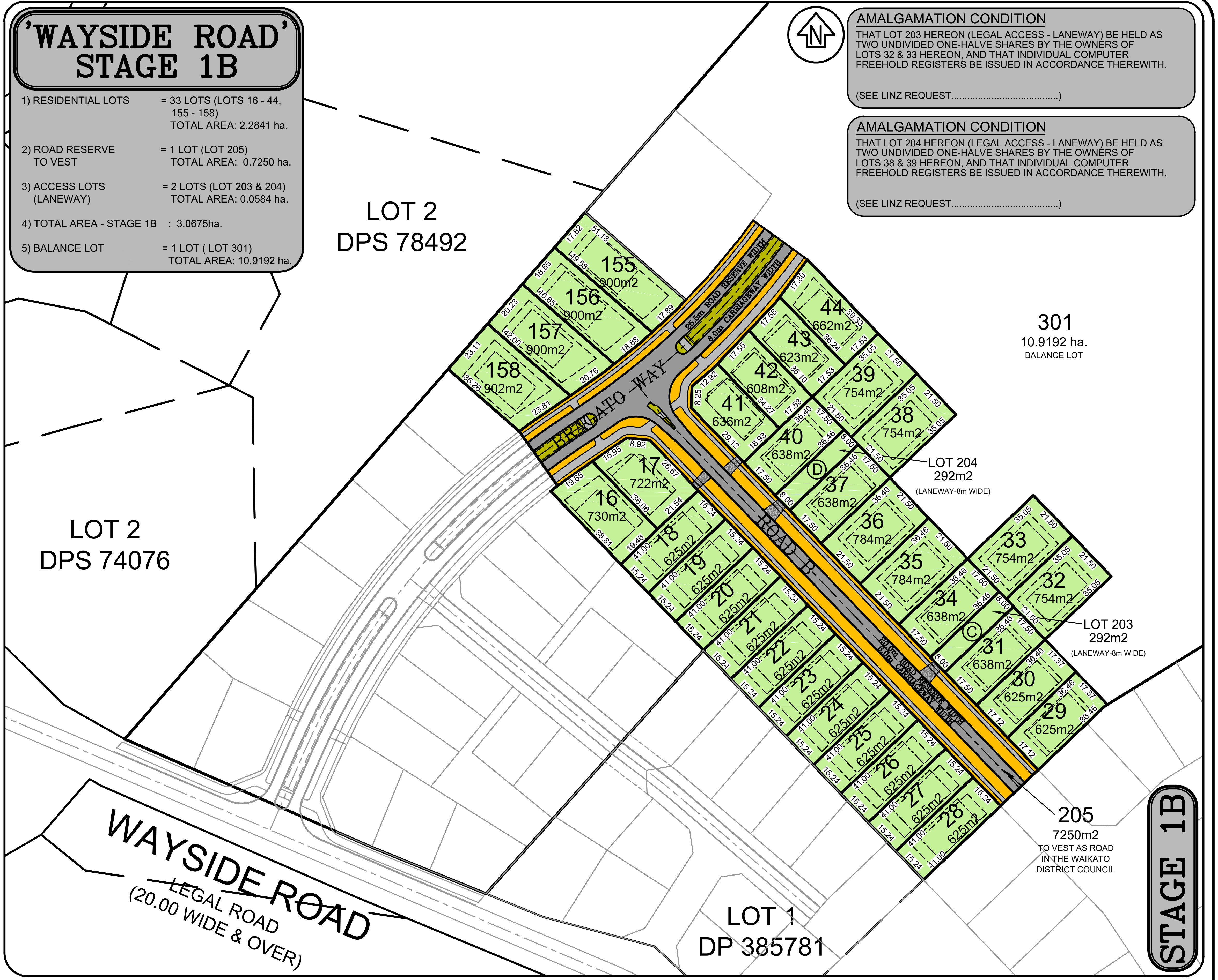
THAT LOT 203 HEREON (LEGAL ACCESS - LANEWAY) BE HELD AS TWO UNDIVIDED ONE-HALVE SHARES BY THE OWNERS OF LOTS 32 & 33 HEREON, AND THAT INDIVIDUAL COMPUTER FREEHOLD REGISTERS BE ISSUED IN ACCORDANCE THEREWITH.

(SEE LINZ REQUEST.......................................)

AMALGAMATION CONDITION

THAT LOT 204 HEREON (LEGAL ACCESS - LANEWAY) BE HELD AS TWO UNDIVIDED ONE-HALVE SHARES BY THE OWNERS OF LOTS 38 & 39 HEREON, AND THAT INDIVIDUAL COMPUTER FREEHOLD REGISTERS BE ISSUED IN ACCORDANCE THEREWITH.

(SEE LINZ REQUEST.......................................)



SCALE: 1:1500 @A3			DATE: JULY 2016	
No.	Amendment	Init.	Date.	Designed. WAB
1	APPLICATION STAGING PLAN - STAGE 1	WAB	07/16	Drawn. WAB 7 JULY 2016
2				Checked.
3				Approved.

S:\2014\14012 - SILVERSPUR\CAD\FOR RC APPROVAL\14012 APPLICATION SCHEME #10 17-06-16.DWG

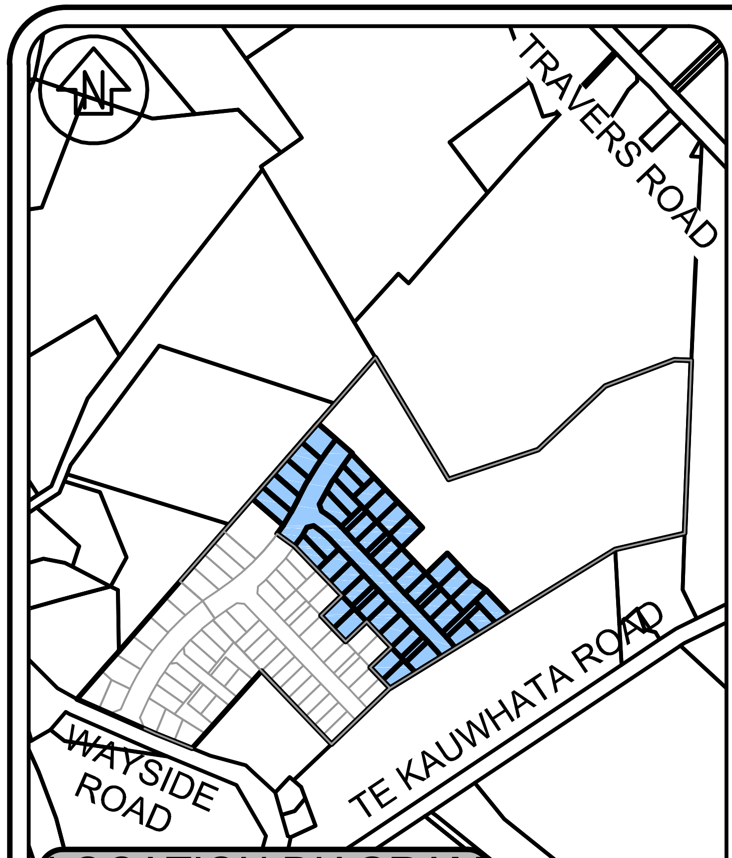
STAGING PLAN - STAGE 1B DETAIL PLAN
LOT 300 DP ??????
WAYSIDE ROAD - TE KAUWHATA
PREPARED FOR: TE KAUWHATA LAND LTD

Version #10

Firm's Name
Blue Wallace
Surveyors Ltd.
25 Harwood Street, P O Box 38,
Hamilton Central, HAMILTON.
Phone (07) 839 7799, Fax (07) 839 4455

File Reference
14/012

Drawing No.
6 of 12



LOCATION DIAGRAM
Scale 1:10000

MEMORANDUM OF EASEMENT

PURPOSE	SERV. TENE.	SHOWN	DOM. TENE.
RIGHT OF WAY RIGHT TO CONVEY ELECTRICITY, TELECOMMUNICATIONS AND COMPUTER MEDIA, WATER RIGHT TO DRAIN SEWER & STORMWATER	LOT 206 HEREON	E	LOT 50 & 51 HEREON
	LOT 207 HEREON	F	LOT 56 & 57 HEREON
	LOT 208 HEREON	G	LOT 60 - 62 HEREON
	LOT 209 HEREON	H	LOT 65 & 66 HEREON
	LOT 210 HEREON	I	LOT 71 & 72 HEREON
	LOT 211 HEREON	J	LOT 75 & 76 HEREON

NOTE:

1) ALL AREAS AND DIMENSIONS SUBJECT TO FINAL SURVEY AND APPROVAL FROM THE WAIKATO DISTRICT COUNCIL

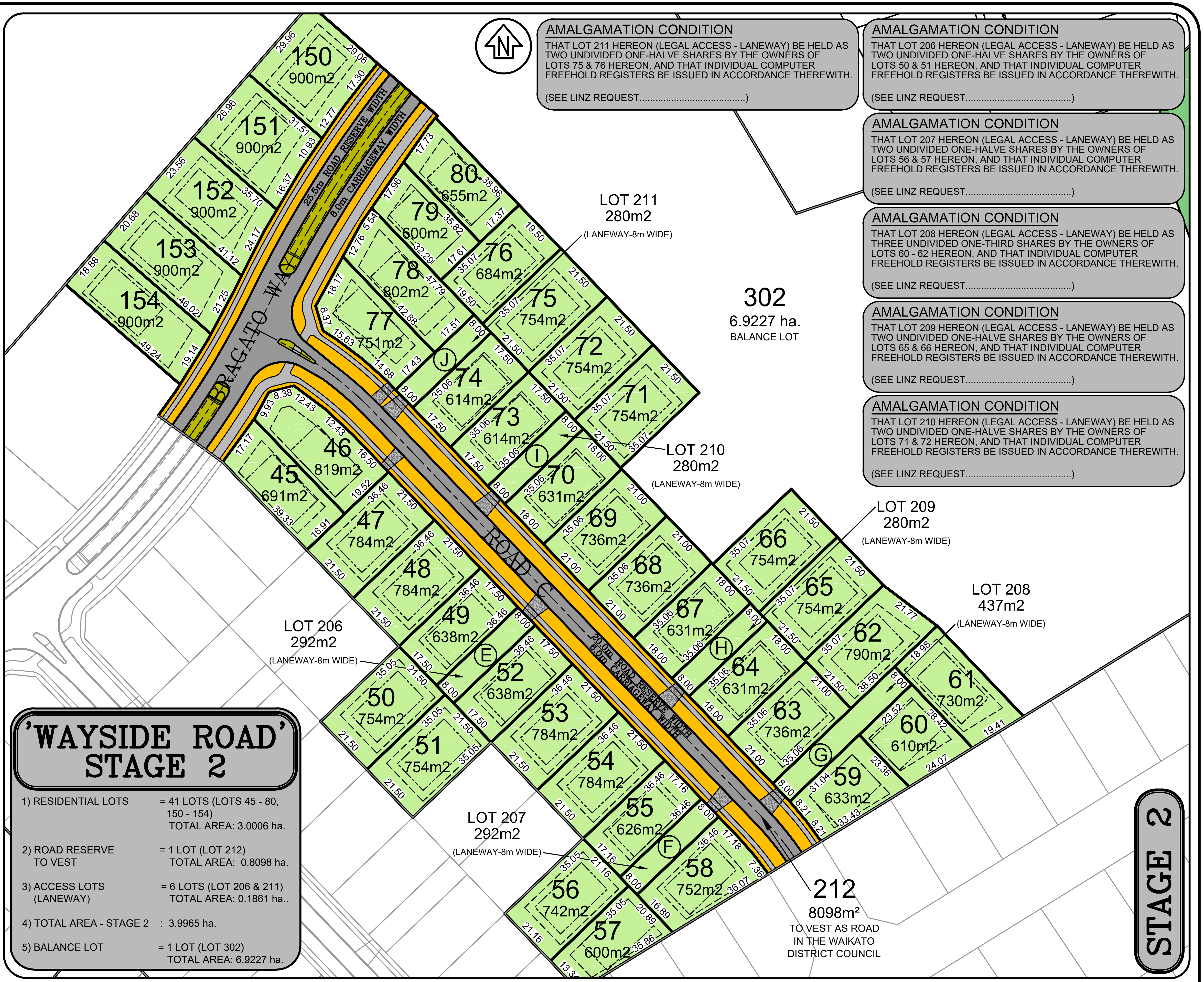
2) LEGAL DESCRIPTION: LOT 301
DP ??????
(CT. ??????)

3) TOTAL AREA: 10.9192 ha.

4) ZONE: LIVING ZONE TE KAUWHATA WEST

5) AERIAL PHOTO SUBJECT TO DISTORTION

6) ALL LEVELS ARE IN TERMS OF MOTURIKI DATUM



AMALGAMATION CONDITION

THAT LOT 211 HEREON (LEGAL ACCESS - LANEWAY) BE HELD AS TWO UNDIVIDED ONE-HALVE SHARES BY THE OWNERS OF LOTS 75 & 76 HEREON, AND THAT INDIVIDUAL COMPUTER FREEHOLD REGISTERS BE ISSUED IN ACCORDANCE THEREWITH.

(SEE LINZ REQUEST.......................................)

AMALGAMATION CONDITION

THAT LOT 206 HEREON (LEGAL ACCESS - LANEWAY) BE HELD AS TWO UNDIVIDED ONE-HALVE SHARES BY THE OWNERS OF LOTS 50 & 51 HEREON, AND THAT INDIVIDUAL COMPUTER FREEHOLD REGISTERS BE ISSUED IN ACCORDANCE THEREWITH.

(SEE LINZ REQUEST.......................................)

AMALGAMATION CONDITION

THAT LOT 207 HEREON (LEGAL ACCESS - LANEWAY) BE HELD AS TWO UNDIVIDED ONE-HALVE SHARES BY THE OWNERS OF LOTS 56 & 57 HEREON, AND THAT INDIVIDUAL COMPUTER FREEHOLD REGISTERS BE ISSUED IN ACCORDANCE THEREWITH.

(SEE LINZ REQUEST.......................................)

AMALGAMATION CONDITION

THAT LOT 208 HEREON (LEGAL ACCESS - LANEWAY) BE HELD AS THREE UNDIVIDED ONE-THIRD SHARES BY THE OWNERS OF LOTS 60 - 62 HEREON, AND THAT INDIVIDUAL COMPUTER FREEHOLD REGISTERS BE ISSUED IN ACCORDANCE THEREWITH.

(SEE LINZ REQUEST.......................................)

AMALGAMATION CONDITION

THAT LOT 209 HEREON (LEGAL ACCESS - LANEWAY) BE HELD AS TWO UNDIVIDED ONE-HALVE SHARES BY THE OWNERS OF LOTS 65 & 66 HEREON, AND THAT INDIVIDUAL COMPUTER FREEHOLD REGISTERS BE ISSUED IN ACCORDANCE THEREWITH.

(SEE LINZ REQUEST.......................................)

AMALGAMATION CONDITION

THAT LOT 210 HEREON (LEGAL ACCESS - LANEWAY) BE HELD AS TWO UNDIVIDED ONE-HALVE SHARES BY THE OWNERS OF LOTS 71 & 72 HEREON, AND THAT INDIVIDUAL COMPUTER FREEHOLD REGISTERS BE ISSUED IN ACCORDANCE THEREWITH.

(SEE LINZ REQUEST.......................................)

'WAYSIDE ROAD' STAGE 2

1) RESIDENTIAL LOTS = 41 LOTS (LOTS 45 - 80, 150 - 154)
TOTAL AREA: 3.0006 ha.

2) ROAD RESERVE TO VEST = 1 LOT (LOT 212)
TOTAL AREA: 0.8098 ha.

3) ACCESS LOTS (LANEWAY) = 6 LOTS (LOT 206 & 211)
TOTAL AREA: 0.1861 ha..

4) TOTAL AREA - STAGE 2 : 3.9965 ha.

5) BALANCE LOT = 1 LOT (LOT 302)
TOTAL AREA: 6.9227 ha.

STAGE 2

SCALE: 1:1250 @A3

DATE: JULY 2016

No.	Amendment	Init.	Date.	
				Designed. WAB
1	APPLICATION STAGING PLAN - STAGE 2	WAB	07/16	Drawn. WAB 7 JULY 2016
2				Checked.
3				Approved.

S:\2014\14012 - SILVERSPUR\CAD\FOR RC APPROVAL\14012 APPLICATION SCHEME #10 17-06-16.DWG

STAGING PLAN - STAGE 2 DETAIL PLAN
LOT 301 DP ??????
WAYSIDE ROAD - TE KAUWHATA
PREPARED FOR: TE KAUWHATA LAND LTD

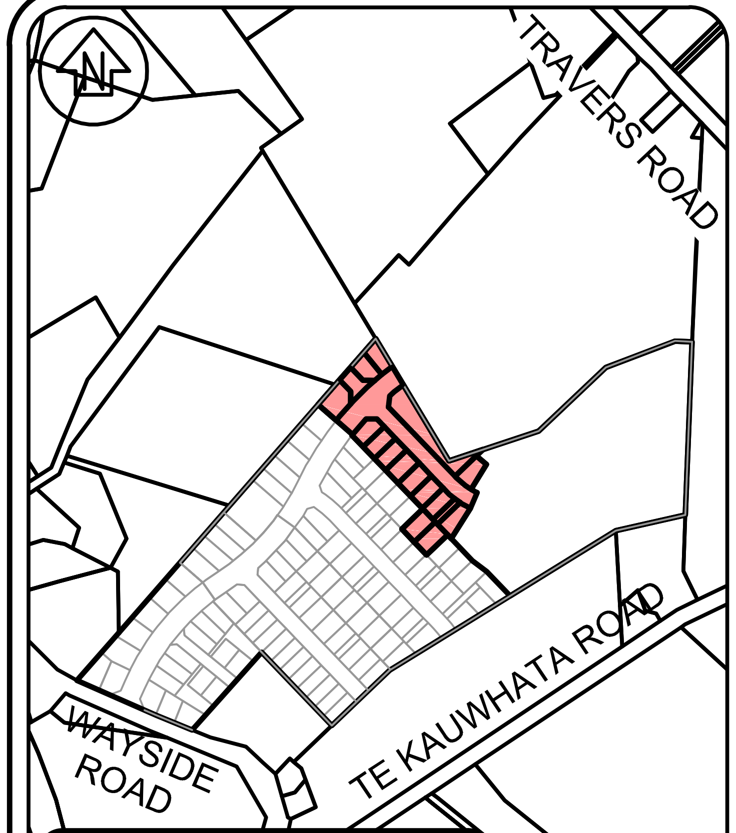
Version #10

Firm's Name

Blue Wallace
Surveyors Ltd.
25 Harwood Street, P O Box 38,
Hamilton Central, HAMILTON.
Phone (07) 839 7799, Fax (07) 839 4455

File Reference
14/012

Drawing No.
7 of 12



LOCATION DIAGRAM
Scale 1:10000

MEMORANDUM OF EASEMENT

PURPOSE	SERV. TENE.	SHOWN	DOM. TENE.
RIGHT OF WAY RIGHT TO CONVEY ELECTRICITY, TELECOMMUNI-CATIONS AND COMPUTER MEDIA, WATER RIGHT TO DRAIN SEWER & STORMWATER	LOT 213 HEREON	K	LOTS 88 & 89 HEREON

AMALGAMATION CONDITION

THAT LOT 213 HEREON (LEGAL ACCESS - LANEWAY) BE HELD AS TWO UNDIVIDED ONE-HALVE SHARES BY THE OWNERS OF LOTS 88 & 89 HEREON, AND THAT INDIVIDUAL COMPUTER FREEHOLD REGISTERS BE ISSUED IN ACCORDANCE THEREWITH.

(SEE LINZ REQUEST.......................................)

NOTE:

1) ALL AREAS AND DIMENSIONS SUBJECT TO FINAL SURVEY AND APPROVAL FROM THE WAIKATO DISTRICT COUNCIL

2) LEGAL DESCRIPTION: LOT 302
DP ??????
(CT. ??????)

3) TOTAL AREA: 6.9227 ha.

4) ZONE: LIVING ZONE TE KAUWHATA WEST

5) AERIAL PHOTO SUBJECT TO DISTORTION

6) ALL LEVELS ARE IN TERMS OF MOTURIKI DATUM

'WAYSIDE ROAD' STAGE 3A

1) RESIDENTIAL LOTS	= 14 LOTS (LOTS 81 - 90, 146 - 149) TOTAL AREA: 1.0331 ha.
2) ROAD RESERVE TO VEST	= 2 LOTS (LOTS 215 & 216) TOTAL AREA: 0.6363 ha.
3) RECREATION RESERVE TO VEST	= 1 LOT (LOT 214) TOTAL AREA: 0.2517 ha.
4) ACCESS LOT (LANEWAY)	= 1 LOT (LOT 213) TOTAL AREA: 0.0297 ha.
5) TOTAL AREA - STAGE 3A	: 1.9508 ha.
6) BALANCE LOT	= 1 LOT (LOT 303) TOTAL AREA: 4.9719 ha.

SCALE: 1:1250 @A3
DATE: JULY 2016

No.	Amendment	Init.	Date.	
				Designed. WAB
1	APPLICATION STAGING PLAN - STAGE 3	WAB	07/16	Drawn. WAB 7 JULY 2016
2				Checked.
3				Approved.

S:\2014\14012 - SILVERSPUR\CAD\FOR RC APPROVAL\14012 APPLICATION SCHEME #10 17-06-16.DWG

STAGING PLAN - STAGE 3A DETAIL PLAN
LOT 302 DP ??????
WAYSIDE ROAD - TE KAUWHATA
PREPARED FOR: TE KAUWHATA LAND LTD

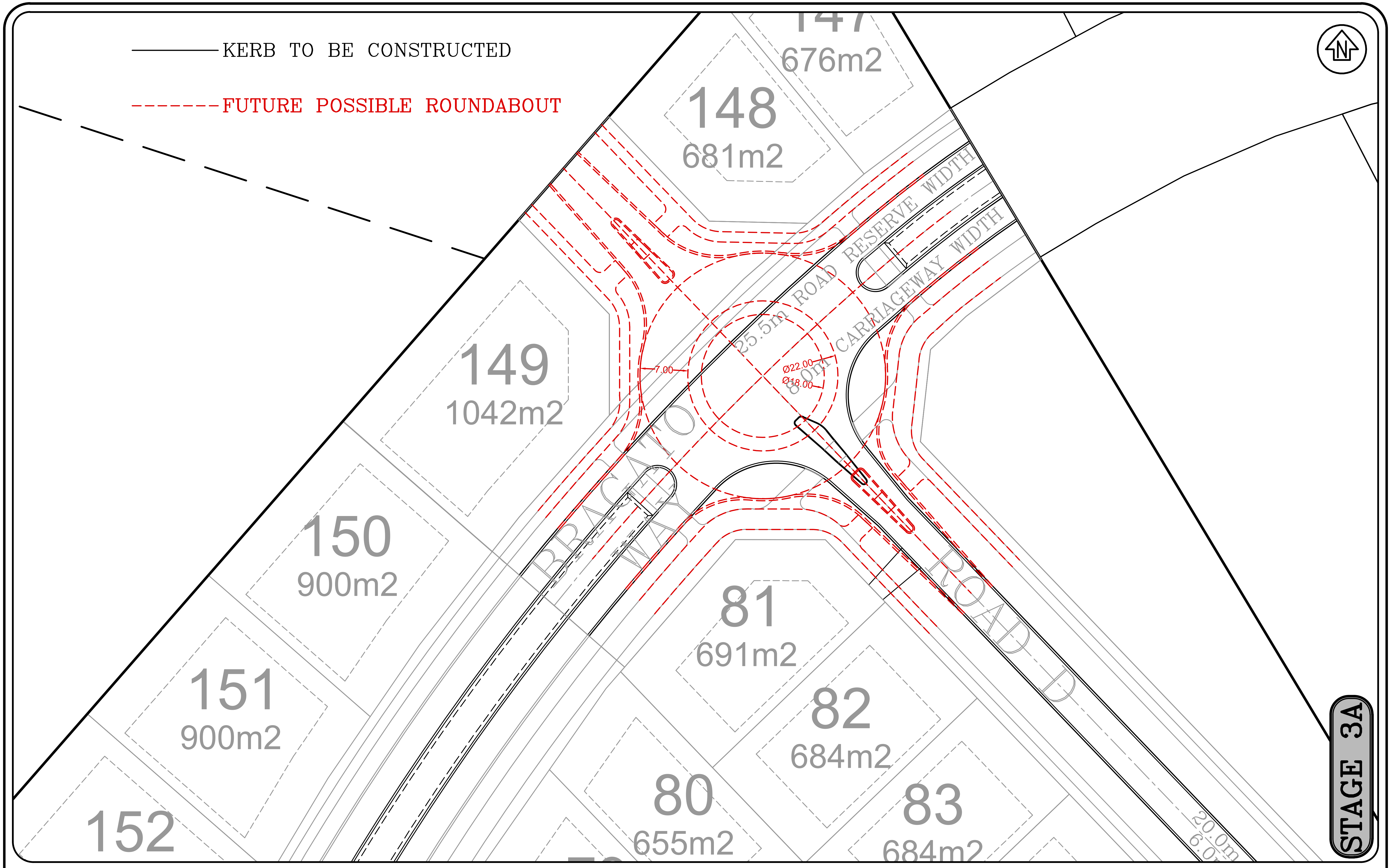
Version #10

Firm's Name

Blue Wallace
Surveyors Ltd.
25 Harwood Street, P O Box 38,
Hamilton Central, HAMILTON.
Phone (07) 839 7799, Fax (07) 839 4455

File Reference
14/012

Drawing No.
8 of 12



SCALE: 1:500 @A3

DATE: JULY 2016

No.	Amendment	Init.	Date.	Designed. WAB
1	APPLICATION STAGING PLAN - STAGE 3A	WAB	07/16	Drawn. WAB 7 JULY 2016
2				Checked.
3				Approved.

S:\2014\14012 - SILVERSPUR\CAD\FOR RC APPROVAL\14012 APPLICATION SCHEME #10 17-06-16.DWG

STAGING PLAN - STAGE 3A
ROUNDABOUT DETAIL PLAN
WAYSIDE ROAD - TE KAUWHATA
PREPARED FOR: TE KAUWHATA LAND LTD

Version #10

Firm's Name

Blue Wallace
Surveyors Ltd.
25 Harwood Street, P O Box 38,
Hamilton Central, HAMILTON.
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File Reference
14/012

Drawing No.
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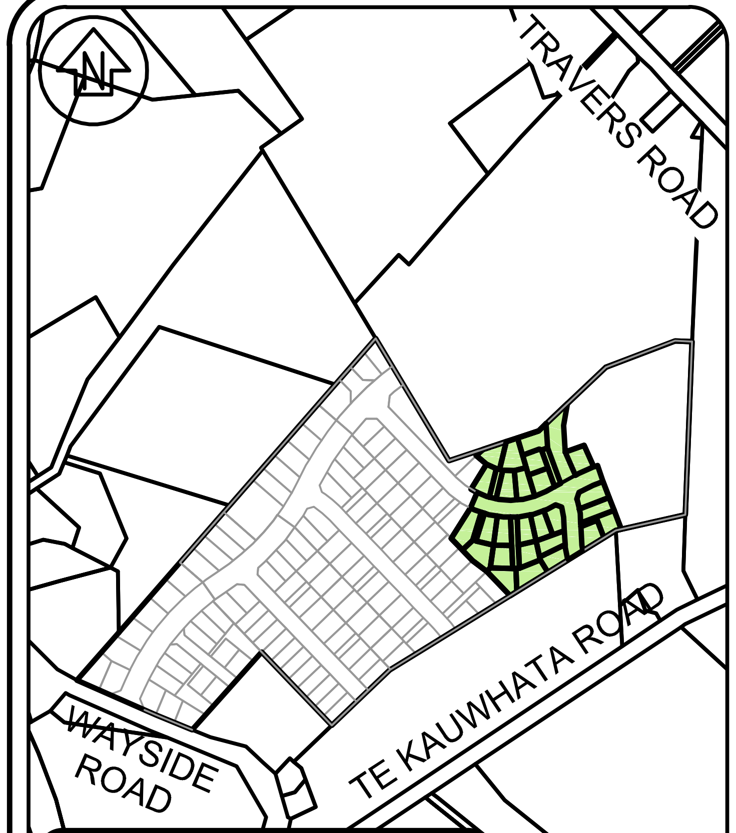


LOCATION DIAGRAM
Scale 1:10000

AMALGAMATION CONDITION

THAT LOT 217 HEREON (LEGAL ACCESS - LANEWAY) BE HELD AS FOUR UNDIVIDED ONE-FOURTH SHARES BY THE OWNERS OF LOTS 95 - 98 HEREON, AND THAT INDIVIDUAL COMPUTER FREEHOLD REGISTERS BE ISSUED IN ACCORDANCE THEREWITH.

(SEE LINZ REQUEST.......................................)

AMALGAMATION CONDITION

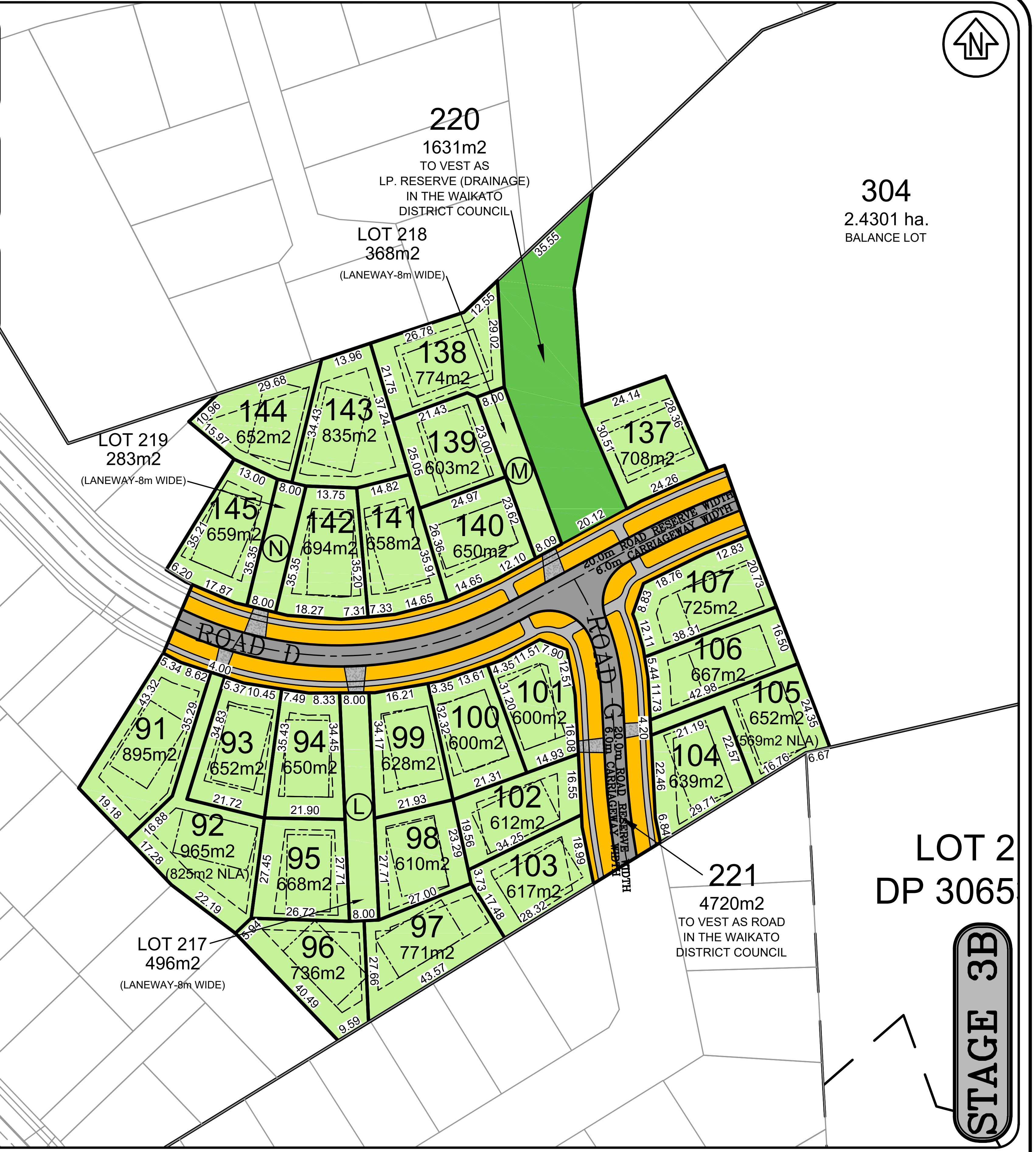
THAT LOT 218 HEREON (LEGAL ACCESS - LANEWAY) BE HELD AS TWO UNDIVIDED ONE-HALVE SHARES BY THE OWNERS OF LOTS 138 & 139 HEREON, AND THAT INDIVIDUAL COMPUTER FREEHOLD REGISTERS BE ISSUED IN ACCORDANCE THEREWITH.

(SEE LINZ REQUEST.......................................)

AMALGAMATION CONDITION

THAT LOT 219 HEREON (LEGAL ACCESS - LANEWAY) BE HELD AS THREE UNDIVIDED ONE-THIRD SHARES BY THE OWNERS OF LOTS 143 & 144 HEREON, AND THAT INDIVIDUAL COMPUTER FREEHOLD REGISTERS BE ISSUED IN ACCORDANCE THEREWITH.

(SEE LINZ REQUEST.......................................)



MEMORANDUM OF EASEMENT

PURPOSE	SERV. TENE.	SHOWN	DOM. TENE.
RIGHT OF WAY RIGHT TO CONVEY ELECTRICITY, TELECOMMUNI-CATIONS AND COMPUTER MEDIA, WATER RIGHT TO DRAIN SEWER & STORMWATER	LOT 217 HEREON	L	LOTS 95 - 98 HEREON
	LOT 218 HEREON	M	LOTS 138 & 139 HEREON
	LOT 219 HEREON	N	LOTS 143 & 144 HEREON

'WAYSIDE ROAD' STAGE 3B

1) RESIDENTIAL LOTS = 26 LOTS (LOTS 91 - 107, 137 - 145)
TOTAL AREA: 1.7920 ha.

2) ROAD RESERVE TO VEST = 1 LOT (LOT 221)
TOTAL AREA: 0.4720 ha.

3) ACCESS LOTS (LANEWAY) = 3 LOTS (LOTS 217 - 219)
TOTAL AREA: 0.1147 ha.

4) LP. RESERVE TO VEST (DRAINAGE) = 1 LOT (LOT 220)
TOTAL AREA: 0.1631 ha.

5) TOTAL AREA - STAGE 3B : 2.5418 ha.

6) BALANCE LOT = 1 LOT (LOT 304)
TOTAL AREA: 2.4301 ha.

NOTE:

1) ALL AREAS AND DIMENSIONS SUBJECT TO FINAL SURVEY AND APPROVAL FROM THE WAIKATO DISTRICT COUNCIL

2) LEGAL DESCRIPTION: LOT 303
DP ??????
(CT. ??????)

3) TOTAL AREA: 4.9719 ha.

4) ZONE: LIVING ZONE TE KAUWHATA WEST

5) AERIAL PHOTO SUBJECT TO DISTORTION

6) ALL LEVELS ARE IN TERMS OF MOTURIKI DATUM

SCALE: 1:1250 @A3
DATE: JULY 2016

No.	Amendment	Init.	Date.	
				Designed. WAB
1	APPLICATION STAGING PLAN - STAGE 3	WAB	07/16	Drawn. WAB 7 JULY 2016
2				Checked.
3				Approved.

S:\2014\14012 - SILVERSPUR\CAD\FOR RC APPROVAL\14012 APPLICATION SCHEME #10 17-06-16.DWG

STAGING PLAN - STAGE 3B DETAIL PLAN
LOT 303 DP ??????
WAYSIDE ROAD - TE KAUWHATA
PREPARED FOR: TE KAUWHATA LAND LTD

Version #10

Firm's Name

Blue Wallace
Surveyors Ltd.
25 Harwood Street, P O Box 38,
Hamilton Central, HAMILTON.
Phone (07) 839 7799, Fax (07) 839 4455

File Reference
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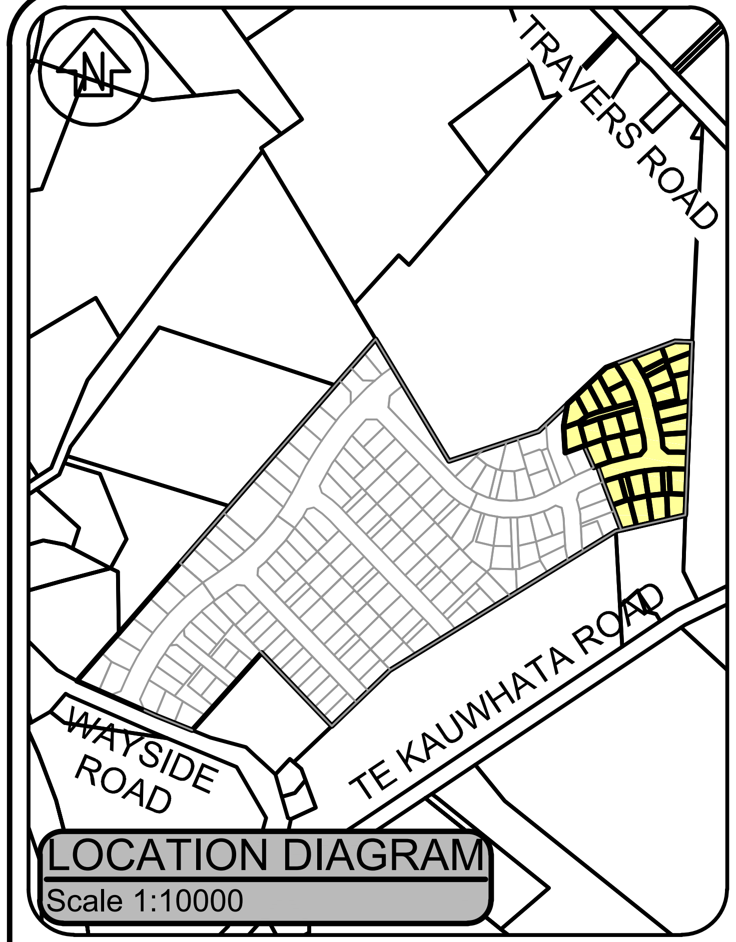
Drawing No.
10 of 12



LOCATION DIAGRAM

Scale 1:10000

AMALGAMATION CONDITION

THAT LOT 222 HEREON (LEGAL ACCESS - LANEWAY) BE HELD AS TWO UNDIVIDED ONE-HALVE SHARES BY THE OWNERS OF LOTS 109 & 110 HEREON, AND THAT INDIVIDUAL COMPUTER FREEHOLD REGISTERS BE ISSUED IN ACCORDANCE THEREWITH.

(SEE LINZ REQUEST.......................................)

AMALGAMATION CONDITION

THAT LOT 223 HEREON (LEGAL ACCESS - LANEWAY) BE HELD AS TWO UNDIVIDED ONE-HALVE SHARES BY THE OWNERS OF LOTS 113 & 114 HEREON, AND THAT INDIVIDUAL COMPUTER FREEHOLD REGISTERS BE ISSUED IN ACCORDANCE THEREWITH.

(SEE LINZ REQUEST.......................................)

AMALGAMATION CONDITION

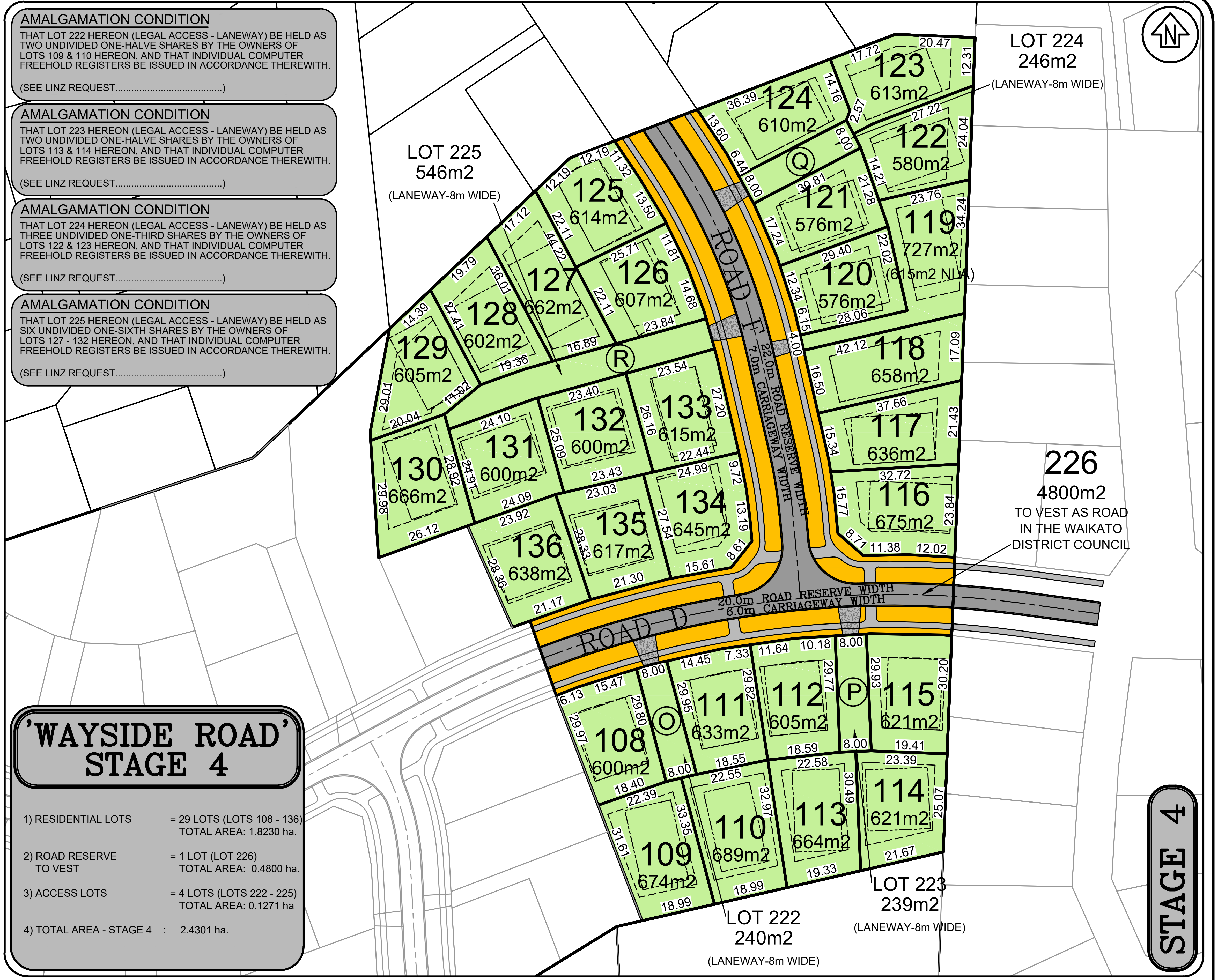
THAT LOT 224 HEREON (LEGAL ACCESS - LANEWAY) BE HELD AS THREE UNDIVIDED ONE-THIRD SHARES BY THE OWNERS OF LOTS 122 & 123 HEREON, AND THAT INDIVIDUAL COMPUTER FREEHOLD REGISTERS BE ISSUED IN ACCORDANCE THEREWITH.

(SEE LINZ REQUEST.......................................)

AMALGAMATION CONDITION

THAT LOT 225 HEREON (LEGAL ACCESS - LANEWAY) BE HELD AS SIX UNDIVIDED ONE-SIXTH SHARES BY THE OWNERS OF LOTS 127 - 132 HEREON, AND THAT INDIVIDUAL COMPUTER FREEHOLD REGISTERS BE ISSUED IN ACCORDANCE THEREWITH.

(SEE LINZ REQUEST.......................................)



MEMORANDUM OF EASEMENT

PURPOSE	SERV. TENE.	SHOWN	DOM. TENE.
RIGHT OF WAY RIGHT TO CONVEY ELECTRICITY, TELECOMMUNICATIONS AND COMPUTER MEDIA, WATER RIGHT TO DRAIN SEWER & STORMWATER	LOT 222 HEREON	O	LOTS 109 & 110 HEREON
	LOT 223 HEREON	P	LOTS 113 & 114 HEREON
	LOT 224 HEREON	Q	LOTS 122 & 123 HEREON
	LOT 225 HEREON	R	LOTS 127 - 132 HEREON

'WAYSIDE ROAD' STAGE 4

1) RESIDENTIAL LOTS	= 29 LOTS (LOTS 108 - 136) TOTAL AREA: 1.8230 ha.
2) ROAD RESERVE TO VEST	= 1 LOT (LOT 226) TOTAL AREA: 0.4800 ha.
3) ACCESS LOTS	= 4 LOTS (LOTS 222 - 225) TOTAL AREA: 0.1271 ha
4) TOTAL AREA - STAGE 4	: 2.4301 ha.

NOTE:

1) ALL AREAS AND DIMENSIONS SUBJECT TO FINAL SURVEY AND APPROVAL FROM THE WAIKATO DISTRICT COUNCIL

2) LEGAL DESCRIPTION: LOT 304
DP ??????
(CT. ??????)

3) TOTAL AREA: 2.1415 ha.

4) ZONE: LIVING ZONE TE KAUWHATA WEST

5) AERIAL PHOTO SUBJECT TO DISTORTION

6) ALL LEVELS ARE IN TERMS OF MOTURIKI DATUM

STAGE 4

SCALE: 1:1000 @A3

DATE: JULY 2016

No.	Amendment	Init.	Date.	
				Designed. WAB
1	APPLICATION STAGING PLAN - STAGE 4	WAB	07/16	Drawn. WAB 7 JULY 2016
2				Checked.
3				Approved.

S:\2014\14012 - SILVERSPUR\CAD\FOR RC APPROVAL\14012 APPLICATION SCHEME #10 17-06-16.DWG

STAGING PLAN - STAGE 4 DETAIL PLAN
LOT 304 DP ??????
WAYSIDE ROAD - TE KAUWHATA
PREPARED FOR: TE KAUWHATA LAND LTD

Version #10

Firm's Name

Blue Wallace
Surveyors Ltd.
25 Harwood Street, P O Box 38,
Hamilton Central, HAMILTON.
Phone (07) 839 7799, Fax (07) 839 4455

File Reference
14/012

Drawing No.
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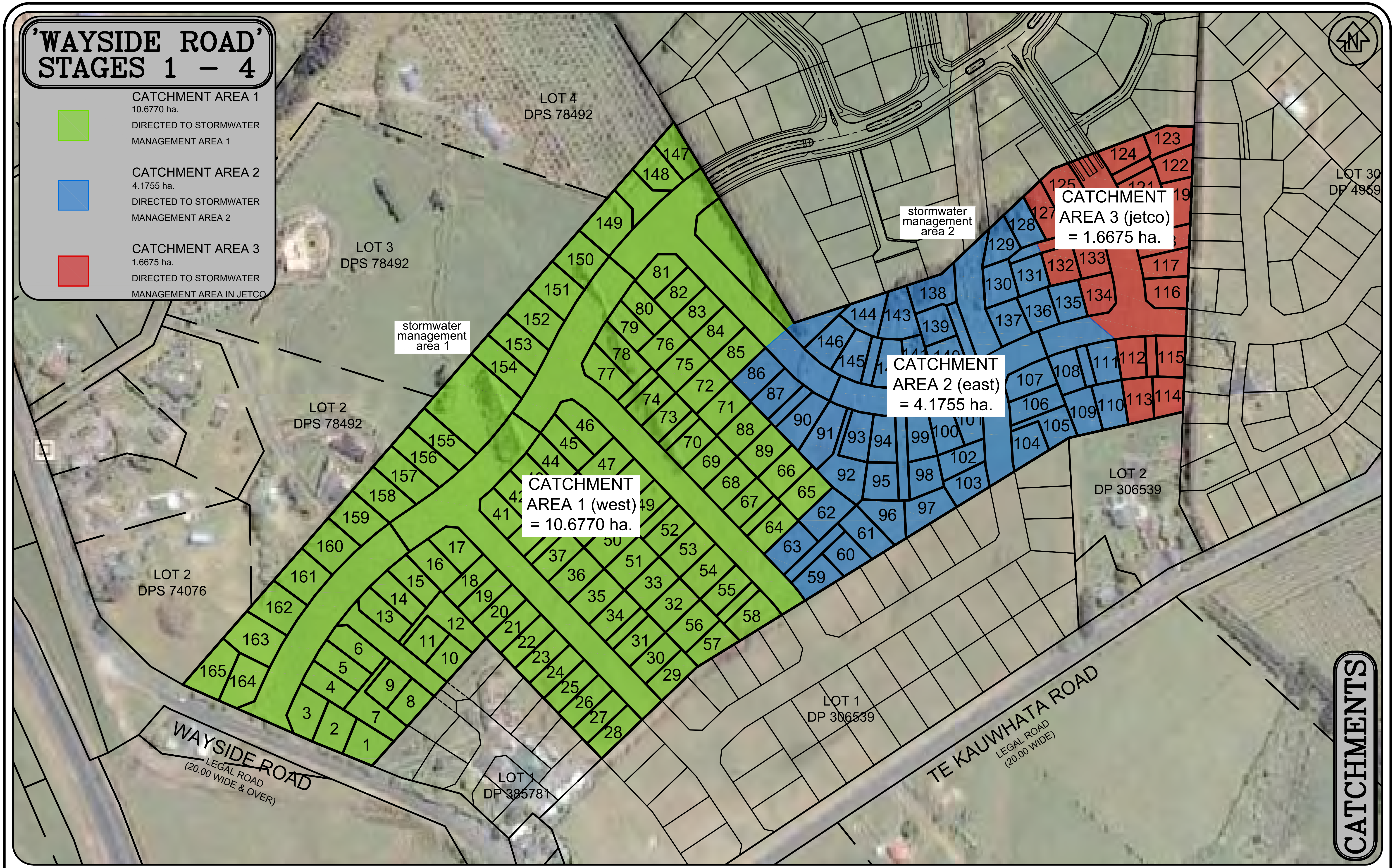

'WAYSIDE ROAD' STAGES 1 - 4

🟩 CATCHMENT AREA 1
10.6770 ha.
DIRECTED TO STORMWATER MANAGEMENT AREA 1

🟦 CATCHMENT AREA 2
4.1755 ha.
DIRECTED TO STORMWATER MANAGEMENT AREA 2

🟥 CATCHMENT AREA 3
1.6675 ha.
DIRECTED TO STORMWATER MANAGEMENT AREA IN JETCO

SCALE: 1:2500 @A3, 1:1250 @A1
DATE: JULY 2016

No.	Amendment	Init.	Date.
1	APPLICATION SCHEME PLAN #10 17-6-16	WAB	07/16
2			
3			

Designed. WAB
Drawn. WAB 7 JULY 2016
Checked.
Approved.

S:\2014\14012 - SILVERSPUR\CAD\FOR RC APPROVAL\14012 APPLICATION SCHEME #10 17-06-16.DWG

LOTS 1 - 165 BEING A SUBDIVISION OF
LOT 306 DP 495940
WAYSIDE ROAD - TE KAUWHATA
PREPARED FOR: TE KAUWHATA LAND LTD

Version #10

Firm's Name
Blue Wallace
Surveyors Ltd.
25 Harwood Street, P O Box 38,
Hamilton Central, HAMILTON.
Phone (07) 839 7799, Fax (07) 839 4455

File Reference
14/012

Drawing No.
12 of 12

Exhibit E: Geotech Report Eastern Catchment

WAYSIDE ROAD SCHOOL SITE

PRELIMINARY GEOTECHNICAL ASSESSMENT

PROJECT NO: HD1151
TE KAUWHATA LAND LIMITED
REFERENCE: PGA
10 JANUARY 2019

26 London Street | Hamilton New Zealand | 07 957 2727 | **hdgeo.co.nz**

Executive Summary

Te Kauwhata Land Limited has engaged us to complete a geotechnical assessment for their site at 24 Wayside Road, Te Kauwhata. The Ministry of Education is investigating the site for a potential primary school on the eastern portion of the subdivision.

Tonkin & Taylor have completed an initial investigation for MOE including four CPTs and four Test Pits. Based on Tonkin & Taylor's study, some aspects of the site require further consideration.

We have completed additional investigations and assessments to supplement Tonkin & Taylor's study.

Our Scope included:

- review of existing information, desk study of geotechnical information, geological maps and historic aerial imagery
- detailed site walkover to inspect the geomorphology and identify key constraints
- 8 hand augers with strength testing to depths up to 4 m
- 10 test pits up to 3 m depth to identify the approximate extent of uncontrolled fill
- 3 CPTs with dissipation testing
- 1 machine drilled borehole with two push tube samples for consolidation testing
- liquefaction assessment
- settlement assessment
- slope stability assessment

Our key findings were:

- the site is underlain by fill and Holocene swamp deposits in low lying areas near the gully
- most of the site is underlain by Hamilton Ash Formation and Whangamarino Formation
- groundwater is expected to be between 0.5 m and 3.5 m depth
- there is a rubbish pit on the northern side of the site within the gully
- to the north-east side of the site, a thick layer of soft soil is shown in the CPTs at depths between 8 m and 14 m
- the site is expected to have a low risk of liquefaction damage in a ULS earthquake event
- Some layers of soil are likely to be susceptible to consolidation on loading
    - The CPT estimates of settlement are significant (>1m in places) however, the CPT analysis appears to be overly conservative, possibly due to the structure of sensitive soils being completely disturbed by the testing
    - The settlement analysis using the consolidation testing results gives estimates of less than 117 mm
- Cut and fill batters around the site are expected to be stable at angles of 1H:2V
- The toe of the fill batter in the gully will need undercutting of the unsuitable material or some other engineered mitigation to ensure stability

Our recommendations are that:

- As predicted consolidation settlements would be above tolerable limits, monitoring during earthworks will be needed to confirm settlement has stopped before building
- Identified rubbish pits and uncontrolled fill should be excavated and replaced by suitable material
- steep slopes should be flattened to stable angles or appropriately retained
- further assessment work will be needed as the proposal develops

Contents

PREPARED BY: **Shima Sheybani Aghdam**

Geotechnical Engineer

Shima@hdgeo.co.nz
Tel 07 957 2727

REVIEWED BY: **Andrew Holland, CPEng**

Technical Director
Principal Engineer
Andrew@hdgeo.co.nz
Tel 022 048 8441

Introduction

Te Kauwhata Land Limited (TKL) has engaged us to complete a geotechnical assessment for a part of their site at 24 Wayside Road, Te Kauwhata. The site is intended to be subdivided into residential land. The Ministry of Education (MoE) is investigating building a primary school in the eastern portion of the site. MOE has had some limited testing undertaken and requested a further geotechnical investigation from TKL.

Tonkin & Taylor have completed an initial investigation for MOE including four CPTs and four Test Pits. Based on Tonkin & Taylor's study, some hazards were identified on the site that need further consideration. These included:

- soft soils that may be at risk of consolidation settlement (areas around T&T CPT01)
- uncontrolled fill on within the gully
- potential instability related to steep proposed slopes some boundaries of the site

We have carried out site-specific investigation including hand augers, CPTs, test pits and a machine drilled borehole. Two push tube samples were taken in the borehole for laboratory consolidation testing. We have assessed the results of the testing and present our assessment below.

We understand that this report will be submitted to the MoE to provide further information on the site as they consider it for development.

Scope

Our scope included:

- review of existing information, geological maps and historic aerial imagery
- detailed site walkover to inspect the geomorphology and identify key constraints
- completion of 8 hand augers with strength testing to depths up to 4 m to evaluate the subsurface material types and strength characteristics
- completion of 10 test pits up to 3 m depth to identify the approximate extent of uncontrolled fill
- completion of 3 CPTs with dissipation testing
- completion of 1 borehole to 10.5 m with two push tube samples for consolidation testing
- liquefaction assessment
- slope stability assessment
- settlement assessment

Site description

The site is located in Te Kauwhata and is the eastern portion of a larger property that will be subdivided into residential lots. The wider property is legally described as Lot 306, DP495940. The site is bounded by undeveloped rural areas to the east and south. Residential development borders the northern and western sides of the site. The site was mostly covered by overgrown plants and trees at the time of our investigation. There is a gully roughly central to the site sloping down from south to north. Most of the site currently slopes down into the gully.

Proposed development

Based on draft cut/fill plans provided by Blue Wallace Surveyors, the site will be cut down and filled to form a near level site for the school. The fill will be up to a maximum 10 m. The cuts will be up to 13 m deep. The draft cut/fill plan is attached in Appendix F.

Desk study

We have completed a desk study including a review of historical aerial imagery, relevant geological maps and existing reports and investigation results completed on or near the site.

Historical aerial imagery

We sourced historical aerial images from Retrolens[1] and Google Earth. Images from 1949, 1963, 1986, 1991 and 2019 were reviewed with relevant images included in Appendix B.

The images showed that:

- the site was undeveloped rural land in 1949 and 1963
- the site was planted with trees from 1986 to 2002
- trees were cut down and the site was undeveloped rural land from 2002 to 2020 (present day)

Geological setting

The New Zealand Geology maps and GNS viewer[2] indicate the site is underlain by Whangamarino Formation of the Walton Subgroup. Whangamarino Formation is described as' slightly pumiceous clays, with lignite, gravel, and some pure pumice silt and sand'.

Hamilton ash is known to mantle the mapped geology in this area.

Previous investigations

Opus and Tonkin & Taylor have previously completed work on, or near, the site. This includes:

- subdivision engineering report prepared by OPUS[3], dated July 2016
- 4 CPTs by Tonkin & Taylor, in July 2019
- 4 Test Pits by Tonkin & Taylor, in July 2019
- email summary of initial findings, T&T to MoE, dated July 2019

The findings and recommendations of these tests or reports have been reviewed and considered in the preparation of this report.

OPUS report

OPUS prepared a subdivision engineering report, dated July 2016. They have done their assessment based on hand augers and CPTs carried out on the site.

According to the report:

- soft and compressible soils are present in shallow depths in the low-lying areas

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[1] http://retrolens.nz/

[2] https://data.gns.cri.nz/geology/

[3] "Engineering Report summary – TK Land Ltd Residential development" prepared by Opus International Consultations Ltd, dated 14 July 2016

- potentially unstable slopes exist directly east of the central ridge on the site
- based on CPTs, there is potential for liquefaction with the highest risk on the eastern side of the site

The recommendations were:

- areas with soft soils will need to be avoided for construction or engineered to improve the ground conditions
- low bearing capacity should be considered for low lying areas
- to improve the slope stability, regrade the slopes or construct retaining structures

Tonkin & Taylor

Tonkin & Taylor have carried out a preliminary assessment on an area near the gully (north of the site) and have raised concerns to MoE that need further consideration. These concerns were:

- soft soils that may be susceptible to consolidation settlement were found near the gully on the northern area of the site (areas around T&T CPT01)
- uncontrolled fill was found in the gully
- There are steep slopes proposed around the boundaries of the site

They have recommended further investigation to be completed around the area to determine the extent and thickness of the compressible soil and uncontrolled fill.

Site investigation

Ground conditions

We have completed additional testing across the site to further characterise the site ground conditions (mainly focusing on low laying areas and the hazards identified).

The ground conditions we encountered during the site investigation were generally consistent with the expected geology. Ground conditions were assessed by conducting 8 Hand Augers with strength testing, 10 Test Pits, 3 CPTs and one machine drill hole, with two push tube samples taken for consolidation testing. A site plan with investigation locations is included in Appendix A. Investigation records are included in Appendix C.

Ground conditions across the site included:

Central low laying areas (to the north)

- rubbish, concrete, metal and topsoil between 0.3 m and 2.6 m depth (areas to the west of the gully have the deepest rubbish/topsoil depth), overlaying
- silty clay of Whangamarino Formation (Walton Subgroup) up to 7 m depth, overlaying
- clayey sand of Tauranga Subgroup up to 14 m depth, overlaying
- silty clay of Whangamarino Formation (Walton Subgroup) up to 18 m depth or more

A marked-up plan indicating the low laying areas is attached in Appendix A (Drawing 1)

Elevated ground (to the east and west)

- topsoil up to 0.5 m depth, overlaying
- silty clay of The Hamilton Ash Formation up to 4 m depth

Rubbish pit

Silt and clay fill with rubbish (plastic, metal, concrete and glass) was encountered on the northern side of the site (around the gully) to approx. 2.5 m depth in TP01, TP02, TP06, and TP07. Highly sensitive material was encountered in TP06, TP07, and TP09 at depths between 2.1 m and 2.6 m and below 6.5 m depth in BH01. Samples were taken in the uncontrolled fill and tested for contaminants.

An outline of the interpreted extent of the rubbish material is provided on Drawing 2 in Appendix A. Note that this is an interpretation and other areas of rubbish may be present.

Groundwater

Groundwater was encountered across the site at varying depths between 0.3 m (HA08) and 3.5 m (HA06).

Groundwater was dipped right after completion of the CPTs. And was found at 2.4 m to 3.15 m depth. Due to hole collapse, no ground water was encountered in CPT03.

Geotechnical assessment

Liquefaction

We have completed a site-specific liquefaction assessment using fourteen existing[4] and three additional site-specific CPT tests (completed by us).

The assessment has been undertaken in accordance with the relevant guidance document[5]. Assessment outputs are included in Appendix D.

Assessment inputs

A screening analysis was completed using CPTs undertaken at the site for 1 in 500-year (ULS) and 1 in 25-year (SLS) design events. We have assumed the proposed buildings will fit into the MoE definition of IL2. The assessment should be revised if the development includes buildings that meet the requirements of IL3.

The test results were analysed using the proprietary software CLIQ (Geologismiki) and engineering calculations.

The design earthquake for the analysis of liquefaction susceptibility has been assessed from Section 6 of the NZTA Bridge Manual[6]. Input parameters are listed below:

- Site seismic classification[7]: Class D (Deep soil site)
- Structure Importance Level[8]: Level 2 (Normal building)
- Peak ground acceleration:
    - 0.07g (SLS) for 1 in 25-year event
    - 0.28g (ULS) for a 1 in 500-year event
- Earthquake magnitude: 5.8

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[4] OPUS and Tonkin & Taylor

[5] Ministry of Business Innovation and Employment (MBIE) / New Zealand Geotechnical Society (NZGS). Module 3: Identification, assessment and mitigation of liquefaction hazards. Dated May 2016

[6] New Zealand Transport Agency (October 2018). Bridge manual (SP/M/022) Third edition.

[7] NZS 1170.5:2004. *Structural Design Actions – Earthquake Actions (New Zealand).*

[8] NZS 1170.0:2002. *Structural Design Actions – General Principles.*

- Groundwater depth: varies between 0.0 m and 6.3 m
- Fill depth: varies between 1 m and 10 m

Liquefaction susceptibility

Based on our site investigation, ground conditions we have encountered on the site are volcanic ash and Whangamarino Formation of Walton Subgroup. This type of material is unlikely to be susceptible to liquefaction due to their cohesive nature and age (up to 1.8 million years). Reviewing the core from the borehole shows the material to be predominantly cohesive and qualitatively unlikely to liquefy.

Yong & Clayton[9] have presented research on correction factors for liquefaction assessment of Waikato soils (on the Hamilton Section of the Waikato Expressway, in similar soils to the site). Based on this study, their conclusion is that using an Ic cutoff of 2.6 is overly conservative for the Hamilton Ash and underlying deposits. Based on laboratory testing, they recommend a conservative lower Ic cutoff of 2.2 for these soils.

We have completed a liquefaction assessment based on using both Ic cutoff values of 2.2 (expected) and 2.6 (conservative). Below is the summary of our assessment:

Soil Behaviour Index of 2.2

SLS conditions:

Under SLS conditions, no liquefaction was predicted for the site.

ULS conditions:

- between 0 mm and 11 mm of predicted vertical settlement
- Liquefaction Potential Index between 0 and 1.5
- Liquefaction Severity Number between 0 and 2

Using the Ic cutoff value of 2.2, under ULS condition, the site falls into performance level L0 (insignificant liquefaction risk).

Soil Behaviour Index of 2.6

We also have completed a liquefaction assessment based on using the Ic cutoff of 2.6 (Robertson and Wride) as a sensitivity check.

SLS conditions:

Under SLS conditions, no liquefaction was predicted for the site.

ULS conditions:

- between 0 mm and 50 mm of predicted vertical settlement
- Liquefaction Potential Index between 0 and 4.5
- Liquefaction Severity Number between 0 and 8

Using the Ic cutoff value of 2.6, under ULS condition, the site lies within performance level L0 to L2 (insignificant to moderate liquefaction risk) in accordance with relevant guidelines.

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[9] 'Application of soil specific correction factors for liquefaction assessment', Yong, I. & Clayton, P.B. (2017)

Settlement

According to Tonkin & Taylor's initial assessment, the presence of very sensitive compressible soils in deeper layers of T&TCPT01 (between approx. 7 m and 14 m) raise a concern of excessive consolidation settlement on loading with the fill.

We have assessed the risk of consolidation settlement at the site including:

- a screening assessment using the proprietary software CPeT (Geologismiki) and CPT data across the site (a simple elastic approximation)
- consolidation testing results from BH01, completed adjacent to T&T CPT01

We took samples from the borehole at depths of 7 m and 10 m bgl, within the layer identified at most risk of consolidation in the CPT and completed laboratory testing (one-dimensional consolidation settlement) to complete a detailed consolidation assessment.

According to the preliminary cut & fill plans provided by Blue Wallace, engineered fill will be placed to elevate the existing ground. Fill depth varies from 0.5 m to 10m.

CPT settlement estimate

Using the CPT data, a maximum settlement of approx. 1.3m (Table 1) is predicted at the T&TCPT01 location.

The majority of this settlement occurs in a 7 m thick layer. This magnitude of settlement is unusual in soils that are not organic and may indicate that the CPT is disturbing the sensitive Tauranga Group material and overestimating the consolidation potential. This is a known shortcoming of the CPT test in sensitive volcanic soils.

Table 1. summary of CPT estimated settlements

	OPUS-CPT05	OPUS-CPT08	T&T-CPT01	T&T-CPT02	T&T-CPT03	HD-CPT01	HD-CPT02	HD-CPT03
Maximum fill depth	10m	1m	10m	10m	10m	10m	4.5m	2.5m
Maximum load applied by fill	150kPa	15kPa	150kPa	150kPa	150kPa	150kPa	67.5kPa	37.5kPa
CPeT settlement estimates	150mm	6mm	1270mm	690mm	140mm	215mm	80mm	22mm

In some CPTs, an excessive consolidation settlement is observed over a thin layer of approx. 1m to 2m (i.e. 140mm in T&T CPT03 and 690mm in T&TCPT02). This is unrealistic and we believe that it is a severe example of the CPT fully disturbing the structure of the soils.

Laboratory settlement estimate

Two pushtube samples were taken from within the layer that the CPT assessment shows is susceptible to consolidation. The lowest strength layer is between approx. 8m and 14m in T&TCPT01. The two samples were tested using one dimensional (oedometer) tests with a stress range that bracketed the current and expected effective stress states of the soil at the sample depth.

The results were fairly consistent between the two samples with m_v between approximately 0.1 and 0.13 $\frac{m^2}{MN}$. The lab data is included in Appendix E.

Using these results to calculate settlement from the soft layer (using the thickness as identified in the borehole and CPT), and with the expected increase in stress from the fill (as for the CPT assessment above), the predicted consolidation settlement (117 mm) is approximately 10% of the CPT prediction.

From the laboratory testing, it appears that the CPT test is disturbing the sensitive soils and over-predicting susceptibility to consolidation.

To estimate susceptibility to consolidation across the site, we have applied a correction to the CPT data based on:

$$\frac{\Delta S_{OED}}{\Delta S_{CPT}} \approx 0.1\ to\ 0.2$$

Based on lab testing and Cpet assessment results, the correction factor of 0.09 can be applied. We have assumed using correction factor of 0.1 and 0.2.

This approach gives:

Table 2. summary of estimated settlements

	OPUS-CPT05	OPUS-CPT08	T&T-CPT01	T&T-CPT02	T&T-CPT03	HD-CPT01	HD-CPT02	HD-CPT03
Fill depth	10m	1m	10m	10m	10m	10m	4.5m	2.5m
Load	150kPa	15kPa	150kPa	150kPa	150kPa	150kPa	67.5kPa	37.5kPa
$\boldsymbol{\Delta S_{0.1CPT}}$	15mm	0.6mm	127mm	69mm	14mm	21.5mm	8mm	2.2mm
$\boldsymbol{\Delta S_{0.2CPT}}$	30mm	1.2mm	254mm	138mm	28mm	23mm	16mm	4.4mm

So, the expected settlement on loading, based on the laboratory testing, ranges from insignificant (<20mm) to approximately 250mm.

Even with the corrections applied, there is significant consolidation predicted for T&TCPT01 and T&TCPT02. During earthworks, we recommend monitoring the settlement to confirm magnitude and that settlement has stopped before building starts.

The CPT screening assessments are attached in Appendix E.

Uncontrolled Fill

We have carried out 10 Test Pits up to 3 m depth to identify the extent and thickness of the uncontrolled fill identified by T&T. Based on our investigation, the uncontrolled fill is within an area approximately 85m by 40m within the gully area.

Drawing 2, showing the interpreted extent of the uncontrolled fill, is attached in Appendix A.

Within the uncontrolled fill, we encountered potentially contaminated rubbish in some test pits.

We undertook contamination testing of 2 samples (from TP02 and TP06). The test results indicated elevated lead and arsenic concentrations. The results were above guideline values for high-density residential developments (which is often used for primary schools). Results for other heavy metals were above background concentrations but below guideline values. The material cannot be disposed of as clean fill because it contains hydrocarbons and heavy metal above background concentrations.

The concentrations are below commercial/industrial value and, based on our limited testing, as long a good practice is used during construction, there isn't an undue risk to construction workers.

Note that this is an interpretation based on limited testing and other areas of uncontrolled fill may be present. Further testing may be warranted during earthworks.

Slope stability

The preliminary cut and fill plans show steep slopes along the boundaries due to cut/fill batters all around the site.

Ground model

We have created six ground models using the investigation results. The geometry has been taken from cross-sections provided by the surveyor.

Stability analysis

We have modelled slope stability using the proprietary software Slide (Rocscience).

The material parameters used in the slope stability assessment are presented below (Table 3). These parameters were based on the investigation results and our previous knowledge of the encountered materials.

Table3. Summary of material parameters

Unit	**Material parameters**				
	C' (kPa)	Ø' (degrees)	ɣ' (kN/m^3)	Su (kPa)	Groundwater condition
Engineered Clayey Fill	4	35	15	100	Ru 0.15 – Normal Ru 0.3 – Elevated
Hamilton Ash Formation	5	32	15	100	Ru 0.15 – Normal Ru 0.3 – Elevated
Whangamarino Formation (Walton Subgroup)	2	30	15	80	Ru 0.15 – Normal Ru 0.3 – Elevated
Holocene Swamp Deposits (Tauranga group)	2	25	14	-	Below GWT
Dense sand (due to refusal in CPT testing)	5	38	17	-	Below GWT
Uncontrolled Fill in gully	0	20	13	30	Ru 0.15 – Normal Ru 0.3 – Elevated

The analysis checked the modelled stability under static (drained), ULS seismic (undrained) and elevated groundwater (drained) conditions with target factors of safety as summarised in Table 4.

Table 4. summary of analysis conditions

Case	Description	Target Factor of Safety (FoS)
Normal conditions (Static)	Drained parameters	1.5
Elevated Groundwater	Drained parameters	1.2
Seismic (ULS)	Undrained parameters	1

The draft cut/fill plans show a 1:1 batter slope. The results of the slope stability assessment indicate that the proposed cut and fill batter slopes are unstable at these angles. We recommend the proposed batter slopes are flattened to approx. 1V:2H.

Retaining walls may be needed if space constraints mean that 1V:2H doesn't work for the development.

A critical section was modelled through the base of the gully, where unsuitable gully materials are to be overlain by nearly 10m of engineered fill. The model shows slope instability is likely without ground improvement. Options for this area include, excavate and replace the unsuitable material with engineered fill, create a shear key or install a barrier wall to stabilise the toe. Further work will be needed to design the mitigation needed in this area.

Our slope stability assessment outputs are attached in Appendix F.

Summary and recommendations

The site has variable ground conditions due to the gully that runs through the center of the site.

Our assessment shows:

- liquefaction hazard is likely to be low
- consolidation is likely in some areas on loading with fill
- stability is marginal as currently modelled

Further works are required for detailed design including:

- flattening the slopes or retaining wall/stabilisation design along the boundaries of the site
- mitigation design for the toe of the fill batter in the base of the gully
- detailed settlement assessment & monitoring during construction
- earthworks specification
- construction observation including removal of the uncontrolled fill
- environmental assessment

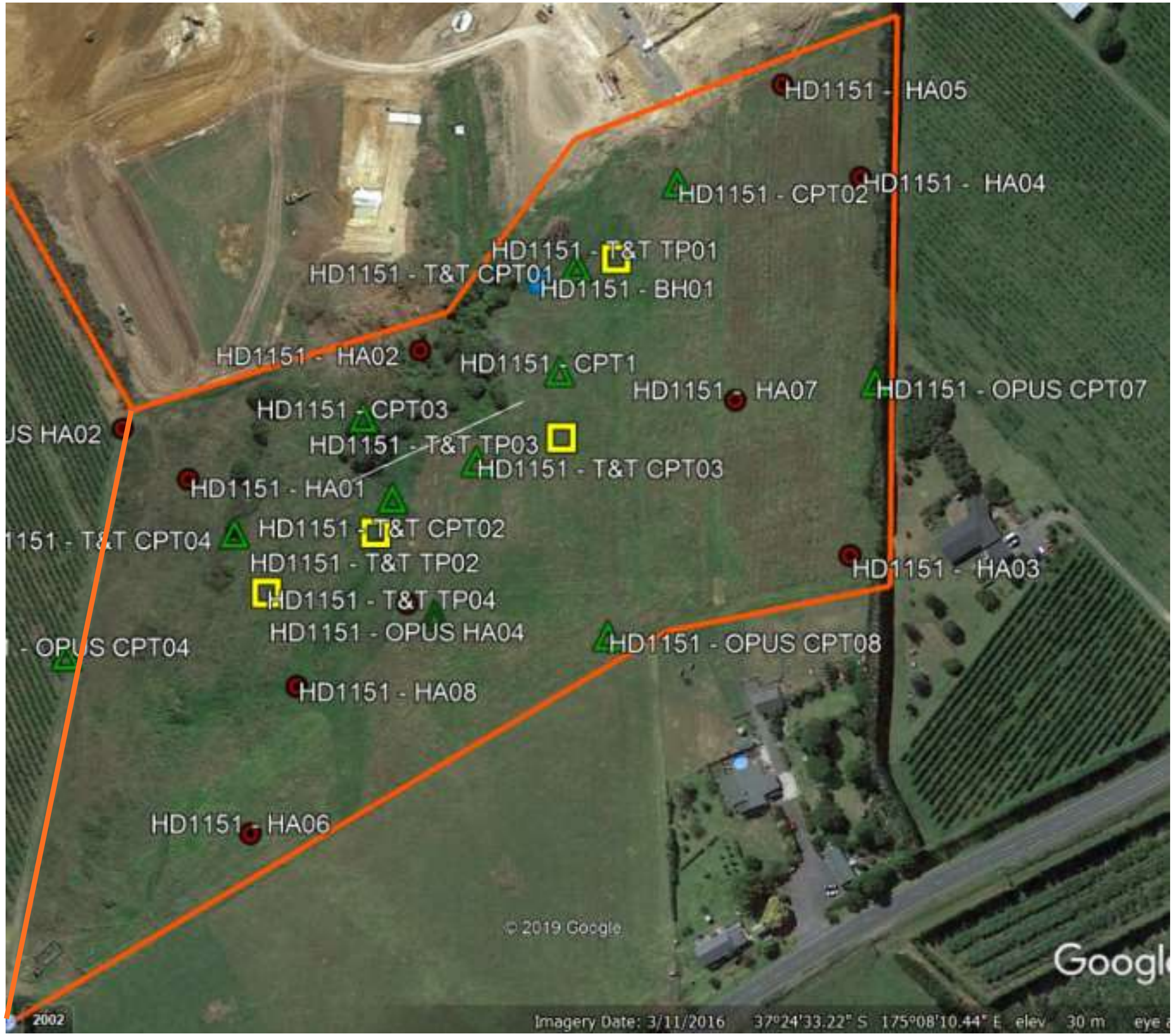
Limitation

This report has been prepared for our client, Te Kauwhata Land Limited, for the purpose detailed above and may not be relied on by any other parties or for any other purpose.

This report contains an assessment based on a site walkover and testing in discrete locations. Inferences about the conditions at the site have been made based on the testing undertaken and our understanding of the geological environment in which the site lies. The nature of the soil deposition in this area is such that ground conditions can vary significantly across small distances.

A suitably qualified geotechnical engineer will need to inspect the cleared ground after removal of the uncontrolled fill. This is to confirm the ground conditions are as expected.

APPENDIX A – SITE PLAN AND DRAWINGS



hd
GEO

●	Hand Augers
☐	Test Pits
△	CPT
○	Borehole

PROJECT:
24 Wayside Road

PROJECT NO:
HD1151

CLIENT:
Te Kauwhata Land Limited

TITLE:
Site plan

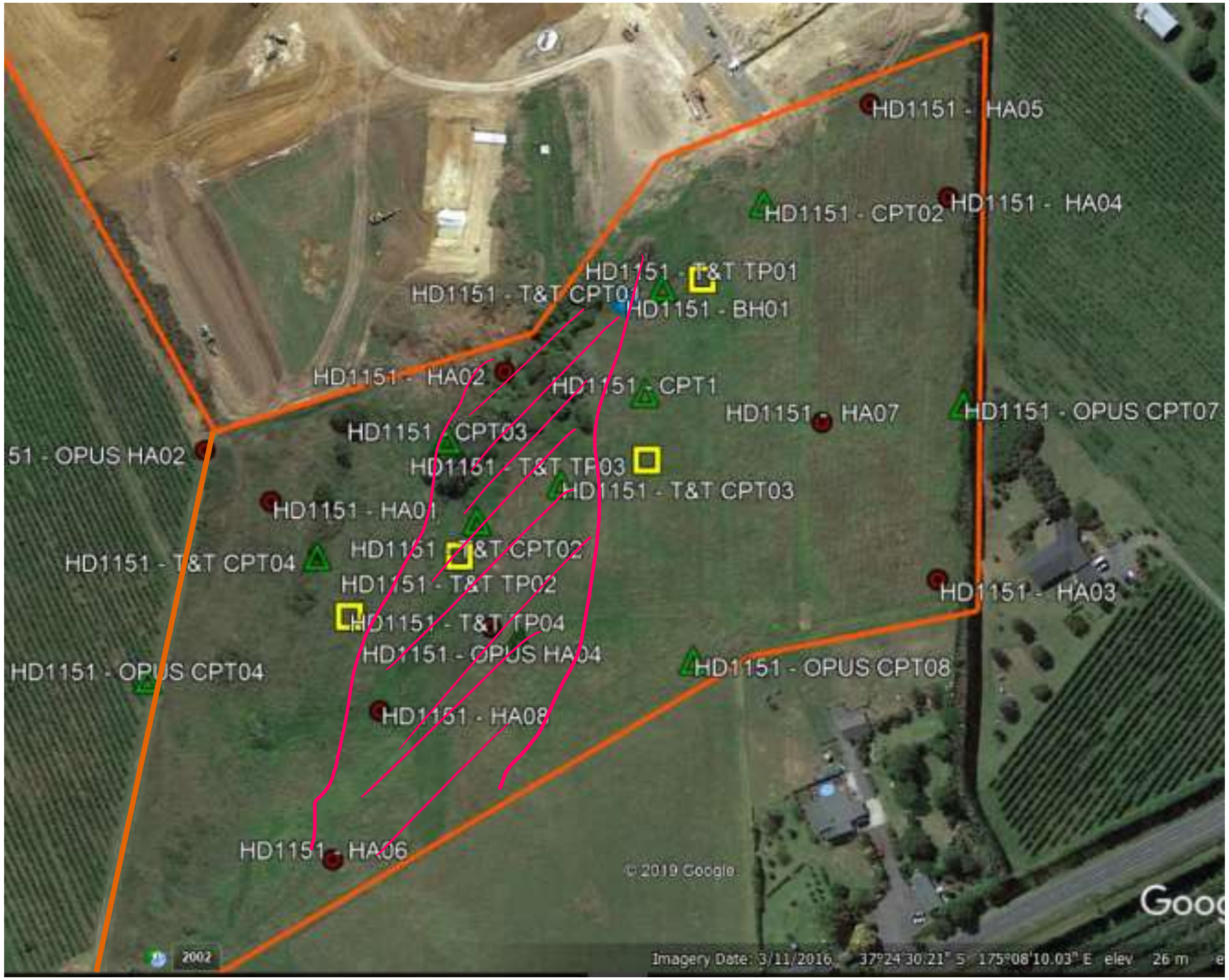
SCALE: N/A

Drawing No: 1

Drawing by : SS

Rev Number

0	
	29.11.19



●	Hand Augers
☐	Test Pits
△	CPT
○	Borehole

PROJECT:
24 Wayside Road

PROJECT NO:
HD1151

CLIENT:
Te Kauwhata Land Limited

TITLE:
Drawing 1 / low laying areas

SCALE: N/A

Drawing No: 1
Drawing by : SS

Rev Number

0	
	29.11.19

hd GEO

● Hand Augers

☐ Test Pits

△ CPT

○ Borehole

PROJECT:
24 Wayside Road

PROJECT NO:
HD1151

CLIENT:
Te Kauwhata Land Limited

TITLE:
Drawing 2

SCALE: N/A

Drawing No: 1

Drawing by : SS

Rev Number

0	
	29.11.19

APPENDIX B – HISTORICAL AERIAL IMAGERY

Image Source: Archives Central

Dated: 1949

PROJECT:
24 Wayside Road

PROJECT NO:
HD1151

CLIENT:
Te Kauwhata Land Limited

TITLE:
1949

SCALE: N/A

Drawing No: FIG 01

Drawing by : SS

Rev Number

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	29.11.19

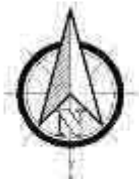

Image Source: Archives Central

Dated: 1963

PROJECT:
24 Wayside Road

PROJECT NO:
HD1151

CLIENT:
Te Kauwhata Land
Limited

TITLE:
1963

SCALE: N/A

Drawing No: FIG 02

Drawing by : SS

Rev Number

0	
	29.11.19

Image Source: Archives Central

Dated: 1986

PROJECT:
24 Wayside Road

PROJECT NO:
HD1151

CLIENT:
Te Kauwhata Land Limited

TITLE:
1986

SCALE: N/A

Drawing No: FIG 03

Drawing by : SS

Rev Number

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	29.11.19

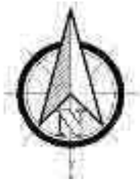


Image Source: Archives Central

Dated: 1991

PROJECT:
24 Wayside Road

PROJECT NO:
HD1151

CLIENT:
Te Kauwhata Land Limited

TITLE:

199
1

SCALE: N/A

Drawing No: FIG 04

Drawing by : SS

Rev Number

0	
	29.11.19

Image Source: Archives Central

Dated: 2002

PROJECT:
24 Wayside Road

PROJECT NO:
HD1151

CLIENT:
Te Kauwhata Land
Limited

TITLE:

2002

SCALE: N/A

Drawing No: FIG 05

Drawing by : SS

Rev Number

0	
	29.11.19

Image Source: Archives Central

Dated: 2019

PROJECT:
24 Wayside Road

PROJECT NO:
HD1151

CLIENT:
Te Kauwhata Land Limited

TITLE:

2019

SCALE: N/A

Drawing No: FIG 06

Drawing by : SS

Rev Number

0	
	29.11.19

APPENDIX C – INVESTIGATION DATA

Hand Augers

Investigation pits

CPT outputs

INVESTIGATION LOG

Job No.: HD1151

No.: HA01

Client: Te Kauwhata Land Limited

Project: Wayside Road

Location: North-west of site

Co-ordinates: 1788725mE, 5857504mN

Elevation: Ground

Date: 19.11.19

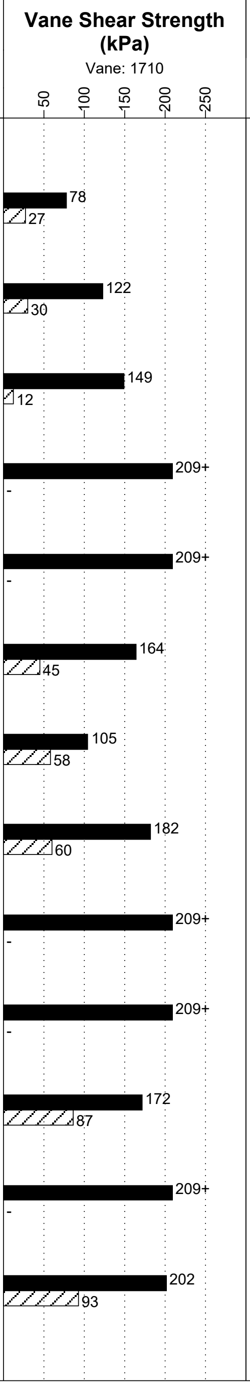
Logged By: SSA

Checked By: HJ

Geology	Geological Interpretation (refer to separate Geotechnical and Geological Information sheet for further information)	Depth (m)
Fill	SiltyFILL; brown. Stiff to hard; dry, moderately sensitive to extra sensitive.	0.0 – 1.9
Volcanic Ash	Silty CLAY; light brown. Very stiff to hard; dry; low plasticity, moderately sensitive to sensitive. 2.3 m: Mottled black. 2.5 m: Grades to orange brown.	1.9 – 2.6
Volcanic Ash	Silty CLAY; orange. Very stiff to hard; moist; moderate to hight plasticity, moderately sensitive to sensitive. EOH: 4.00 m	2.6 – 4.0

Depth (m): 0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4, 1.6, 1.8, 2.0, 2.2, 2.4, 2.6, 2.8, 3.0, 3.2, 3.4, 3.6, 3.8, 4.0

Scala Penetrometer (Blows / 100 mm): 2 4 6 8 10 12 14 16 18



Water: Groundwater Not Encountered

Photo

Remarks

End of log at 4.0 m, target depth.

Shear Vanes

- ■ Peak
- ▨ Remoulded

Water

- ▼ Standing Water Level
- ◁ Out flow
- ▷ In flow

Investigation Type

- ☑ Hand Auger
- ☐ Investigation Pit
- ☐ Machine Borehole

Generated with CORE-GS by Geroc - 10/01/2020 11:16:59 AM

INVESTIGATION LOG

Job No.: HD1151

No.: HA02

Client: Te Kauwhata Land Limited

Project: Wayside Road

Location: North of Gully

Co-ordinates: 1788815mE, 5857552mN

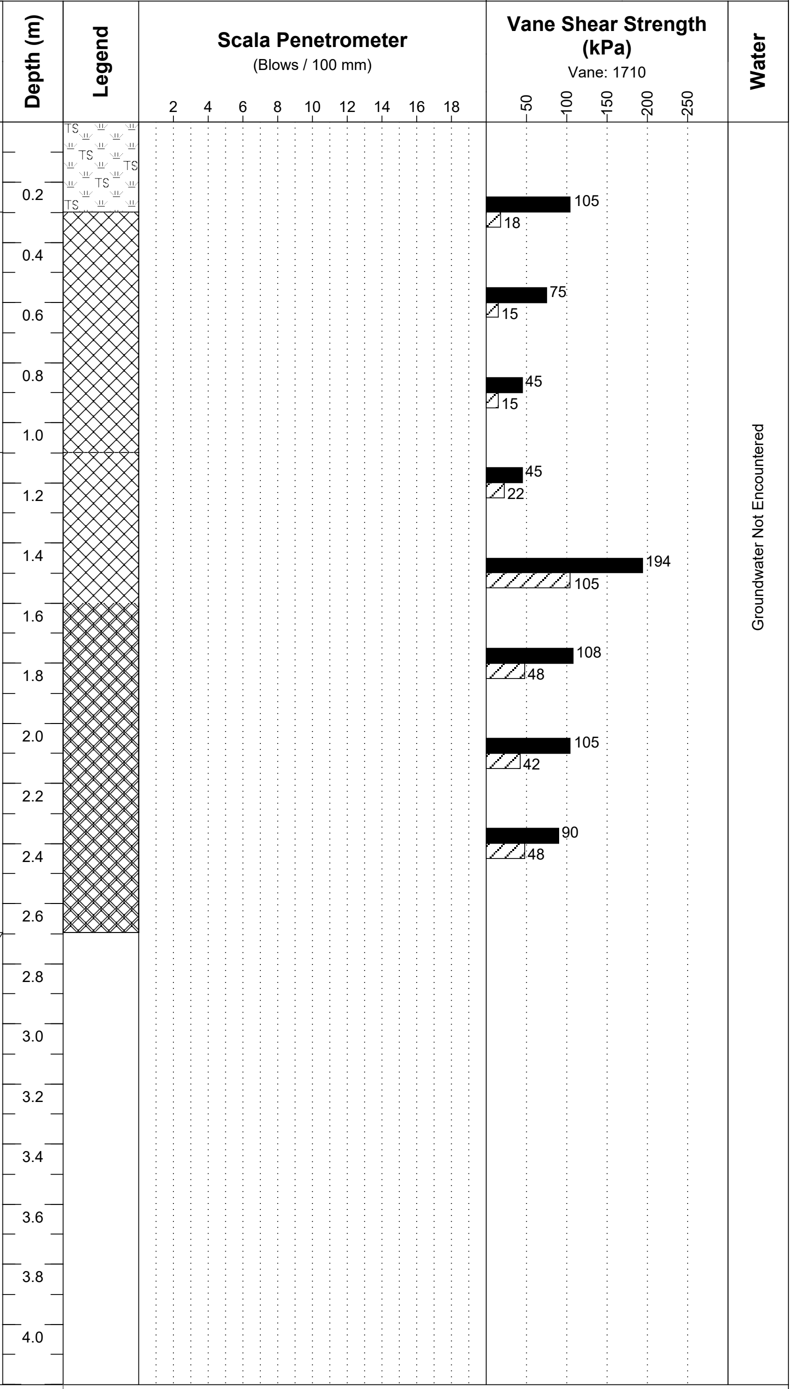
Elevation: Ground

Date: 19.11.19

Logged By: SSA

Checked By: HJ

Geology	Geological Interpretation (refer to separate Geotechnical and Geological Information sheet for further information)
Topsoil	TOPSOIL; brown. Dry, insensitive.
Engineer Controlled Fill	ENGINEERING FILL; light brown. Firm to stiff; dry.
	Organic; dark brown. Stiff to very stiff; smell like topsoil.
Uncontrolled Fill	1.6 m: Environmental sample, black purple material, wood fragment, stinky, looks oily. 2.4 m: Woody material in the soil. 2.6 m: Environmental sample (glass in soil).
	EOH: 2.70 m



Photo

Remarks

End of log at 2.7 m, no progress due to contamination.

Shear Vanes

■ Peak

▨ Remoulded

Water

▼ Standing Water Level

◁ Out flow

▷ In flow

Investigation Type

☑ Hand Auger

☐ Investigation Pit

☐ Machine Borehole

INVESTIGATION LOG

Job No.: HD1151

No.: HA03

Client: Te Kauwhata Land Limited

Project: Wayside Road

Location: South-east corner of site

Co-ordinates: 1788976mE, 5857470mN

Elevation: Ground

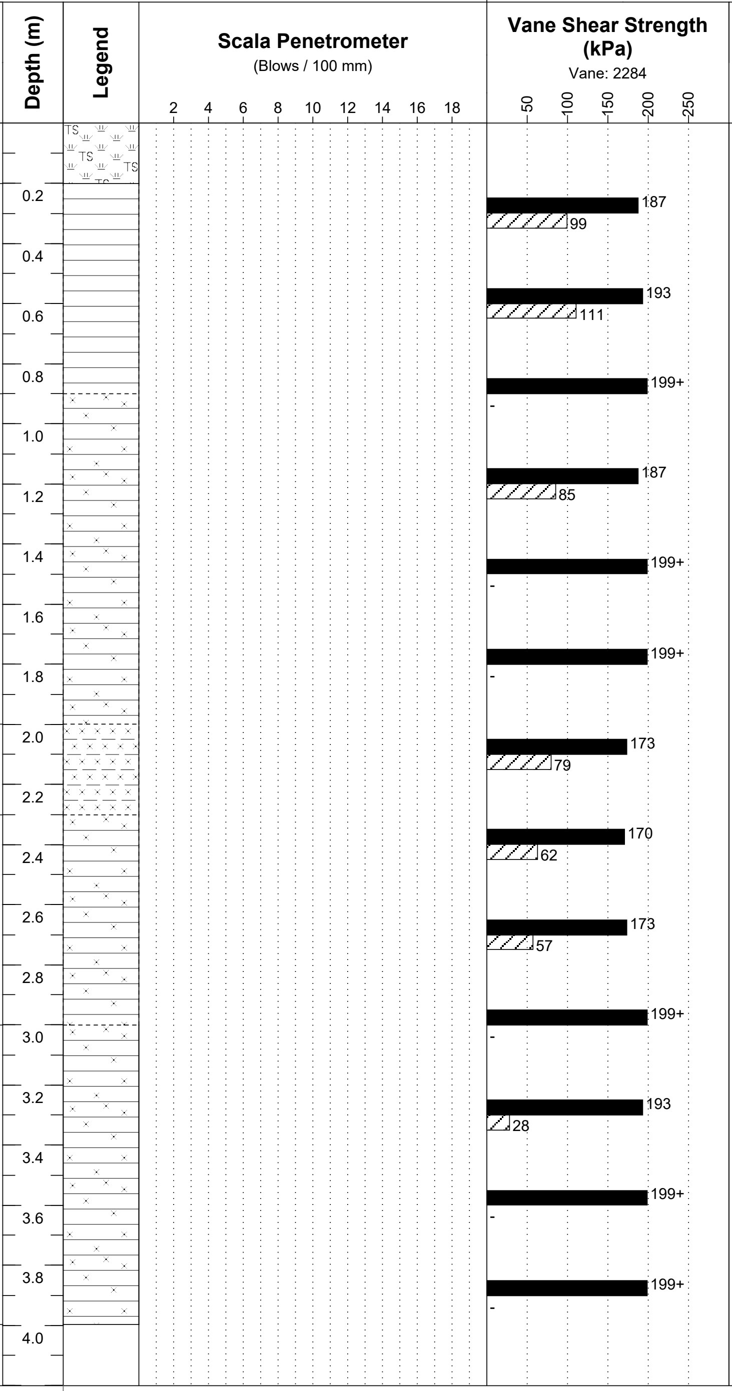
Date: 19.11.19

Logged By: BK

Checked By: SSA

Geology	Geological Interpretation (refer to separate Geotechnical and Geological Information sheet for further information)
Topsoil	TOPSOIL (OL); dark brownish black. Moist.
Volcanic Ash	CLAY (CL), with some silt; dark brown. Very stiff; moist; low plasticity, insensitive.
	Silty CLAY (CL); light brown. Very stiff; moist; low plasticity, moderately sensitive. 1.5 m: becomes dark brown.
	Clayey SILT (ML), with trace sand; light brown. Very stiff; moist; low plasticity, moderately sensitive; sand, fine.
	Silty CLAY (CL); dark reddish brown. Very stiff; moist; low plasticity, moderately sensitive. 2.7 m: becomes light red brown.
	Silty CLAY (CL), with trace sand; light brown. Very stiff; moist to wet; moderate plasticity, sensitive; sand, fine.

EOH: 4.00 m



Water

Groundwater Not Encountered

Photo

Remarks

End of log at 4.0 m, target depth.

Shear Vanes

■ Peak

▨ Remoulded

Water

▼ Standing Water Level

◁ Out flow

▷ In flow

Investigation Type

☑ Hand Auger

☐ Investigation Pit

☐ Machine Borehole

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INVESTIGATION LOG

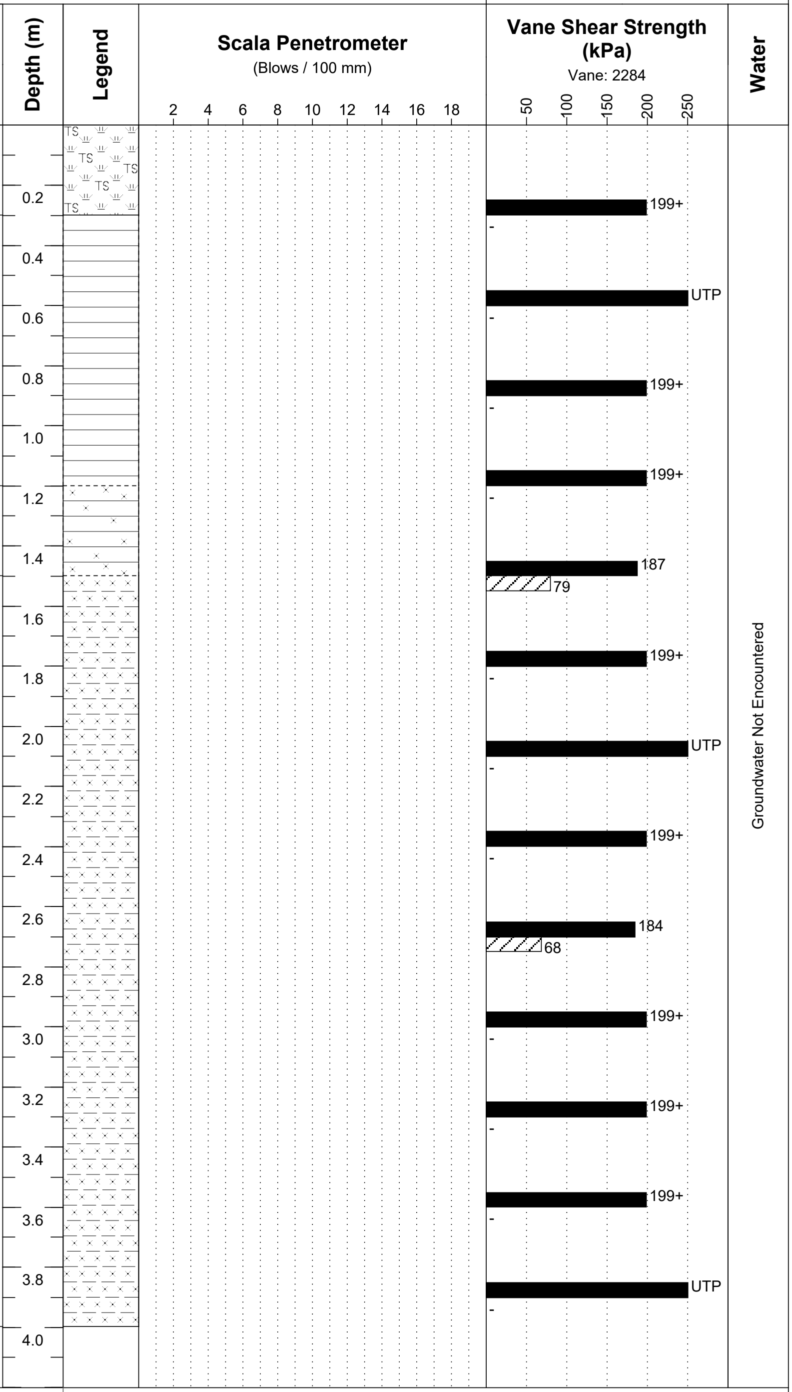
Job No.: HD1151
No.: HA04

Client: Te Kauwhata Land Limited
Project: Wayside Road

Location: East side of site
Co-ordinates: 1788986mE, 5857614mN
Elevation: Ground

Date: 19.11.19
Logged By: BK
Checked By: SSA

Geology	Geological Interpretation (refer to separate Geotechnical and Geological Information sheet for further information)
Topsoil	TOPSOIL (OL); dark brownish black. Moist.
Volcanic Ash	CLAY (CL), with some silt; dark brown. Very stiff; moist; low plasticity.
	Silty CLAY (CL), with trace sand; pinkish grey. Very stiff; moist; low plasticity, moderately sensitive; sand, fine.
	Clayey SILT (ML), with some sand; greyish brown. Very stiff; moist; low plasticity; sand, fine to medium. 2.0 m: becomes orange brown. 3.4 m: becomes yellow brown. EOH: 4.00 m



Photo

Remarks

End of log at 4.0 m, target depth.

Shear Vanes

■ Peak
▨ Remoulded

Water

▼ Standing Water Level
◁ Out flow
▷ In flow

Investigation Type

☑ Hand Auger
☐ Investigation Pit
☐ Machine Borehole

INVESTIGATION LOG

Job No.: HD1151

No.: HA05

Client: Te Kauwhata Land Limited

Project: Wayside Road

Location: North-east of site

Co-ordinates: 1788957mE, 5857651mN

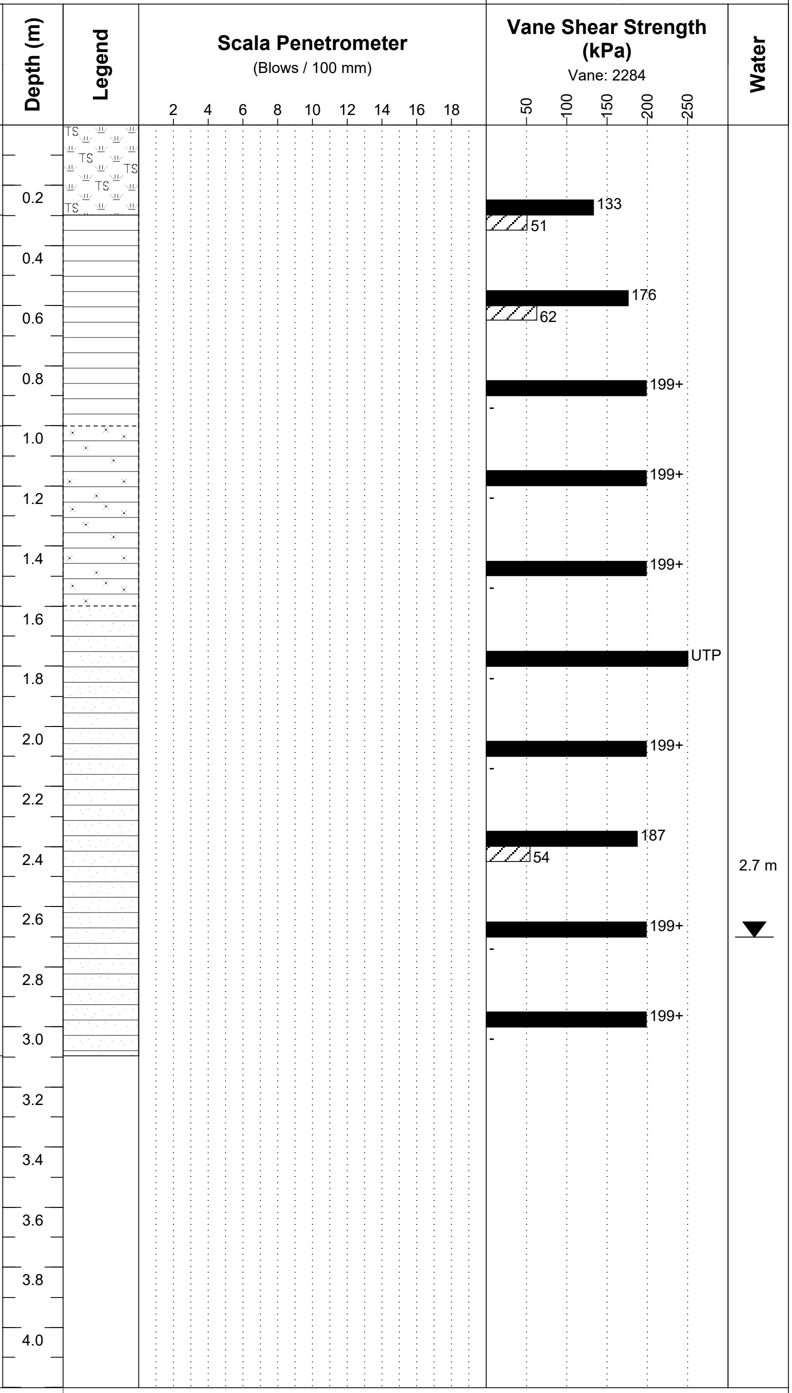
Elevation: Ground

Date: 19.11.19

Logged By: BK

Checked By: SSA

Geology	Geological Interpretation (refer to separate Geotechnical and Geological Information sheet for further information)
Topsoil	TOPSOIL (OL); dark brownish black. Moist; rootlets.
Volcanic Ash	CLAY (CL), with some silt; dark brown. Very stiff; moist; low plasticity, moderately sensitive.
	Silty CLAY (CL); brown mottled grey. Very stiff; moist; low plasticity.
	Sandy CLAY (CL); orange brown. Very stiff; moist to wet; low plasticity, moderately sensitive. 2.5 m: becomes greyish brown. 2.7 m: becomes saturated. EOH: 3.10 m



Photo

Remarks

End of log at 3.1 m, due to hole collapse.

Shear Vanes

■ Peak

▨ Remoulded

Water

▼ Standing Water Level

◁ Out flow

▷ In flow

Investigation Type

☑ Hand Auger

☐ Investigation Pit

☐ Machine Borehole

INVESTIGATION LOG

GEO

Job No.:	HD1151
No.:	HA06
Client:	Te Kauwhata Land Limited
Project:	Wayside Road
Location:	South-west corner of site
Co-ordinates:	1788747mE, 5857470mN
Elevation:	Ground
Date:	19.11.19
Logged By:	SSA
Checked By:	HJ

Geology	Geological Interpretation (refer to separate Geotechnical and Geological Information sheet for further information)	Depth (m)
Topsoil	TOPSOIL; dark brown. Dry.	0.0–0.2
Fill	CLAY; brown. Hard; dry; low plasticity; iron staining. 0.8 m: minor Mica flakes.	0.2–0.8
Fill	CLAY; light brown. Very stiff to hard; low plasticity. 1.5 m: Sensitive, grades to grey, mottled orange. 1.8 m: sand, fine to coarse: moist.	0.8–1.8
Fill	Sandy CLAY; orange. Hard; moist to wet; low plasticity, sensitive. 2.2 m: mottled red and bklack. 2.4 m: Pumice, white. 2.5 m: becomes wet, poor retrieval EOH: 3.30 m	1.8–3.3
	3.3 m: Shear vane pushed down by hand from 3.3 m to 4 m.	3.3–4.0

Scala Penetrometer (Blows / 100 mm): 2, 4, 6, 8, 10, 12, 14, 16, 18

Vane Shear Strength (kPa) Vane: 1710 — 50, 100, 150, 200, 250

Peak	Remoulded
209+	-
209+	-
209+	-
194	78
194	105
209+	-
UTP	-
209	27
209+	-
209+	-
-	-
-	-
-	-

Water: 3.5 m ▼

Photo

Remarks

End of log at 3.3 m, due to no retrieval.

Shear Vanes
- ■ Peak
- ▨ Remoulded

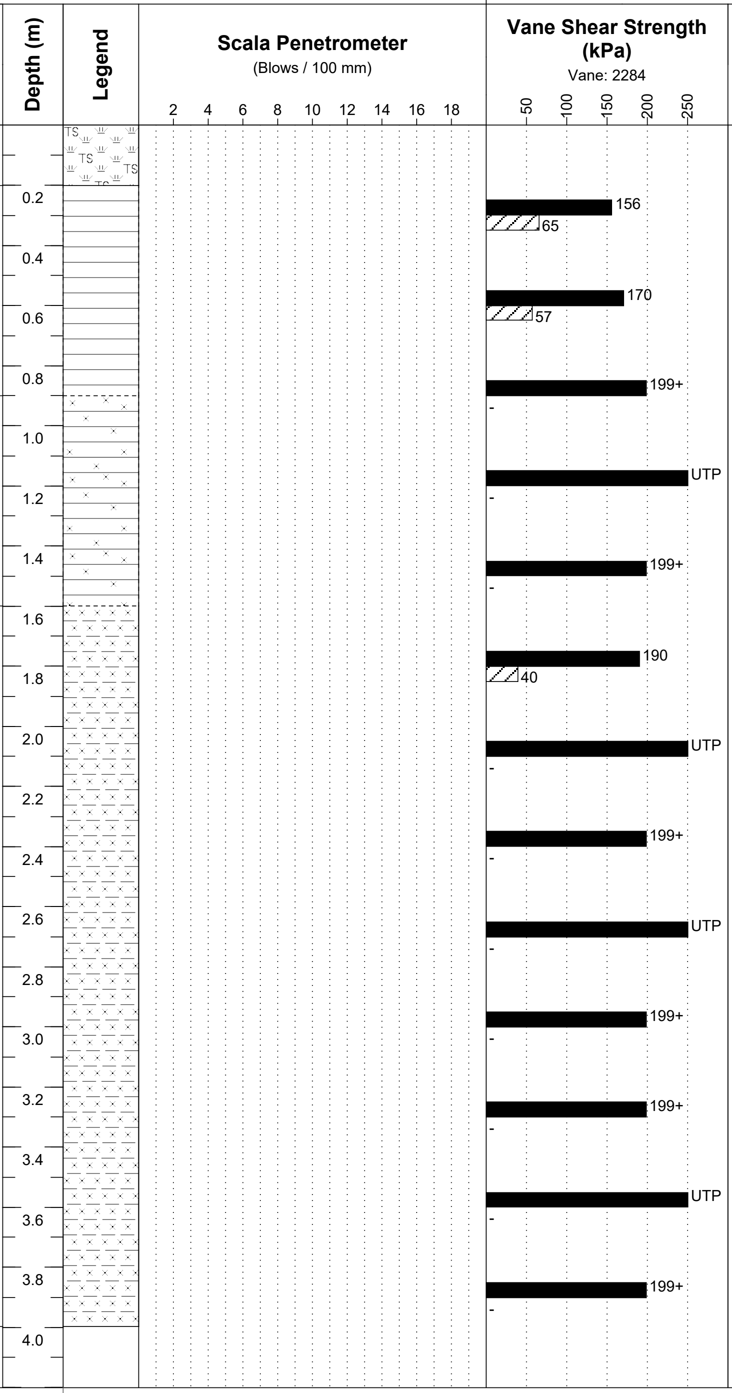
Water
- ▼ Standing Water Level
- ◁ Out flow
- ▷ In flow

Investigation Type
- ☑ Hand Auger
- ☐ Investigation Pit
- ☐ Machine Borehole

INVESTIGATION LOG

Job No.:	HD1151
No.:	HA07
Client:	Te Kauwhata Land Limited
Project:	Wayside Road
Location:	East of site
Co-ordinates:	1788935mE, 5857529mN
Elevation:	Ground
Date:	19.11.19
Logged By:	BK
Checked By:	SSA

Geology	**Geological Interpretation** (refer to separate Geotechnical and Geological Information sheet for further information)
Topsoil	TOPSOIL (OL); dark brownish black. Moist.
Volcanic Ash	CLAY (CL); dark brown. Very stiff; moist; low plasticity, moderately sensitive.
	Silty CLAY (CL); dark brown. Very stiff; moist; low plasticity.
	Clayey SILT (ML), with some sand; light orange brown. Very stiff to hard; moist; low plasticity; sand, fine. 3.8 m: becomes reddish brown.
	EOH: 4.00 m



Water: Groundwater Not Encountered

Photo

Remarks

End of log at 4.0 m, target depth.

Shear Vanes

■ Peak

▨ Remoulded

Water

▼ Standing Water Level

◁ Out flow

▷ In flow

Investigation Type

☑ Hand Auger

☐ Investigation Pit

☐ Machine Borehole

INVESTIGATION LOG

Client: Te Kauwhata Land Limited
Project: Wayside Road
Location: South-west of site
Co-ordinates: 1788766mE, 5857425mN
Elevation: Ground

Job No.: HD1151
No.: HA08
Date: 19.11.19
Logged By: SSA
Checked By: HJ

Geology	Geological Interpretation (refer to separate Geotechnical and Geological Information sheet for further information)	Depth (m)
Fill	SiltyFILL; brown. Wet.	0.0 – 0.6
	Organic-black material, saturated,	0.6 – 3.5
	EOH: 3.50 m	

Scala Penetrometer (Blows / 100 mm)

Depth (m)	Blows
0.2	1
0.3	2
0.4	3
0.5	2
0.6	2
0.7	2
0.8	2
0.9	1
1.0	3
1.1	1
1.2	1
1.3	1
1.4	2
1.5	2
1.6	1
1.7	2
1.8	1
1.9	1
2.0	2
2.1	2
2.2	1
2.3	2
2.4	1
2.5	2
2.6	1
2.7	1
2.8	1
2.9	1
3.0	2
3.1	2
3.2	2
3.3	3
3.4	2
3.5	2
3.6	4
3.7	4
3.8	3
3.9	4
4.0	7
4.1	6
4.2	5
4.3	3
4.4	3
4.5	3
4.6	3
4.7	3
4.8	3
4.9	3

Vane Shear Strength (kPa)
Vane: 1710

Peak 78, Remoulded 18 (at approx. 0.25 m)

Water
0.3 m ▼

Photo

Remarks

End of log at 3.5m, hand auger pushed with body weight, no sample retrieved.

Shear Vanes
■ Peak
▨ Remoulded

Water
▼ Standing Water Level
◁ Out flow
▷ In flow

Investigation Type
☑ Hand Auger
☐ Investigation Pit
☐ Machine Borehole

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INVESTIGATION LOG

Job No.: HD1151

No.: BH01

Client: Te Kauwhata Land Limited

Project: Wayside Road

Location: 24 Wayside Road

Co-ordinates: 1788861mE, 5857576mN

Elevation: Ground

Contractor: Drillcore

Sampling Method:

Date: 22.11.19

Logged By: SSA

Checked By: HJ

Geology	Geological Interpretation (refer to separate Geotechnical and Geological Information sheet for further information)	Testing	Method	TCR (%)	RQD (%)	Defect Log	Additional Comments	Fluid Loss (%)	Water	Installation
Topsoil	TOPSOIL; brown. Dry; rootlets.									
Fill	Silty CLAY; dark brown. Dry; sticky.								0.7 m ▼	
Whangamarino Formation	Silty CLAY, with trace sand; light brown orange. Moist to wet; moderate plasticity; sand, fine to coarse; iron stained, pumice.									
	Sandy SILT, with trace clay; orange brown mottled brown. Wet; moderate to high plasticity; sand, fine to coarse; pumice.									
	Sandy SILT, with some clay; light brown mottled black and grey. Moderate to high plasticity; sand, fine to coarse; iron stained, pumice.									
	Silty SAND; brown and orange. Wet; non-plastic; sand, fine to coarse; pumice, black fragments.									
	Silty CLAY, with trace sand; light white orange mottled black. Wet; low plasticity; iron stained.									
	SAND, with some silt; brown mottled black, grey and white. Wet; non-plastic; sand, fine to coarse; pumice quartz, iron stained. 6.0 m: Brown soil.									
Tauranga Group	Clayey SAND; white grey. Wet, extra sensitive; sand, fine; soft. EOH: 10.00 m	Push tube sampling Push tube sampling								

Remarks

EOH at 10.5 m, target depth.

Legend

Key	
TCR	Total core recovery
RQD	Rock quality designation

Water	
▼	Standing Water Level
◁	Out flow
▷	In flow

CORE PHOTOS

HOLE No.: **BH01-photos**

JOB No.: HD1151

0.00-3.00m

3.00-6.00m

CORE PHOTOS

HOLE No.: **BH01-photos**
JOB No.: HD1151

6.00-10.00m

INVESTIGATION LOG

Job No.: HD1151

No.: TP01

Client: Te Kauwhata Land Limited

Project: Wayside Road

Location: West of gully

Co-ordinates: 1788795mE, 5857499mN

Elevation: Ground

Date: 20.11.19

Logged By: SSA

Checked By: HJ

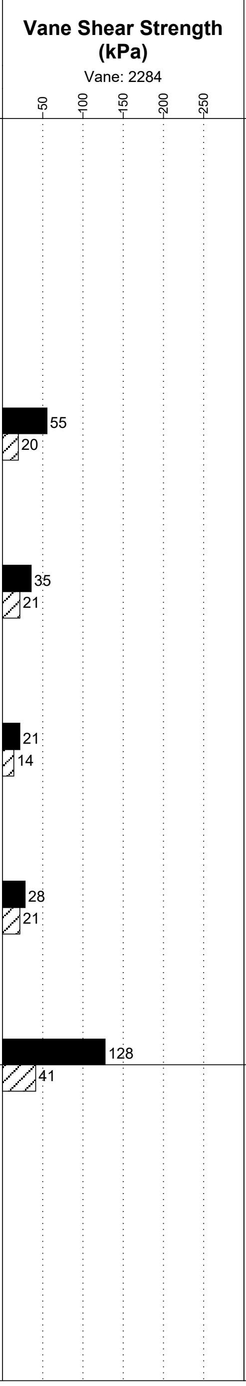
Geology	Geological Interpretation (refer to separate Geotechnical and Geological Information sheet for further information)	Legend
Uncontrolled Fill	SiltyFILL. Soft to very stiff, moderately sensitive to insensitive. 0.9 m: Rubbish, pipe, old petrol tank, concrete and cloth. 1.2 m: Ground water seepage. 1.4 m: End of the fill and looks natural.	▨
Holocene Swamp Deposits	CLAY; light grey. Very soft to soft; moist; moderate plasticity. EOH: 1.80 m	☰

Depth (m): 0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4, 1.6, 1.8, 2.0, 2.2

Samples

PID (ppm)

Scala Penetrometer (Blows / 100 mm): 2, 4, 6, 8, 10, 12, 14, 16, 18



55	20
35	21
21	14
28	21
128	41

Water: Groundwater Not Encountered

Photo

Remarks

End of log at 1.8m. target depth achieved.

Shear Vanes

■ Peak

▨ Remoulded

Water

▼ Standing Water Level

◁ Out flow

▷ In flow

Investigation Type

☐ Hand Auger

☑ Investigation Pit

☐ Machine Borehole

INVESTIGATION LOG

Client:	Te Kauwhata Land Limited	**Job No.:**	HD1151
Project:	Wayside Road	**No.:**	TP02
Location:	West of gully	**Date:**	20.11.19
Co-ordinates:	1788788mE, 5857485mN	**Logged By:**	SSA
Elevation:	Ground	**Checked By:**	HJ

Geology	Geological Interpretation (refer to separate Geotechnical and Geological Information sheet for further information)	Depth (m)	Legend	Samples	PID (ppm)	Scala Penetrometer (Blows / 100 mm)	Vane Shear Strength (kPa) Vane: 2284	Water
Uncontrolled Fill	TOPSOIL; dark brown. Moist.	0.0–0.2	TS					Groundwater Not Encountered
	Silty CLAY; light grey mottled orange light brown. Very stiff; dry to moist; low plasticity, sensitive.	0.2–0.4					Peak 156 Remoulded 28	
	TOPSOIL & CLAY & SILT; dark brown. Stiff; moist, moderately sensitive to sensitive; metal pieces. 0.5 m: Dark brown mottled orange, concrete, rags and rubbish.	0.4–1.8					Peak 71 Remoulded 28	
	0.8 m: Drums, brown liquid.						Peak 57 Remoulded 14	
	1.4 m: Grades to lightish brown.							
							Peak 99 Remoulded 14	
Holocene Swamp Deposits	1.8 m: Natural soil. Silty CLAY; greyish blue. Very soft to soft; moist.	1.8–2.0						
	EOH: 2.00 m							

Photo

Remarks

End of log at 2m. target depth achieved
Test pit visually logged due to contamination.
water in hole from ruptured subsoil drain.

Shear Vanes	Water	Investigation Type
■ Peak	▼ Standing Water Level	☐ Hand Auger
▨ Remoulded	◁ Out flow	☑ Investigation Pit
	▷ In flow	☐ Machine Borehole

INVESTIGATION LOG

Client:	Te Kauwhata Land Limited	**Job No.:**	HD1151
Project:	Wayside Road	**No.:**	TP03
Location:	South of gully	**Date:**	20.11.19
Co-ordinates:	1788782mE, 5857456mN	**Logged By:**	SSA
Elevation:	Ground	**Checked By:**	HJ

Geology	Geological Interpretation (refer to separate Geotechnical and Geological Information sheet for further information)
Topsoil	TOPSOIL; brown. Wet.
Uncontrolled Fill	SiltyFILL; light brown. Stiff, moderately sensitive.
Holocene Swamp Deposits	Silty CLAY; light grey mottled orange. Firm, moderately sensitive to sensitive; iron staining.
	Clayey SILT; bluish grey. Firm to stiff; wet; moderate to high plasticity, moderately sensitive to sensitive. 1.2 m: Bluish grey.
	EOH: 1.50 m

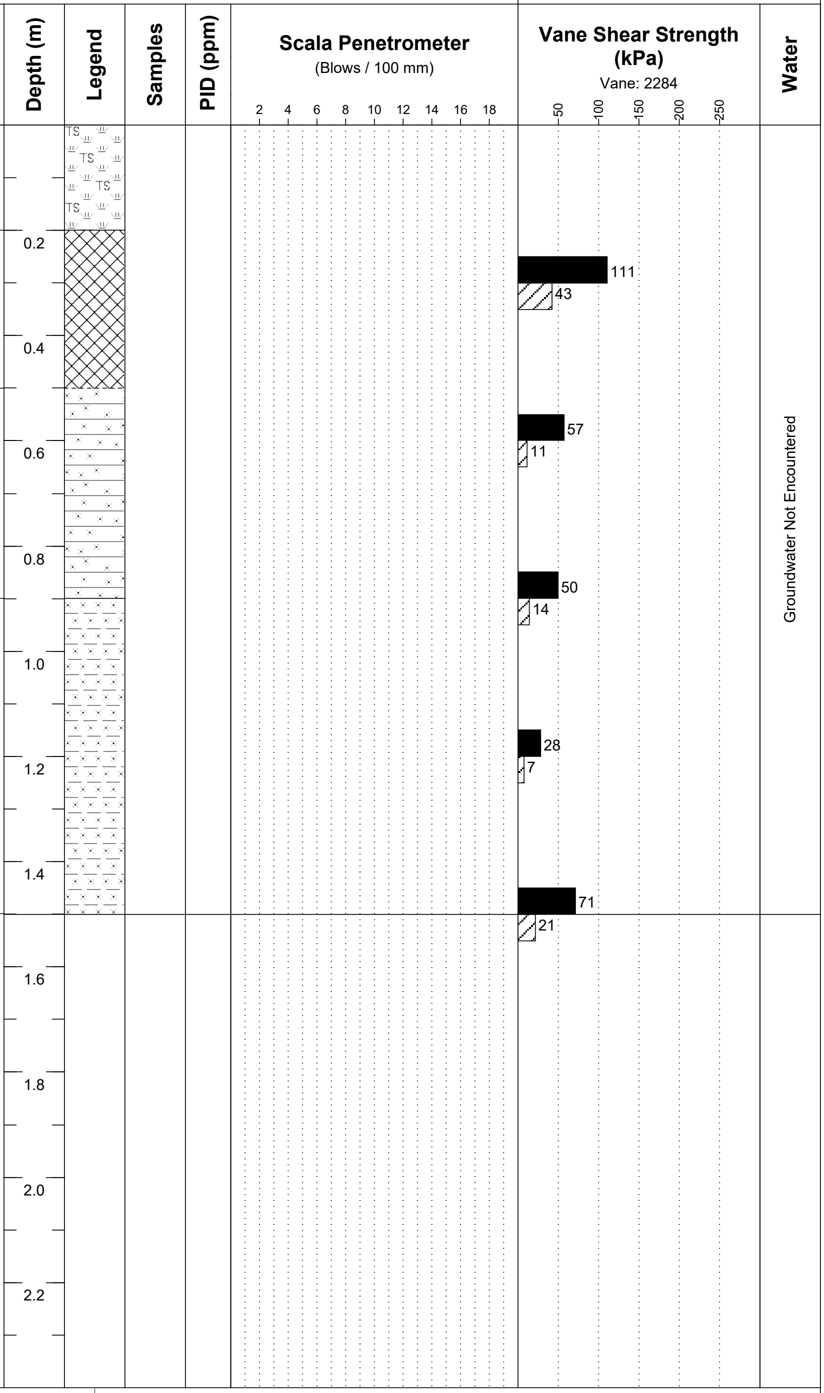


Photo	Remarks
	End of log at 1.5m. target depth achieved.

Shear Vanes	Water	Investigation Type
■ Peak	▼ Standing Water Level	☐ Hand Auger
▨ Remoulded	◁ Out flow	☑ Investigation Pit
	▷ In flow	☐ Machine Borehole

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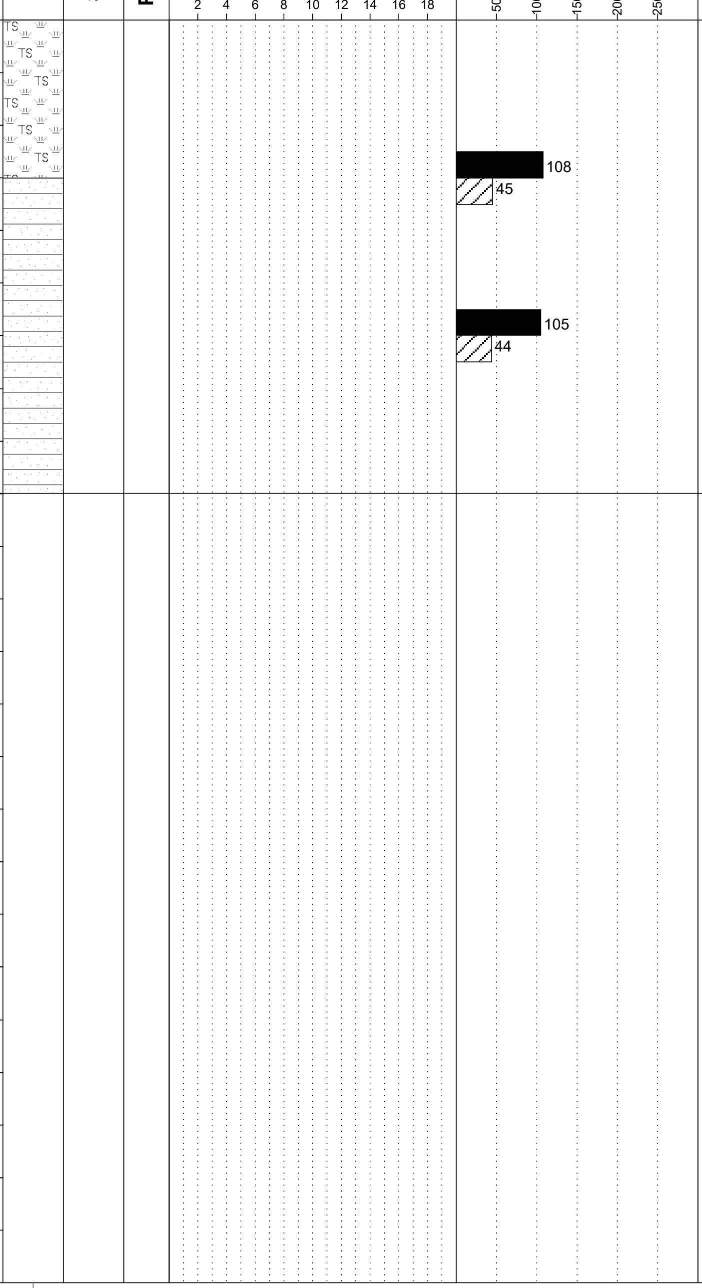
INVESTIGATION LOG

Client:	Te Kauwhata Land Limited	**Job No.:**	HD1151
Project:	Wayside Road	**No.:**	TP04
Location:	South of gully	**Date:**	20.11.19
Co-ordinates:	1788802mE, 5857449mN	**Logged By:**	SSA
Elevation:	Ground	**Checked By:**	HJ

Geology	**Geological Interpretation** (refer to separate Geotechnical and Geological Information sheet for further information)	**Depth (m)**	**Legend**	**Samples**	**PID (ppm)**	**Scala Penetrometer** (Blows / 100 mm)	**Vane Shear Strength (kPa)** Vane: 2284	**Water**
Topsoil	TOPSOIL; brown. Dry.	0.2	TS					Groundwater Not Encountered
Volcanic Ash	Sandy CLAY. Very stiff; moist; low to moderate plasticity, moderately sensitive; sand, fine; light white orange weathered pumice, iron staining. EOH: 0.90 m	0.4 0.6 0.8					108 / 45 105 / 44	

Depth (m): 0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4, 1.6, 1.8, 2.0, 2.2



Photo

Remarks

End of log at 0.9m. target depth achieved.

Shear Vanes	**Water**	**Investigation Type**
■ Peak	▼ Standing Water Level	☐ Hand Auger
▨ Remoulded	◁ Out flow	☑ Investigation Pit
	▷ In flow	☐ Machine Borehole

INVESTIGATION LOG

Job No.: HD1151

No.: TP05

Client: Te Kauwhata Land Limited

Project: Wayside Road

Location: East to gully

Co-ordinates: 1788805mE, 5857484mN

Elevation: Ground

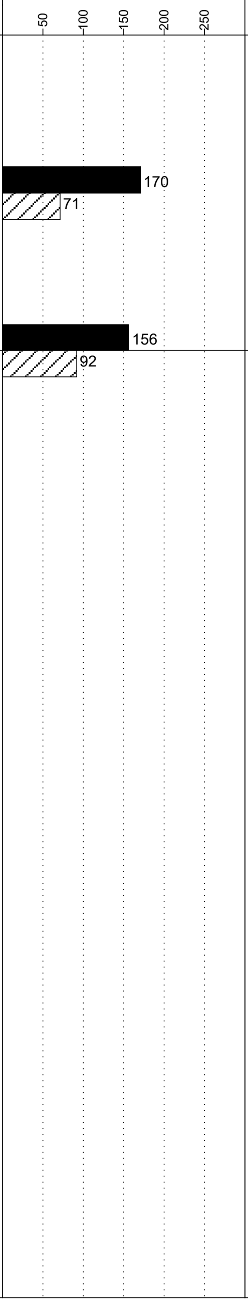
Date: 20.11.19

Logged By: SSA

Checked By: HJ

Geology	Geological Interpretation (refer to separate Geotechnical and Geological Information sheet for further information)	Depth (m)	Legend	Samples	PID (ppm)	Scala Penetrometer (Blows / 100 mm)	Vane Shear Strength (kPa) Vane: 2284	Water
Uncontrolled Fill	SiltyFILL. Dry.							Groundwater Not Encountered
Volcanic Ash	Sandy CLAY; light orange mottled grey. Very stiff; dry; low plasticity, moderately sensitive to insensitive; sand, fine; pumice, iron staining . EOH: 0.60 m	0.2 0.4					170 71 156 92	
		0.6 0.8 1.0 1.2 1.4 1.6 1.8 2.0 2.2						

Scala Penetrometer scale: 2 4 6 8 10 12 14 16 18



Photo

Remarks

End of log at 0.6m. target depth achieved.

Shear Vanes

■ Peak

▨ Remoulded

Water

▼ Standing Water Level

◁ Out flow

▷ In flow

Investigation Type

☐ Hand Auger

☑ Investigation Pit

☐ Machine Borehole

INVESTIGATION LOG

Job No.:	HD1151
Client:	Te Kauwhata Land Limited
Project:	Wayside Road
No.:	TP06
Location:	North of gully
Co-ordinates:	1788805mE, 5857510mN
Elevation:	Ground
Date:	20.11.19
Logged By:	SSA
Checked By:	HJ

Geology	Geological Interpretation (refer to separate Geotechnical and Geological Information sheet for further information)	Depth (m)	Legend	Samples	PID (ppm)	Scala Penetrometer (Blows / 100 mm) 2 4 6 8 10 12 14 16 18	Vane Shear Strength (kPa) Vane: 2284 50 100 150 200 250	Water
Uncontrolled Fill	SiltyFILL; dark bluish grey. Firm; moist to wet, insensitive to moderately sensitive; steel, broken concrete, brick, rope, oil filter, plastic, glass, wood, paper, wire and tile. 1.4 m: Water seepage.	0.2 0.4 0.6 0.8 1.0 1.2 1.4 1.6 1.8					28 16 28 14 34 21	Groundwater Not Encountered
Holocene Swamp Deposits	Silty CLAY; light blue; homogeneous. Firm; moist; high plasticity, insensitive; very sticky. EOH: 2.30 m	2.0 2.2					26 17	

Photo

Remarks

End of log at 2.3m. target depth achieved.

Shear Vanes
- ■ Peak
- ▨ Remoulded

Water
- ▼ Standing Water Level
- ◁ Out flow
- ▷ In flow

Investigation Type
- ☐ Hand Auger
- ☑ Investigation Pit
- ☐ Machine Borehole

INVESTIGATION LOG

Job No.: HD1151

Client: Te Kauwhata Land Limited

Project: Wayside Road

No.: TP07

Location: North to gully

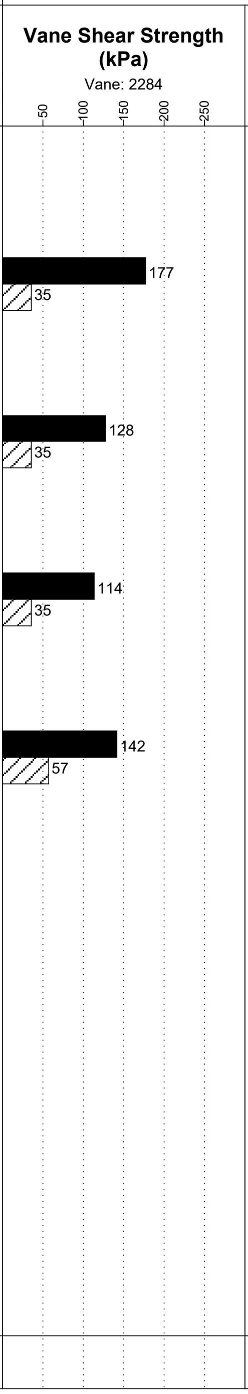
Date: 20.11.19

Co-ordinates: 1788800mE, 5857517mN

Logged By: SSA

Elevation: Ground

Checked By: HJ



Geology	Geological Interpretation (refer to separate Geotechnical and Geological Information sheet for further information)	Depth (m)	Legend	Samples	PID (ppm)	Scala Penetrometer (Blows / 100 mm)	Vane Shear Strength (kPa)	Water
Uncontrolled Fill	Silty CLAY; orange. Very stiff; low to moderate plasticity, moderately sensitive to sensitive; rootlets, iron staining. 0.8 m: moist. 1.0 m: Topsoil. 1.2 m: Grades to light orange. EOH: 2.30 m	0.2 0.4 0.6 0.8 1.0 1.2 1.4 1.6 1.8 2.0 2.2	▨			2 4 6 8 10 12 14 16 18	177 / 35 128 / 35 114 / 35 142 / 57	Groundwater Not Encountered
	2.3 m: Natural soil.							

Photo

Remarks

End of log at 2.3m. target depth achieved.

Shear Vanes	Water	Investigation Type
■ Peak	▼ Standing Water Level	☐ Hand Auger
▨ Remoulded	◁ Out flow	☑ Investigation Pit
	▷ In flow	☐ Machine Borehole

INVESTIGATION LOG

Job No.: HD1151

No.: TP08

Client: Te Kauwhata Land Limited

Project: Wayside Road

Location: West to the gully

Co-ordinates: 1788999mE, 5857509mN

Elevation: Ground

Date: 20.11.19

Logged By: SSA

Checked By: HJ

Geology	Geological Interpretation (refer to separate Geotechnical and Geological Information sheet for further information)	Depth (m)	Legend	Samples	PID (ppm)	Scala Penetrometer (Blows / 100 mm) 2 4 6 8 10 12 14 16 18	Vane Shear Strength (kPa) Vane: 2284 50 100 150 200 250	Water
Topsoil	TOPSOIL; dark brown. Dry.		TS					Groundwater Not Encountered
Volcanic Ash	Silty CLAY; dark brown. Very stiff; dry; low plasticity, moderately sensitive.	0.2 0.4					199+ -	
	EOH: 0.60 m						176	
		0.6 0.8 1.0 1.2 1.4 1.6 1.8 2.0 2.2					65	

Photo

Remarks

End of log at 0.6m. target depth achieve.

Shear Vanes

- ▬ Peak
- ▨ Remoulded

Water

- ▼ Standing Water Level
- ◁ Out flow
- ▷ In flow

Investigation Type

- ☐ Hand Auger
- ☑ Investigation Pit
- ☐ Machine Borehole

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INVESTIGATION LOG

Client:	Te Kauwhata Land Limited	**Job No.:**	HD1151
Project:	Wayside Road	**No.:**	TP09
Location:	North to gully	**Date:**	20.11.19
Co-ordinates:	178835mE, 5857521mN	**Logged By:**	SSA
Elevation:	Ground	**Checked By:**	HJ

Geology	Geological Interpretation (refer to separate Geotechnical and Geological Information sheet for further information)	Depth (m)	Legend	Samples	PID (ppm)	Scala Penetrometer (Blows / 100 mm)	Vane Shear Strength (kPa) Vane: 2284	Water
Topsoil	TOPSOIL; dark brown.	0.0–0.2	TS					Groundwater Not Encountered
Volcanic Ash	Silty CLAY, with some gravel; orange brown mottled black. Very stiff to soft, sensitive; iron staining.	0.2–0.6					114 / 28 17 / 4	
Holocene Swamp Deposits	Silty CLAY; light to dark, purple blue. Soft, sensitive to moderately sensitive. 0.6 m: Very soft, wet, orange brown. 0.7 m: Grades to blackish blue, wet.	0.6–0.9					31 / 13	
	Silty CLAY; dark purplish black. Firm to soft; wet; high plasticity, moderately sensitive. 1.2 m: Purplish black, wet. 1.3 m: grades to light purple blue. 1.8 m: Trace rootlets.	0.9–2.3					17 / 6 14 / -	
	EOH: 2.30 m							

Photo

Remarks

End of log at 2.3m. target depth achieved.

Shear Vanes

■	Peak
▨	Remoulded

Water

▼	Standing Water Level
◁	Out flow
▷	In flow

Investigation Type

☐ Hand Auger
☑ Investigation Pit
☐ Machine Borehole

INVESTIGATION LOG

Client:	Te Kauwhata Land Limited	**Job No.:**	HD1151
Project:	Wayside Road	**No.:**	TP10
Location:	East of gully	**Date:**	20.11.19
Co-ordinates:	1788849mE, 5857545mN	**Logged By:**	SSA
Elevation:	Ground	**Checked By:**	HJ

Geology	Geological Interpretation (refer to separate Geotechnical and Geological Information sheet for further information)	Depth (m)	Legend	Samples	PID (ppm)	Scala Penetrometer (Blows / 100 mm)	Vane Shear Strength (kPa) Vane: 2284	Water
Topsoil	TOPSOIL; brown. Dry.		TS					Groundwater Not Encountered
Volcanic Ash	Silty CLAY; light brown mottled orange. Hard; non-plastic; iron staining, pumice, treeroots.	0.2					199+	
		0.4						
	Silty CLAY; light greyish white. Stiff; moist; moderate plasticity, moderately sensitive; iron stained.						105 33	
	EOH: 0.60 m	0.6						

Depth scale (m): 0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4, 1.6, 1.8, 2.0, 2.2

Scala Penetrometer scale: 2, 4, 6, 8, 10, 12, 14, 16, 18

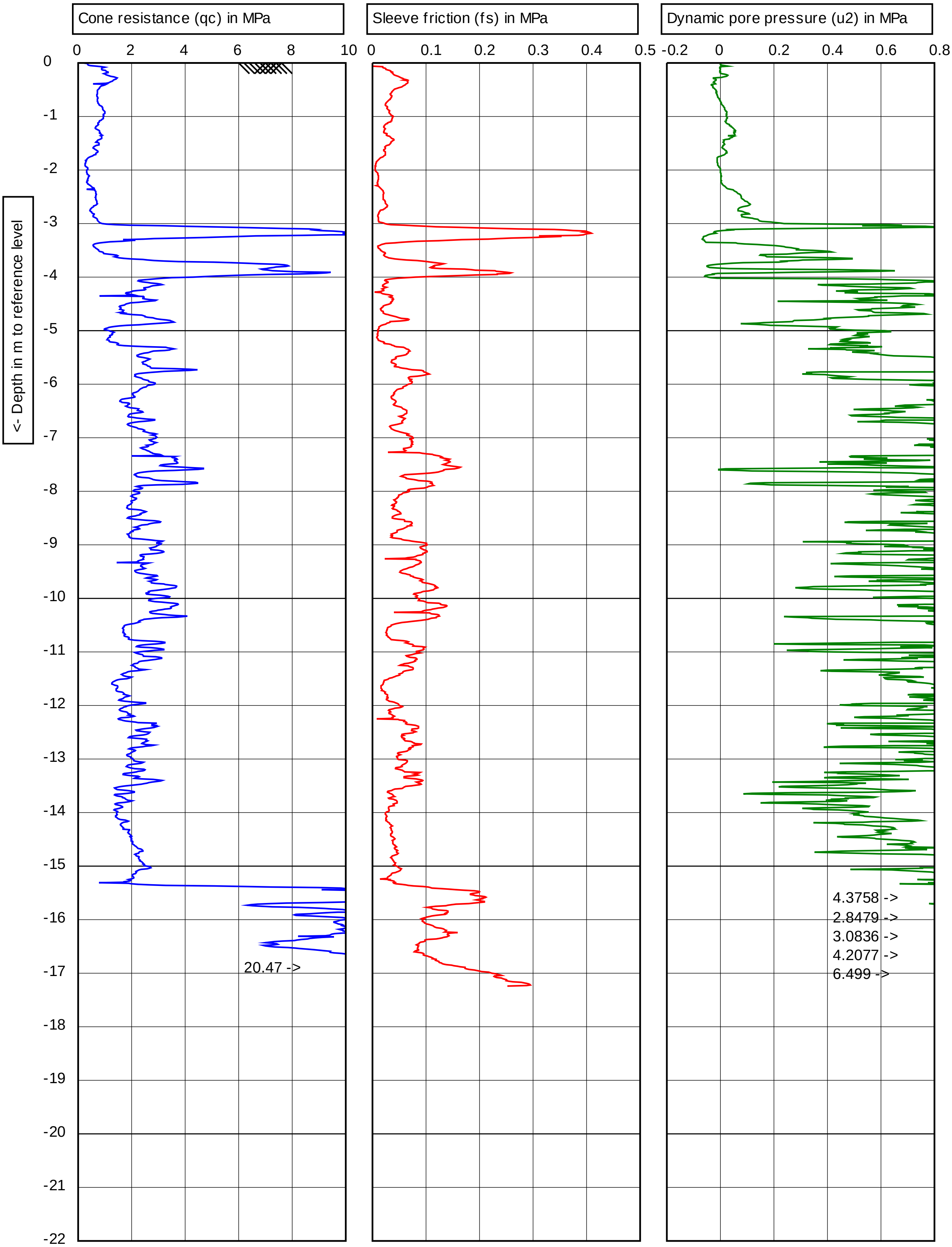
Vane Shear Strength scale: 50, 100, 150, 200, 250

Photo

Remarks

End of log at 2.3m. target depth achieved.

Shear Vanes	Water	Investigation Type
■ Peak	▼ Standing Water Level	☐ Hand Auger
▨ Remoulded	◁ Out flow	☑ Investigation Pit
	▷ In flow	☐ Machine Borehole



Refusal (Tonnage)

EOH - Dipped - Collapsed dry @ 1.7m

u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL

W.L.: **-1.7**

Predrill : **0 m Predrilled**

Date: **4/08/2014**

Cone no.: **C10CFIPT.C11306**

Project no.: **338720.00**

CPT no.: **05**

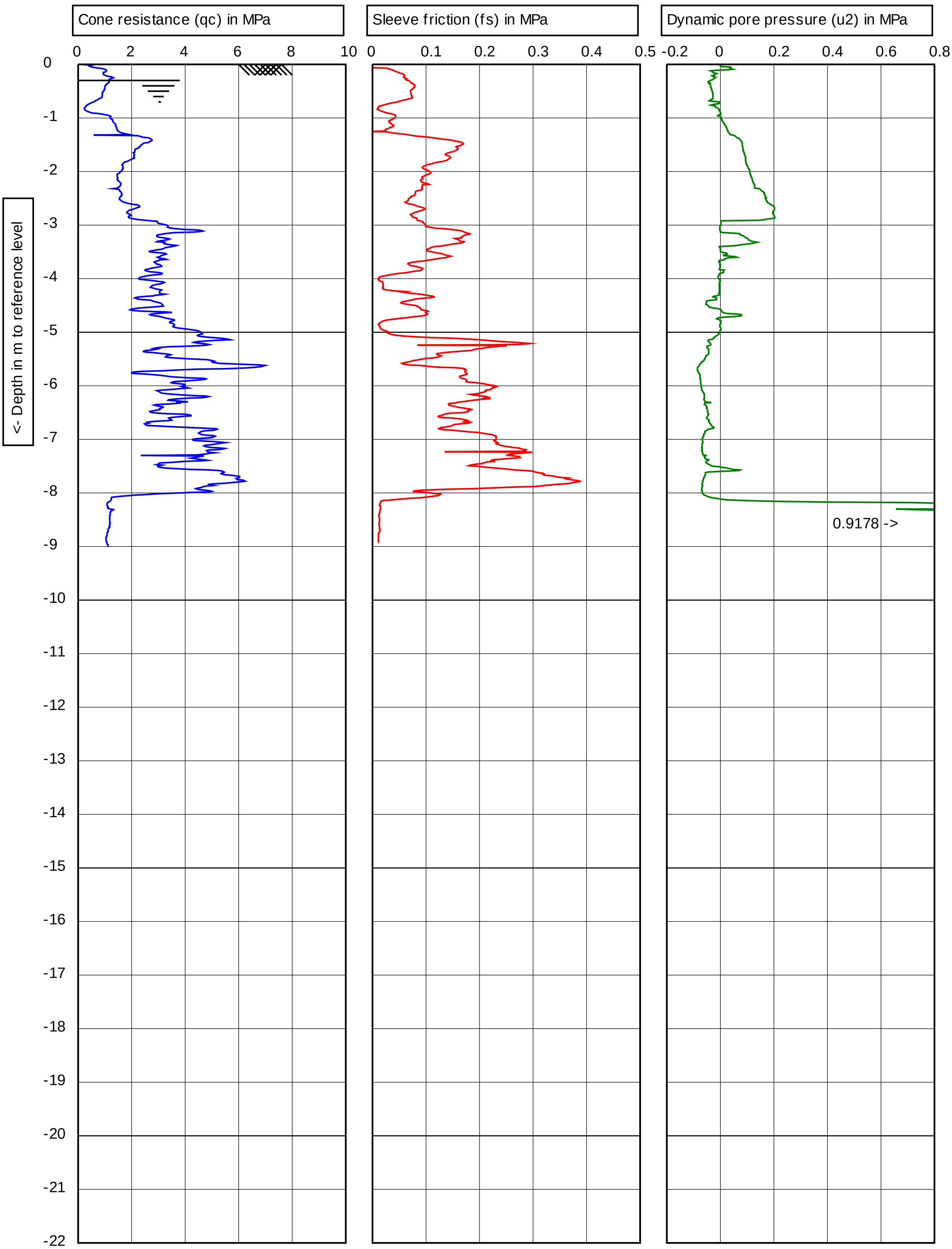
1/6

Project: **Blue Wallace 1**

Location: **Wayside Rd - Te Kauwhata**

Position: **1788820, 5857452 NZTM**

1.40



Target Depth

EOH - Dipped - GWL @ 0.3m

u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL

W.L.: **-0.3**

Predrill : **0 m Predrilled**

Date: **4/08/2014**

Project: **Blue Wallace 1**

Location: **Wayside Rd - Te Kauwhata**

Position: **1788895, 5857444 NZTM**

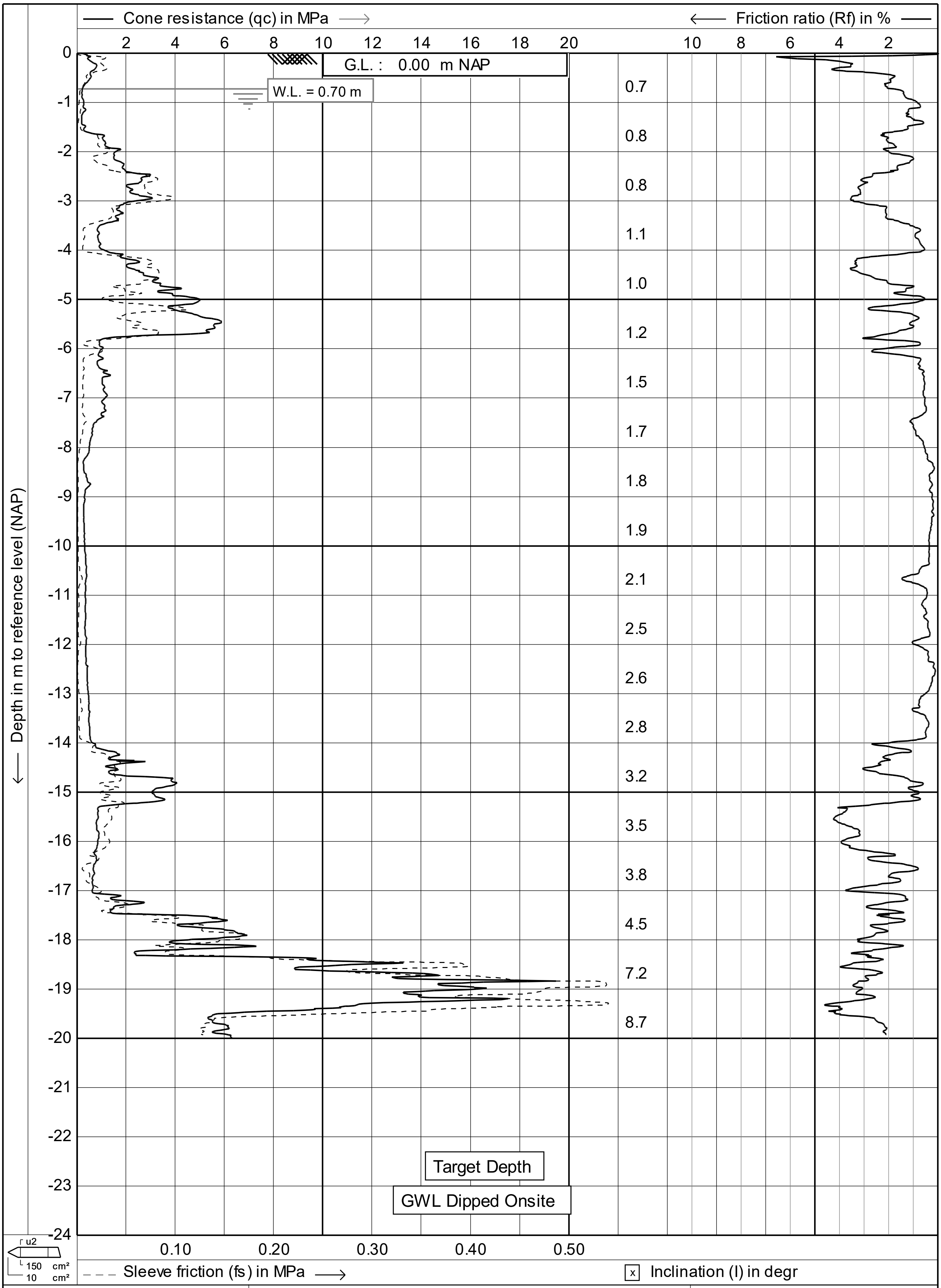
Cone no.: **C10CFIPT.C11306**

Project no.: **338720.00**

CPT no.: **08**

1/6

1.40



PERRY GEOTECH

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

Project : **Site Investigations**

Location: **Travers Rd - Te Kauwhata**

Position: **0, 0 RD**

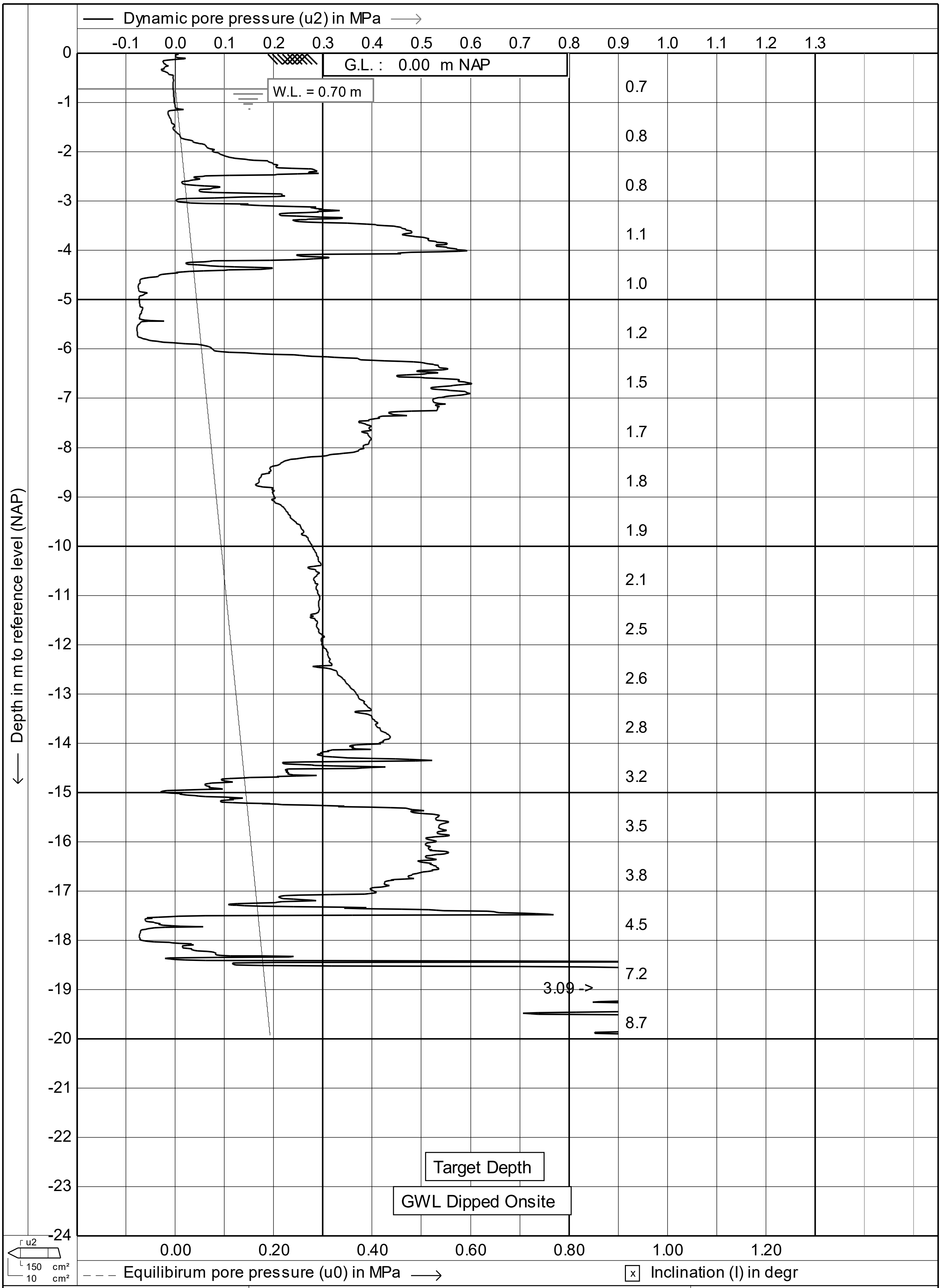
Date : **10/07/2019**

Cone no. : **C10CFIIP.C13184**

Project no. : **01TT05**

CPT no. : **101** **1/14**

1.47



PERRY GEOTECH

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

Project : **Site Investigations**

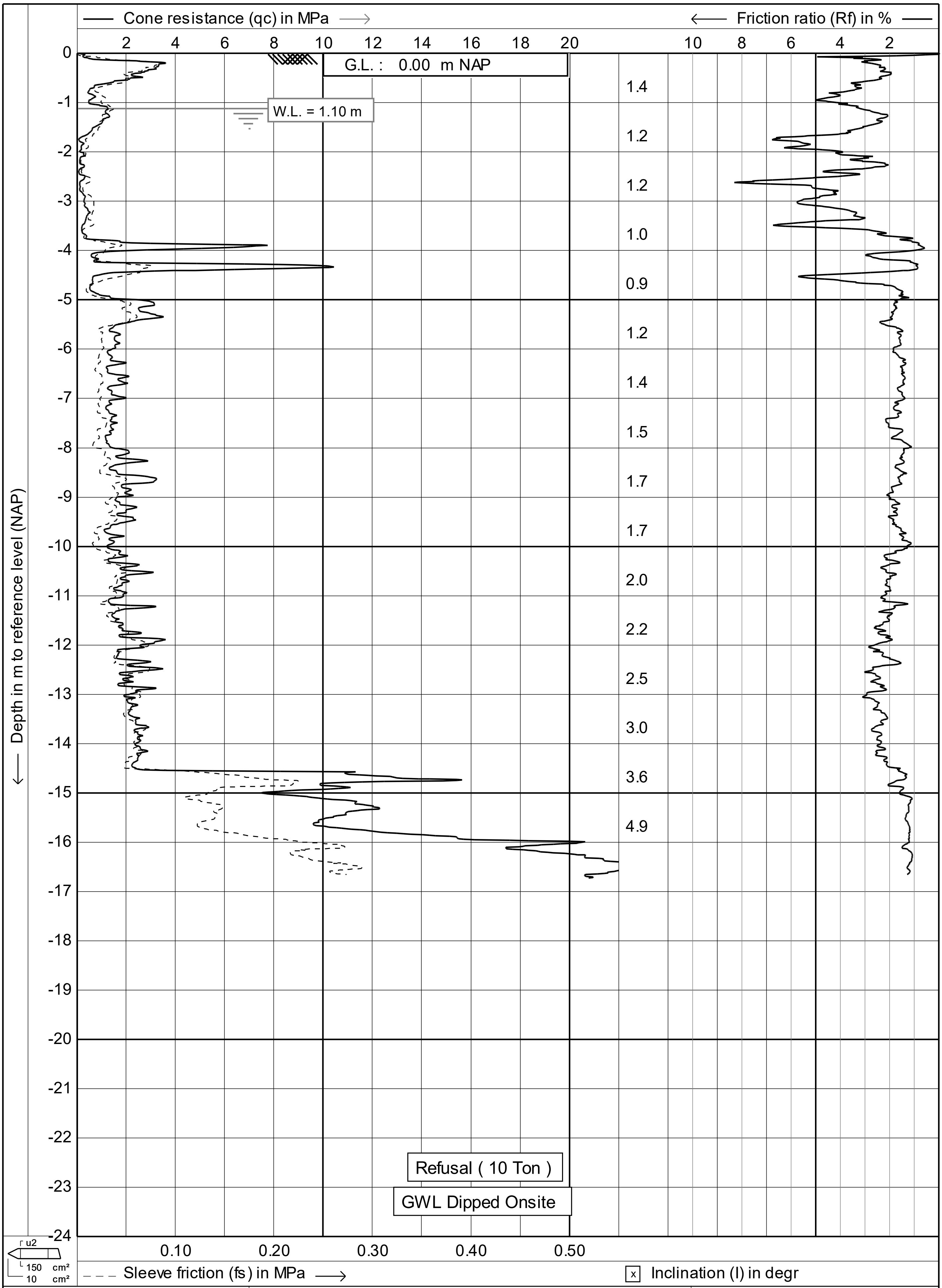
Location: **Travers Rd - Te Kauwhata**

Position: **0, 0 RD**

Date	: **10/07/2019**
Cone no.	: **C10CFIIP.C13184**
Project no. :	**01TT05**
CPT no.	: **101**

2/14

1.47



G.L. : 0.00 m NAP

W.L. = 1.10 m

Refusal (10 Ton)

GWL Dipped Onsite

PERRY GEOTECH

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

Project : **Site Investigations**

Location: **Travers Rd - Te Kauwhata**

Position: **0, 0 RD**

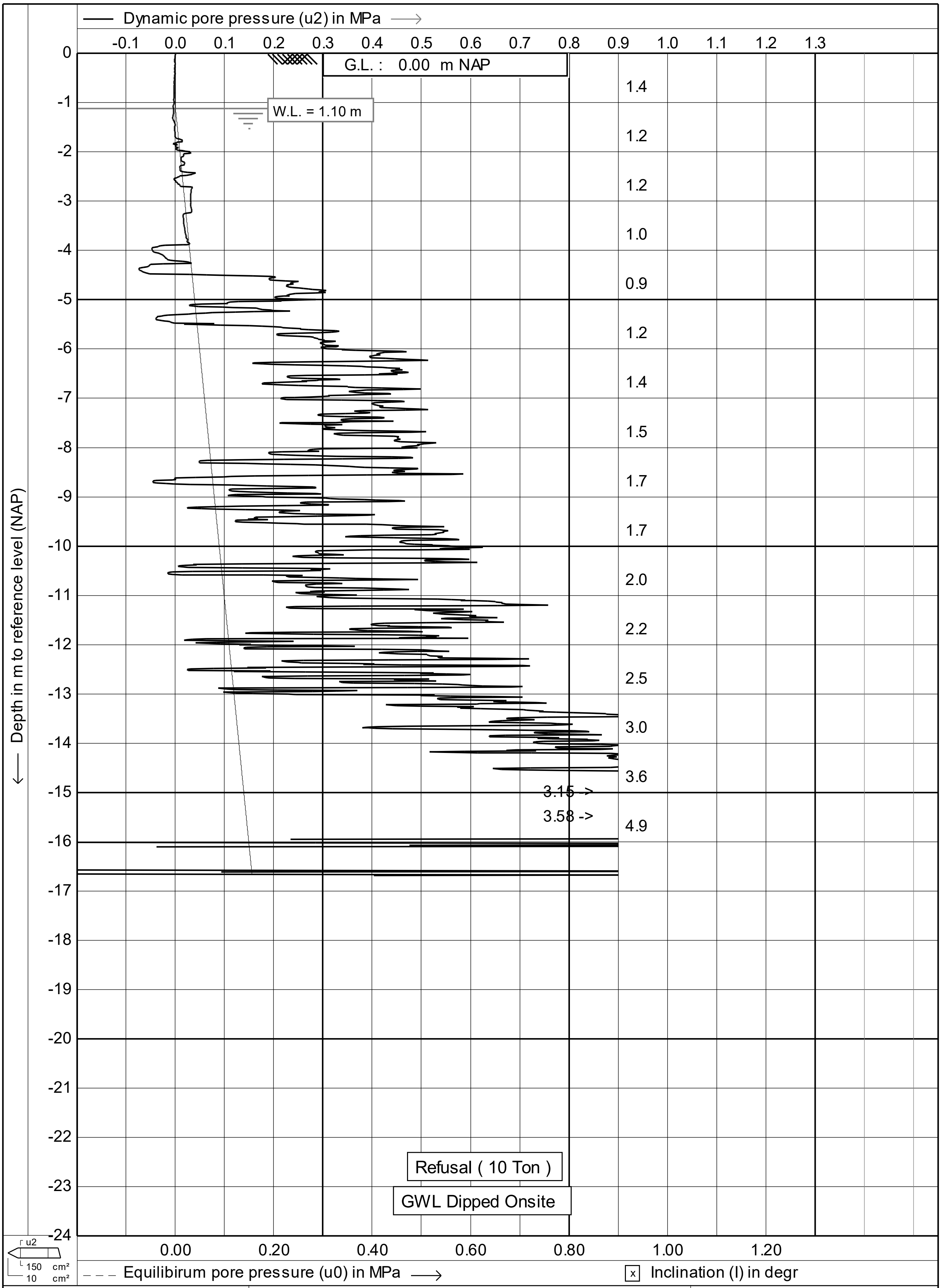
Date : **10/07/2019**

Cone no. : **C10CFIIP.C13184**

Project no. : **01TT05**

CPT no. : **102** **1/14**

1.47



PERRY
GEOTECH

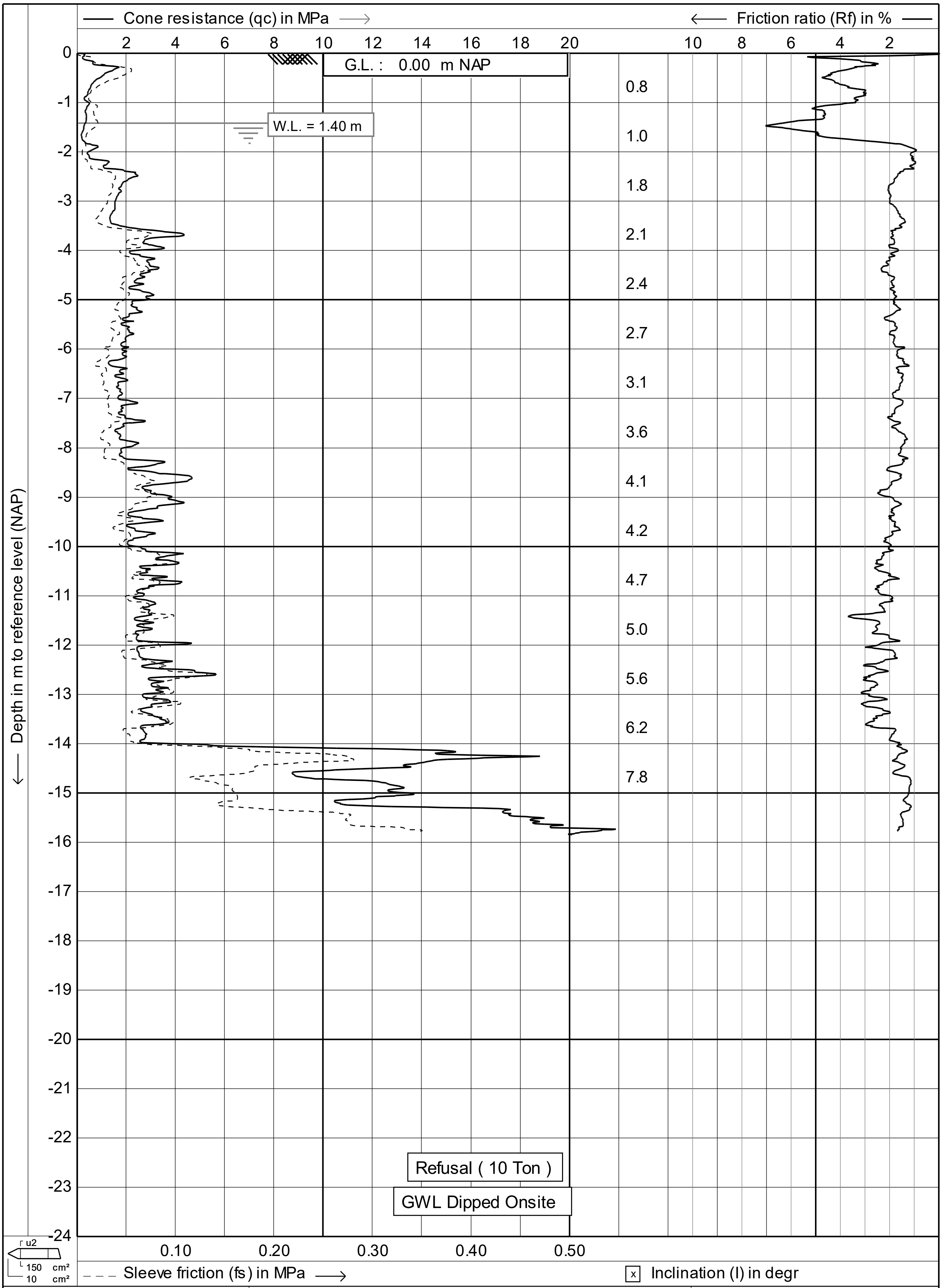
Test according A.S.T.M Standard D 5778-12

Project : **Site Investigations**
Location: **Travers Rd - Te Kauwhata**
Position: **0, 0 RD**

Date : **10/07/2019**
Cone no. : **C10CFIIP.C13184**
Project no. : **01TT05**
CPT no. : **102**

2/14

1.47



PERRY GEOTECH

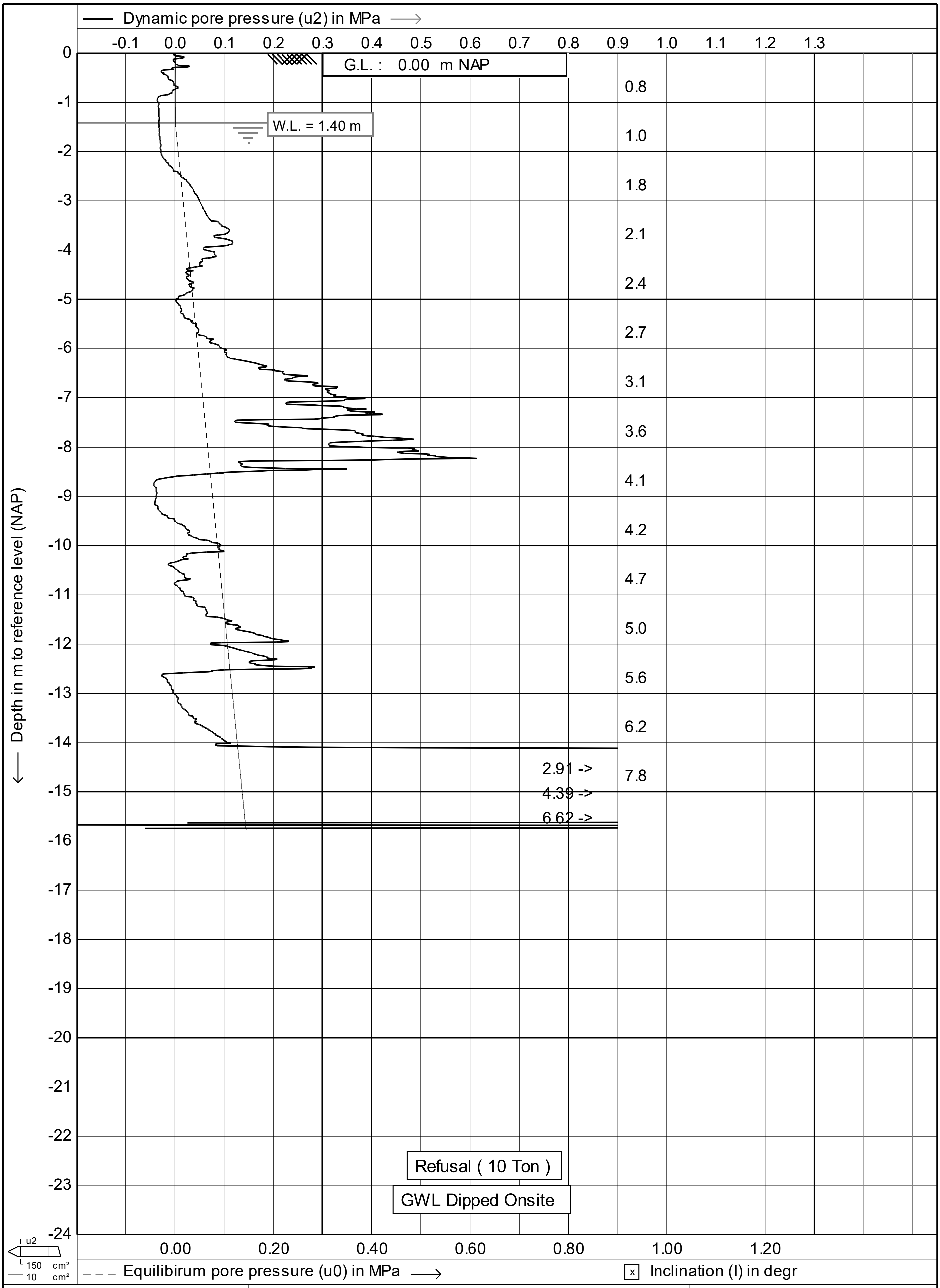
Test according A.S.T.M Standard D 5778-12

Project : **Site Investigations**
Location: **Travers Rd - Te Kauwhata**
Position: **0, 0 RD**

Date : **10/07/2019**
Cone no. : **C10CFIIP.C13184**
Project no. : **01TT05**
CPT no. : **103**

1/14

1.47



PERRY GEOTECH

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

Project : **Site Investigations**

Location: **Travers Rd - Te Kauwhata**

Position: **0, 0 RD**

Date : **10/07/2019**

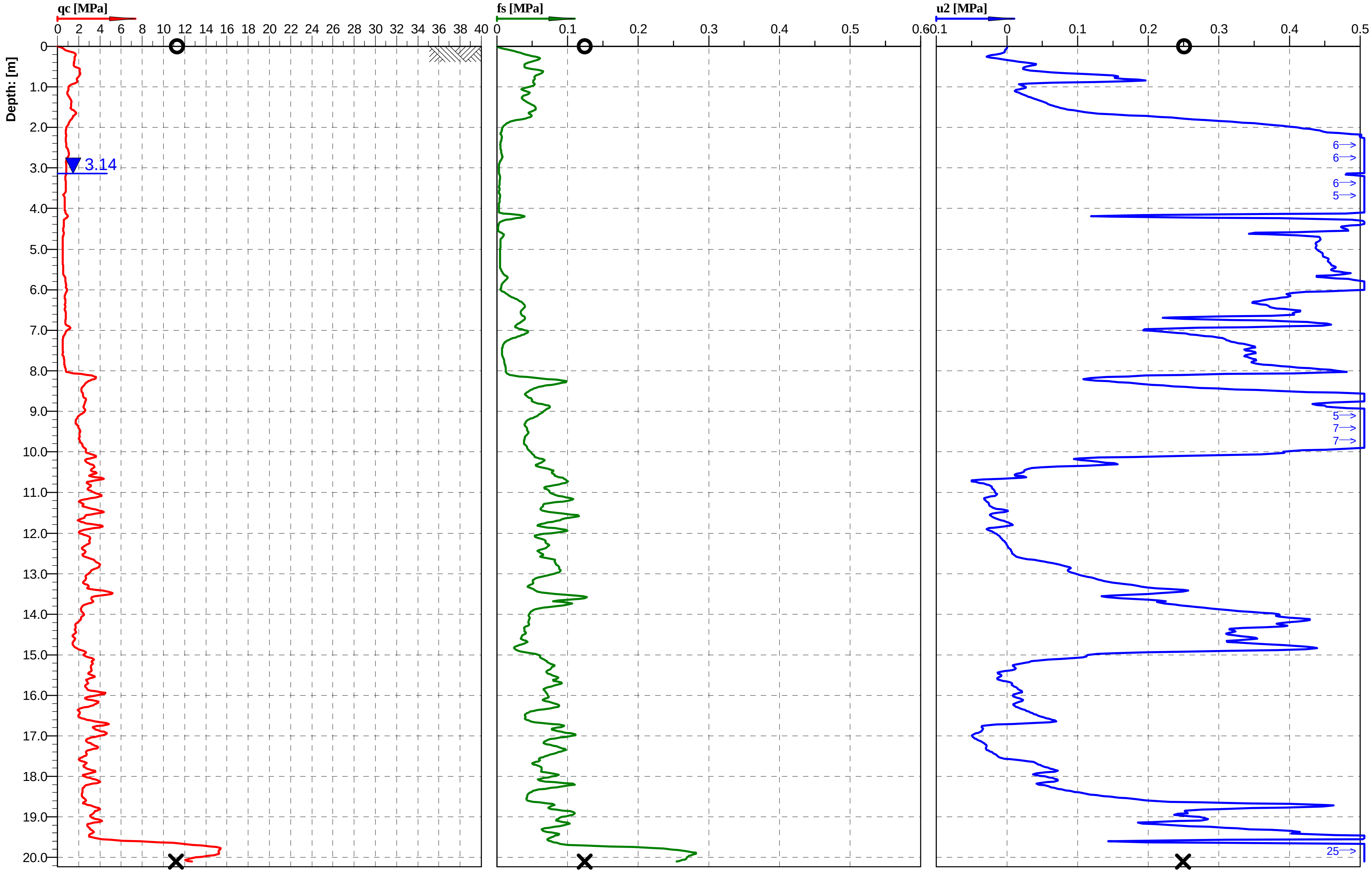
Cone no. : **C10CFIIP.C13184**

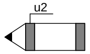
Project no. : **01TT05**

CPT no. : **103**

2/14

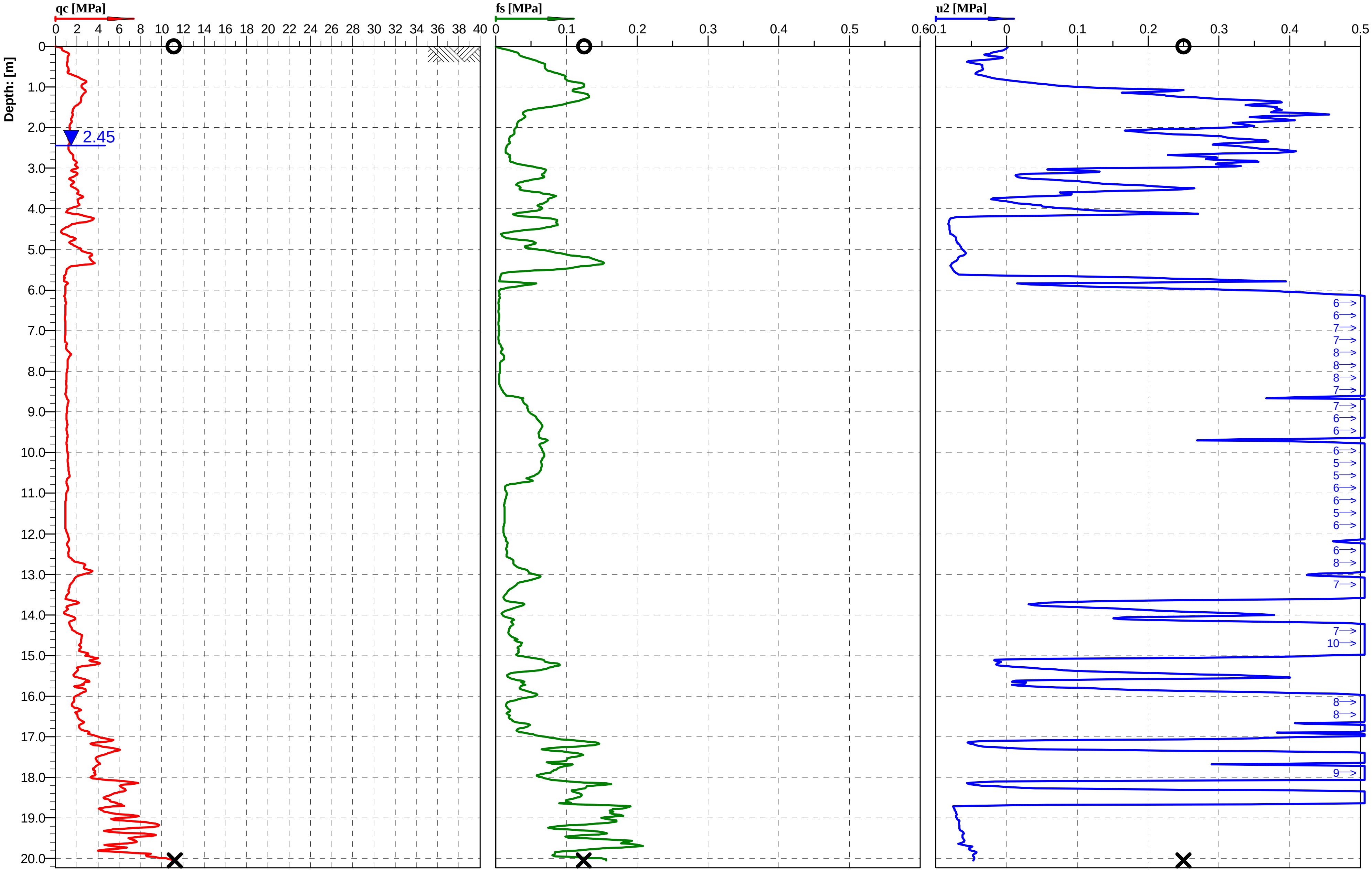
1.47

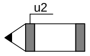




Cone No: 5252
Tip area [cm2]: 10
Sleeve area [cm2]: 150

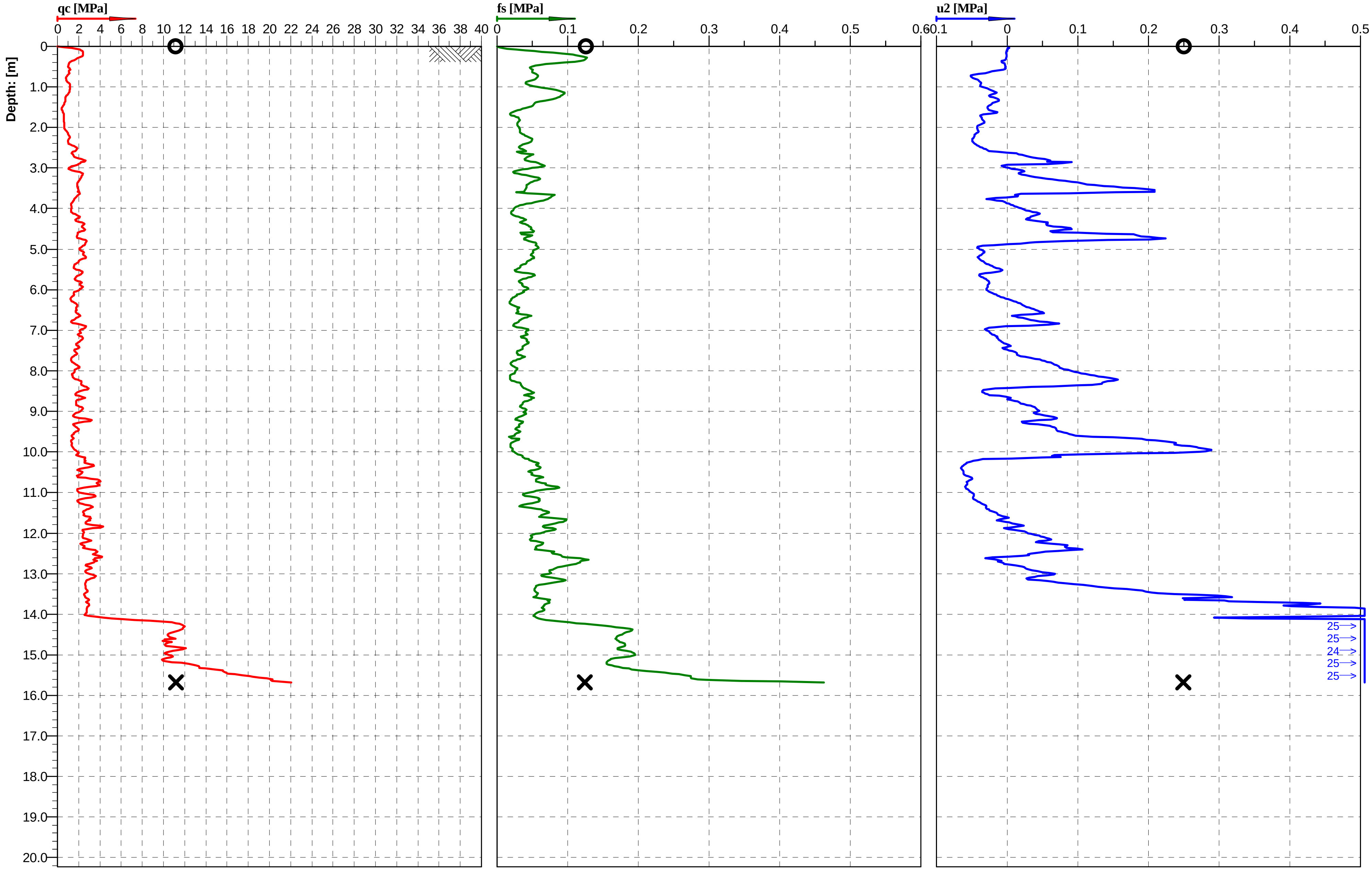
Location: Te Kauwhata
Position: X: 0.00 m, Y: 0.00 m
Ground level: 0.00
Test No.: CPT01
Project ID: E1788863 N5857537
Client: HD Geo Ltd
Date: 19/11/2019
Scale: 1 : 128
Project: Travers Rd
Page: 1/2
Fig.:
Target depth 20.0m
File: CPT01.cpt

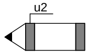




Cone No: 5252
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Te Kauwhata	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT02
Project ID: E1788918 N5857613	Client: HD Geo Ltd	Date: 19/11/2019	Scale: 1 : 128
Project: Travers Rd		Page: 1/2	Fig.:
Target depth 20.0m		File: CPT02.cpt	



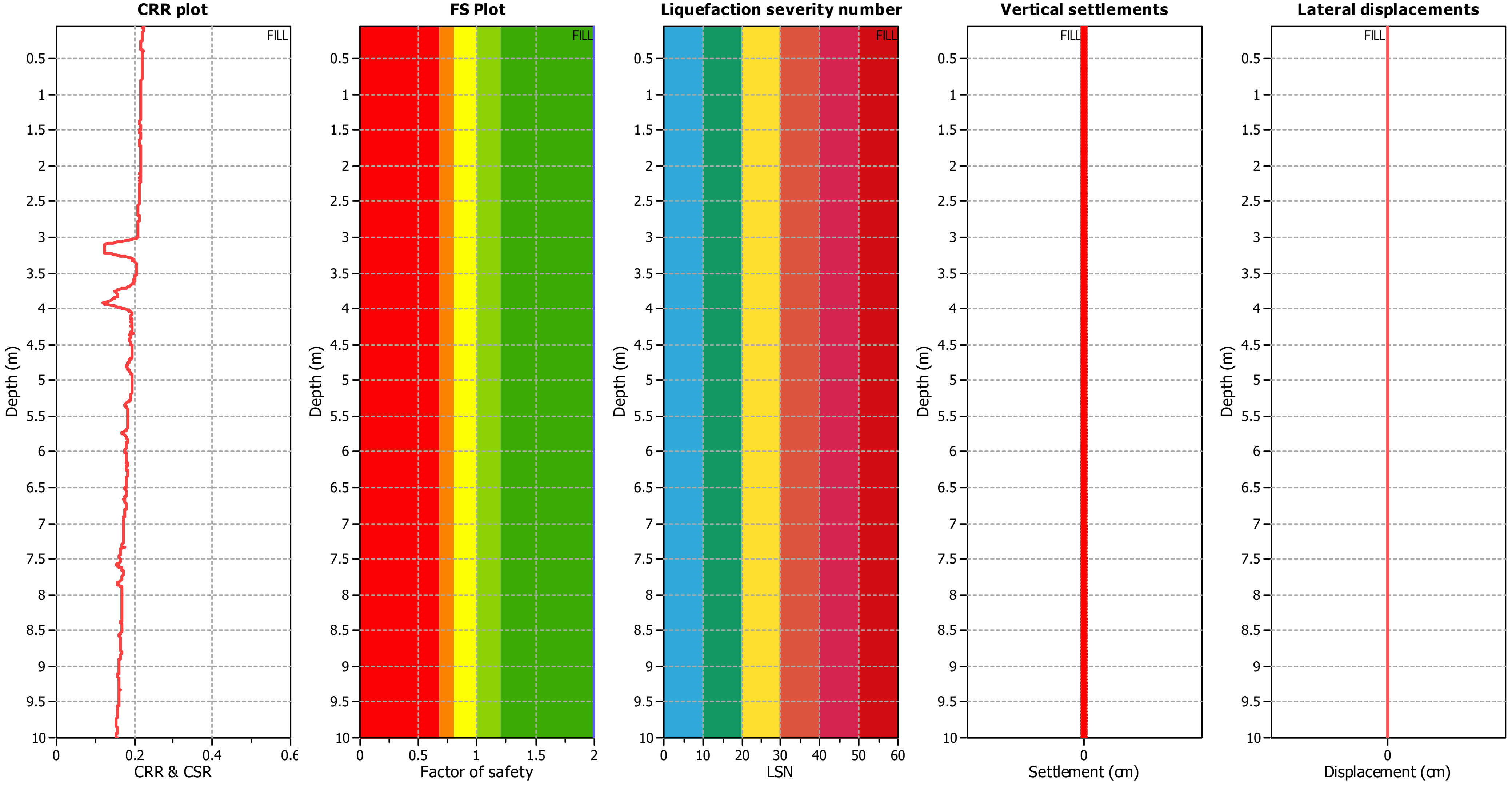


Cone No: 5252
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Te Kauwhata
Position: X: 0.00 m, Y: 0.00 m
Ground level: 0.00
Test No.: CPT03
Project ID: E1788801 N5857517
Client: HD Geo Ltd
Date: 19/11/2019
Scale: 1 : 128
Project: Travers Rd
Page: 1/2
Fig.:
Refusal at 15.69m, high qc and fs, no water detected, hole collapsed back to 1.10m
File: CPT03.cpt

APPENDIX D – LIQUEFACTION ASSESSMENT

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)
Fines correction method:	B&I (2014)
Points to test:	Based on Ic value
Earthquake magnitude M_w:	5.80
Peak ground acceleration:	0.22
Depth to water table (insitu):	1.70 m
Depth to GWT (erthq.):	1.70 m
Average results interval:	3
Ic cut-off value:	2.20
Unit weight calculation:	Based on SBT
Use fill:	Yes
Fill height:	10.00 m
Fill weight:	15.00 kN/m³
Transition detect. applied:	Yes
K_σ applied:	No
Clay like behavior applied:	Sand & Clay
Limit depth applied:	Yes
Limit depth:	10.00 m

F.S. color scheme

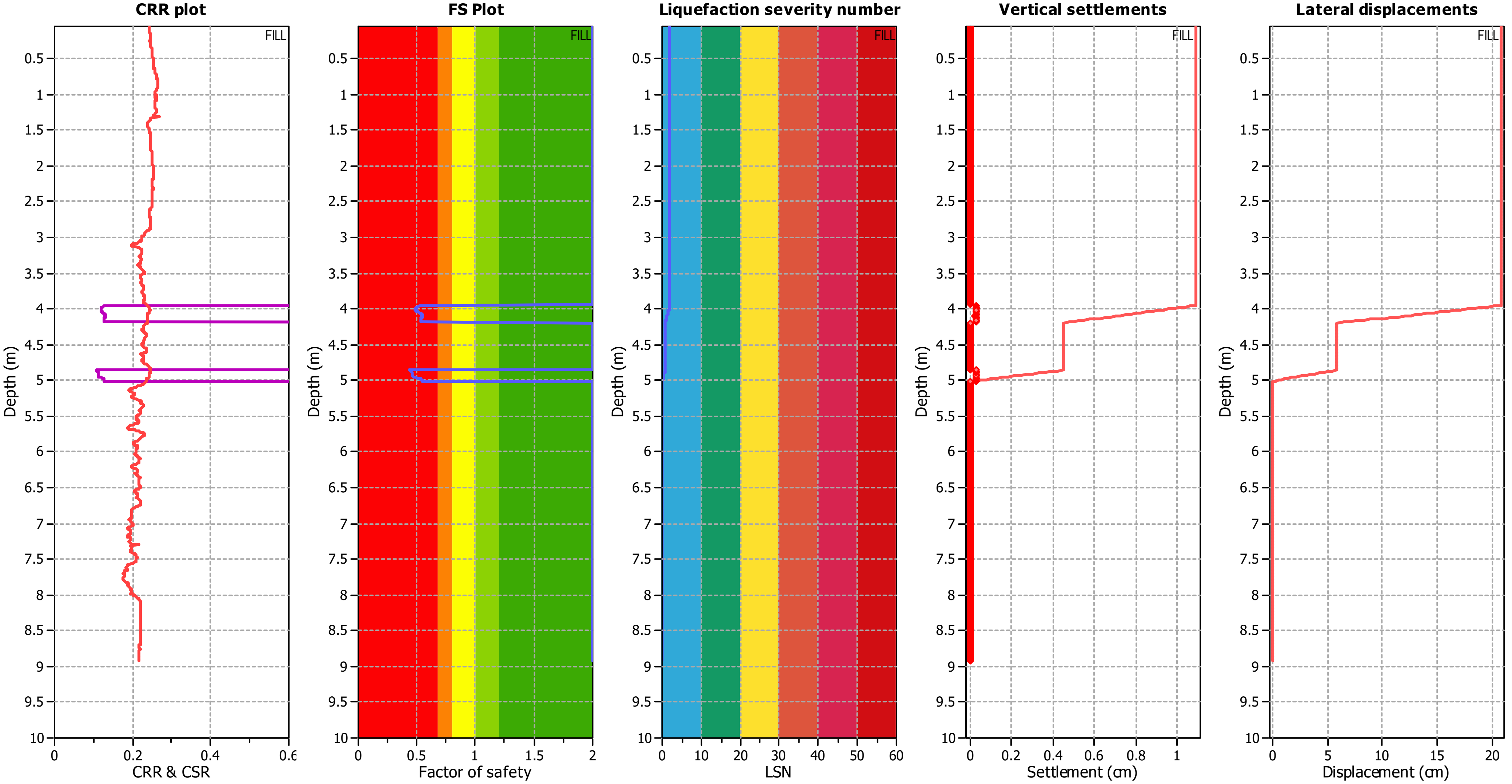
- 🟥 Almost certain it will liquefy
- 🟧 Very likely to liquefy
- 🟨 Liquefaction and no liq. are equally likely
- 🟩 Unlike to liquefy
- 🟩 Almost certain it will not liquefy

LSN color scheme

- 🟥 Severe damage
- 🟥 Major expression of liquefaction
- 🟧 Moderate to severe exp. of liquefaction
- 🟨 Moderate expression of liquefaction
- 🟩 Minor expression of liquefaction
- 🟦 Little to no expression of liquefaction

OPUSCPT08

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)
Fines correction method:	B&I (2014)
Points to test:	Based on Ic value
Earthquake magnitude M_w:	5.80
Peak ground acceleration:	0.22
Depth to water table (insitu):	0.30 m
Depth to GWT (erthq.):	0.30 m
Average results interval:	3
Ic cut-off value:	2.20
Unit weight calculation:	Based on SBT
Use fill:	Yes
Fill height:	1.00 m
Fill weight:	15.00 kN/m^3
Transition detect. applied:	Yes
K_σ applied:	No
Clay like behavior applied:	Sand & Clay
Limit depth applied:	Yes
Limit depth:	10.00 m

F.S. color scheme

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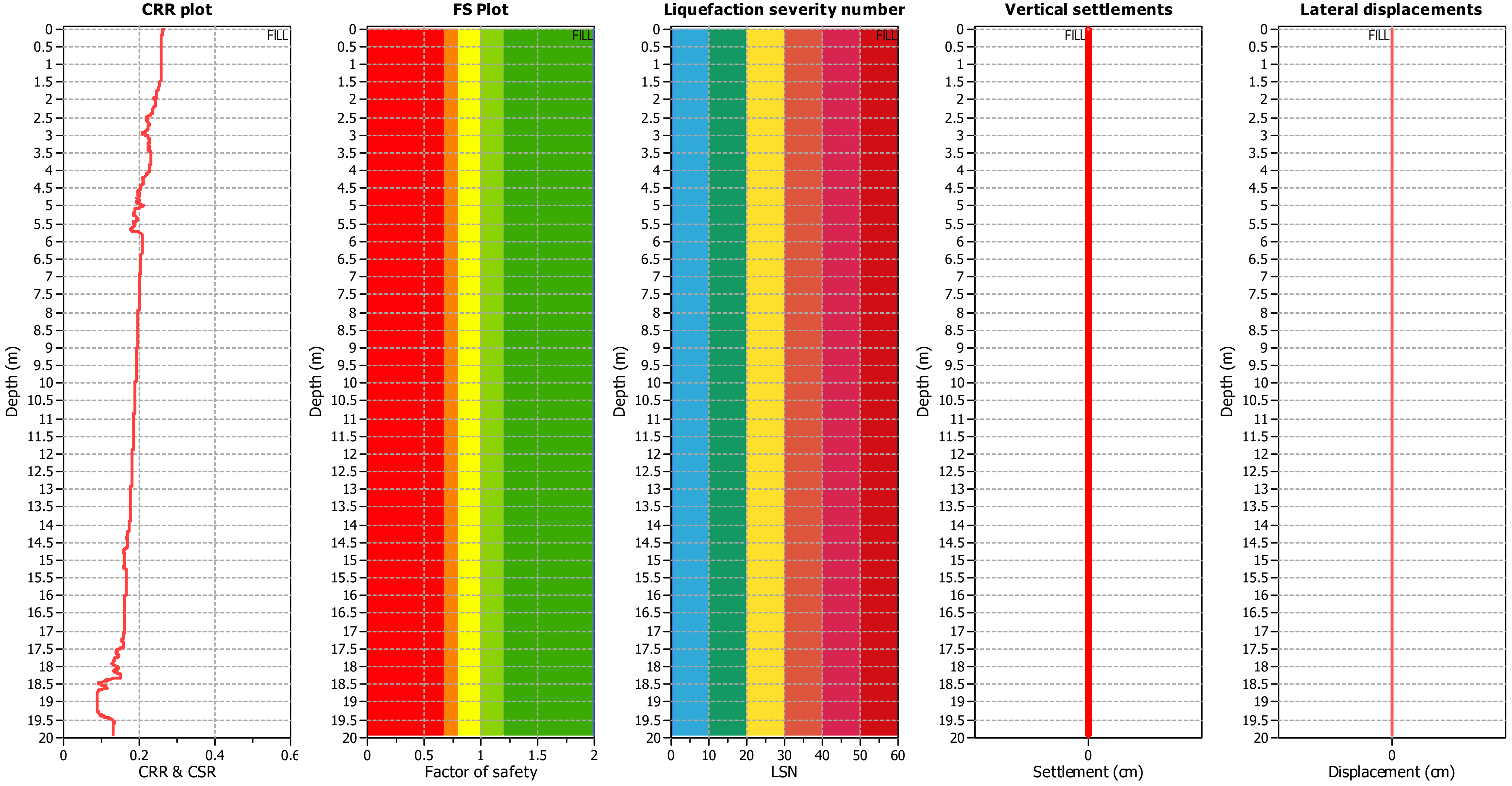
T&TCPT01

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.70 m	Fill weight:	15.00 kN/m^3
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.20	K_{σ} applied:	No
Earthquake magnitude M_w:	5.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.22	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	0.70 m	Fill height:	10.00 m	Limit depth:	10.00 m

F.S. color scheme

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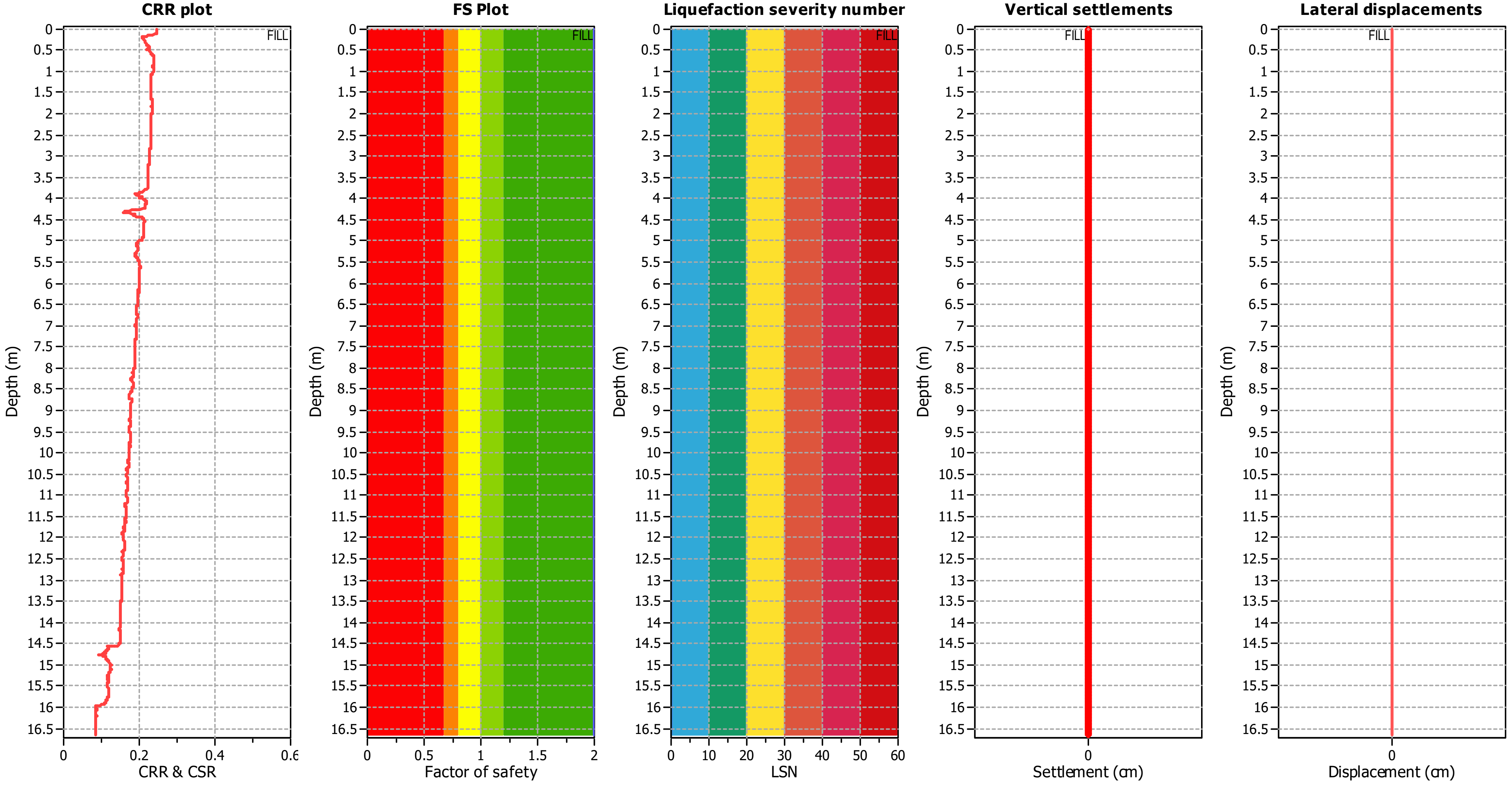
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 5.80
Peak ground acceleration: 0.22
Depth to water table (insitu): 1.10 m

Depth to GWT (erthq.): 1.10 m
Average results interval: 3
Ic cut-off value: 2.20
Unit weight calculation: Based on SBT
Use fill: Yes
Fill height: 10.00 m

Fill weight: 15.00 kN/m^3
Transition detect. applied: Yes
K_σ applied: No
Clay like behavior applied: Sand & Clay
Limit depth applied: Yes
Limit depth: 10.00 m

F.S. color scheme

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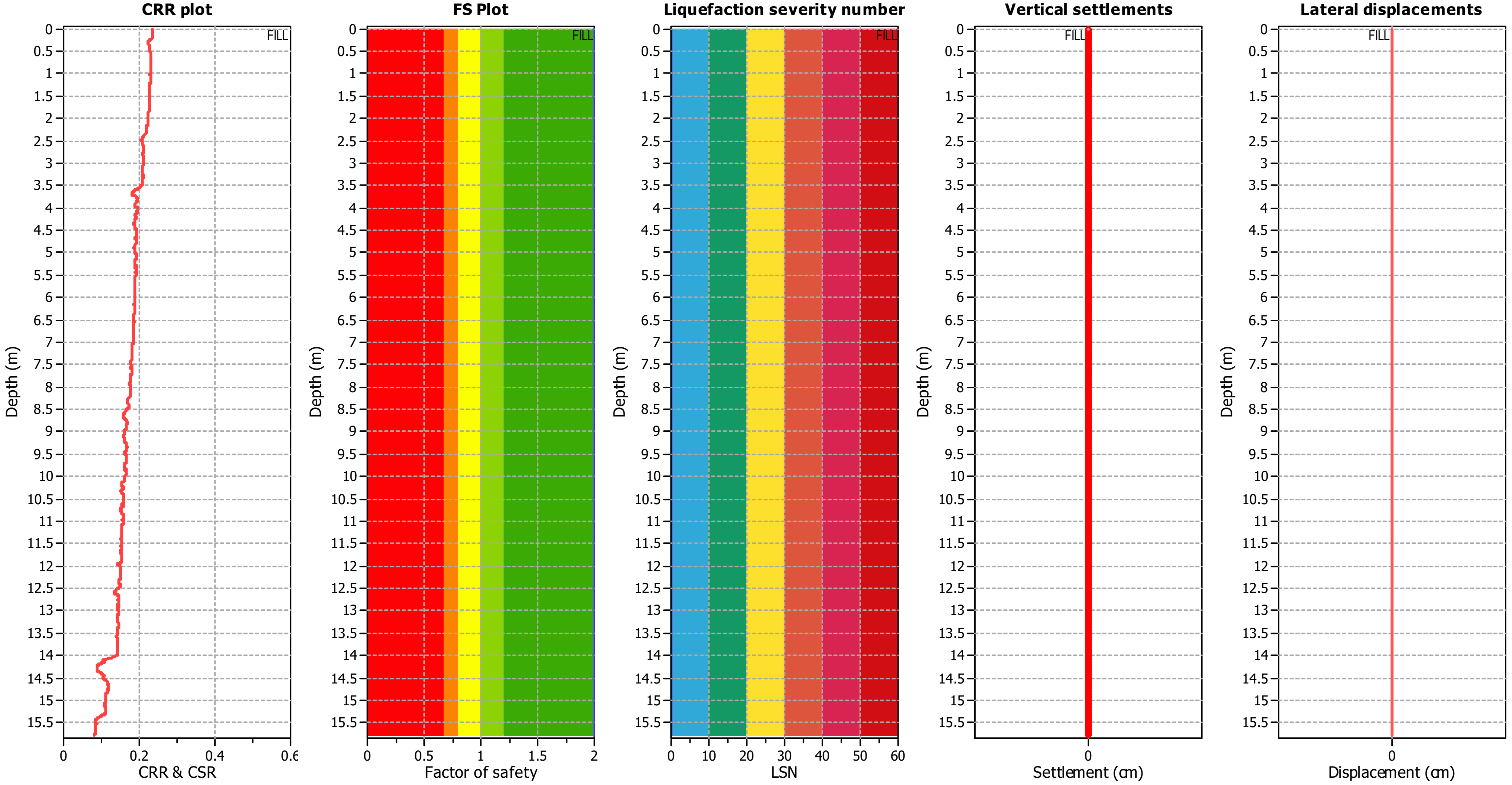
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 5.80
Peak ground acceleration: 0.22
Depth to water table (insitu): 1.40 m

Depth to GWT (erthq.): 1.40 m
Average results interval: 3
Ic cut-off value: 2.20
Unit weight calculation: Based on SBT
Use fill: Yes
Fill height: 10.00 m

Fill weight: 15.00 kN/m³
Transition detect. applied: Yes
K_σ applied: No
Clay like behavior applied: Sand & Clay
Limit depth applied: Yes
Limit depth: 10.00 m

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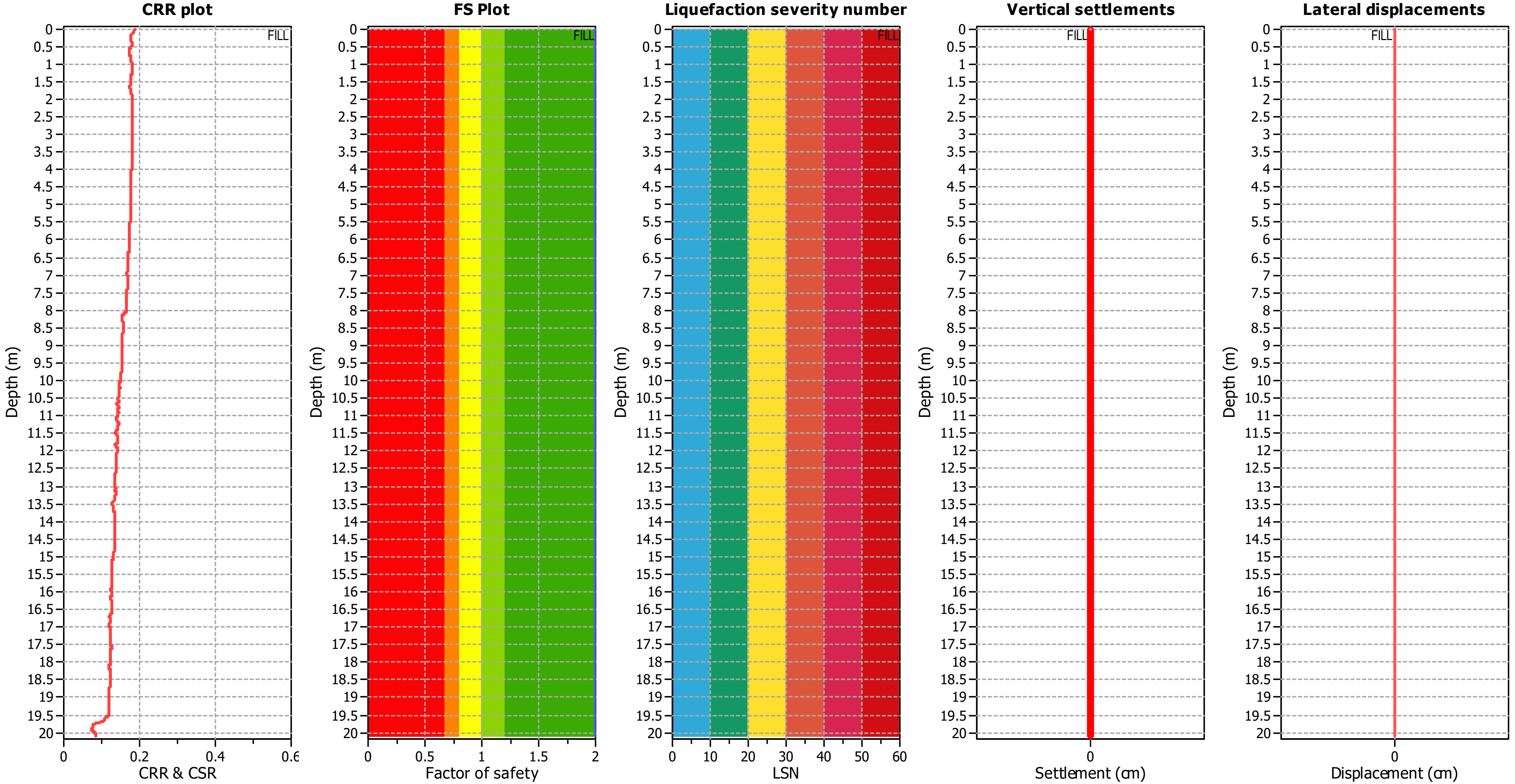
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 5.80
Peak ground acceleration: 0.22
Depth to water table (insitu): 3.14 m

Depth to GWT (erthq.): 3.14 m
Average results interval: 3
Ic cut-off value: 2.20
Unit weight calculation: Based on SBT
Use fill: Yes
Fill height: 10.00 m

Fill weight: 15.00 kN/m^3
Transition detect. applied: Yes
K_σ applied: No
Clay like behavior applied: Sand & Clay
Limit depth applied: Yes
Limit depth: 10.00 m

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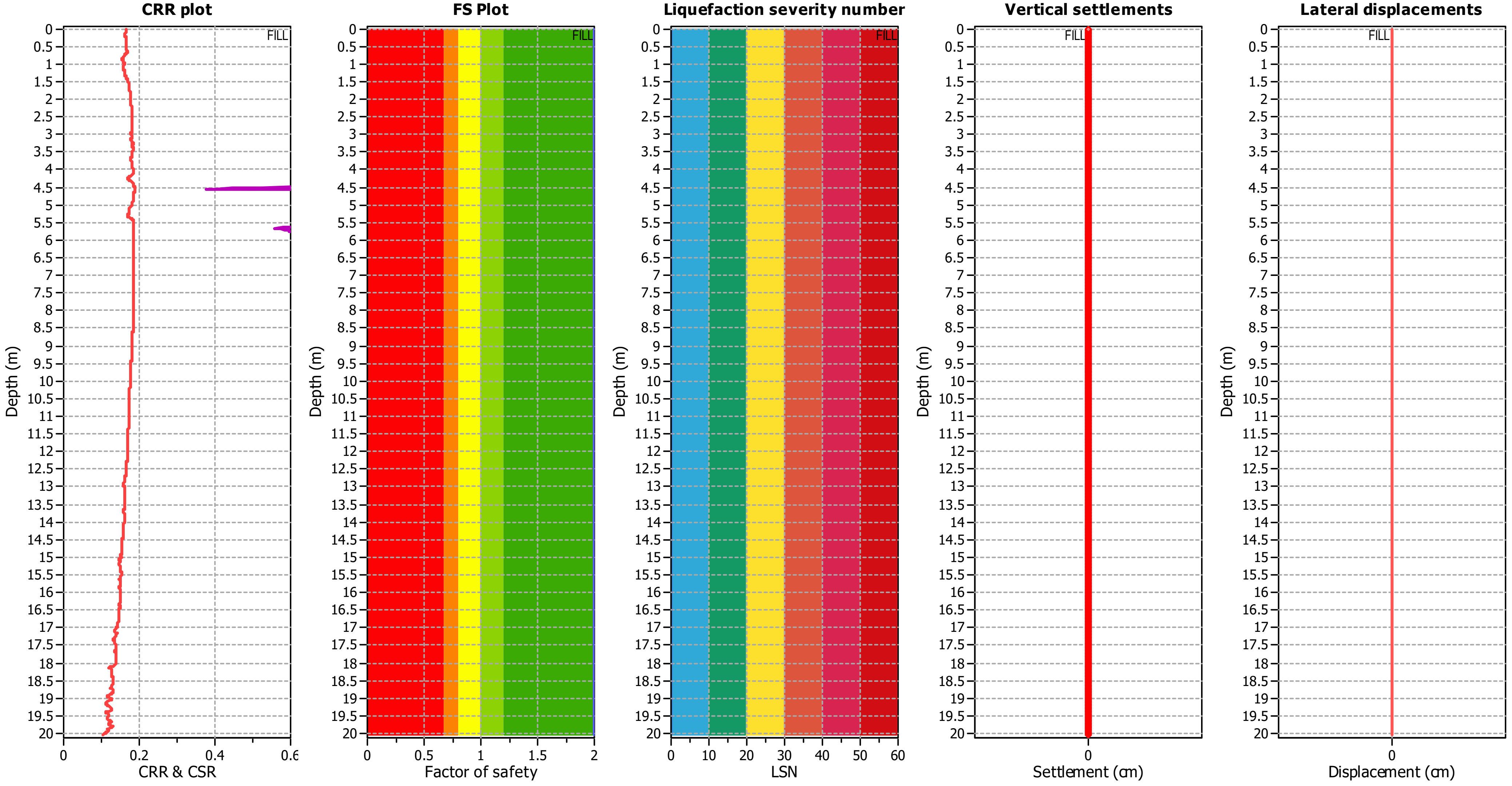
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)
Fines correction method:	B&I (2014)
Points to test:	Based on Ic value
Earthquake magnitude M_w:	5.80
Peak ground acceleration:	0.22
Depth to water table (insitu):	2.45 m
Depth to GWT (erthq.):	2.45 m
Average results interval:	3
Ic cut-off value:	2.20
Unit weight calculation:	Based on SBT
Use fill:	Yes
Fill height:	4.00 m
Fill weight:	15.00 kN/m³
Transition detect. applied:	Yes
K_σ applied:	No
Clay like behavior applied:	Sand & Clay
Limit depth applied:	Yes
Limit depth:	10.00 m

F.S. color scheme

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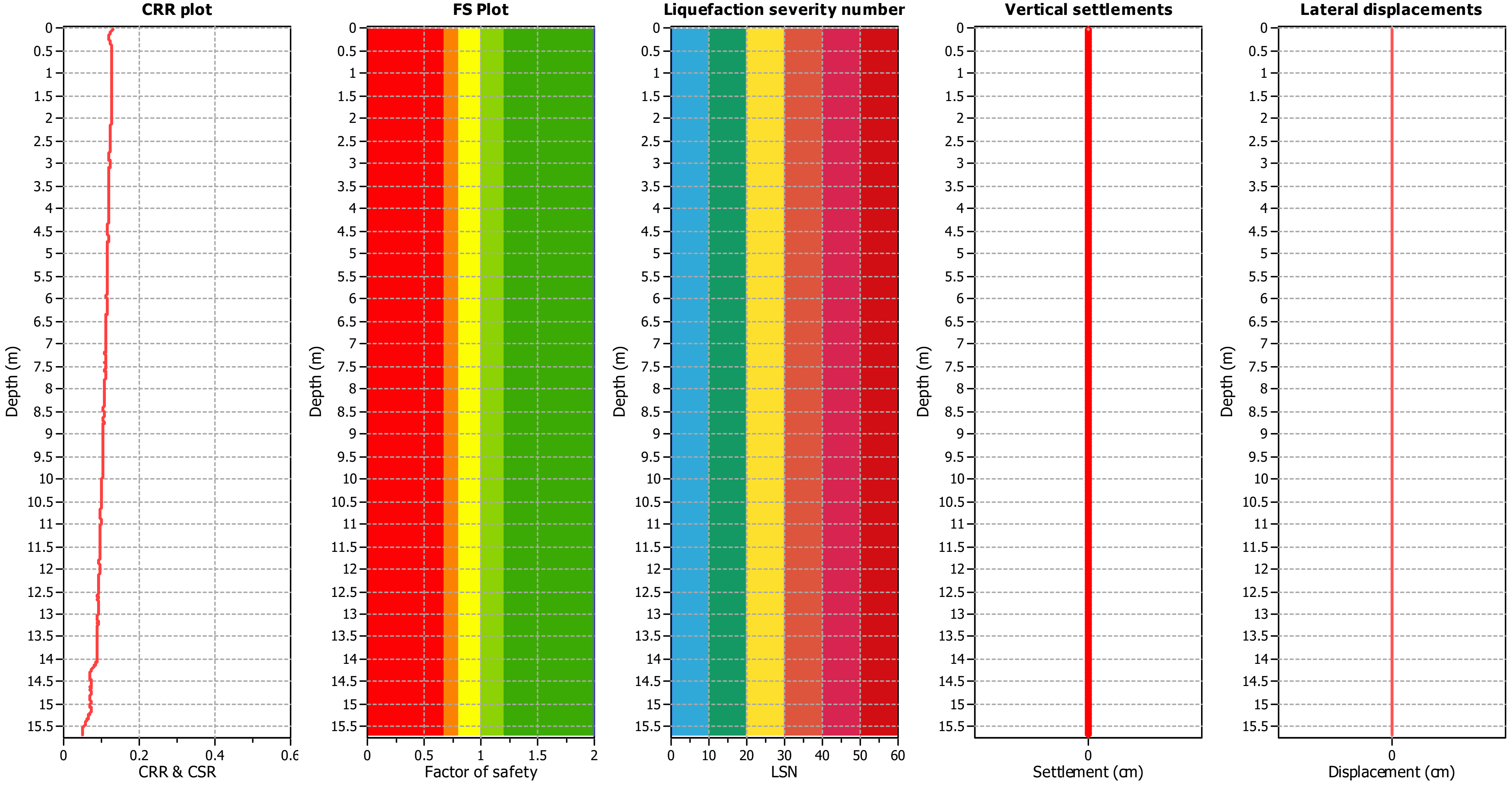
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 5.80
Peak ground acceleration: 0.22
Depth to water table (insitu): 20.00 m

Depth to GWT (erthq.): 20.00 m
Average results interval: 3
Ic cut-off value: 2.20
Unit weight calculation: Based on SBT
Use fill: No
Fill height: N/A

Fill weight: N/A
Transition detect. applied: Yes
K_σ applied: No
Clay like behavior applied: Sand & Clay
Limit depth applied: Yes
Limit depth: 10.00 m

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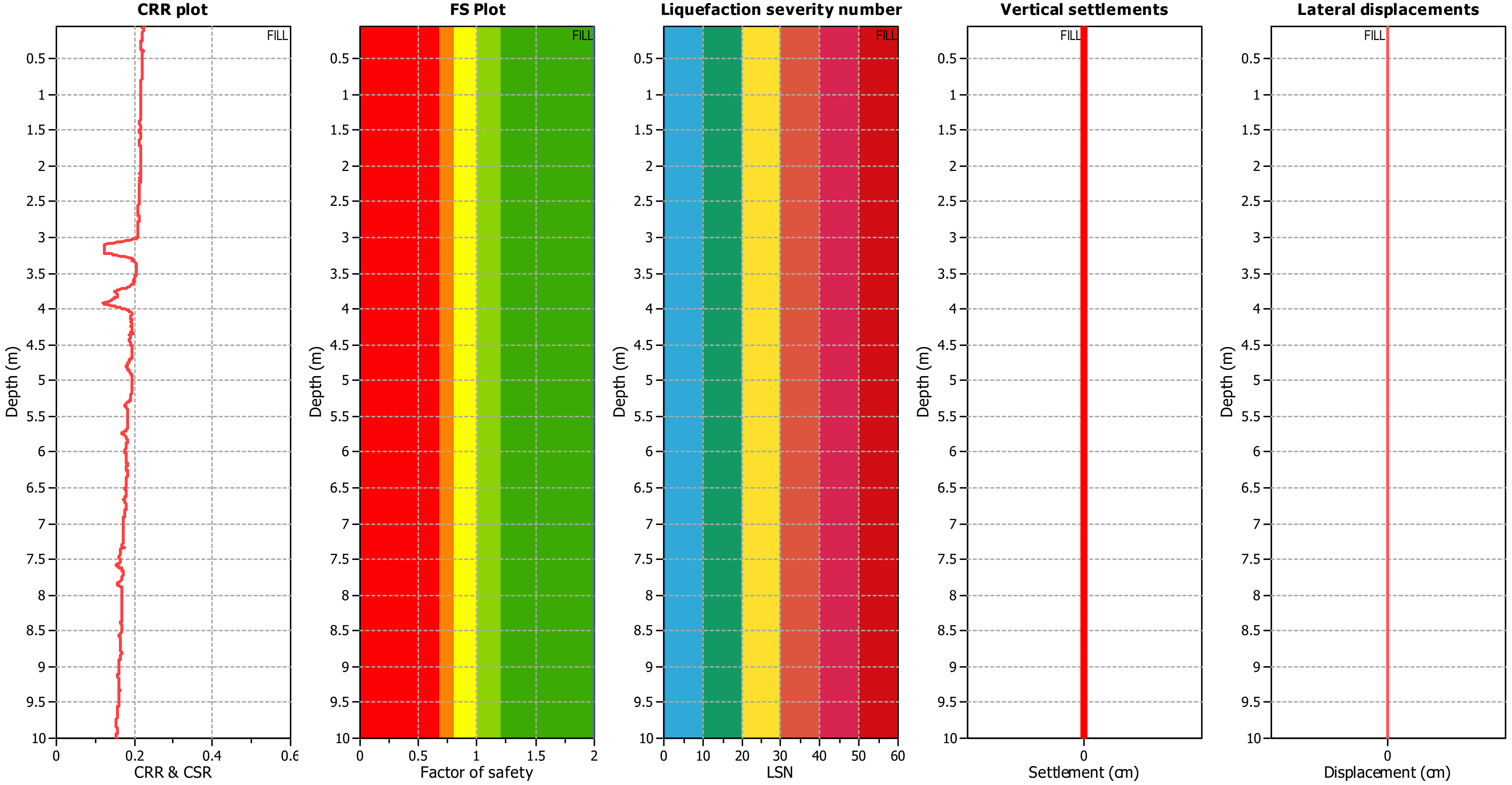
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)
Fines correction method:	B&I (2014)
Points to test:	Based on Ic value
Earthquake magnitude M_w:	5.80
Peak ground acceleration:	0.22
Depth to water table (insitu):	1.70 m
Depth to GWT (erthq.):	1.70 m
Average results interval:	3
Ic cut-off value:	2.60
Unit weight calculation:	Based on SBT
Use fill:	Yes
Fill height:	10.00 m
Fill weight:	15.00 kN/m^3
Transition detect. applied:	Yes
K_σ applied:	No
Clay like behavior applied:	Sand & Clay
Limit depth applied:	Yes
Limit depth:	10.00 m

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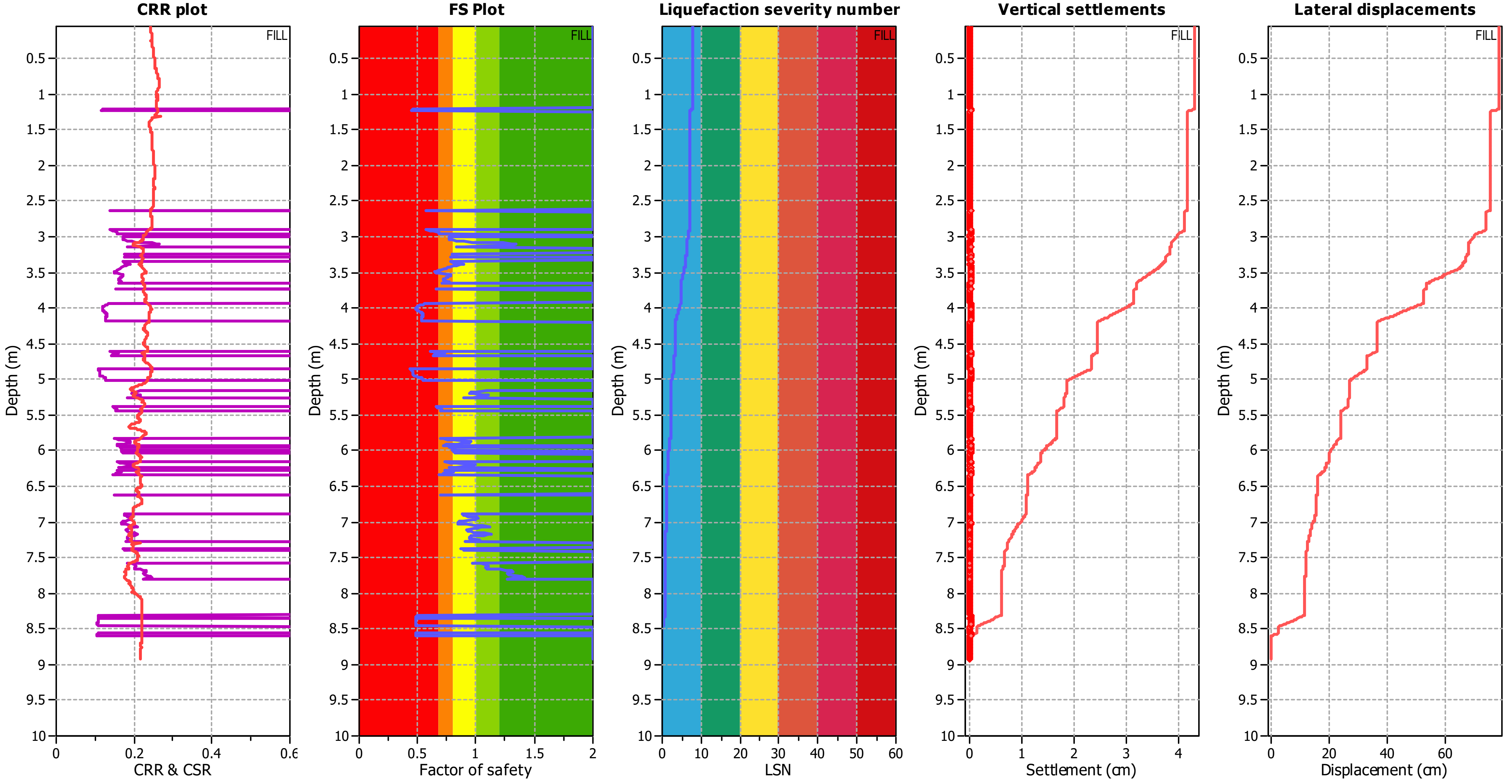
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.30 m	Fill weight:	15.00 kN/m^3
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	No
Earthquake magnitude M_w:	5.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.22	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	0.30 m	Fill height:	1.00 m	Limit depth:	10.00 m

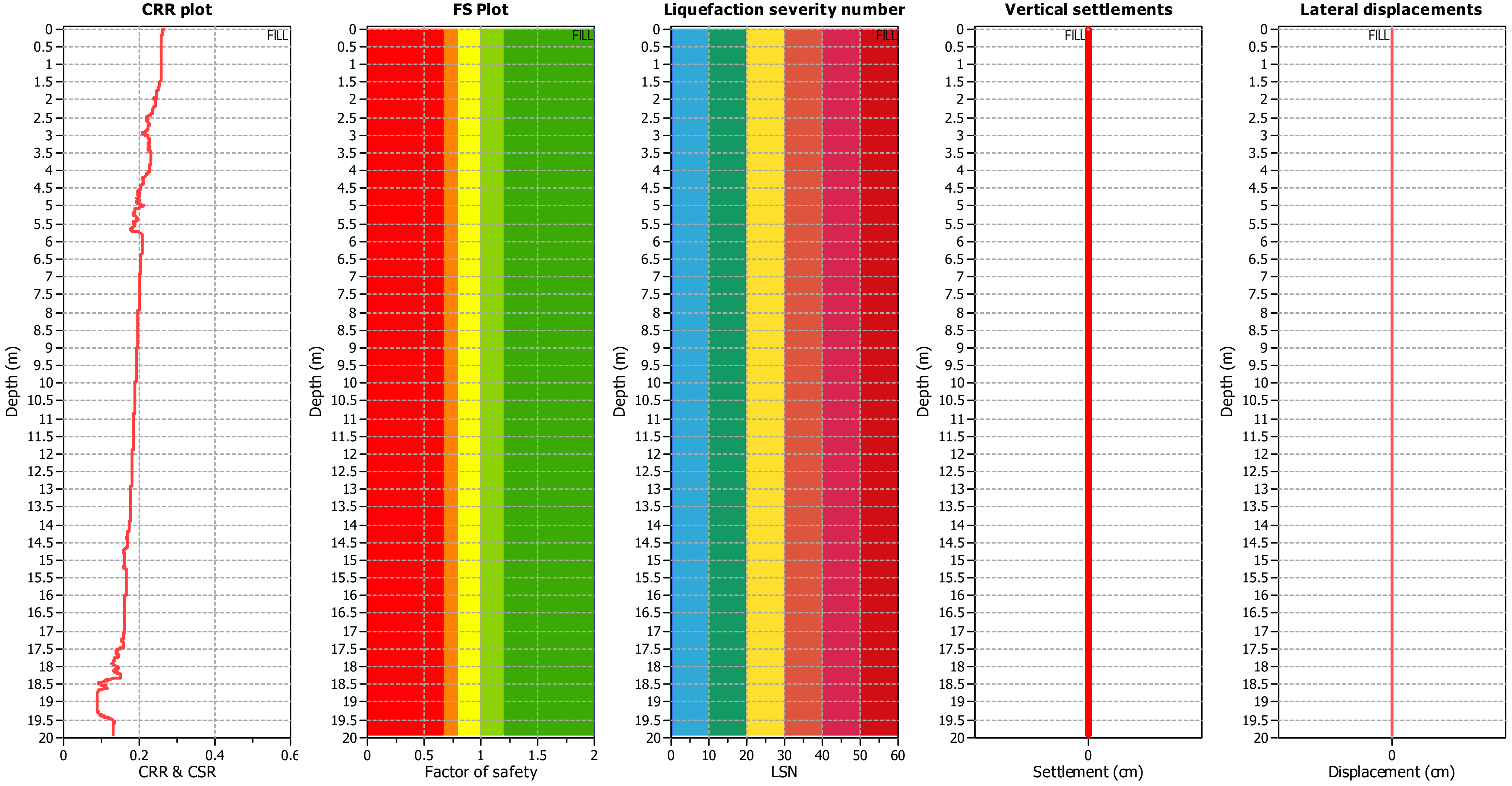
F.S. color scheme

- 🟥 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

LSN color scheme

- 🟥 Severe damage
- 🟥 Major expression of liquefaction
- 🟧 Moderate to severe exp. of liquefaction
- 🟨 Moderate expression of liquefaction
- 🟩 Minor expression of liquefaction
- 🟦 Little to no expression of liquefaction

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.70 m	Fill weight:	15.00 kN/m³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	No
Earthquake magnitude M_w:	5.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.22	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	0.70 m	Fill height:	10.00 m	Limit depth:	10.00 m

F.S. color scheme

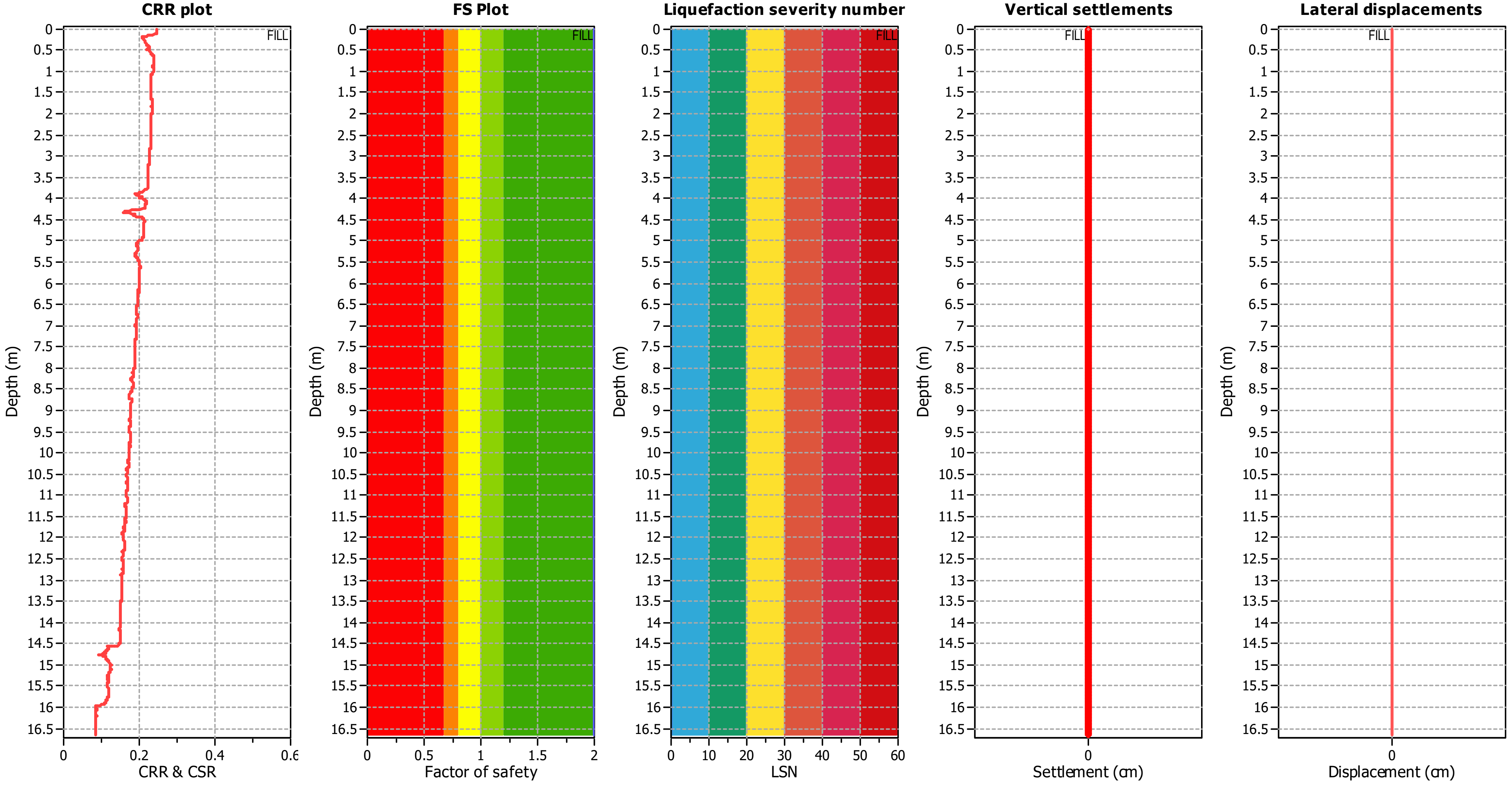
- 🟥 Almost certain it will liquefy
- 🟧 Very likely to liquefy
- 🟨 Liquefaction and no liq. are equally likely
- 🟩 Unlike to liquefy
- 🟩 Almost certain it will not liquefy

LSN color scheme

- 🟥 Severe damage
- 🟥 Major expression of liquefaction
- 🟧 Moderate to severe exp. of liquefaction
- 🟨 Moderate expression of liquefaction
- 🟩 Minor expression of liquefaction
- 🟦 Little to no expression of liquefaction

T&TCPT02

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M$_w$: 5.80
Peak ground acceleration: 0.22
Depth to water table (insitu): 1.10 m

Depth to GWT (erthq.): 1.10 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT
Use fill: Yes
Fill height: 10.00 m

Fill weight: 15.00 kN/m^3
Transition detect. applied: Yes
K$_\sigma$ applied: No
Clay like behavior applied: Sand & Clay
Limit depth applied: Yes
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
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- 🟩 Almost certain it will not liquefy

LSN color scheme

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- 🟥 Major expression of liquefaction
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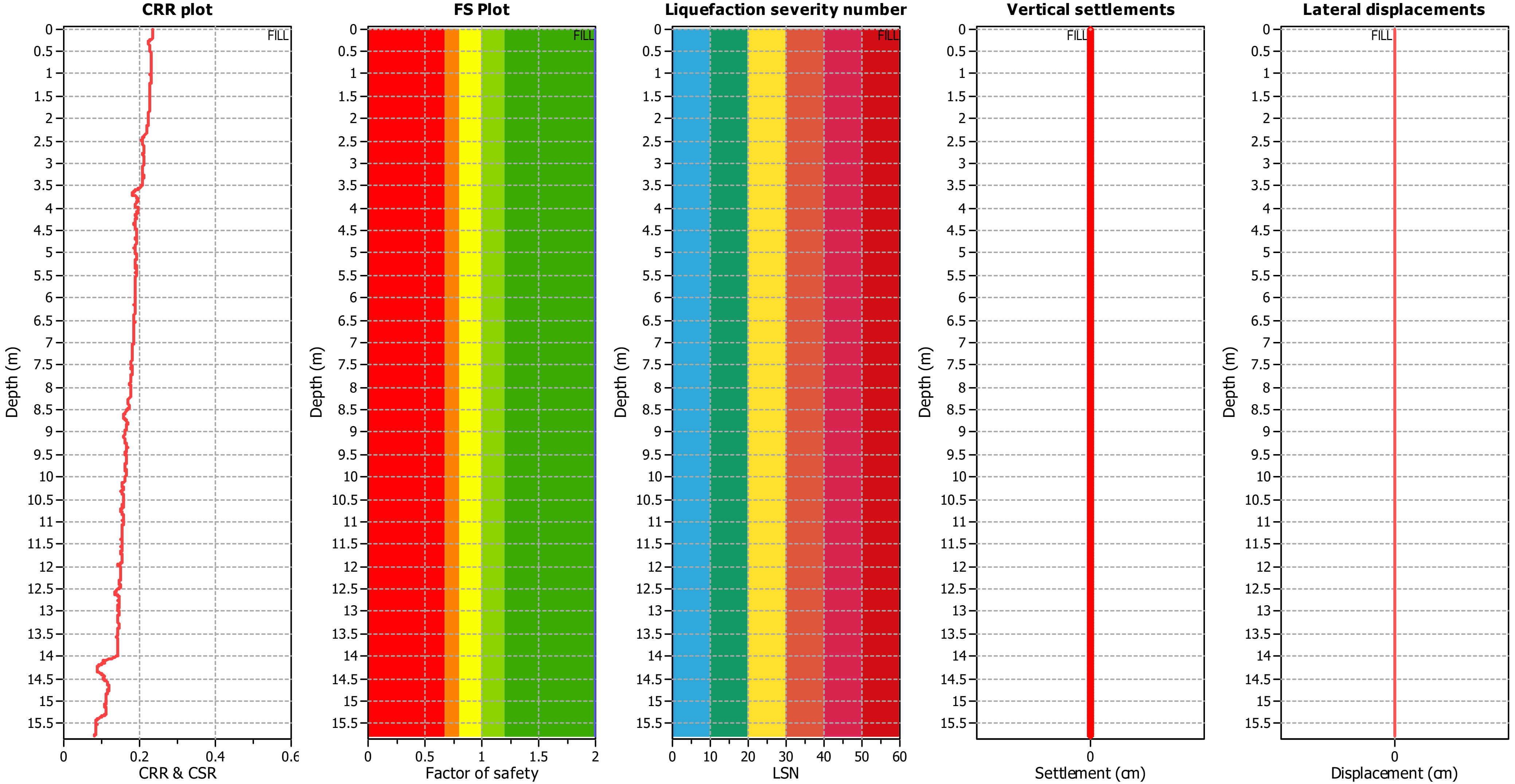
- 🟦 Little to no expression of liquefaction

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.40 m	Fill weight:	15.00 kN/m^3
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	No
Earthquake magnitude M_w:	5.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.22	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	1.40 m	Fill height:	10.00 m	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

LSN color scheme

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- 🟥 Major expression of liquefaction
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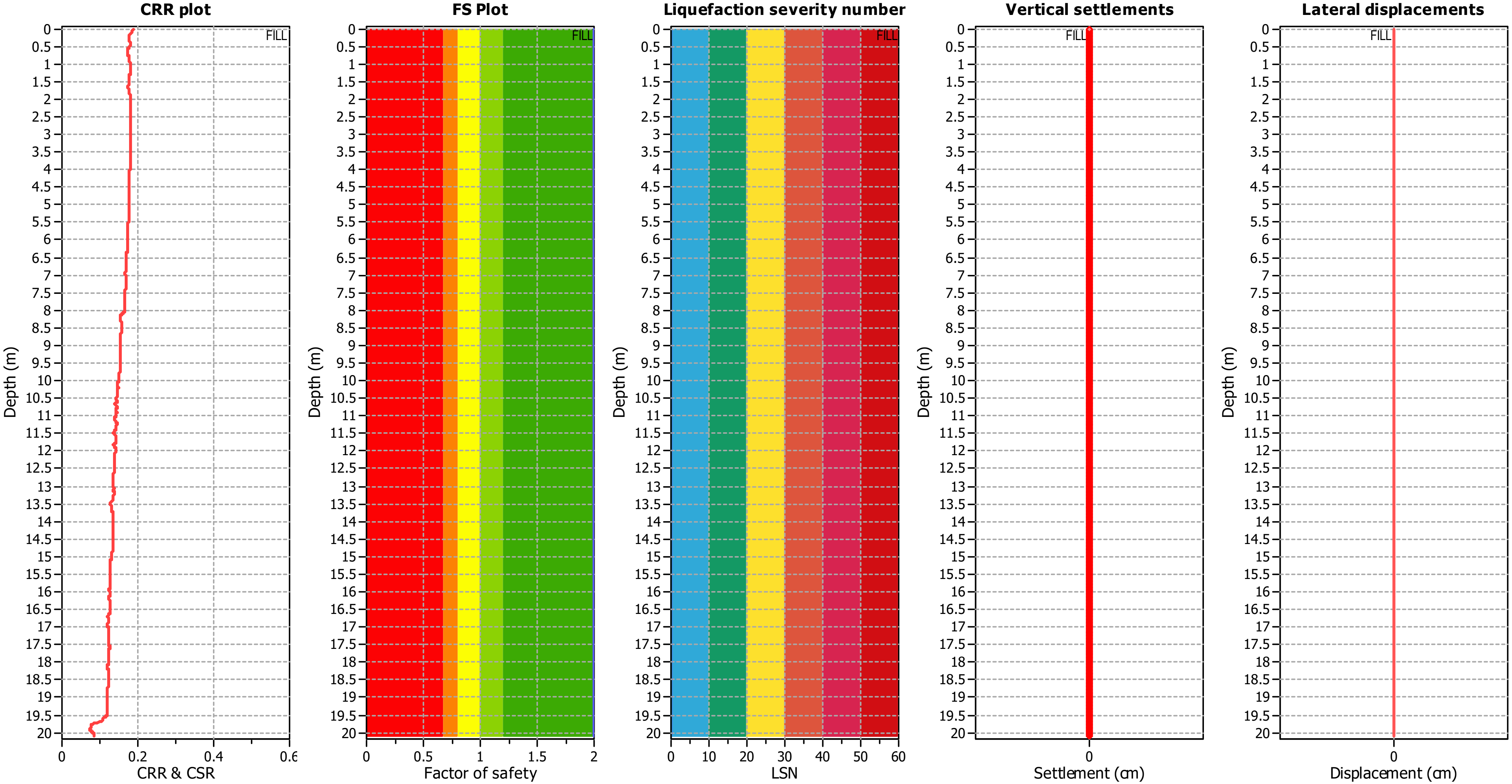
- 🟨 Moderate expression of liquefaction
- 🟩 Minor expression of liquefaction
- 🟦 Little to no expression of liquefaction

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.14 m	Fill weight:	15.00 kN/m³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	No
Earthquake magnitude M_w:	5.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.22	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.14 m	Fill height:	10.00 m	Limit depth:	10.00 m

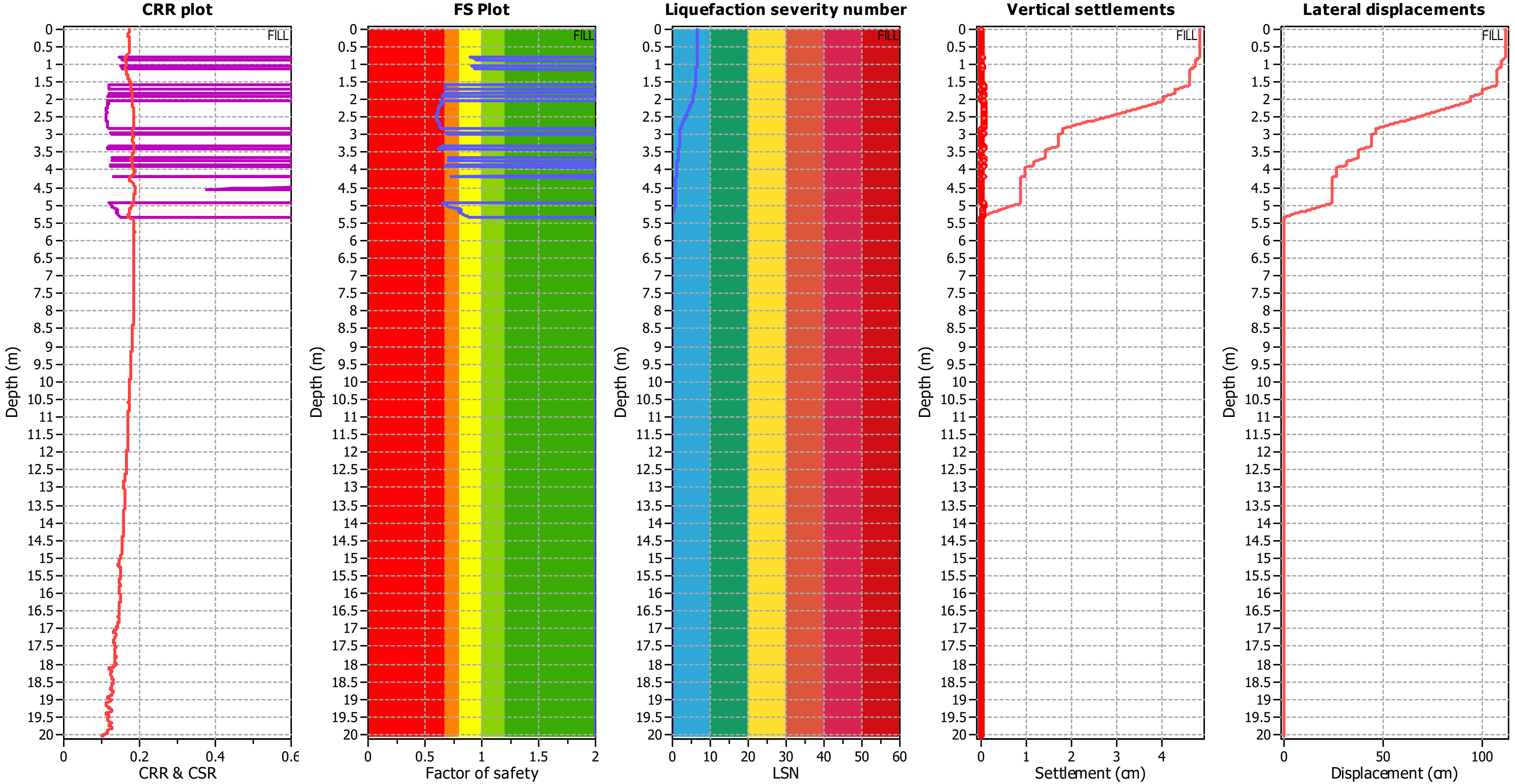
F.S. color scheme

- 🟥 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

LSN color scheme

- 🟥 Severe damage
- 🟥 Major expression of liquefaction
- 🟧 Moderate to severe exp. of liquefaction
- 🟨 Moderate expression of liquefaction
- 🟩 Minor expression of liquefaction
- 🟦 Little to no expression of liquefaction

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.45 m	Fill weight:	15.00 kN/m³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	No
Earthquake magnitude M_w:	5.80	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.22	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	2.45 m	Fill height:	4.50 m	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
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LSN color scheme

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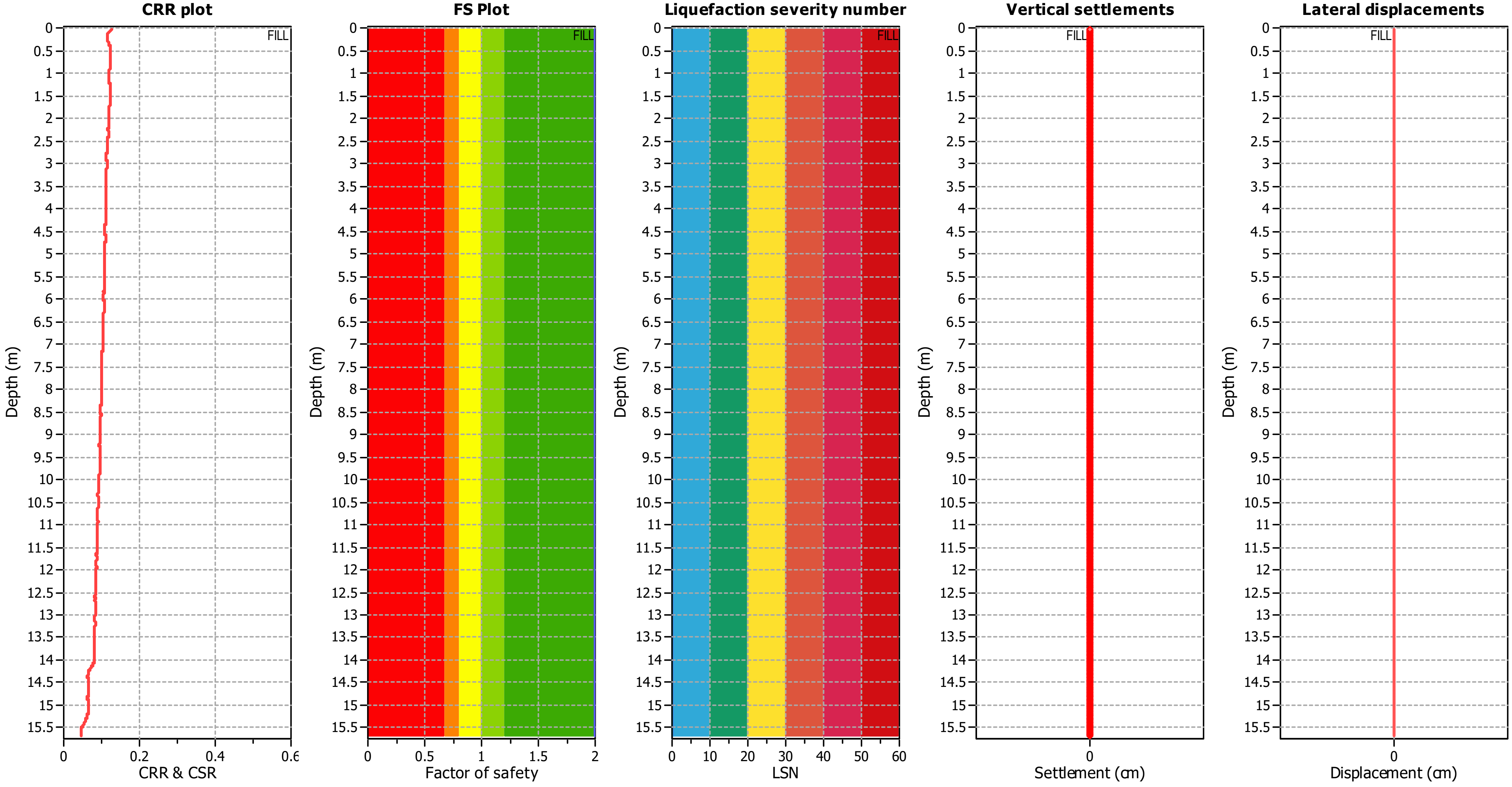
- 🟥 Major expression of liquefaction
- 🟧 Moderate to severe exp. of liquefaction
- 🟨 Moderate expression of liquefaction
- 🟩 Minor expression of liquefaction
- 🟦 Little to no expression of liquefaction

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on Ic value
Earthquake magnitude M_w: 5.80
Peak ground acceleration: 0.22
Depth to water table (insitu): 20.00 m

Depth to GWT (erthq.): 20.00 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT
Use fill: Yes
Fill height: 2.50 m

Fill weight: 15.00 kN/m³
Transition detect. applied: Yes
K_σ applied: No
Clay like behavior applied: Sand & Clay
Limit depth applied: Yes
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
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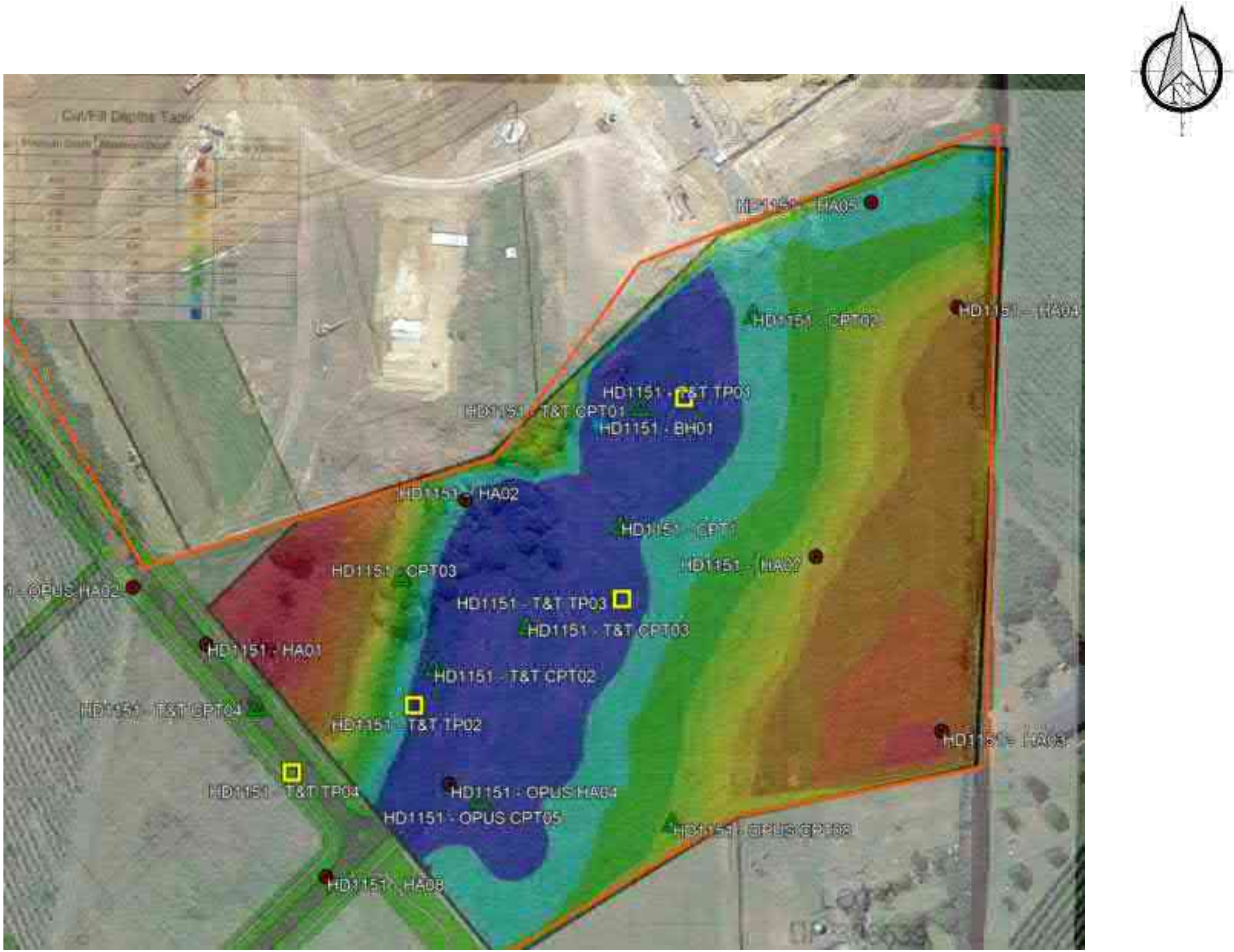
APPENDIX E – CONSOLIDATION SETTLEMENT



hd
GEO

●	Hand Augers
□	Test Pits
△	CPT
○	Borehole

PROJECT:
24 Wayside Road

PROJECT NO:
HD1151

CLIENT:
Te Kauwhata Land Limited

TITLE:
Cut/fill overlay plan

SCALE: N/A

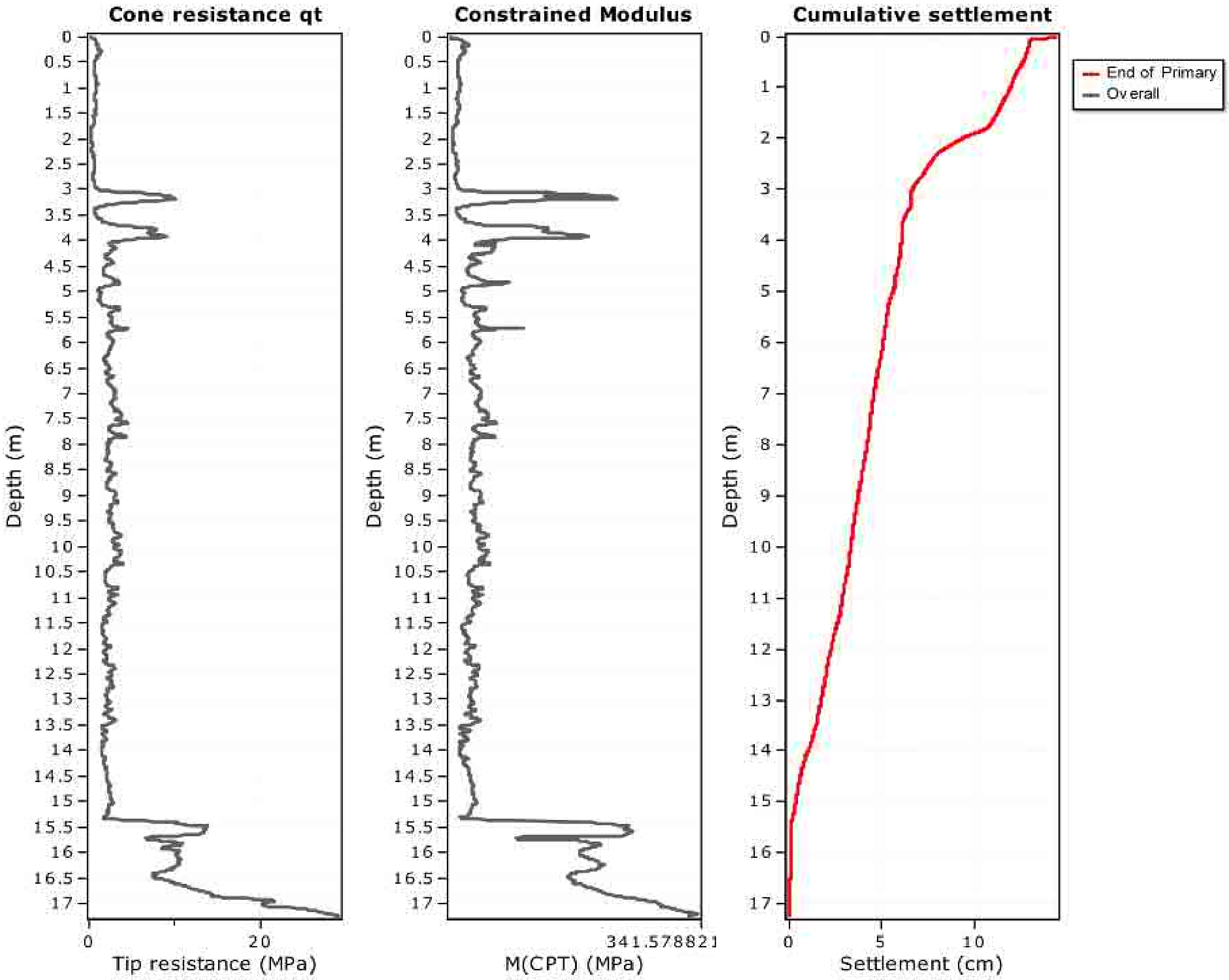
Drawing No: 1

Drawing by : SS

Rev Number

0	
	19.12.19

Settlements calculation according to theory of elastidty *



Calculation properties

Footing type: Rectangular
Footing width: 1000.00 (m)
L/B: 1.0
Footing pressure: 150.00 (kPa)
Embedment depth: 0.00 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: Yes
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:

[illegible]

where t_p is the duration of primary consolidation

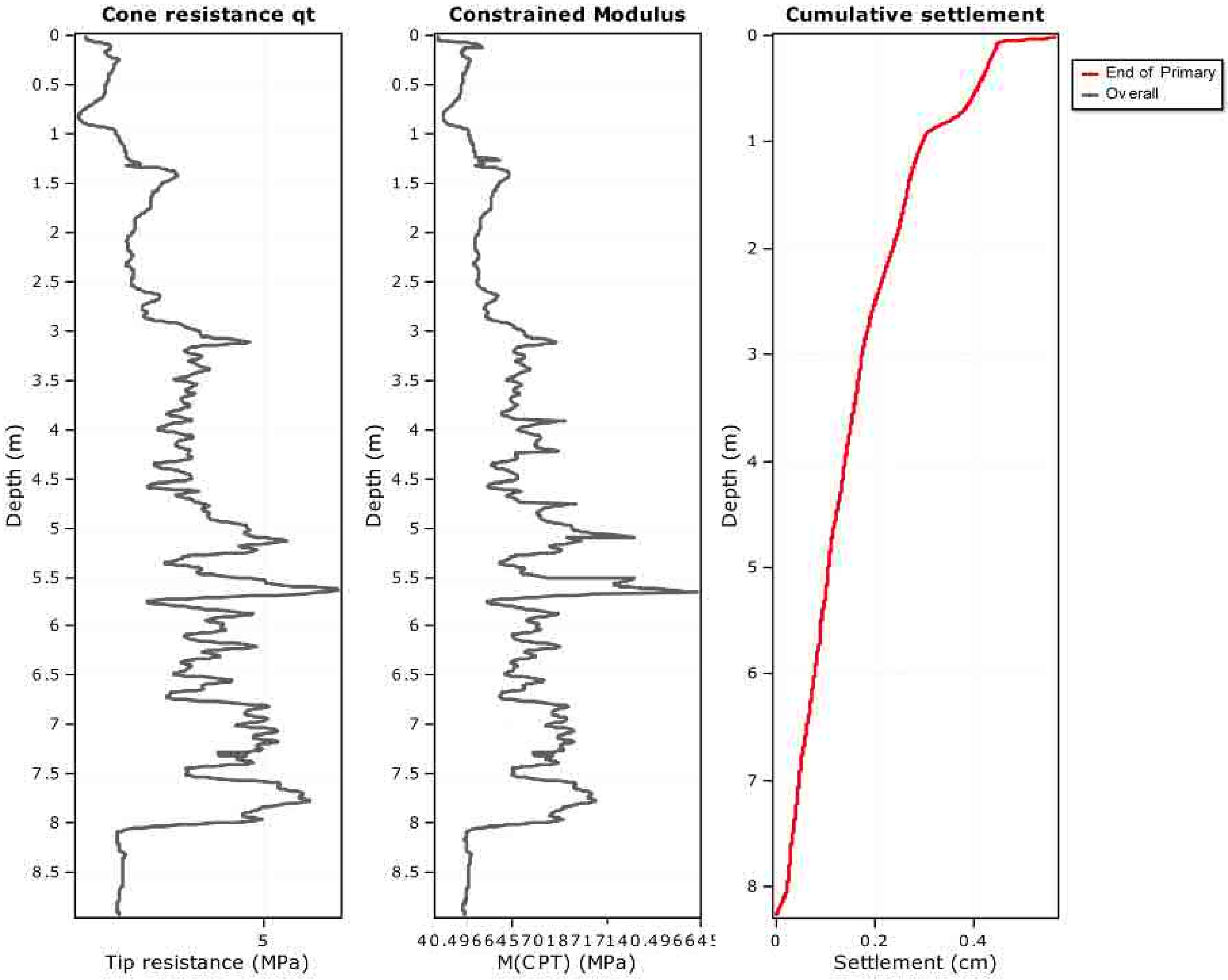
HD Geo Ltd
PO Box 9266
Waikato MAil Centre, Hamilton
www.hdgeo.co.nz

OPUSCPT08

Total depth: 8.93 m, Date: 9/01/2020
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **HD1151 - School site at 24 Wayside Road**
Location: **24 Wayside Road**

Settlements calculation according to theory of elastidty *



Calculation properties

Footing type: Rectangular
Footing width: 1000.00 (m)
L/B: 1.0
Footing pressure: 15.00 (kPa)
Embedment depth: 0.00 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: Yes
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:

[illegible]

where t_p is the duration of primary consolidation

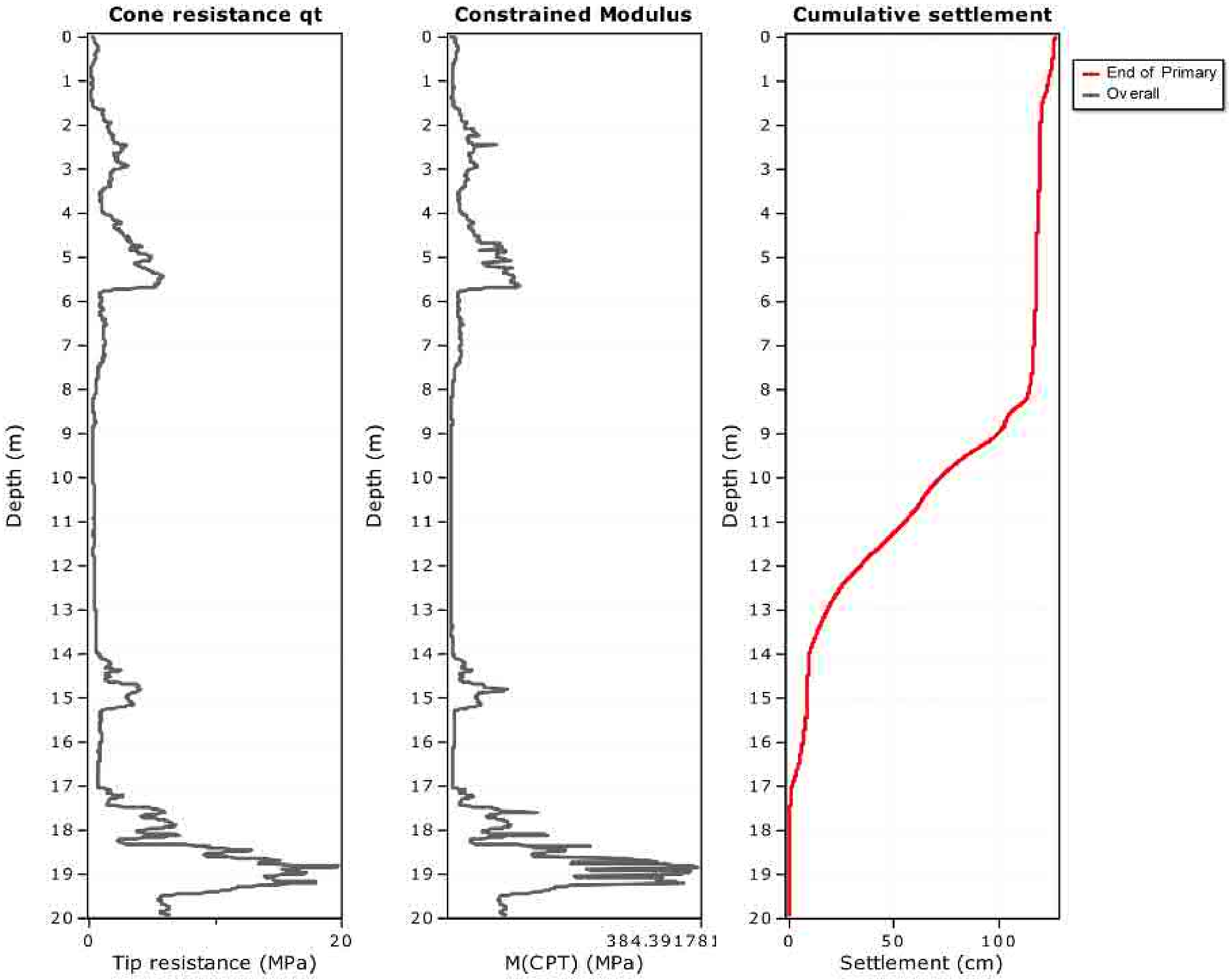
HD Geo Ltd
PO Box 9266
Waikato MAil Centre, Hamilton
www.hdgeo.co.nz

T&TCPT01

Total depth: 19.93 m, Date: 9/01/2020
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **HD1151 - School site at 24 Wayside Road**
Location: **24 Wayside Road**

Settlements calculation according to theory of elasticity *



Calculation properties

Footing type: Rectangular
Footing width: 1000.00 (m)
L/B: 1.0
Footing pressure: 150.00 (kPa)
Embedment depth: 0.00 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: Yes
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:

[illegible]

where t_p is the duration of primary consolidation

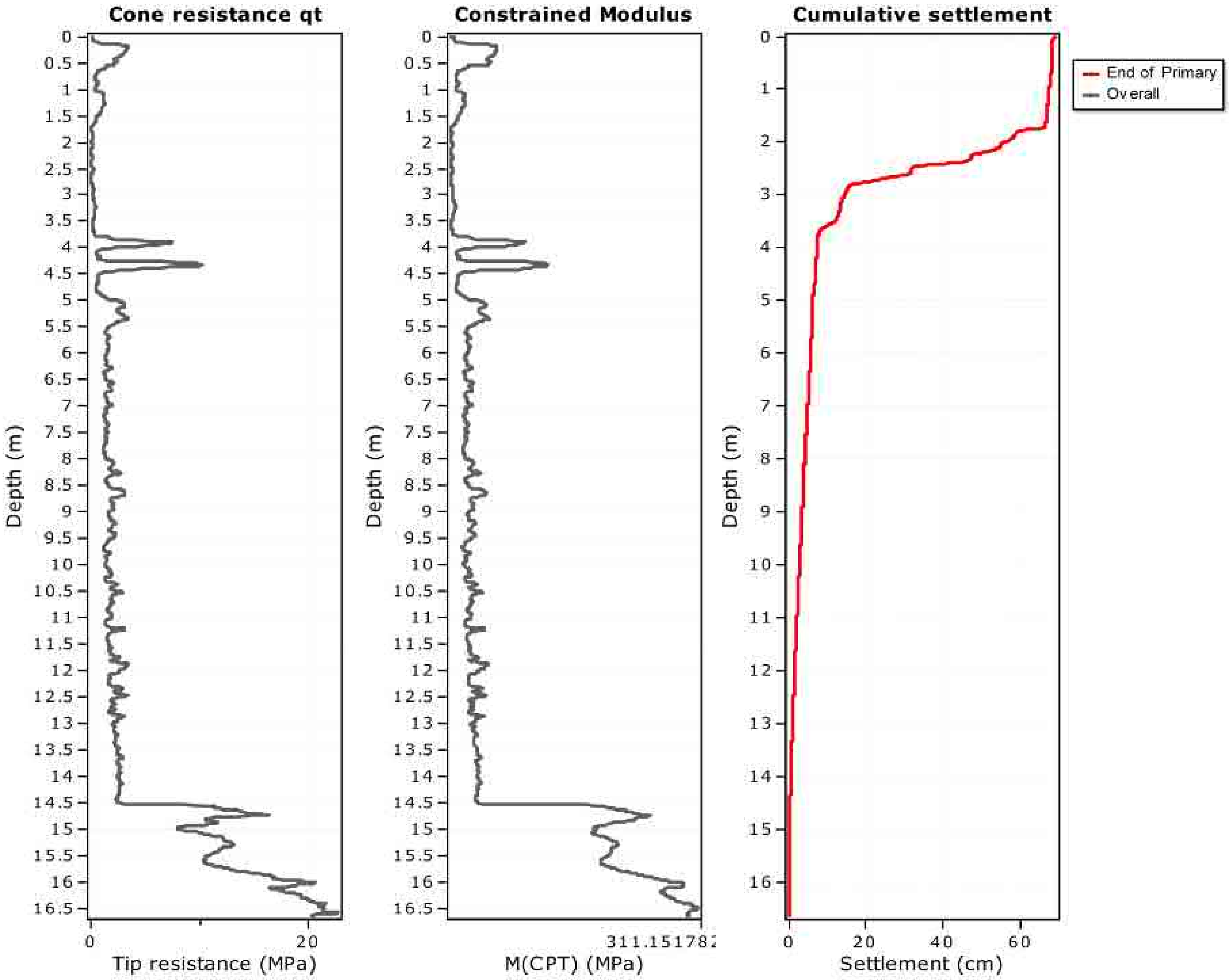
HD Geo Ltd
PO Box 9266
Waikato MAil Centre, Hamilton
www.hdgeo.co.nz

T&TCPT02

Total depth: 16.65 m, Date: 9/01/2020
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **HD1151 - School site at 24 Wayside Road**
Location: **24 Wayside Road**

Settlements calculation according to theory of elastidity *



Calculation properties

Footing type: Rectangular
Footing width: 1000.00 (m)
L/B: 1.0
Footing pressure: 150.00 (kPa)
Embedment depth: 0.00 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: Yes
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:

[illegible]

where t_p is the duration of primary consolidation

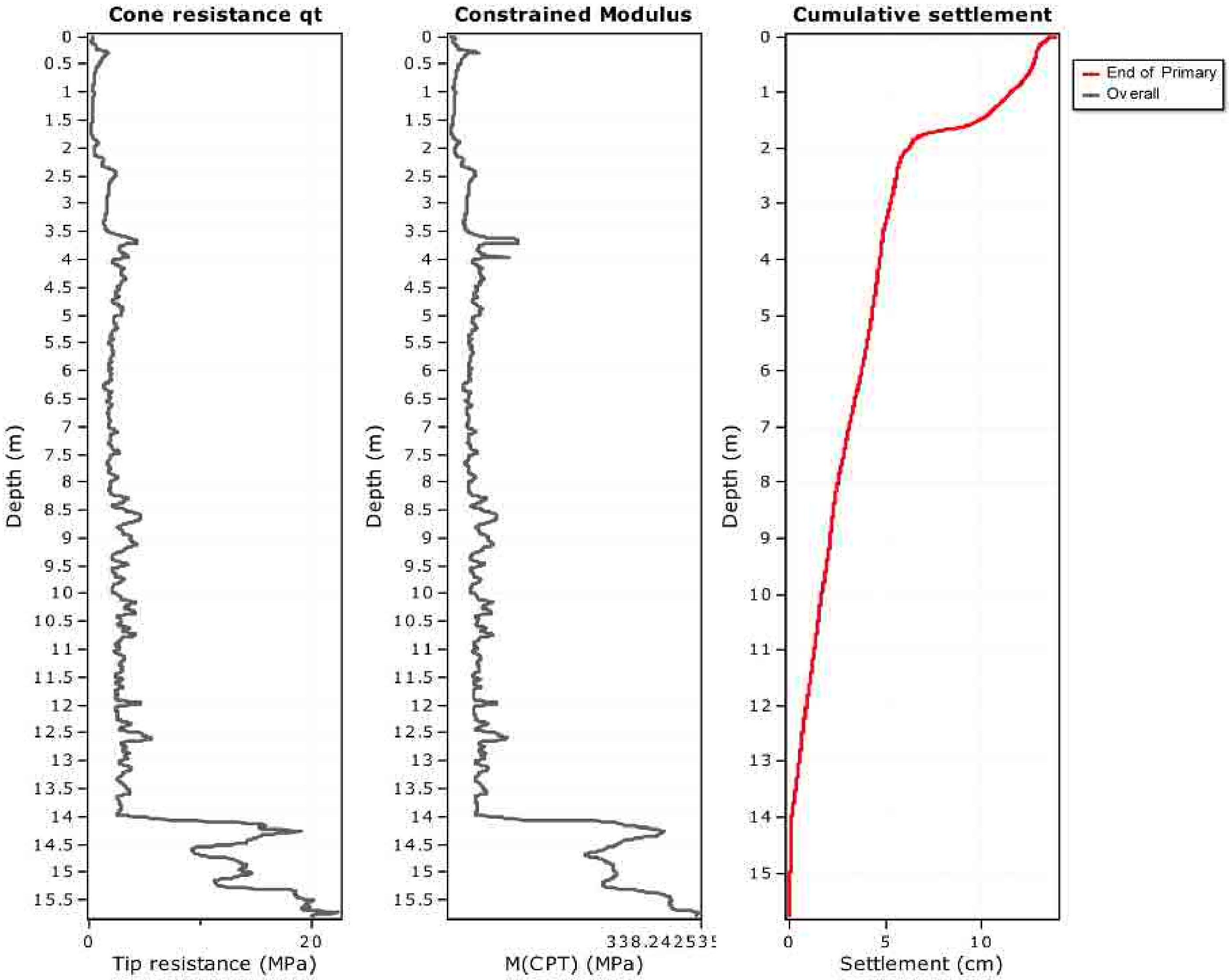
HD Geo Ltd
PO Box 9266
Waikato MAil Centre, Hamilton
www.hdgeo.co.nz

T&TCPT03

Total depth: 15.78 m, Date: 9/01/2020
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **HD1151 - School site at 24 Wayside Road**
Location: **24 Wayside Road**

Settlements calculation according to theory of elasticity *



Calculation properties

Footing type: Rectangular
Footing width: 1000.00 (m)
L/B: 1.0
Footing pressure: 150.00 (kPa)
Embedment depth: 0.00 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: Yes
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:

[illegible]

where t_p is the duration of primary consolidation

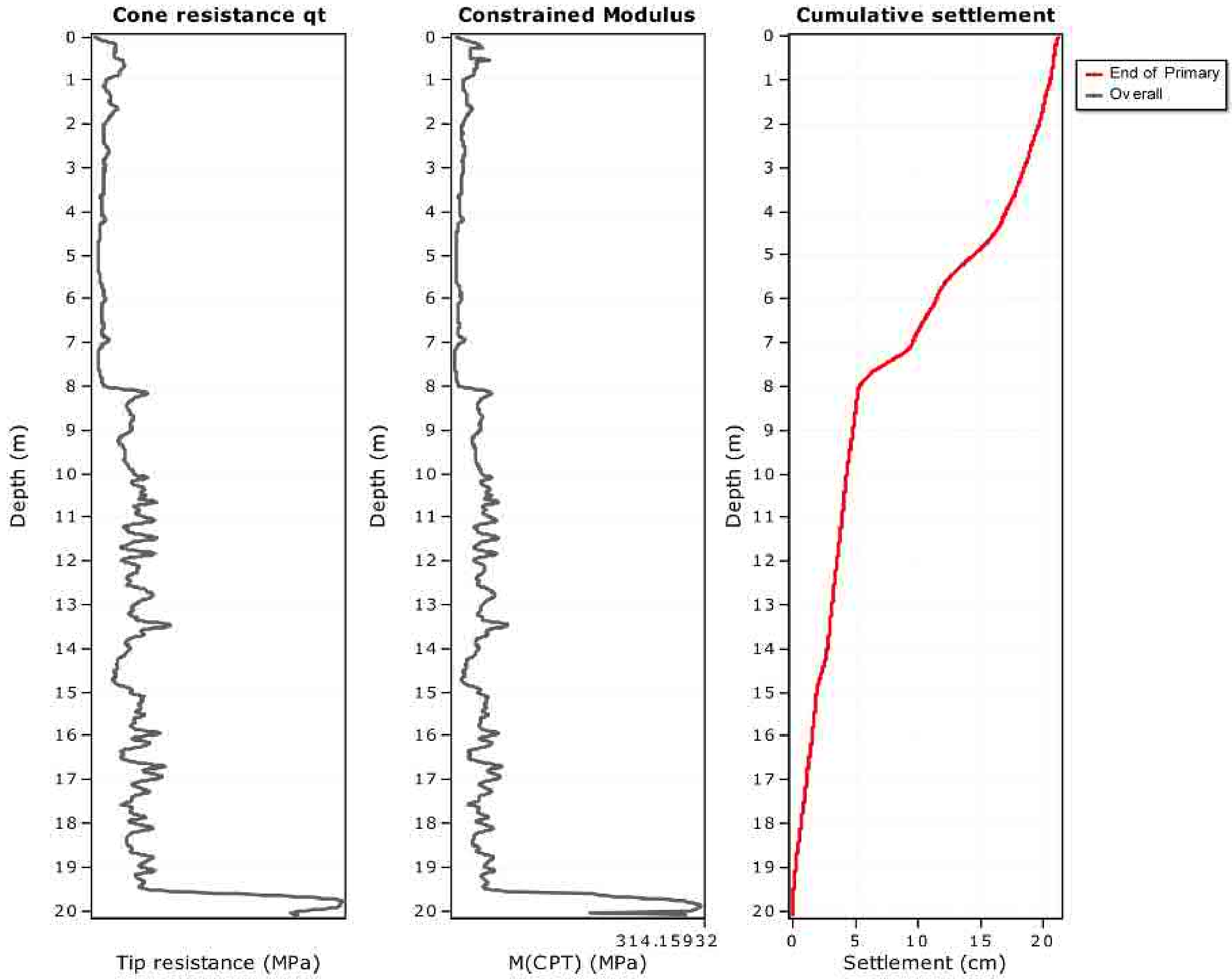
HD Geo Ltd
PO Box 9266
Waikato MAil Centre, Hamilton
www.hdgeo.co.nz

HDCPT01

Total depth: 20.10 m, Date: 9/01/2020
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **HD1151 - School site at 24 Wayside Road**
Location: **24 Wayside Road**

Settlements calculation according to theory of elastidty *



Calculation properties

Footing type: Rectangular
Footing width: 1000.00 (m)
L/B: 1.0
Footing pressure: 150.00 (kPa)
Embedment depth: 0.00 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: Yes
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:

where t_p is the duration of primary consolidation

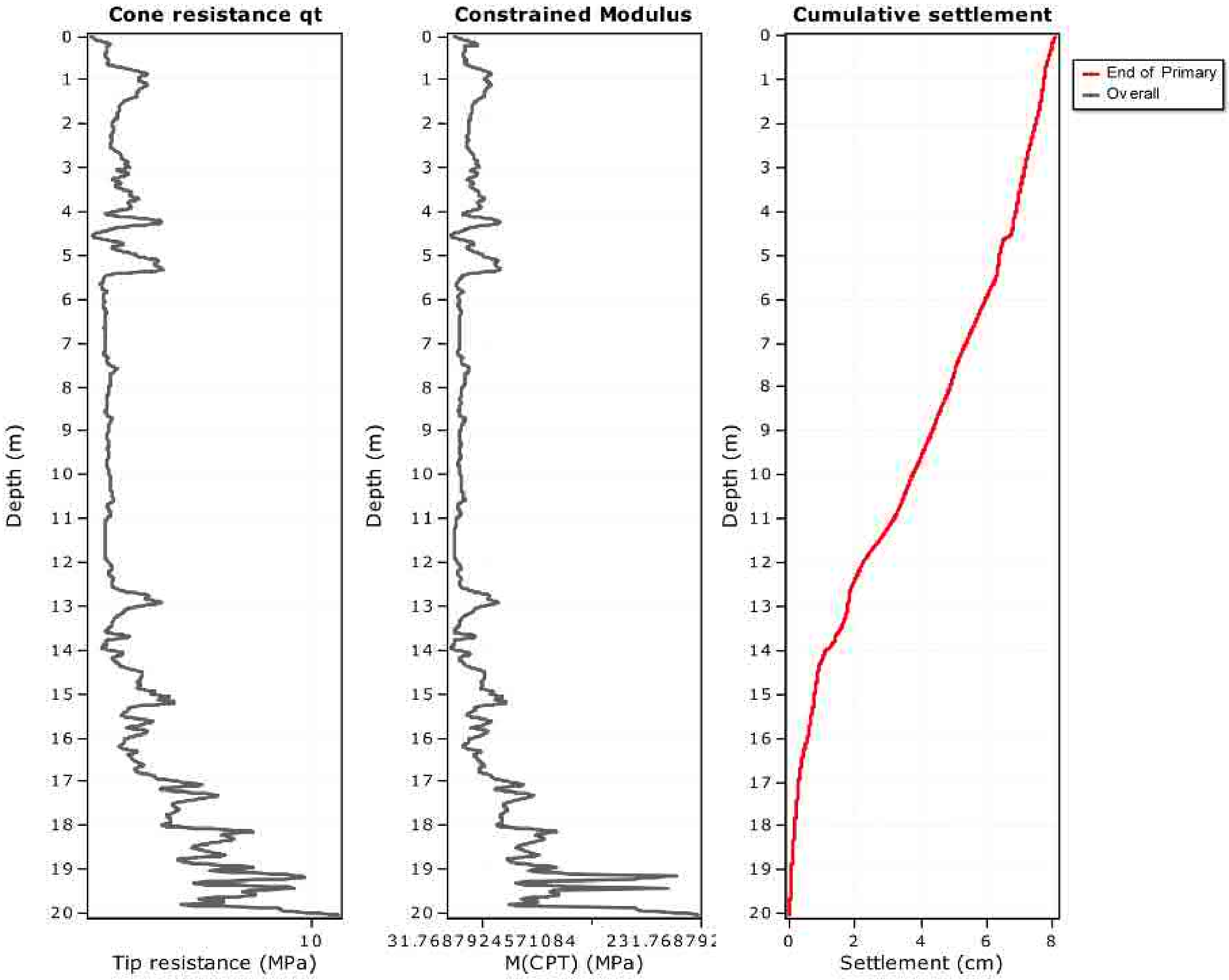
HD Geo Ltd
PO Box 9266
Waikato MAil Centre, Hamilton
www.hdgeo.co.nz

HDCPT02

Total depth: 20.04 m, Date: 9/01/2020
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **HD1151 - School site at 24 Wayside Road**
Location: **24 Wayside Road**

Settlements calculation according to theory of elastidty *



Calculation properties

Footing type: Rectangular
Footing width: 1000.00 (m)
L/B: 1.0
Footing pressure: 67.50 (kPa)
Embedment depth: 0.00 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: Yes
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:

[illegible]

where t_p is the duration of primary consolidation

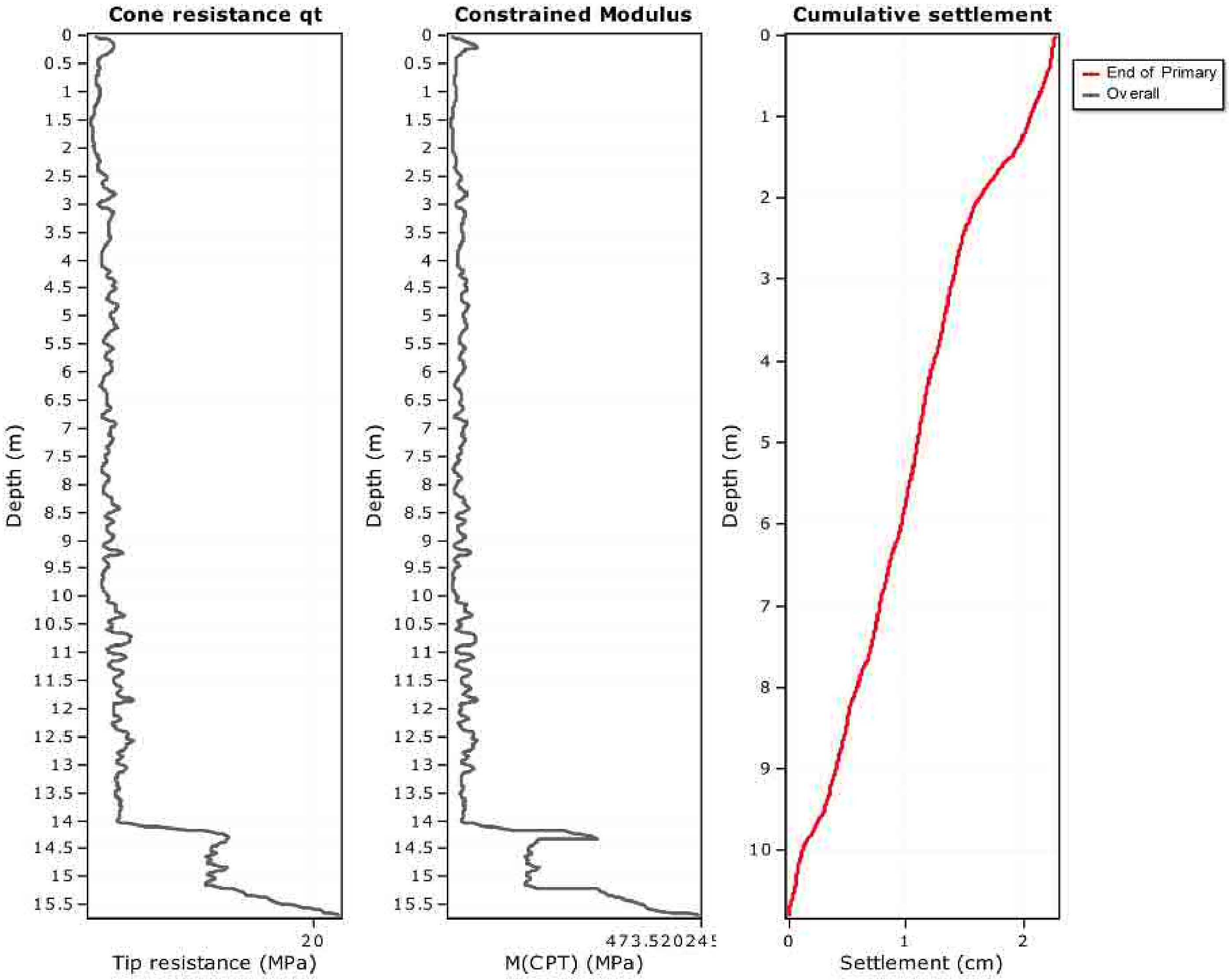
HD Geo Ltd
PO Box 9266
Waikato MAil Centre, Hamilton
www.hdgeo.co.nz

HDCPT03

Total depth: 15.68 m, Date: 9/01/2020
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **HD1151 - School site at 24 Wayside Road**
Location: **24 Wayside Road**

Settlements calculation according to theory of elasticity *



Calculation properties

Footing type: Rectangular
Footing width: 1000.00 (m)
L/B: 1.0
Footing pressure: 37.50 (kPa)
Embedment depth: 0.00 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: Yes
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:

[illegible]

where t_p is the duration of primary consolidation

BGL
Babbage Geotechnical Laboratory

Babbage Geotechnical Laboratory
Level 4
68 Beach Road | P O Box 2027
Auckland 1010 | New Zealand
Telephone | 64-9-367 4954
E-mail | wec@babbage.co.nz

Please reply to: W.E. Campton

HD Geo Ltd.
PO Box 9266
Hamilton 3240

Job Number: 63177#L
BGL Registration Number: 2750
Checked by: JF

Attention: **SHIMA SHEYBANIAGHDAM**

10th December 2019

ONE DIMENSIONAL CONSOLIDATION TESTING

Dear Shima,

Re: 24 WAYSIDE ROAD

Report Number: 63177#L/Consol 7.00 – 7.50m

Sample No: TUBE 1 **Depth: 7.00 – 7.50m**

The following report presents the results of one dimensional consolidation testing at BGL of a 54mm diameter undisturbed push-tube soil sample delivered to this laboratory on the 29th of November 2019. Our instructions were to carry out a one dimensional consolidation test using cycle times that would give both the $\sqrt{T_{90}}$ and T_{50} values, and using a standard pressure sequence.

The push-tube sample was tested in accordance with the following standards:

Water Content:	NZS4402:1986:Test 2.1
One Dimensional Consolidation:	NZS4402:1986:Test 7.1

The sample was extruded from the tube in small increments & trimmed into the consolidation ring, until the sample protruded from both sides of the ring. A wire was then used to cut the sample from the soil remaining in the tube, and a scalpel and straight edge was used to trim the sample flat in the ring.

These test results only relate to the sample tested. The values of m_v shown on the table have been calculated for each pressure increment, using void ratio difference for that increment. Note that a solid density value of 2.65t/m^3 was assumed for this test, and is not part of the IANZ endorsement for this report. This test was carried out in a laboratory in which the temperature is kept at 20°C ± 3°C.

As per the reporting requirements of NZS4402: 1986: Test 2.1: water content is reported to two significant figures for values below 10%, and to three significant figures for values of 10% or greater. As per the reporting requirements of NZS4402: 1986: Test 7.1: one dimensional consolidation, the coefficients of consolidation (c_v's), and coefficients of volume compressibility (m_v's) are reported to two significant figures.

Note that the Coefficient of Secondary Compression (C_{sec}) and the Coefficient of Permeability (k) values reported on page 4 have been calculated based on the methods described in "Manual of Soil Laboratory Testing Volume 2: Permeability, Shear Strength & Compressibility Tests" by K.H. Head & R.J. Epps, 3rd Edition, 2011. The Coefficient of Permeability values were calculated using the c_v(log) values determined in the test. The reporting of these figures is not part of NZS4402:1986:Test 7.1, therefore these figures are not part of the IANZ endorsement for this report.

Sample Description (***not part of BGL IANZ Accreditation***)

TUBE 1 / 7.00 – 7.50m: SILT, clayey, some medium sand, stiff, moderately plastic, light yellowish white with occasional black organic inclusions.

Each test result is data obtained at a specific test location. The nature and continuity of subsoil conditions away from the test area could vary from the data recovered during this testing, therefore the test results relate only to the sample as-received, and relate only to the sample under test.

Thank you for the opportunity to carry out this testing. If you have any queries regarding the content of this report please contact the person authorising this report below at your convenience.

Yours faithfully,

Wayne Campton
Signatory (Laboratory Manager)
Babbage Geotechnical Laboratory

IANZ
ACCREDITED LABORATORY
ACCREDITATION Nº: 126

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation. This report may not be reproduced except in full & with written approval from BGL.

[redacted]

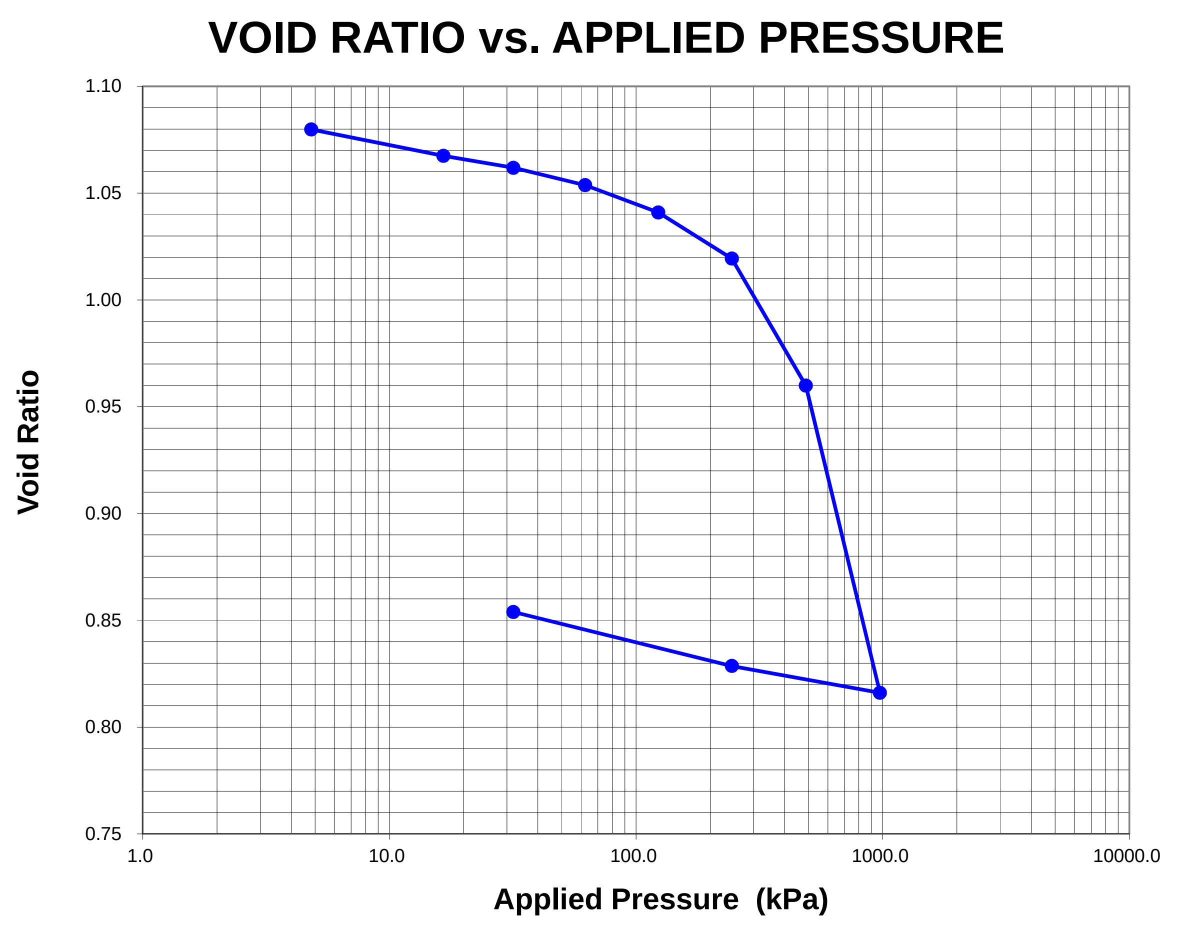
BGL Babbage Geotechnical Laboratory	Job No:	Reg. No:	Sheet	of	Version No:	8
	63177#L	2750	3	4	Issue Date:	October 2017
	PROJECT:				Auth. By:	WEC

24 WAYSIDE ROAD

ONE DIMENSIONAL CONSOLIDATION

	Tested By:	TH	December 2019
Test Method: NZS4402:1986:Test 2.1 - Water Content	Compiled By:	WEC	10-Dec-19
Test Method: NZS4402:1986:Test 7.1 - Consolidation	Checked By:	WEC	10-Dec-19

Borehole No: - **Sample No:** TUBE 1 **Depth:** 7.00 - 7.50m



SPECIMEN HISTORY

undisturbed ~~/ disturbed / remoulded / compacted / other:~~
Specimen from 54mm diameter push-tube
~~Compacted with NZ Standard Compaction effort / other compaction:~~

SPECIMEN PREPARATION

Extruded from 54mm diameter tube in small increments & trimmed into consol ring. Both sides of ring then trimmed flat with a scalpel & straight edge.

TEST DETAILS

Consol machine number:	2		Surface area of top of sample:	2015	mm^2
Consol ring number:	2a		Solid density of soil particles (assumed / ~~measured):~~	2.65	t/m^3
Sample diameter:	50.65	mm			

BGL
Babbage Geotechnical Laboratory

Job No:	Reg. No:	Sheet	of	Version No:	8
63177#L	2750	4	4	Issue Date:	October 2017
PROJECT:				Auth. By:	WEC

24 WAYSIDE ROAD

ONE DIMENSIONAL CONSOLIDATION

Test Method: NZS4402:1986:Test 2.1 - Water Content
Test Method: NZS4402:1986:Test 7.1 - Consolidation

Tested By:	TH	December 2019
Compiled By:	WEC	10-Dec-19
Checked By:	WEC	10-Dec-19

Borehole No: - **Sample No:** TUBE 1 **Depth:** 7.00 - 7.50m

Applied Pressure	Incremental Deflection	Specimen Thickness	Compression Ratio	Height of Voids	Void Ratio	Coefficient of Volume Compressibility m_v	Coefficient of Consolidation - c_v (log time)	(sqrt time)
kPa	mm	mm		mm	e	m^2/MN	$m^2/year$	$m^2/year$
4.8	0.000	19.970	1.000	10.368	1.080			
16.6	0.118	19.852	0.994	10.250	1.067	seating cycle		
31.8	0.054	19.798	0.991	10.196	1.062	0.18	19	36
62.2	0.078	19.720	0.987	10.118	1.054	0.13	29	26
123.1	0.123	19.597	0.981	9.995	1.041	0.10	25	36
244.7	0.207	19.390	0.971	9.788	1.019	0.087	33	30
488.1	0.571	18.819	0.942	9.217	0.960	0.12	24	34
974.8	1.381	17.437	0.873	7.836	0.816	0.15	26	32
244.7	-0.121	17.558	0.879	7.956	0.829	BACKLOAD 1		
31.8	-0.243	17.801	0.891	8.199	0.854	BACKLOAD 2		

Coefficient of Secondary Compression - C_{sec}	
Applied Pressure	**C_{sec}**
31.8	**0.001**
62.2	**0.001**
123.1	**0.001**
244.7	**0.002**
488.1	**0.004**
974.8	**0.003**

Coefficient of Permeability - k	
Applied Pressure	**k (m/s)**
31.8	**1.0E-09**
62.2	**1.2E-09**
123.1	**8.0E-10**
244.7	**9.0E-10**
488.1	**9.2E-10**
974.8	**1.2E-09**

	INITIAL	FINAL
Mass of dry specimen (g)	51.27	51.27
Thickness of specimen (mm)	19.970	17.437 (after consolidation) 17.801 (after rebound)
Water Content (%)	40.6	37.4
Dry Density (t/m^3)	1.27	1.46
Height of soil particles (mm)	9.602	9.602
Void Ratio	1.080	0.816 (after consolidation) 0.854 (after rebound)
Degree of saturation (%)	99.6	-

Babbage Geotechnical Laboratory

Babbage Geotechnical Laboratory
Level 4
68 Beach Road
Auckland 1010
Telephone
E-mail

P O Box 2027
New Zealand
64-9-367 4954
wec@babbage.co.nz

Please reply to: W.E. Campton

HD Geo Ltd.
PO Box 9266
Hamilton 3240

Job Number: 63177#L
BGL Registration Number: 2750
Checked by: WEC

Attention: **SHIMA SHEYBANIAGHDAM**

10th December 2019

ONE DIMENSIONAL CONSOLIDATION TESTING

Dear Shima,

Re: 24 WAYSIDE ROAD

Report Number: 63177#L/Consol 10.00 – 10.50m

Sample No: TUBE 2 **Depth: 10.00 – 10.50m**

The following report presents the results of one dimensional consolidation testing at BGL of a 54mm diameter undisturbed push-tube soil sample delivered to this laboratory on the 29th of November 2019. Our instructions were to carry out a one dimensional consolidation test using cycle times that would give both the $\sqrt{T_{90}}$ and T_{50} values, and using a standard pressure sequence.

The push-tube sample was tested in accordance with the following standards:

Water Content: NZS4402:1986:Test 2.1
One Dimensional Consolidation: NZS4402:1986:Test 7.1

Please note that consolidation cycles were of a variable time duration, and hence is a departure from the test standard which states that the cycle time period for the consolidation loads after the initial cycle should be of approximately the same length.

The sample was extruded from the tube in small increments & trimmed into the consolidation ring, until the sample protruded from both sides of the ring. A wire was then used to cut the sample from the soil remaining in the tube, and a scalpel and straight edge was used to trim the sample flat in the ring.

These test results only relate to the sample tested. The values of m_v shown on the table have been calculated for each pressure increment, using void ratio difference for that increment. Note that a solid density value of $2.65 t/m^3$ was assumed for this test, and is not part of the IANZ endorsement for this report. This test was carried out in a laboratory in which the temperature is kept at 20°C ± 3°C.

As per the reporting requirements of NZS4402: 1986: Test 2.1: water content is reported to two significant figures for values below 10%, and to three significant figures for values of 10% or greater. As per the reporting requirements of NZS4402: 1986: Test 7.1: one dimensional consolidation, the coefficients of consolidation (c_v's), and coefficients of volume compressibility (m_v's) are reported to two significant figures.

Note that the Coefficient of Secondary Compression (C_{sec}) and the Coefficient of Permeability (k) values reported on page 4 have been calculated based on the methods described in "Manual of Soil Laboratory Testing Volume 2: Permeability, Shear Strength & Compressibility Tests" by K.H. Head & R.J. Epps, 3rd Edition, 2011. The Coefficient of Permeability values were calculated using the c_v(log) values determined in the test. The reporting of these figures is not part of NZS4402:1986:Test 7.1, therefore these figures are not part of the IANZ endorsement for this report

Sample Description (***not part of BGL IANZ Accreditation***)

TUBE 2 / 10.00 – 10.50m: SAND, fine to medium, silty, non-plastic, white to light grey, wet.

Each test result is data obtained at a specific test location. The nature and continuity of subsoil conditions away from the test area could vary from the data recovered during this testing, therefore the test results relate only to the sample as-received, and relate only to the sample under test.

Thank you for the opportunity to carry out this testing. If you have any queries regarding the content of this report please contact the person authorising this report below at your convenience.

Yours faithfully,

Wayne Campton
Signatory (Laboratory Manager)
Babbage Geotechnical Laboratory

IANZ
ACCREDITED LABORATORY
ACCREDITATION Nº: 126

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation. This report may not be reproduced except in full & with written approval from BGL.

BGL Babbage Geotechnical Laboratory	**Job No:**	**Reg. No:**	**Sheet**	**of**	Version No:	8
	63177#L	**2750**	3	4	Issue Date:	October 2017
	PROJECT:				Auth. By:	WEC

24 WAYSIDE ROAD

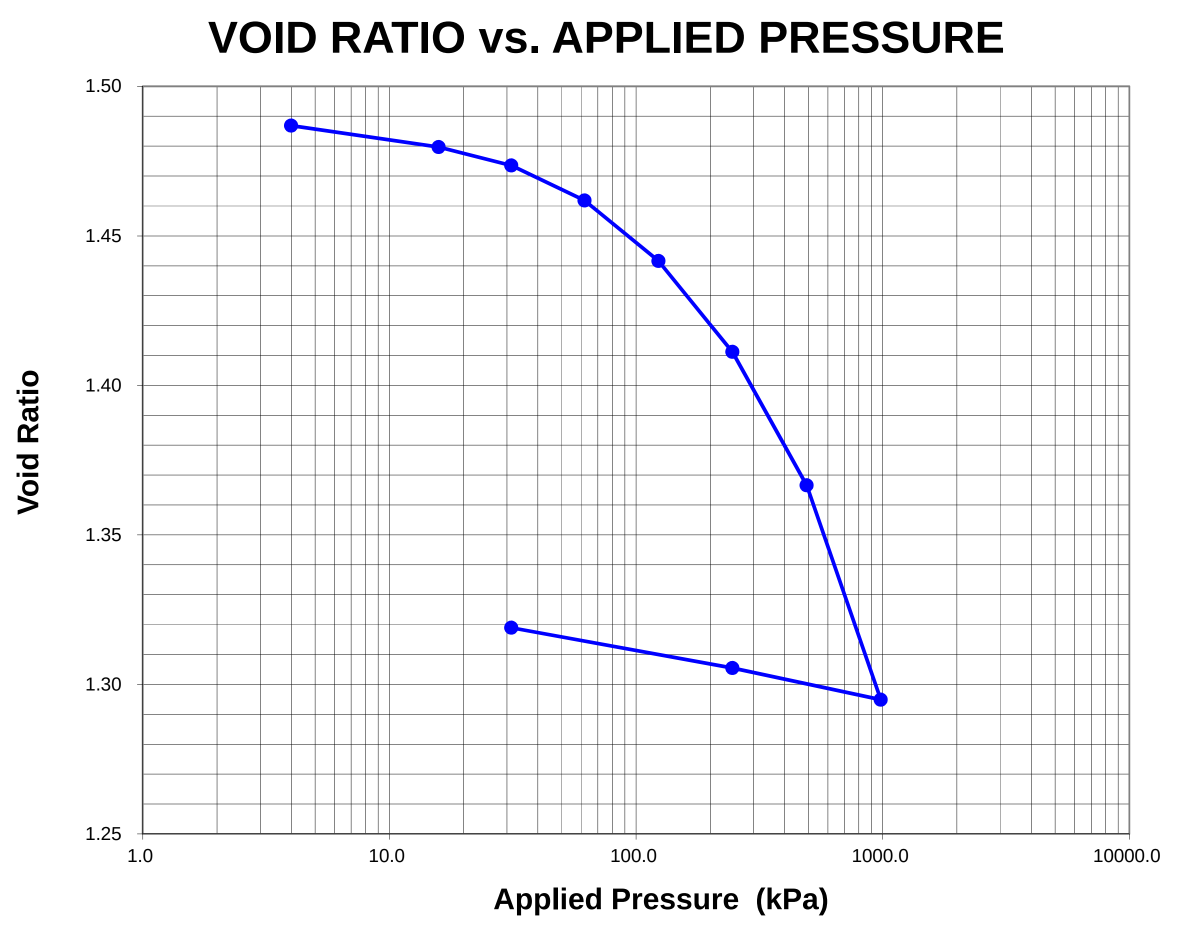
ONE DIMENSIONAL CONSOLIDATION

Test Method: NZS4402:1986:Test 2.1 - Water Content

Test Method: NZS4402:1986:Test 7.1 - Consolidation

Tested By:	TH	December 2019
Compiled By:	WEC	5-Dec-19
Checked By:	WEC	6-Dec-19

Borehole No: - **Sample No:** TUBE **Depth:** 10.00 - 10.50m



SPECIMEN HISTORY

undisturbed ~~/ disturbed / remoulded / compacted / other:~~

Specimen from 54mm diameter push-tube

~~Compacted with NZ Standard Compaction effort / other compaction:~~

SPECIMEN PREPARATION

Extruded from 54mm diameter tube in small increments & trimmed into consol ring. Both sides of ring then trimmed flat with a scalpel & straight edge.

TEST DETAILS

Consol machine number:	4		Surface area of top of sample:	1998	mm^2
Consol ring number:	4b		Solid density of soil particles (assumed / ~~measured):~~	2.65	t/m^3
Sample diameter:	50.44	mm			

BGL Babbage Geotechnical Laboratory	Job No:	Reg. No:	Sheet	of	Version No:	8
	63177#L	2750	4	4	Issue Date:	October 2017
	PROJECT:				Auth. By:	WEC

24 WAYSIDE ROAD

ONE DIMENSIONAL CONSOLIDATION

Test Method: NZS4402:1986:Test 2.1 - Water Content
Test Method: NZS4402:1986:Test 7.1 - Consolidation

Tested By:	TH	December 2019
Compiled By:	WEC	5-Dec-19
Checked By:	WEC	6-Dec-19

Borehole No: -   **Sample No:** TUBE   **Depth:** 10.00 - 10.50m

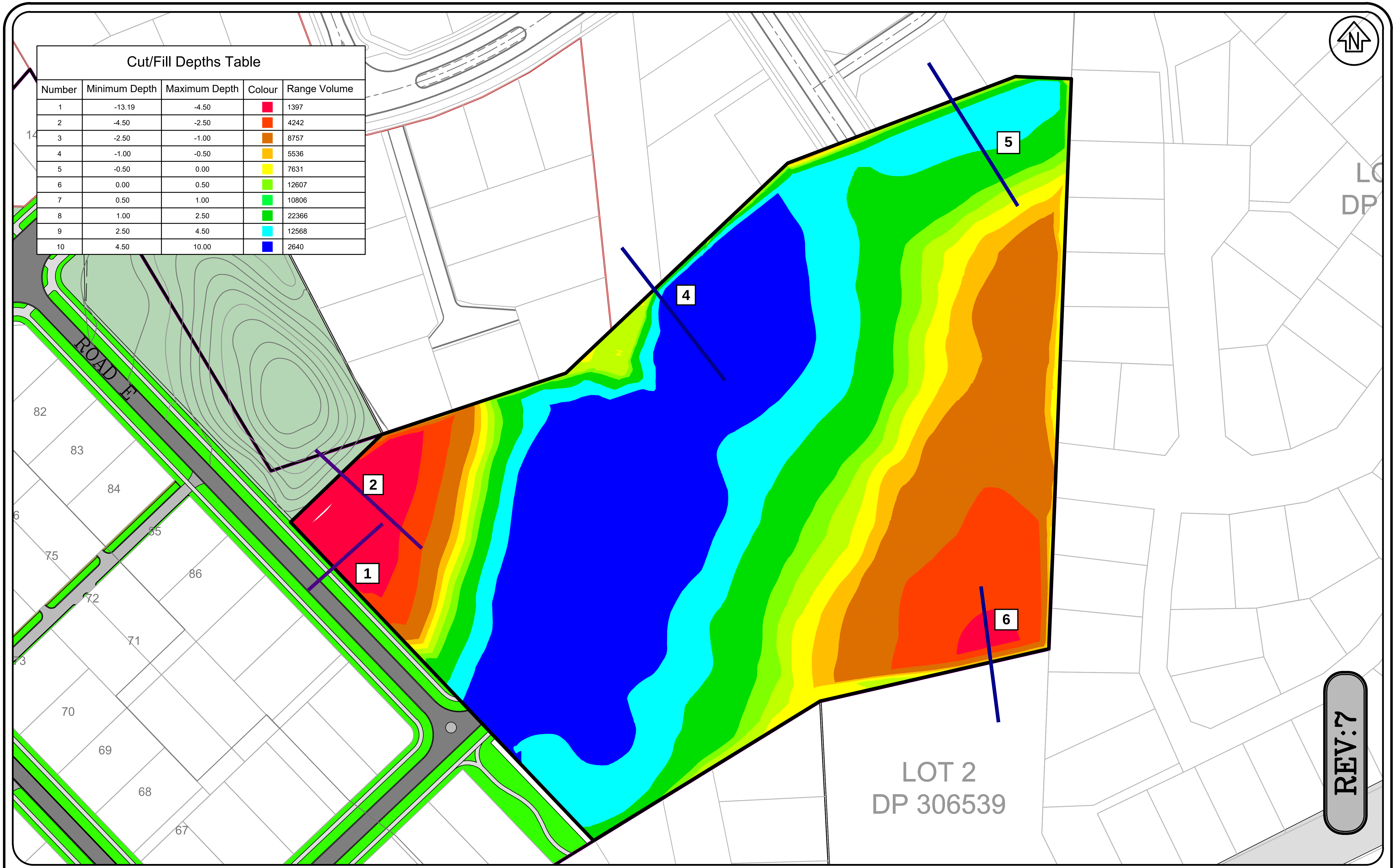
Applied Pressure	Incremental Deflection	Specimen Thickness	Compression Ratio	Height of Voids	Void Ratio	Coefficient of Volume Compressibility m_v	Coefficient of Consolidation - c_v	
							(log time)	(sqrt time)
kPa	mm	mm		mm	e	m^2/MN	$m^2/year$	$m^2/year$
4.0	0.000	20.000	1.000	11.958	1.487			
15.8	0.058	19.942	0.997	11.900	1.480	seating cycle		
31.2	0.050	19.893	0.995	11.850	1.474	0.16	5.2	8.3
61.9	0.094	19.798	0.990	11.756	1.462	0.15	9.4	26
123.2	0.162	19.636	0.982	11.594	1.442	0.13	15	19
245.9	0.244	19.392	0.970	11.349	1.411	0.10	22	19
491.3	0.359	19.033	0.952	10.990	1.367	0.075	12	19
982.1	0.577	18.456	0.923	10.414	1.295	0.062	24	24
245.9	-0.085	18.541	0.927	10.499	1.305	BACKLOAD 1		
31.2	-0.108	18.649	0.932	10.607	1.319	BACKLOAD 2		

Coefficient of Secondary Compression - C_{sec}	
Applied Pressure	C_{sec}
31.2	**0.001**
61.9	**0.001**
123.2	**0.001**
245.9	**0.002**
491.3	**0.002**
982.1	**0.004**

Coefficient of Permeability - k	
Applied Pressure	k (m/s)
31.2	**2.6E-10**
61.9	**4.5E-10**
123.2	**6.1E-10**
245.9	**7.0E-10**
491.3	**2.9E-10**
982.1	**4.5E-10**

	INITIAL	FINAL
Mass of dry specimen (g)	42.59	42.59
Thickness of specimen (mm)	20.000	18.456 (after consolidation) 18.649 (after rebound)
Water Content (%)	51.3	46.3
Dry Density (t/m^3)	1.07	1.15
Height of soil particles (mm)	8.042	8.042
Void Ratio	1.487	1.295 (after consolidation) 1.319 (after rebound)
Degree of saturation (%)	91.4	93.1

APPENDIX F – SLOPE STABILITY



Cut/Fill Depths Table

Number	Minimum Depth	Maximum Depth	Colour	Range Volume
1	-13.19	-4.50	🟥	1397
2	-4.50	-2.50	🟥	4242
3	-2.50	-1.00	🟧	8757
4	-1.00	-0.50	🟧	5536
5	-0.50	0.00	🟨	7631
6	0.00	0.50	🟩	12607
7	0.50	1.00	🟩	10806
8	1.00	2.50	🟩	22366
9	2.50	4.50	🟦	12568
10	4.50	10.00	🟦	2640

SCALE: 1:1000

DATE: MAY 2019

No.	Amendment	Init.	Date.	
1	Design Contours - OVERALL	SM	05/19	Designed. SM
2				Drawn. SM May 2019
3				Checked.
				Approved.

S:\2014\14012 - TK LAND\CAD\ENGINEERING\14012 ROADING AND GRADING DESIGN REV 7(TKL SCHOOL SITE 1% REV 7A).DWG

PROPOSED DESIGN - SCHOOL SITE 1% (CUT FILL)
WAYSIDE ROAD - TE KAUWHATA
PREPARED FOR: TKL DEVELOPMENT

Firm's Name

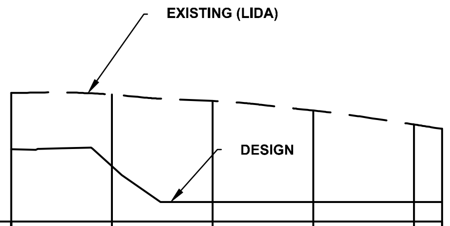
Blue Wallace
Surveyors Ltd.
25 Harwood Street, P O Box 38,
Hamilton Central, HAMILTON.
Phone (07) 839 7799, Fax (07) 839 4455

File Reference
14/012

Drawing No.
6

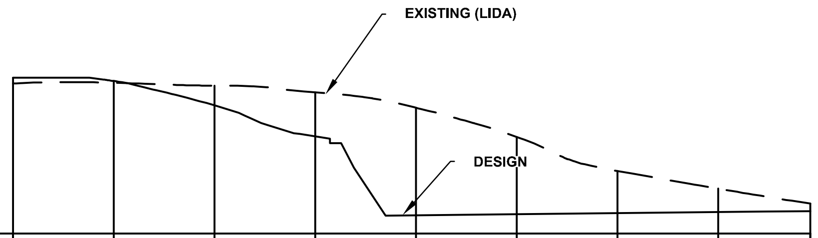
N

HD 1
DATUM: 28.00



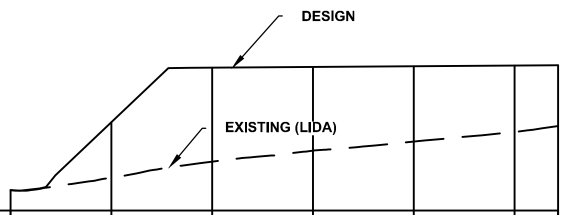
EXISTING LEVELS	40.79	40.61	39.97	39.02	37.65	37.21
RETAIN HEIGHT		-7.10	-10.01	-9.07	-7.70	
DESIGN LEVELS	35.20	33.52	29.96	29.95	29.95	29.95
VERTICAL GEOMETRY		[illegible]	2.91 3.84 69.4%	24.83 -0.0%		3.15 0.0%
CHAINAGE	0	10	20	30	40	43

HD 2
DATUM: 28.00



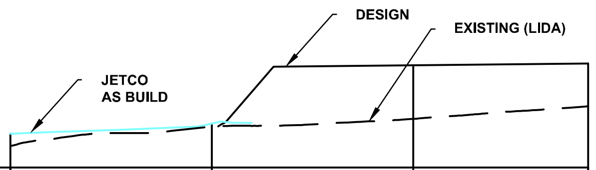
EXISTING LEVELS	42.92	43.01	42.70	42.06	40.52	37.60	34.23	32.47	30.99
RETAIN HEIGHT		0.17	-1.95	-4.37	-10.68	-7.66	-4.19	-2.33	
DESIGN LEVELS	43.50	43.17	40.75	37.68	29.84	29.94	30.04	30.14	30.23
VERTICAL GEOMETRY	0.50	[illegible]	[illegible]	[illegible]	3.12 52.3%	11.32 1.0%	26.42 1.0%		4.44 1.0%
CHAINAGE	0	10	20	30	40	50	60	70	79

HD 3
DATUM: 16.00



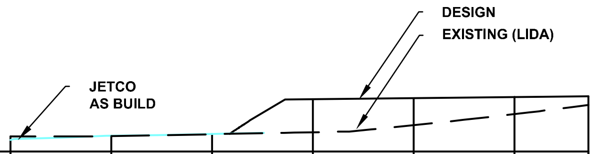
EXISTING LEVELS	18.03	19.26	20.87	21.95	22.86	23.82	24.38
RETAIN HEIGHT		5.50	9.31	8.30	7.45	6.56	
DESIGN LEVELS	18.04	24.77	30.18	30.25	30.31	30.38	30.41
VERTICAL GEOMETRY	-12.5%	[illegible]	11.20 95.1% 2.13 0.8%		36.54 0.7%		
CHAINAGE	0	10	20	30	40	50	54

HD 4
DATUM: 20.00



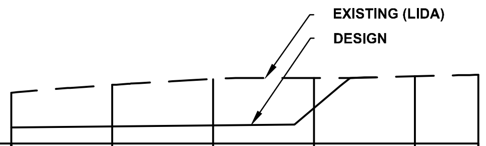
EXISTING LEVELS	22.12	24.04	24.84	26.09
RETAIN HEIGHT			5.33	
DESIGN LEVELS			30.17	30.35
VERTICAL GEOMETRY			4.73 116.4%	31.23 1.0%
CHAINAGE	0	20	40	57

HD 5
DATUM: 25.00



EXISTING LEVELS	26.47	26.51	26.70	26.90	27.60	28.69	29.58
RETAIN HEIGHT				3.27	2.67	1.68	
DESIGN LEVELS				30.16	30.27	30.37	30.45
VERTICAL GEOMETRY				59.2%	30.11 1.0%		
CHAINAGE	0	10	20	30	40	50	57

HD 6
DATUM: 30.00



EXISTING LEVELS	35.02	35.78	36.35	36.47	36.64	36.78
RETAIN HEIGHT		-4.09	-4.56	-2.98		
DESIGN LEVELS	31.59	31.69	31.79	33.49		
VERTICAL GEOMETRY			28.09 1.0%		4.42 84.5% 1.8%	
CHAINAGE	0	10	20	30	40	46

S:\2014\14012 - TK LAND\CAD\ENGINEERING\14012 ROADING AND GRADING DESIGN REV 7\(TKL SCHOOL SITE 1% REV 7A).DWG

Size A3	Scale 1:750		Date ##############			
No.	Amendment	Init.	Date	Designed	#	#
0	######################	##	########	Drawn	#	#
1	#	#	#	Checked	#	#
2	#	#	#	Approved	#	#

(1%) SCHOOL SITE CROSS SECTIONS

Prepared for: HD

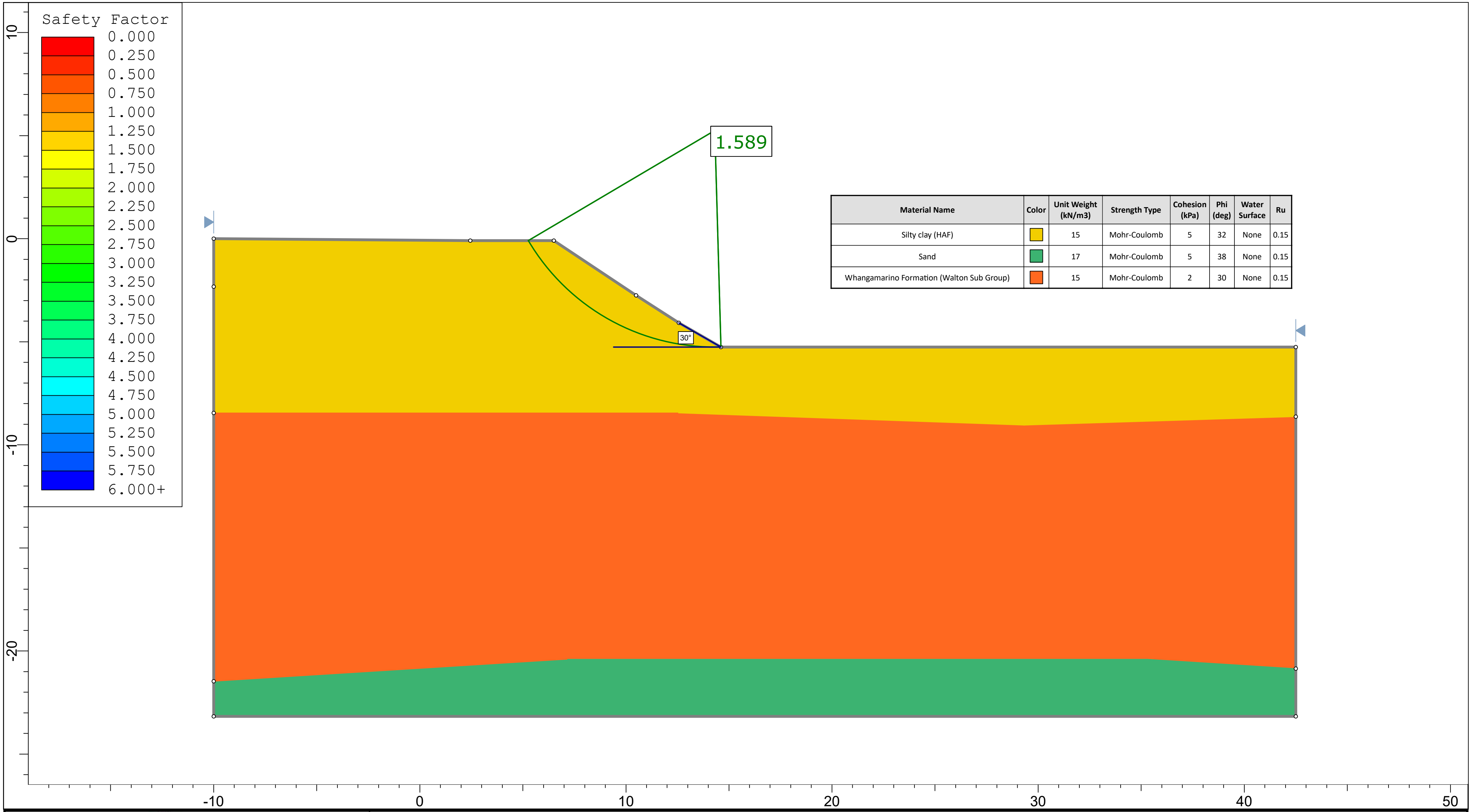
Blue Wallace Surveyors Ltd.
25 Harwood Street, P O Box 38,
Hamilton Central, HAMILTON.
Phone (07) 839 7799, Fax (07) 839 4455

Datum: Circuit: ############
Height: ####################

Resource Consent Number:
####################

BW Ref. Stg. Purp. Dwg. #
14012-##-##-001

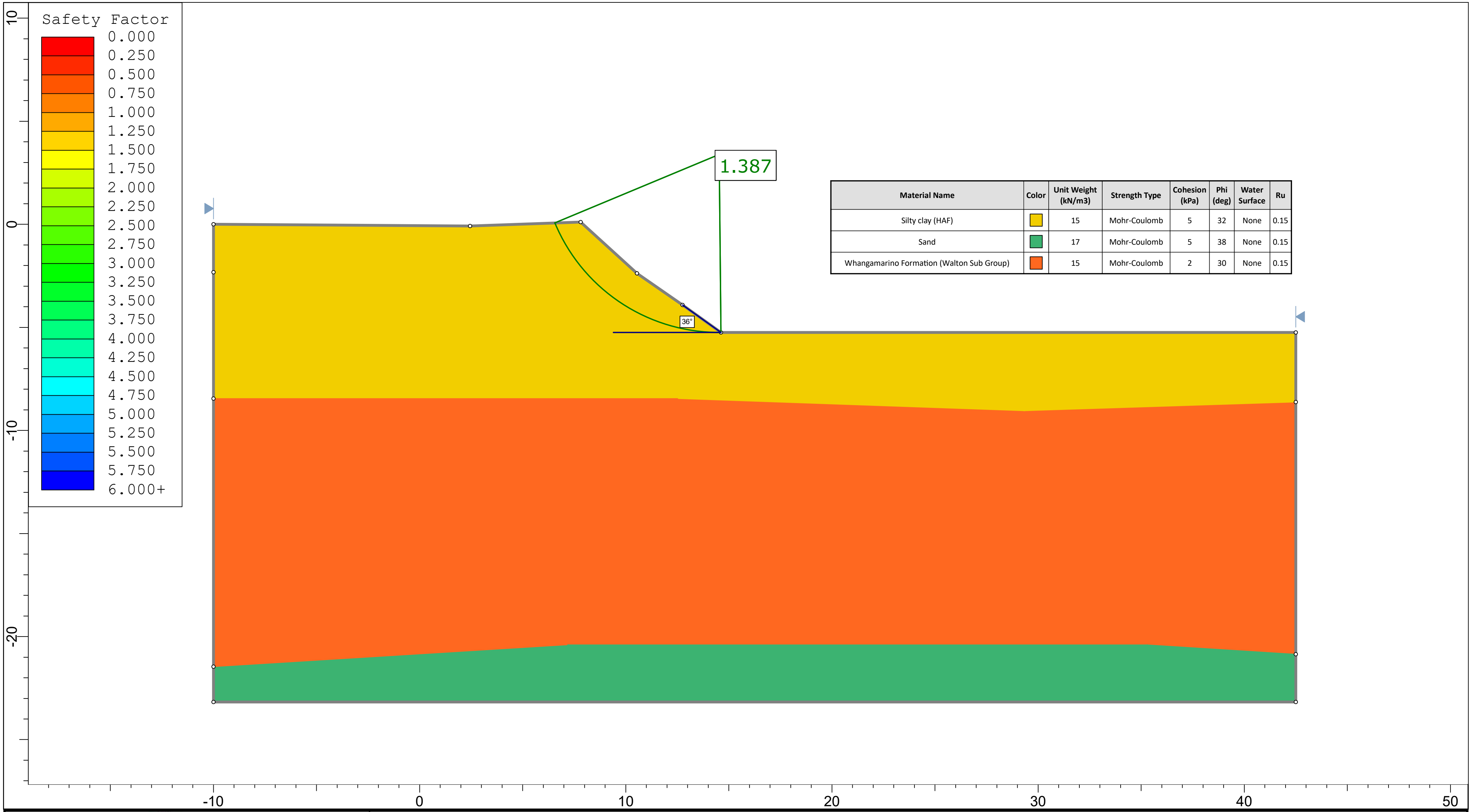
Revision:
#####



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Ru
Silty clay (HAF)	🟨	15	Mohr-Coulomb	5	32	None	0.15
Sand	🟩	17	Mohr-Coulomb	5	38	None	0.15
Whangamarino Formation (Walton Sub Group)	🟧	15	Mohr-Coulomb	2	30	None	0.15

Project	HD1151 - Cross section 1		
Analysis Description	Drained - Static - Ru0.15 - 30 degrees		
Drawn By	SSA	*Scale*	1:250
Company	HD Geo		
Date	12/4/2019, 12:35:30 PM	*File Name*	HD1151 - Cross section 1 - Drained - Static - Ru0.15.slmd

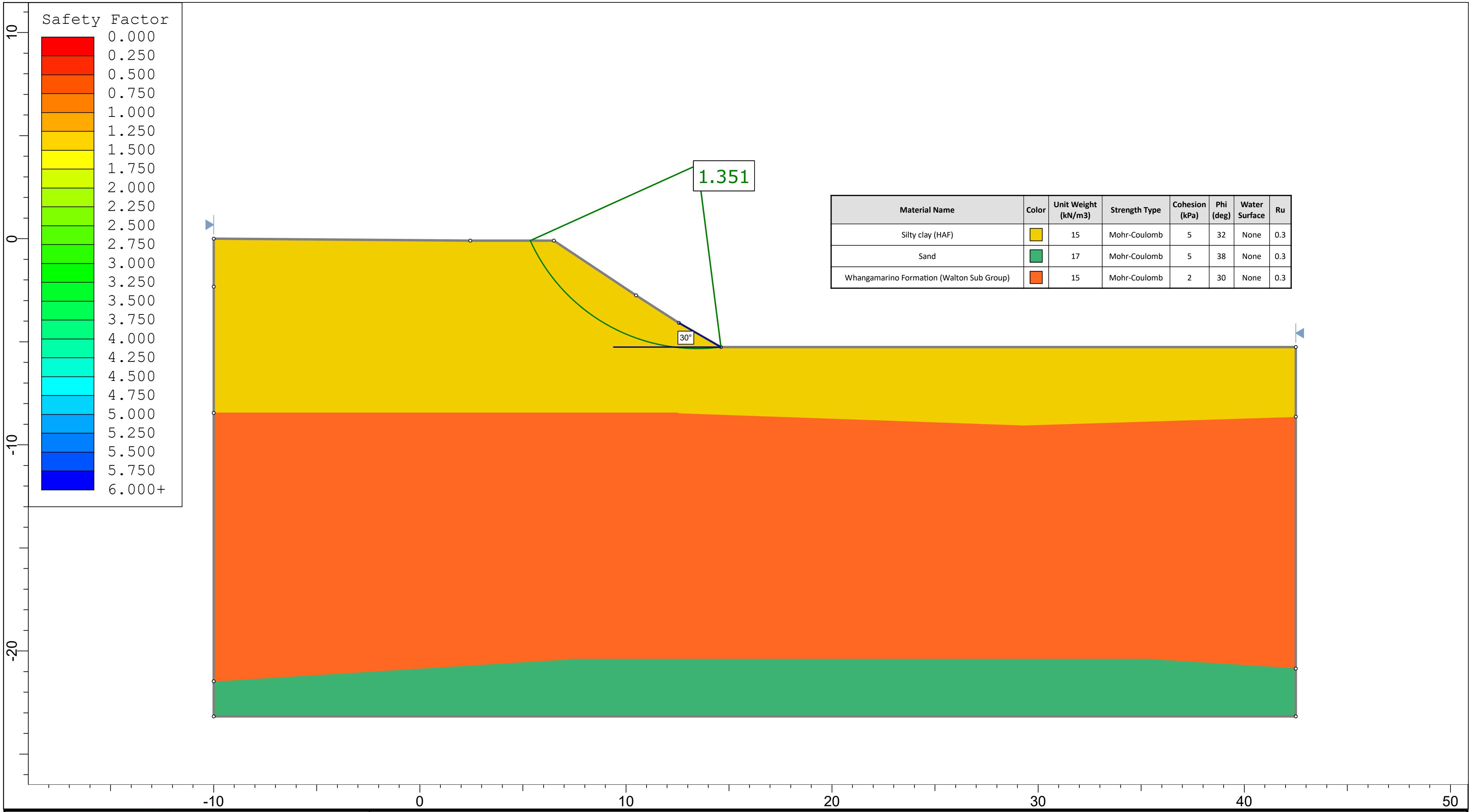
SLIDEINTERPRET 8.028



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Ru
Silty clay (HAF)	🟨	15	Mohr-Coulomb	5	32	None	0.15
Sand	🟩	17	Mohr-Coulomb	5	38	None	0.15
Whangamarino Formation (Walton Sub Group)	🟧	15	Mohr-Coulomb	2	30	None	0.15

Project	HD1151 - Cross section 1
Analysis Description	Drained - Static - Ru0.15 - 36 degrees
Drawn By	SSA
Scale	1:250
Company	HD Geo
Date	12/4/2019, 12:35:30 PM
File Name	HD1151 - Cross section 1 - Drained - Static - Ru0.15.slmd

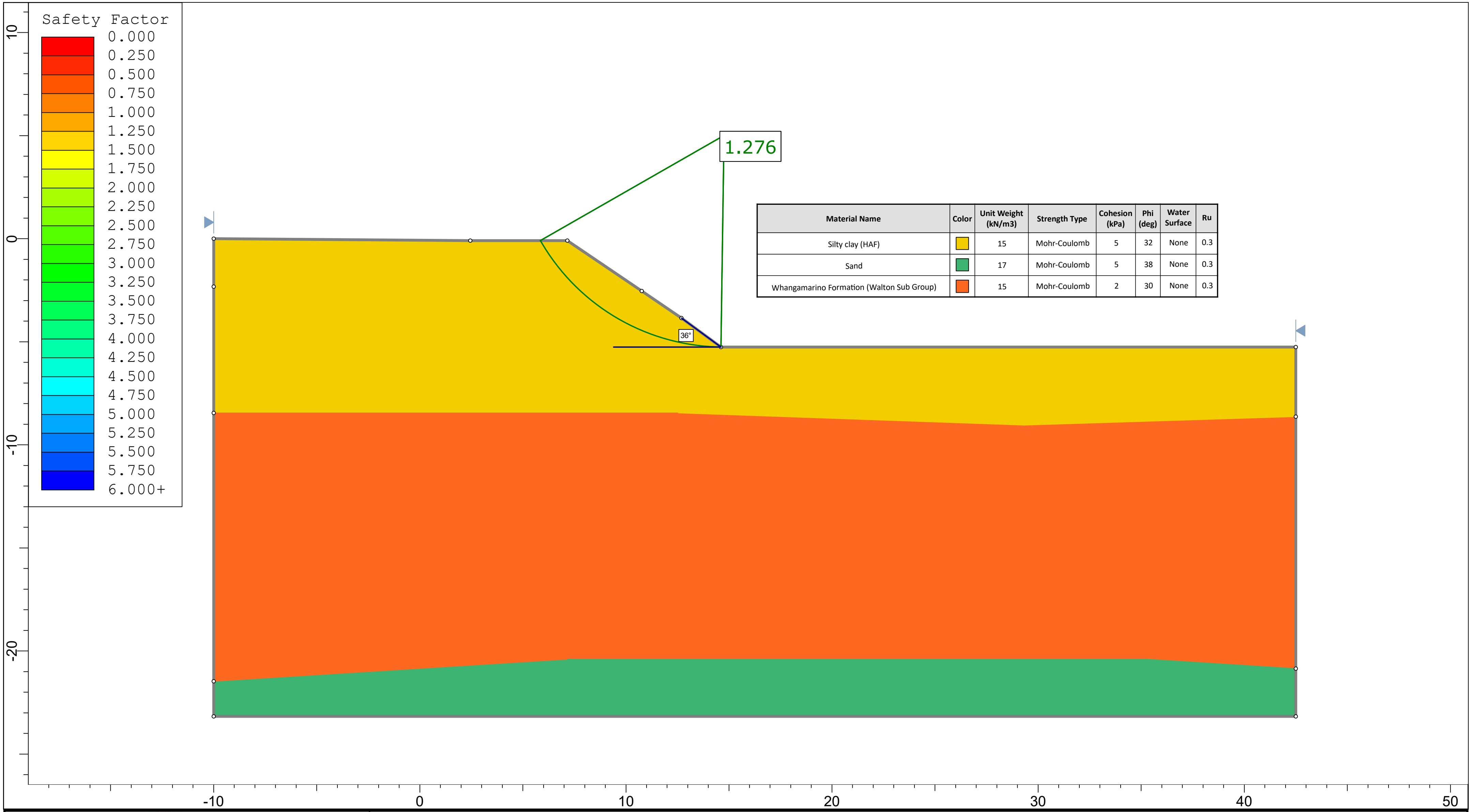
SLIDEINTERPRET 8.028



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Ru
Silty clay (HAF)	🟨	15	Mohr-Coulomb	5	32	None	0.3
Sand	🟩	17	Mohr-Coulomb	5	38	None	0.3
Whangamarino Formation (Walton Sub Group)	🟧	15	Mohr-Coulomb	2	30	None	0.3

Project	HD1151 - Cross section 1		
Analysis Description	Drained - Elevated GW- Ru0.3 - 30 degrees		
Drawn By	SSA	*Scale*	1:250
Company	HD Geo		
Date	12/4/2019, 12:35:30 PM	*File Name*	HD1151 - Cross section 1 - Drained - Static - Ru0.3.slmd

SLIDEINTERPRET 8.028

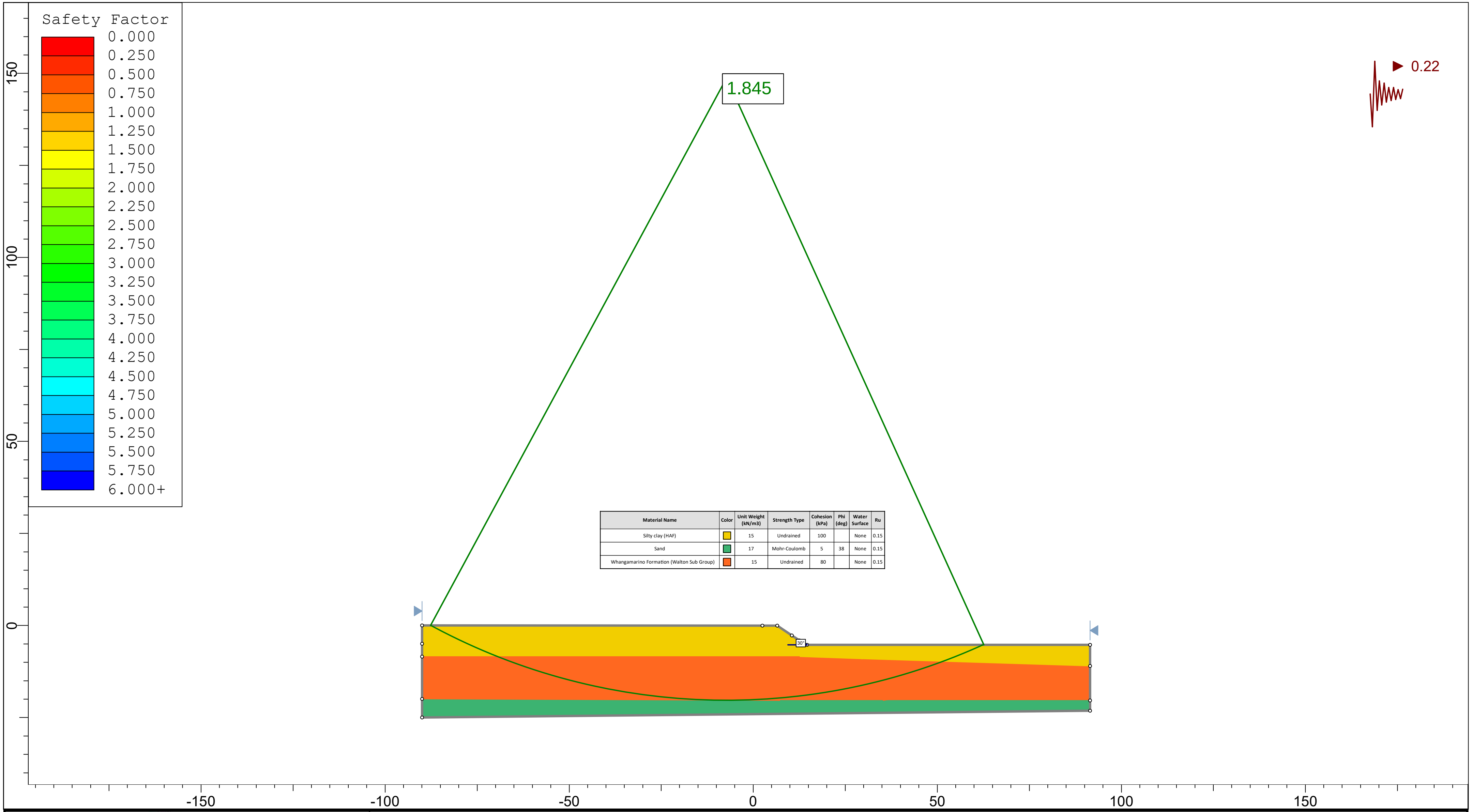


Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Ru
Silty clay (HAF)	🟨	15	Mohr-Coulomb	5	32	None	0.3
Sand	🟩	17	Mohr-Coulomb	5	38	None	0.3
Whangamarino Formation (Walton Sub Group)	🟧	15	Mohr-Coulomb	2	30	None	0.3

Project	HD1151 - Cross section 1		
Analysis Description	Drained - Elevated GW - Ru0.15 - 36 degrees		
Drawn By	SSA	*Scale*	1:250
Company	HD Geo		
Date	12/4/2019, 12:35:30 PM	*File Name*	HD1151 - Cross section 1 - Drained - Static - Ru0.3.slmd

GEO

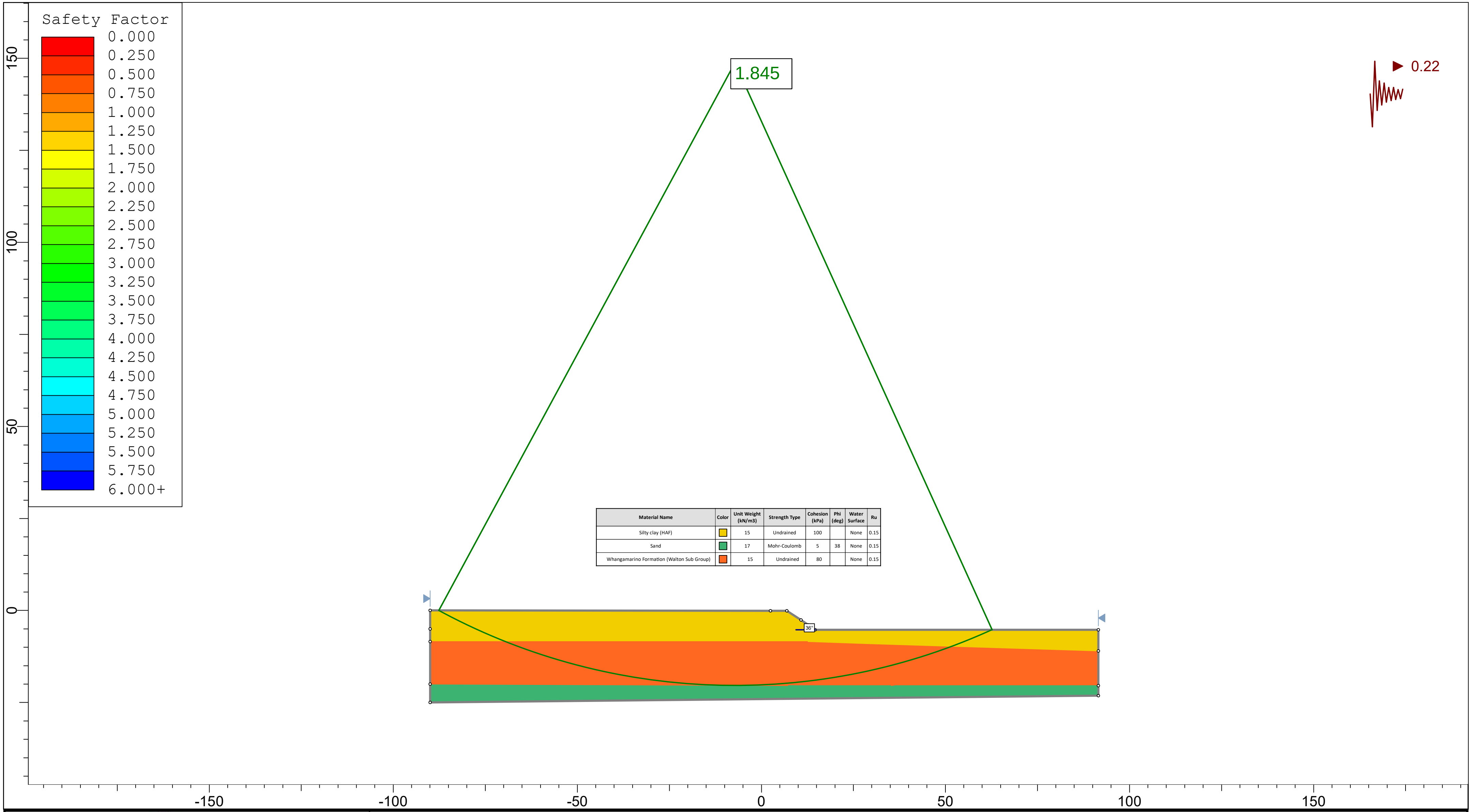
SLIDEINTERPRET 8.028



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Ru
Silty clay (HAF)	🟨	15	Undrained	100		None	0.15
Sand	🟩	17	Mohr-Coulomb	5	38	None	0.15
Whangamarino Formation (Walton Sub Group)	🟧	15	Undrained	80		None	0.15

Project	HD1151 - Cross section 1		
Analysis Description	Undrained - Seismic - Ru0.15 - 30 degrees		
Drawn By	SSA	*Scale*	1:1400
Company	HD Geo		
Date	12/4/2019, 12:35:30 PM		
File Name	HD1151 - Cross section 1 - Undrained - Seismic - Ru0.15.slmd		

SLIDEINTERPRET 8.028



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Ru
Silty clay (HAF)	🟨	15	Undrained	100		None	0.15
Sand	🟩	17	Mohr-Coulomb	5	38	None	0.15
Whangamarino Formation (Walton Sub Group)	🟧	15	Undrained	80		None	0.15

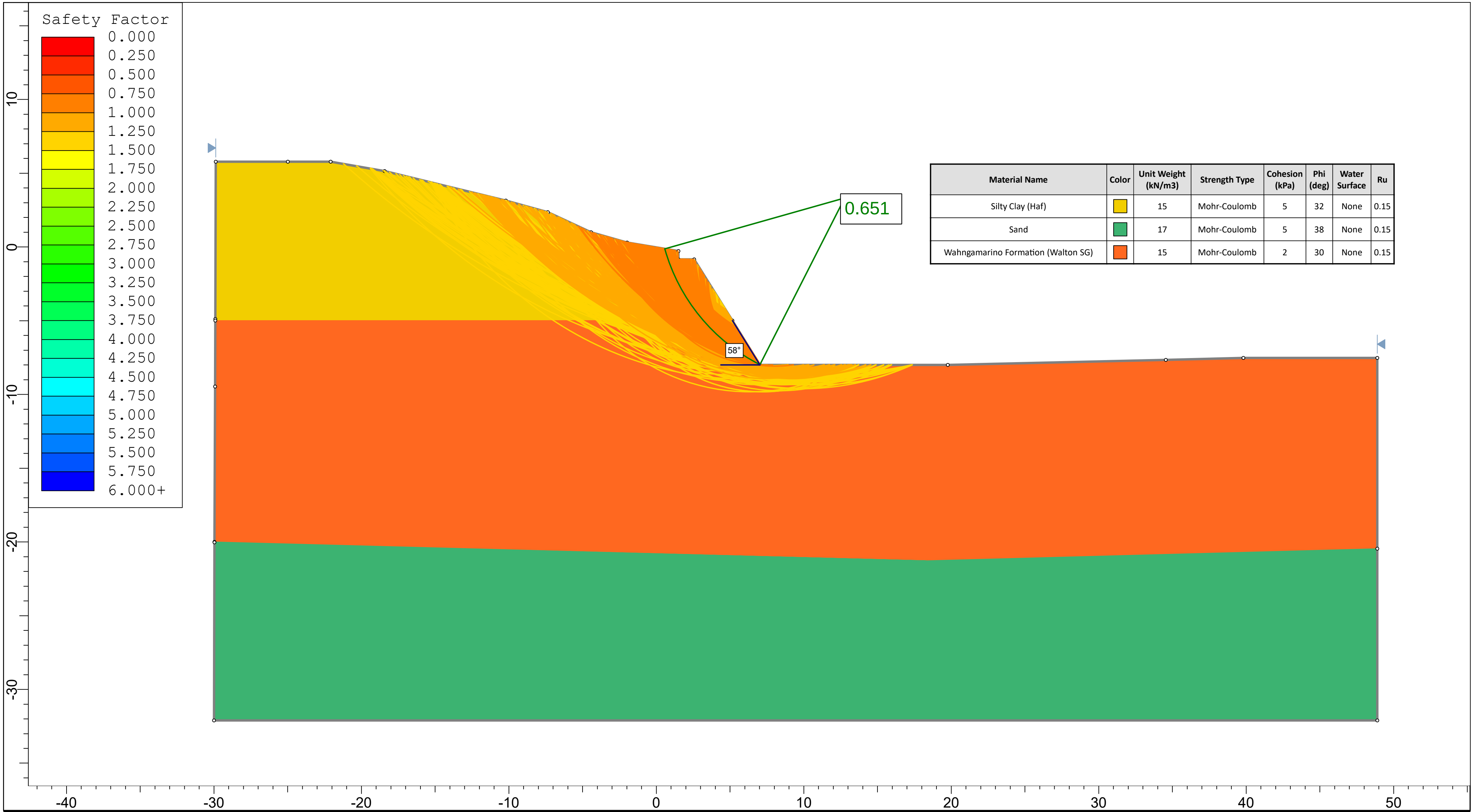
Project
HD1151 - Cross section 1

Analysis Description
Undrained - Seismic - Ru0.15 - 36 degrees

Drawn By SSA
Scale 1:1400
Company HD Geo

Date 12/4/2019, 12:35:30 PM
File Name HD1151 - Cross section 1 - Undrained - Seismic - Ru0.15.slmd

SLIDEINTERPRET 8.028



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Ru
Silty Clay (Haf)	🟨	15	Mohr-Coulomb	5	32	None	0.15
Sand	🟩	17	Mohr-Coulomb	5	38	None	0.15
Wahngamarino Formation (Walton SG)	🟧	15	Mohr-Coulomb	2	30	None	0.15

Project
HD1151 - Cross section 2

Analysis Description
Drained - Static - Ru0.15 - 58 degrees

Drawn By SSA

Scale 1:350

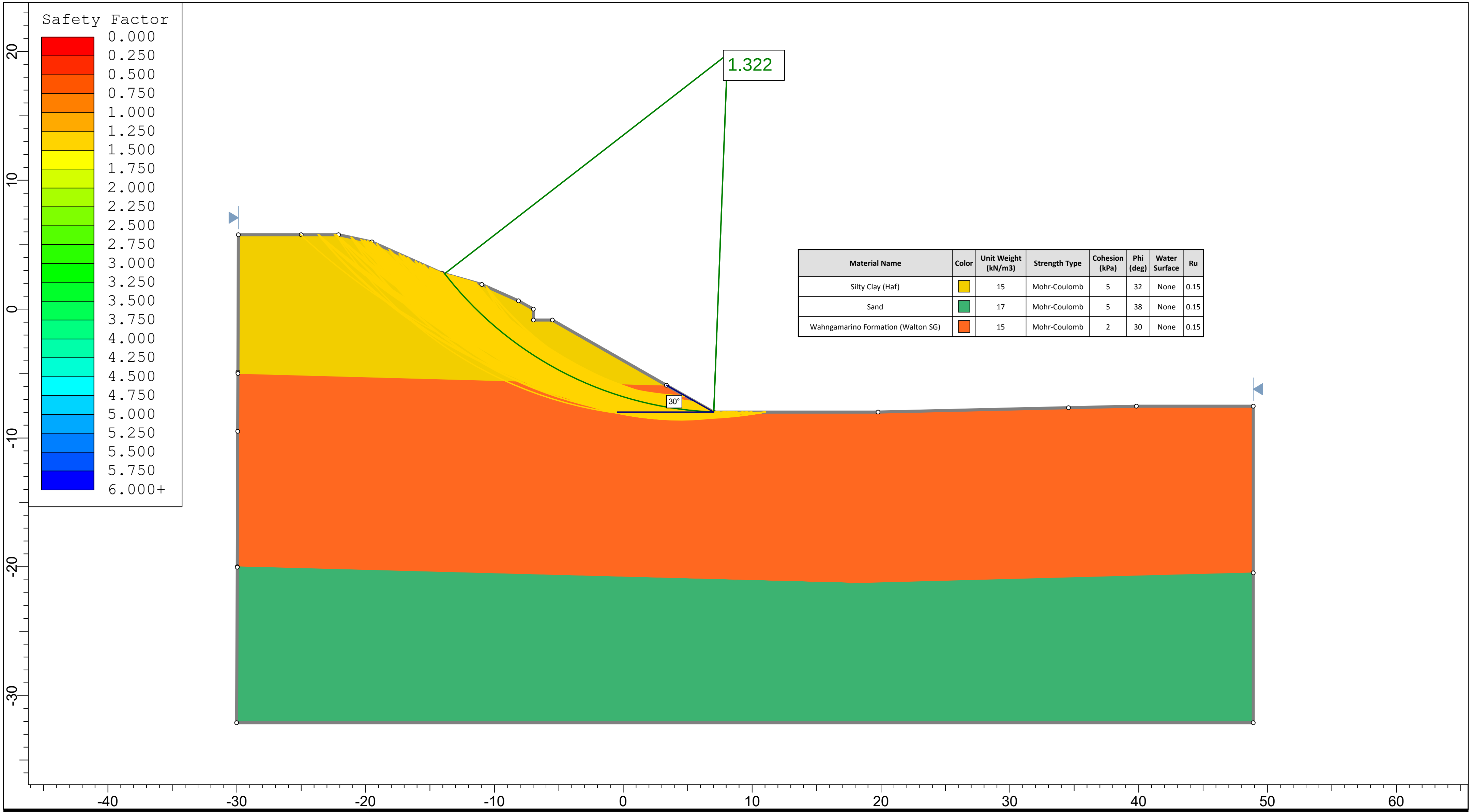
Company HD Geo

Date 12/4/2019, 2:15:02 PM

File Name HD1151 - Cross section 2 - Static - Drained - Ru0.15.slmd

hd GEO

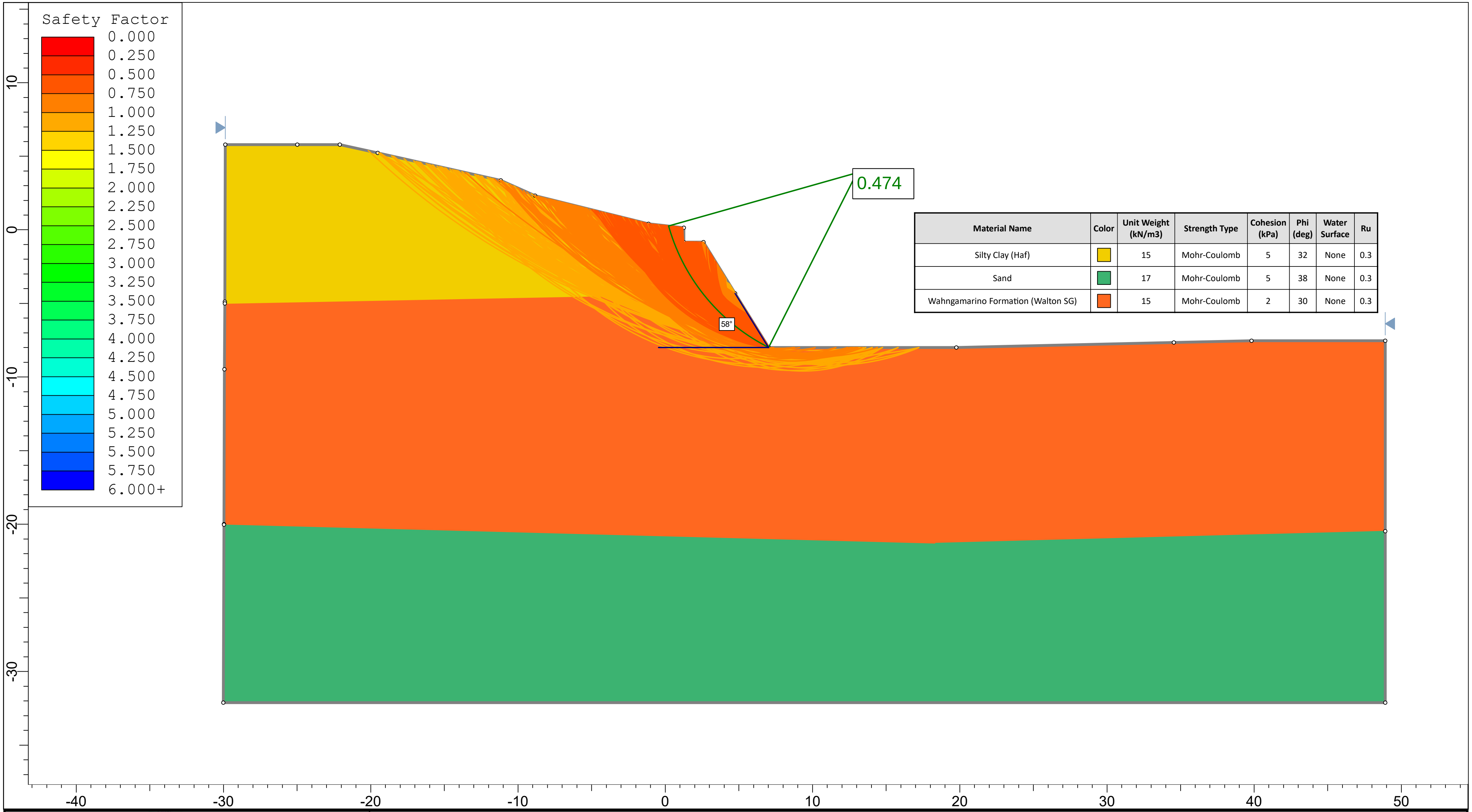
SLIDEINTERPRET 8.028



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Ru
Silty Clay (Haf)	🟨	15	Mohr-Coulomb	5	32	None	0.15
Sand	🟩	17	Mohr-Coulomb	5	38	None	0.15
Wahngamarino Formation (Walton SG)	🟧	15	Mohr-Coulomb	2	30	None	0.15

Project	HD1151 - Cross section 2
Analysis Description	Drained - Static - Ru0.15 - 30 degrees
Drawn By	SSA
Scale	1:400
Company	HD Geo
Date	12/4/2019, 2:15:02 PM
File Name	HD1151 - Cross section 2 - Static - Drained - Ru0.15.slmd

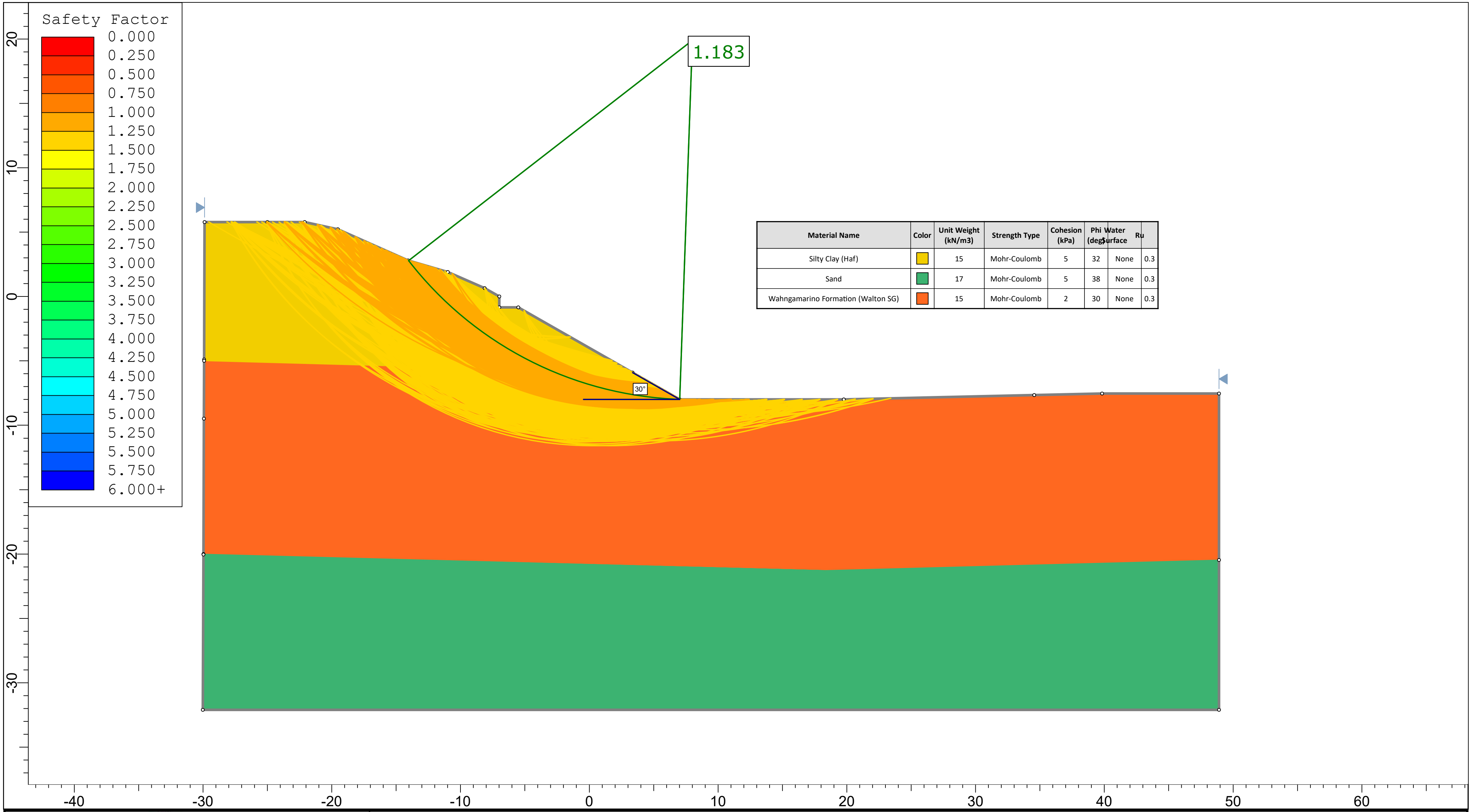
SLIDEINTERPRET 8.028



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Ru
Silty Clay (Haf)	🟨	15	Mohr-Coulomb	5	32	None	0.3
Sand	🟩	17	Mohr-Coulomb	5	38	None	0.3
Wahngamarino Formation (Walton SG)	🟧	15	Mohr-Coulomb	2	30	None	0.3

Project	HD1151 - Cross section 2		
Analysis Description	Drained - Elevated GW - Ru0.3 - 58 degrees		
Drawn By SSA	*Scale* 1:350	*Company*	HD Geo
Date	12/4/2019, 2:15:02 PM	*File Name*	HD1151 - Cross section 2 - Elevated GW - Drained - Ru0.3.slmd

SLIDEINTERPRET 8.028



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Ru
Silty Clay (Haf)	🟨	15	Mohr-Coulomb	5	32	None	0.3
Sand	🟩	17	Mohr-Coulomb	5	38	None	0.3
Wahngamarino Formation (Walton SG)	🟧	15	Mohr-Coulomb	2	30	None	0.3

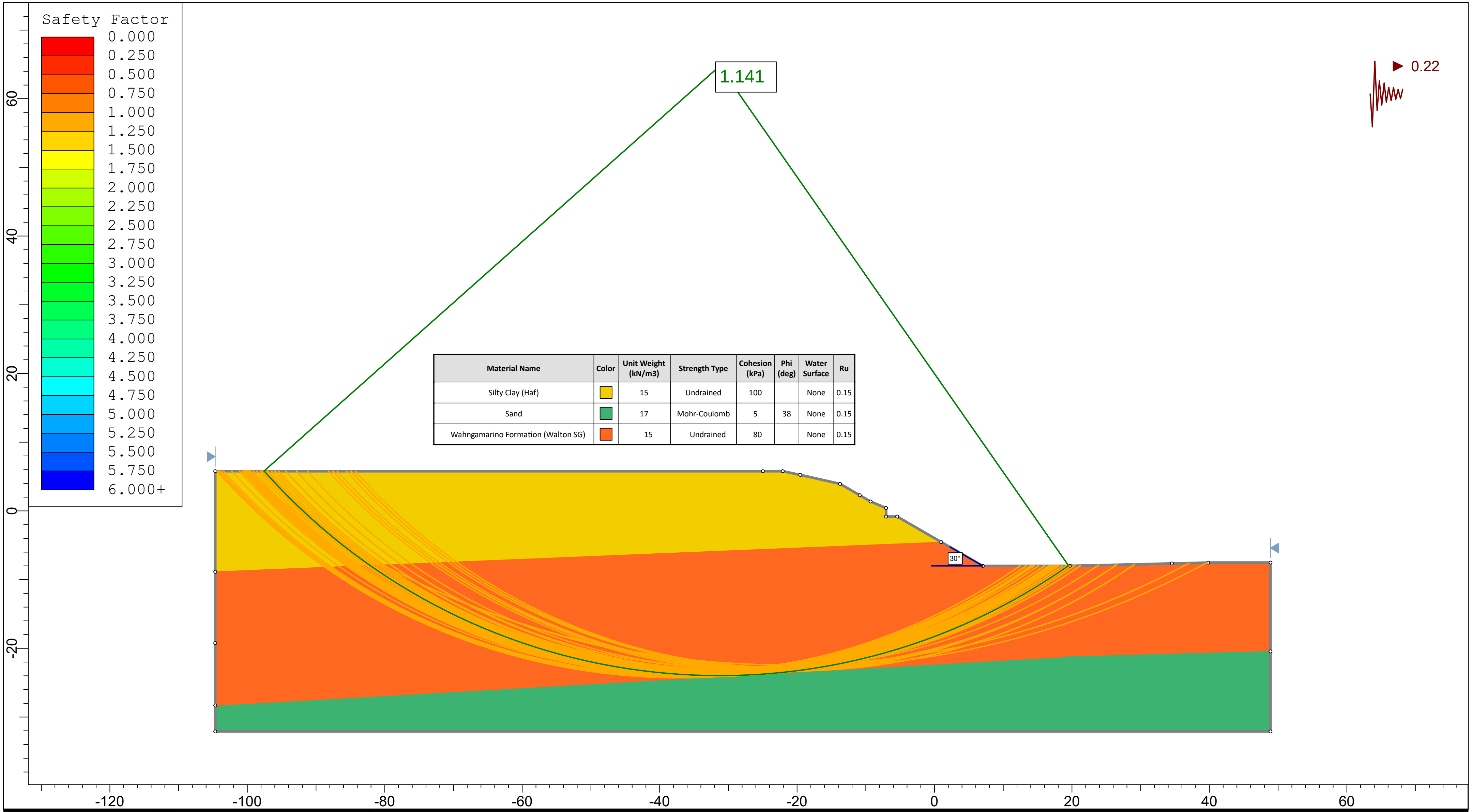
Project
HD1151 - Cross section 2

Analysis Description
Drained - Elevated GW - Ru0.3 - 30 degrees

Drawn By SSA
Scale 1:400
Company HD Geo

Date 12/4/2019, 2:15:02 PM
File Name HD1151 - Cross section 2 - Elevated GW - Drained - Ru0.3.slmd

SLIDEINTERPRET 8.028



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Ru
Silty Clay (Haf)	🟨	15	Undrained	100		None	0.15
Sand	🟩	17	Mohr-Coulomb	5	38	None	0.15
Wahngamarino Formation (Walton SG)	🟧	15	Undrained	80		None	0.15

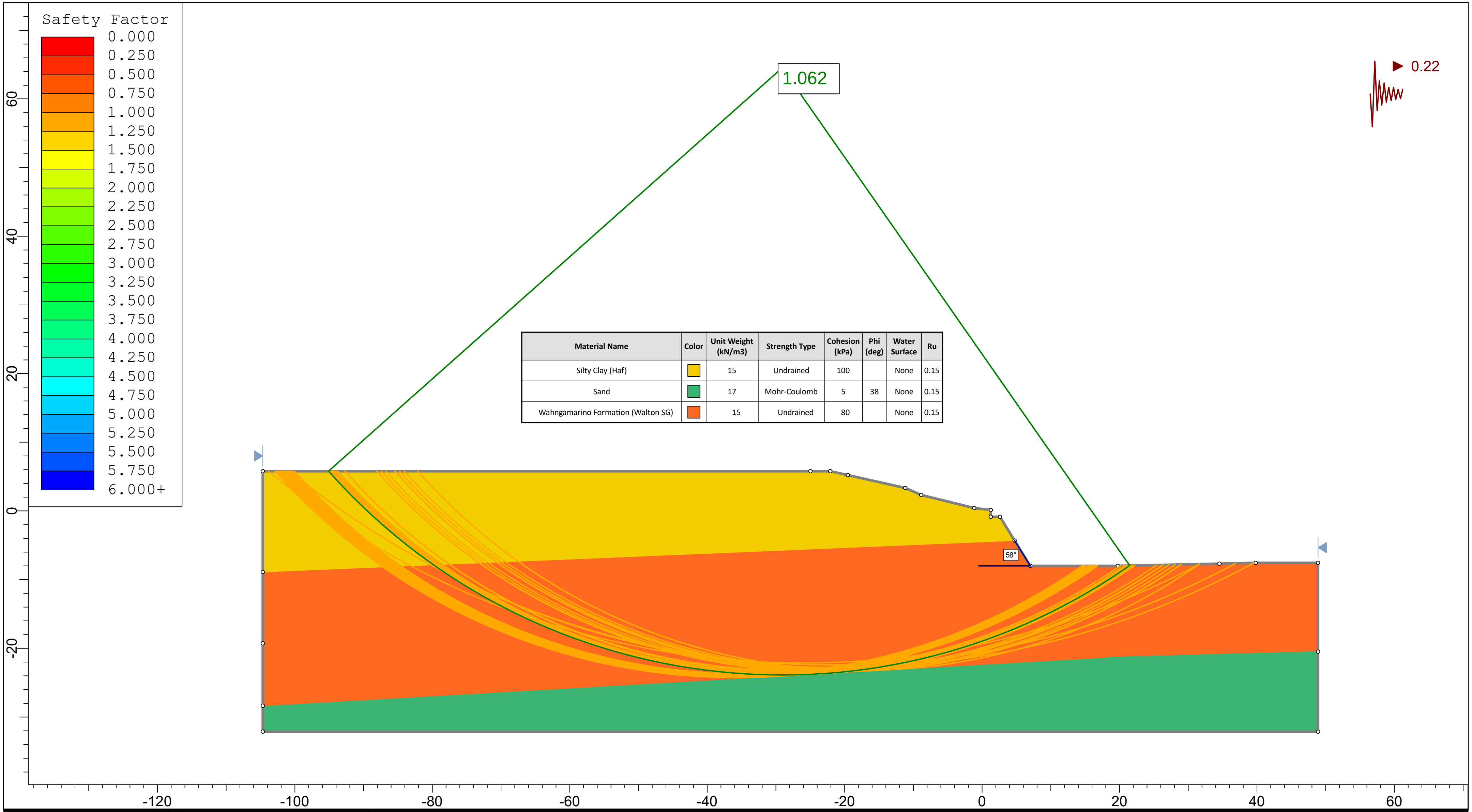
Project
HD1151 - Cross section 2

Analysis Description
Undrained - Seismic- Ru0.15 - 30 degrees

Drawn By SSA
Scale 1:750
Company HD Geo

Date 12/4/2019, 2:15:02 PM
File Name HD1151 - Cross section 2 - Seismic - Undrained - Ru0.15.slmd

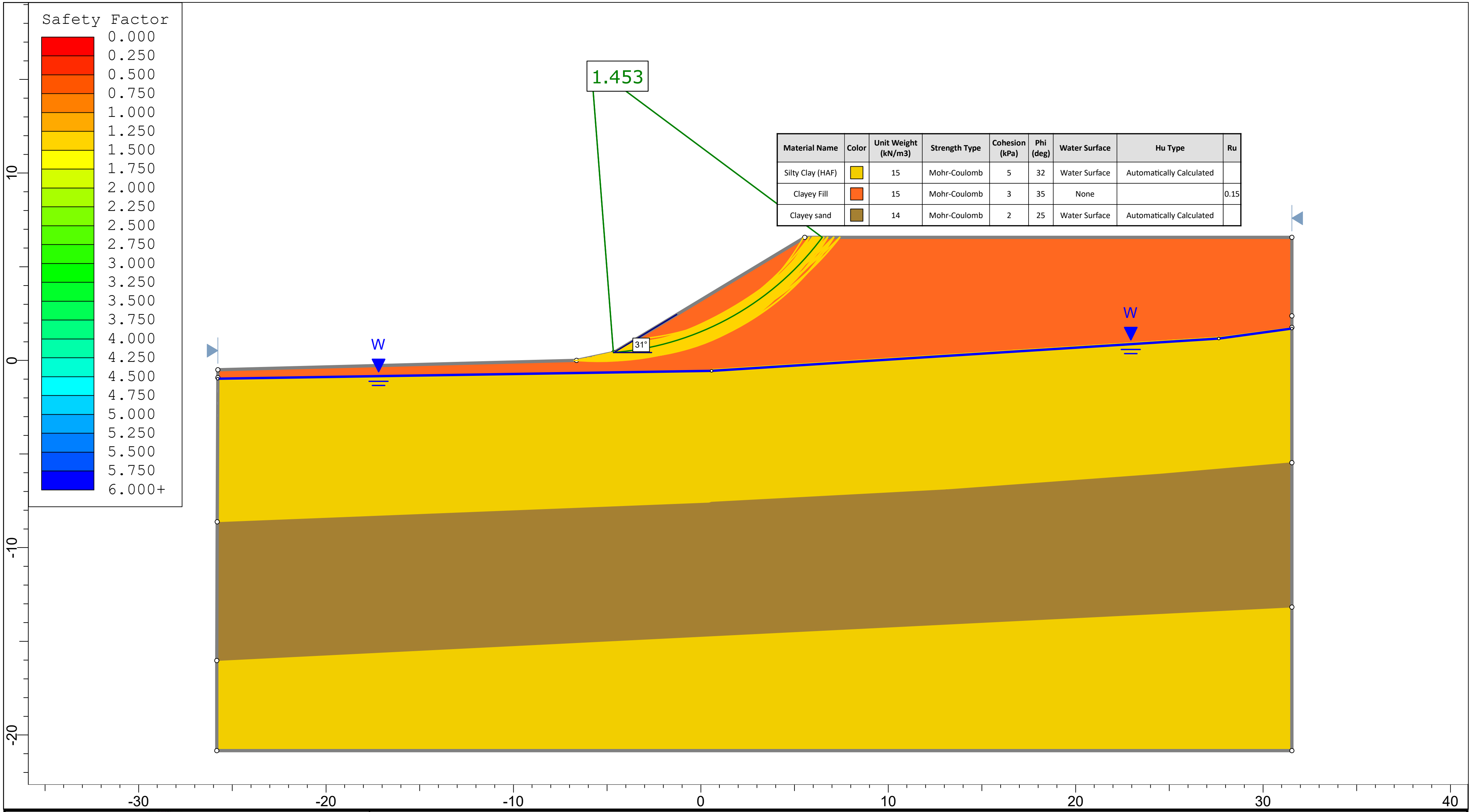
SLIDEINTERPRET 8.028



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Ru
Silty Clay (Haf)	🟨	15	Undrained	100		None	0.15
Sand	🟩	17	Mohr-Coulomb	5	38	None	0.15
Wahngamarino Formation (Walton SG)	🟧	15	Undrained	80		None	0.15

Project	HD1151 - Cross section 2
Analysis Description	Undrained - Seismic- Ru0.15 - 58 degrees
Drawn By	SSA
Scale	1:750
Company	HD Geo
Date	12/4/2019, 2:15:02 PM
File Name	HD1151 - Cross section 2 - Seismic - Undrained - Ru0.15.slmd

SLIDEINTERPRET 8.028



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Ru
Silty Clay (HAF)	🟨	15	Mohr-Coulomb	5	32	Water Surface	Automatically Calculated	
Clayey Fill	🟧	15	Mohr-Coulomb	3	35	None		0.15
Clayey sand	🟫	14	Mohr-Coulomb	2	25	Water Surface	Automatically Calculated	

Project HD1151 - Cross section 4

Analysis Description Drained - Static - Ru0.15 - 30 degrees

Drawn By SSA

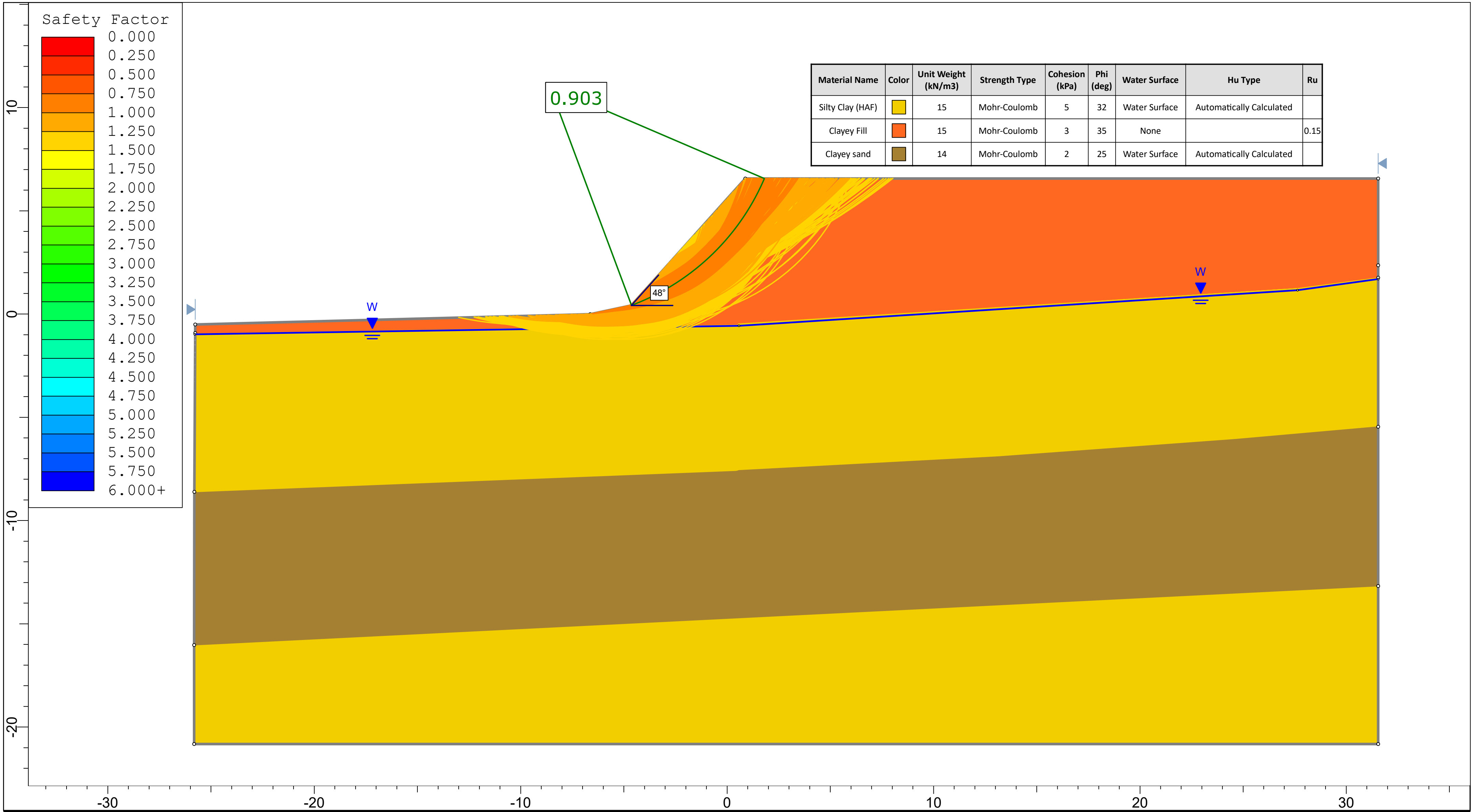
Scale 1:275

Company HD Geo

Date 12/4/2019, 3:01:32 PM

File Name HD1151 - Cross section 4 - Static - Drained - Ru0.15 - 30 degrees.slmd

SLIDEINTERPRET 8.028



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Ru
Silty Clay (HAF)	🟨	15	Mohr-Coulomb	5	32	Water Surface	Automatically Calculated	
Clayey Fill	🟧	15	Mohr-Coulomb	3	35	None		0.15
Clayey sand	🟫	14	Mohr-Coulomb	2	25	Water Surface	Automatically Calculated	

SLIDEINTERPRET 8.028

Project
HD1151 - Cross section 4

Analysis Description
Drained - Static - Ru0.15 - 48 degrees

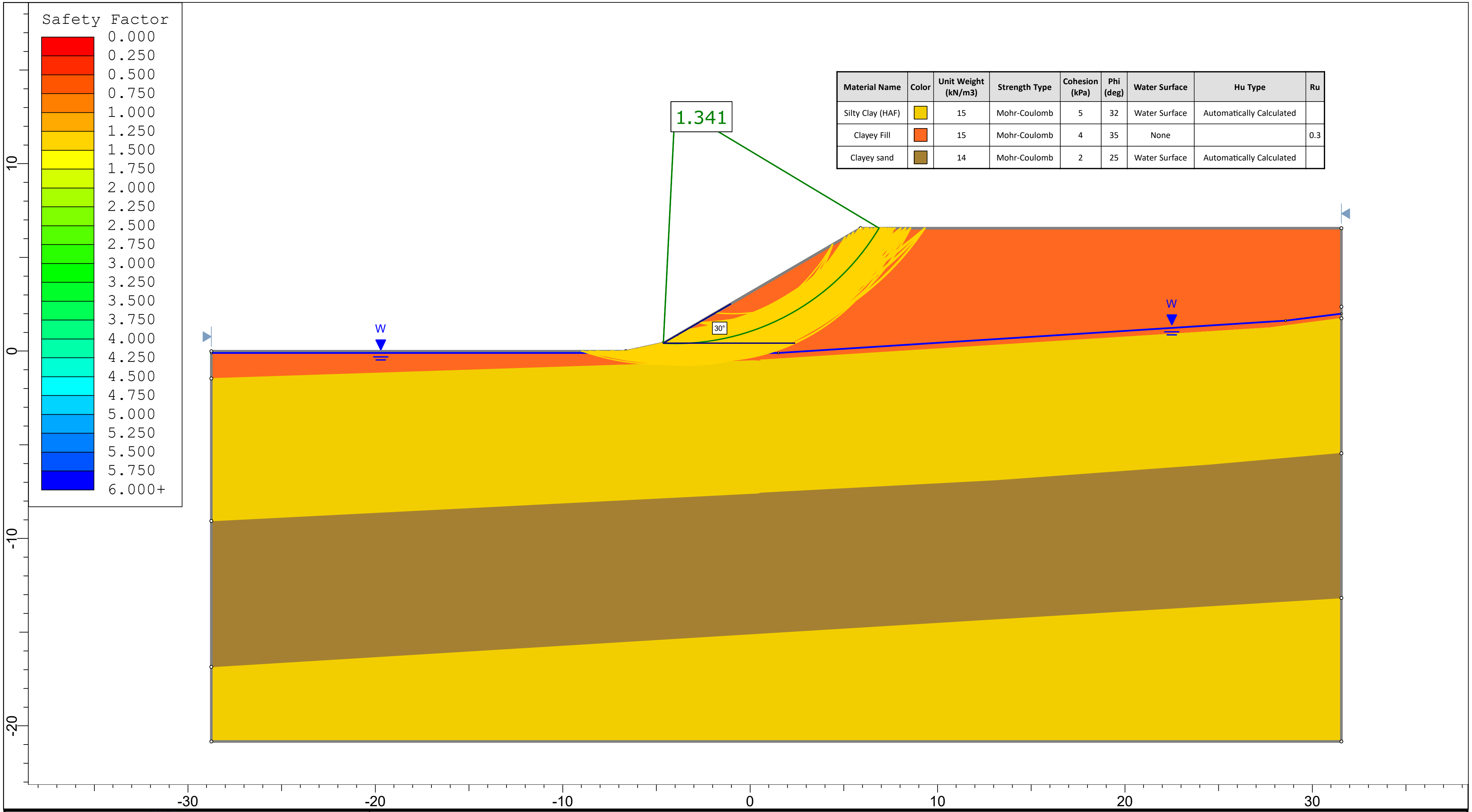
Drawn By SSA

Scale 1:250

Company HD Geo

Date 12/4/2019, 3:01:32 PM

File Name HD1151 - Cross section 4 - Static - Drained - Ru0.15 - 48 degrees.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Ru
Silty Clay (HAF)	🟨	15	Mohr-Coulomb	5	32	Water Surface	Automatically Calculated	
Clayey Fill	🟧	15	Mohr-Coulomb	4	35	None		0.3
Clayey sand	🟫	14	Mohr-Coulomb	2	25	Water Surface	Automatically Calculated	

SLIDEINTERPRET 8.028

Project HD1151 - Cross section 4

Analysis Description Drained - Elevated GW - Ru0.3 - 30 degrees

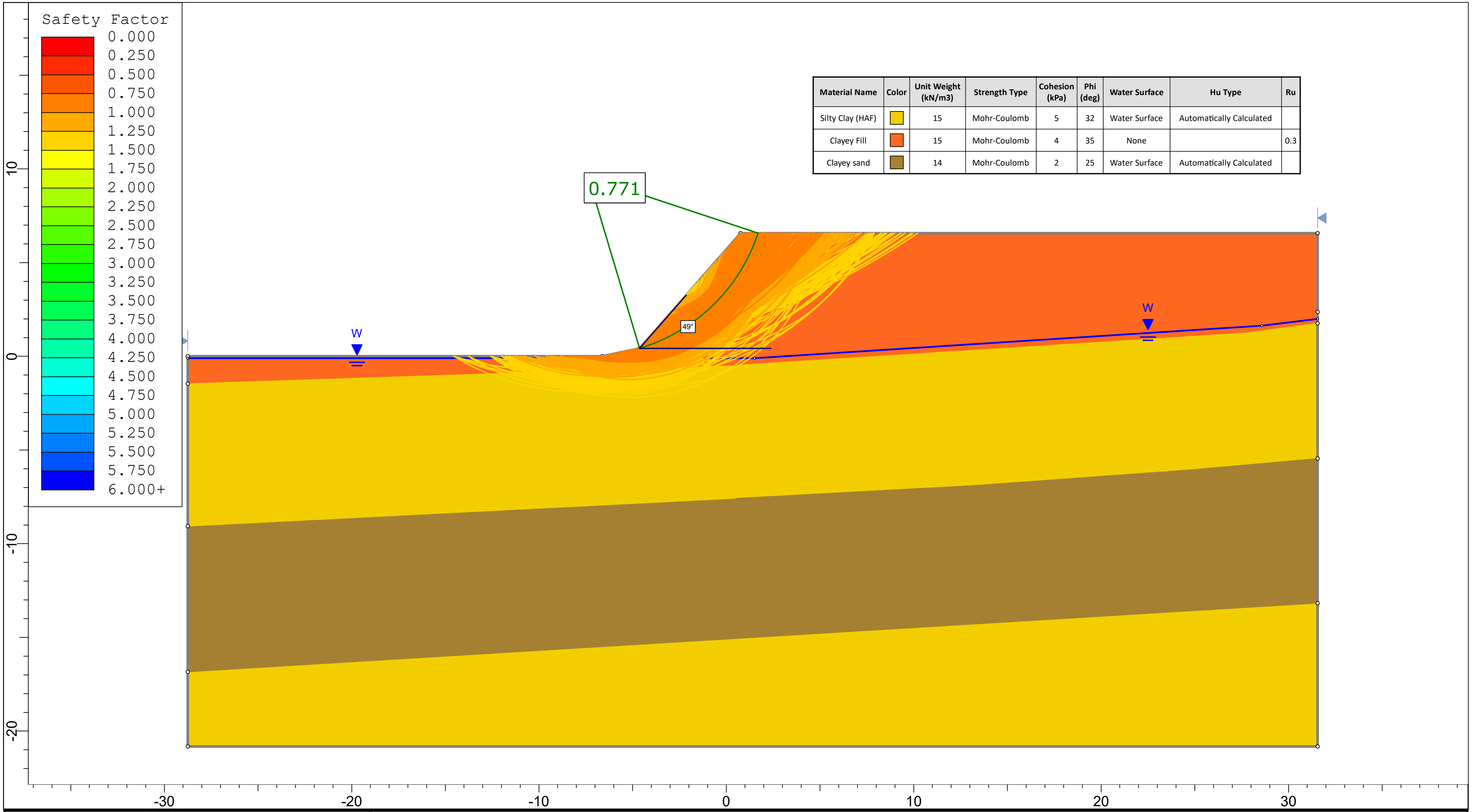
Drawn By SSA

Scale 1:275

Company HD Geo

Date 12/4/2019, 3:01:32 PM

File Name HD1151 - Cross section 4 - Static -Undrained - Ru0.5.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Ru
Silty Clay (HAF)	🟨	15	Mohr-Coulomb	5	32	Water Surface	Automatically Calculated	
Clayey Fill	🟧	15	Mohr-Coulomb	4	35	None		0.3
Clayey sand	🟫	14	Mohr-Coulomb	2	25	Water Surface	Automatically Calculated	

SLIDEINTERPRET 8.028

Project HD1151 - Cross section 4

Analysis Description Drained - Elevated GW - Ru0.3 - 48 degrees

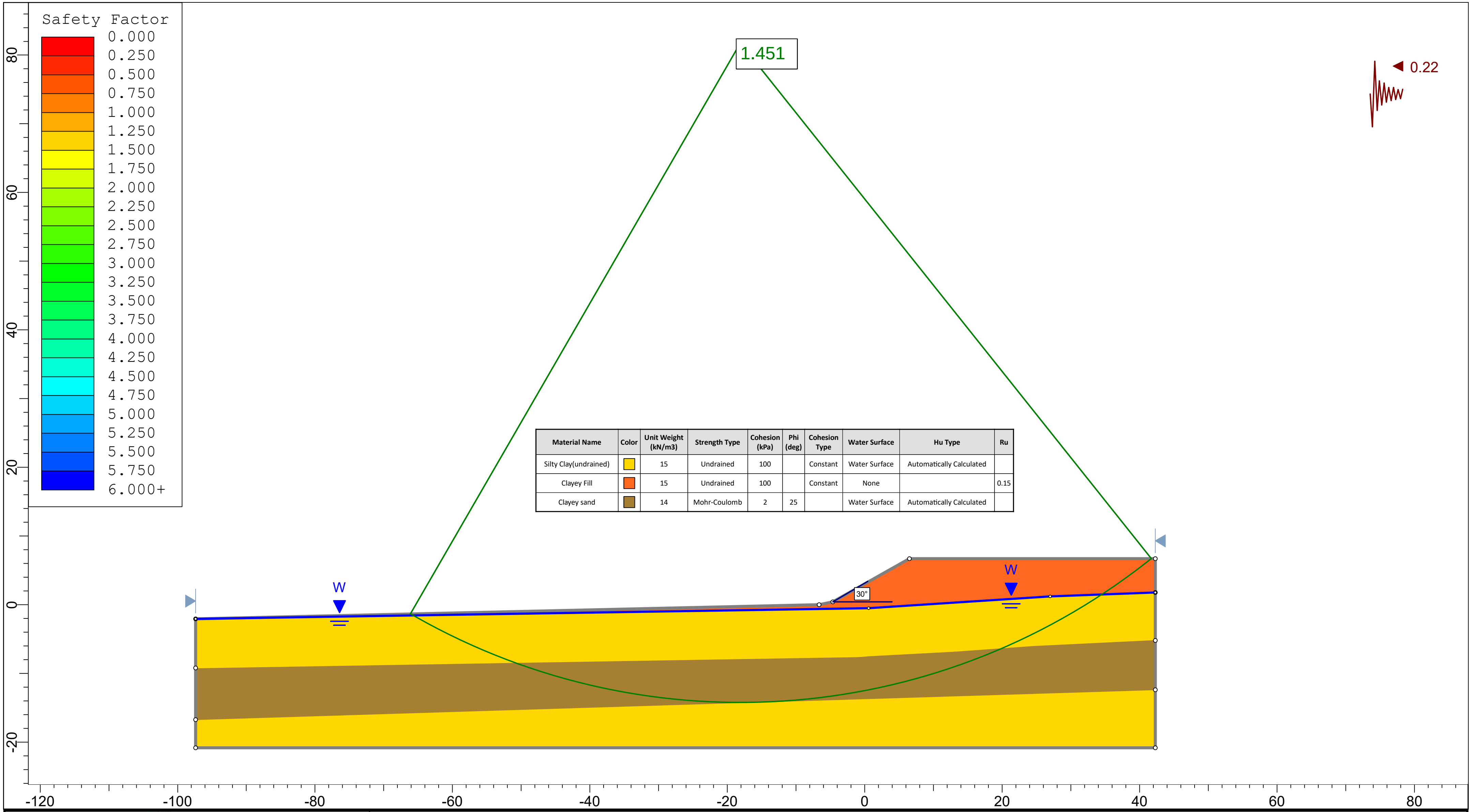
Drawn By SSA

Scale 1:275

Company HD Geo

Date 12/4/2019, 3:01:32 PM

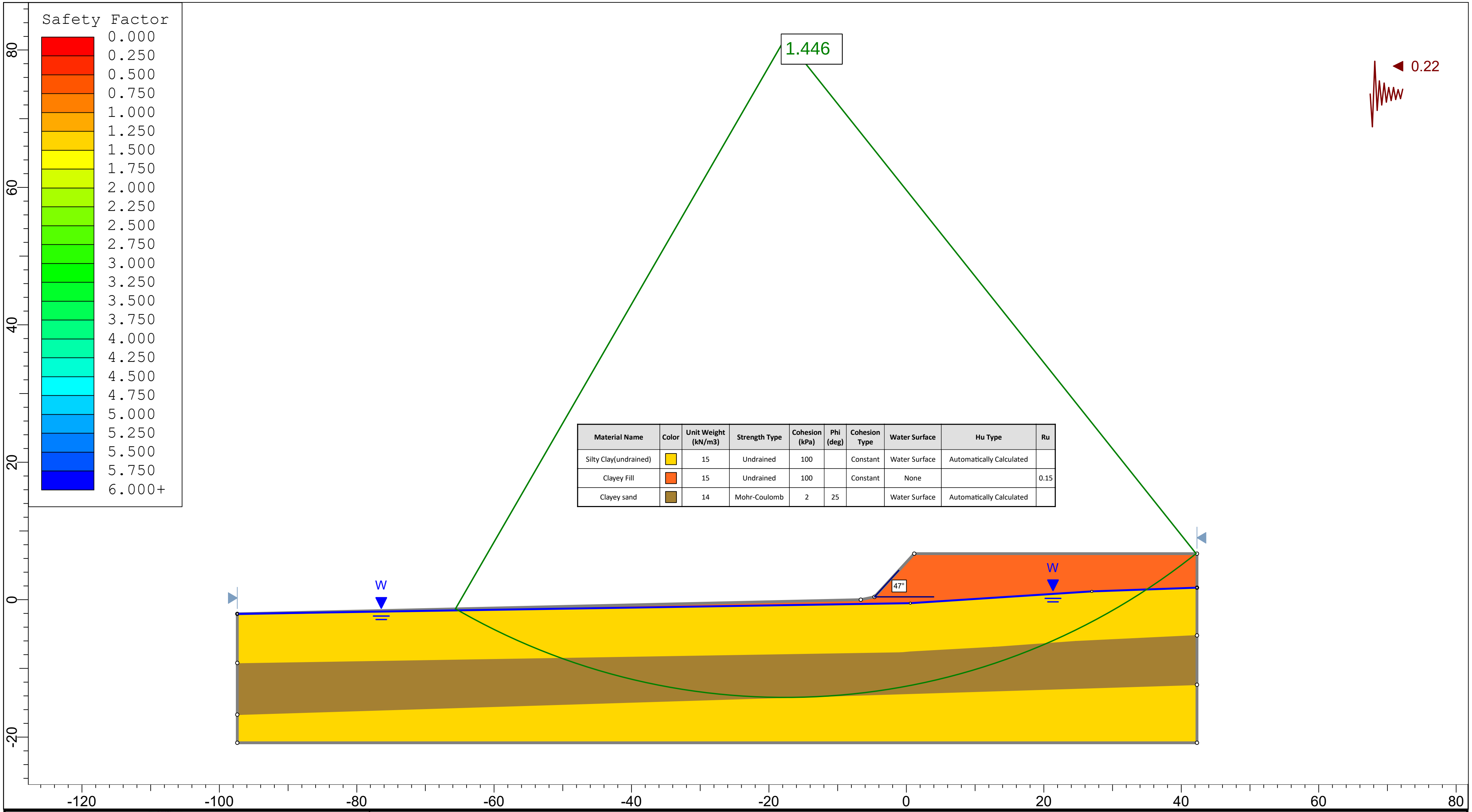
File Name HD1151 - Cross section 4 - Elevated GW -Drained - Ru0.3 - 48 degrees.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Water Surface	Hu Type	Ru
Silty Clay(undrained)	🟨	15	Undrained	100		Constant	Water Surface	Automatically Calculated	
Clayey Fill	🟧	15	Undrained	100		Constant	None		0.15
Clayey sand	🟫	14	Mohr-Coulomb	2	25		Water Surface	Automatically Calculated	

Project	HD1151 - Cross section 4		
Analysis Description	Undrained - Seismic - Ru0.15 - 30 degrees		
Drawn By SSA	*Scale* 1:750	*Company*	HD Geo
Date	12/4/2019, 3:01:32 PM	*File Name*	HD1151 - Cross section 4 - Seismic - Undrained - Ru0.3.slmd

SLIDEINTERPRET 8.028



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Water Surface	Hu Type	Ru
Silty Clay(undrained)	🟨	15	Undrained	100		Constant	Water Surface	Automatically Calculated	
Clayey Fill	🟧	15	Undrained	100		Constant	None		0.15
Clayey sand	🟫	14	Mohr-Coulomb	2	25		Water Surface	Automatically Calculated	

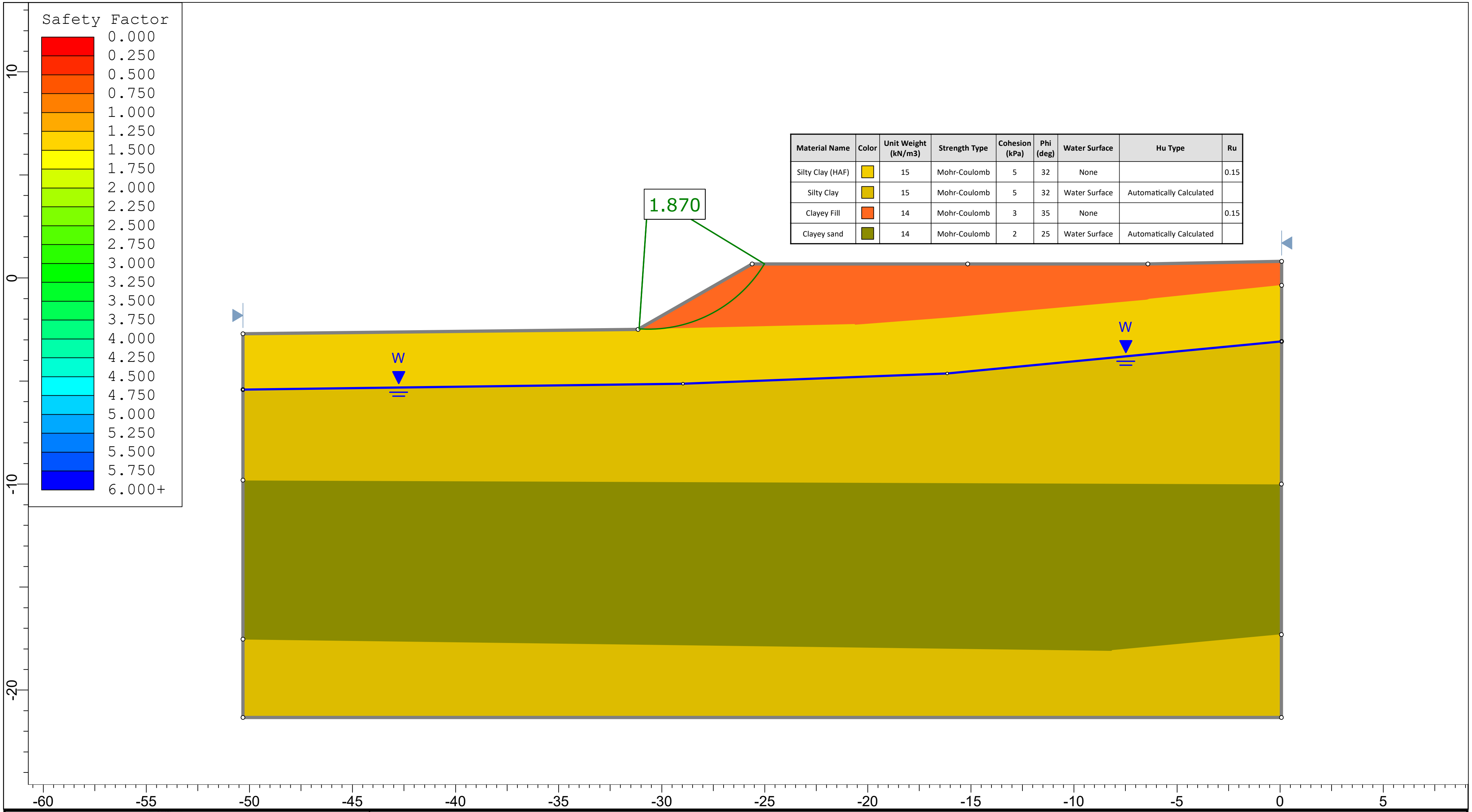
Project
HD1151 - Cross section 4

Analysis Description
Undrained - Seismic- Ru0.3 - 48 degrees

Drawn By SSA
Scale 1:750
Company HD Geo

Date 12/4/2019, 3:01:32 PM
File Name HD1151 - Cross section 4 - Seismic - Undrained - Ru0.15 - 48 degrees.slmd

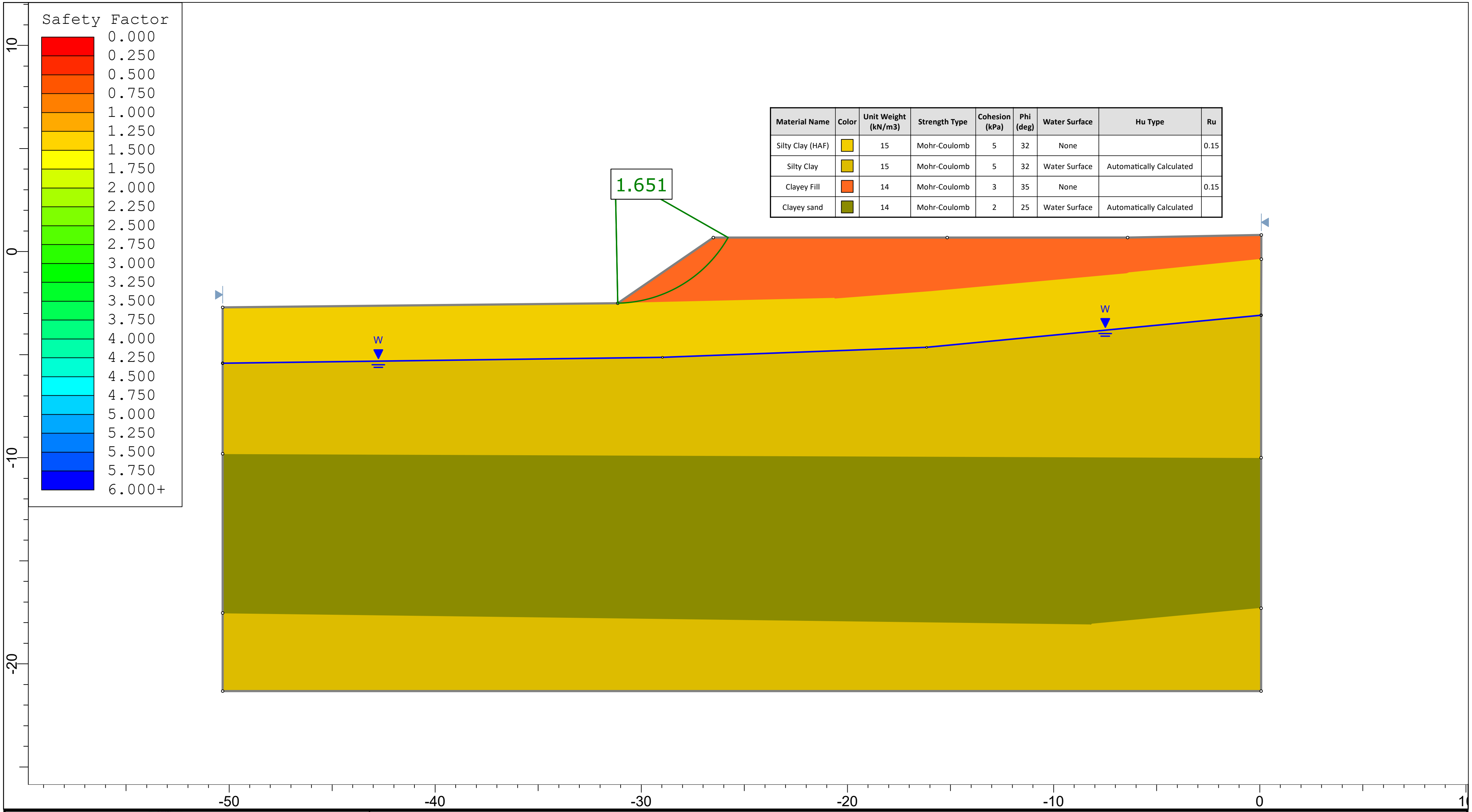
SLIDEINTERPRET 8.028



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Ru
Silty Clay (HAF)	🟨	15	Mohr-Coulomb	5	32	None		0.15
Silty Clay	🟨	15	Mohr-Coulomb	5	32	Water Surface	Automatically Calculated	
Clayey Fill	🟧	14	Mohr-Coulomb	3	35	None		0.15
Clayey sand	🟫	14	Mohr-Coulomb	2	25	Water Surface	Automatically Calculated	

Project	HD1151 - Cross Section 5		
Analysis Description	Drained - Static - Ru0.15 - 30 degrees		
Drawn By	SSA	*Scale*	1:250
Company	HD Geo		
Date	12/4/2019, 3:14:50 PM	*File Name*	HD1151 - Cross section 5 - Static - Drained - Ru0.15 - 30 degrees.slmd

SLIDEINTERPRET 8.028

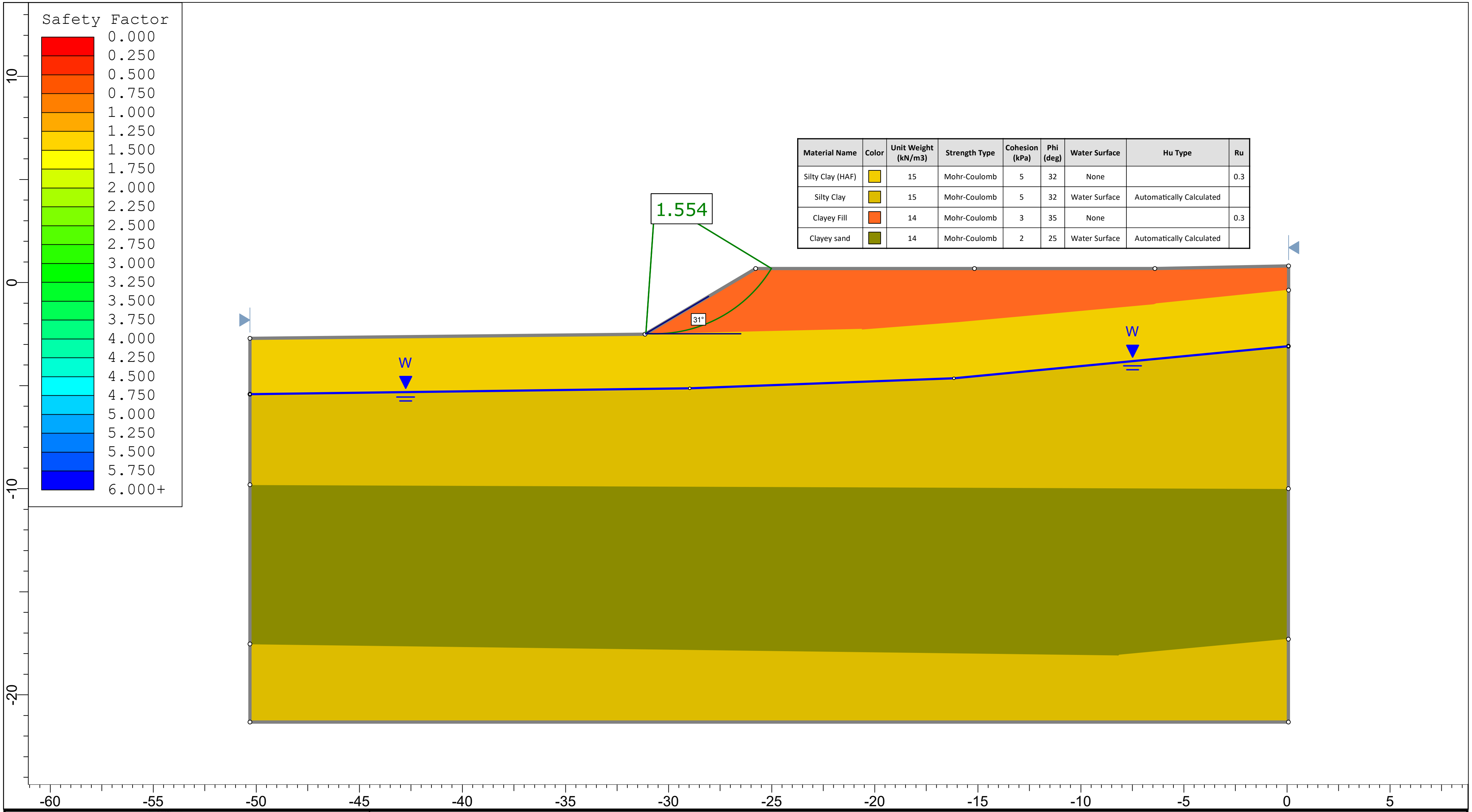


Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Ru
Silty Clay (HAF)	🟨	15	Mohr-Coulomb	5	32	None		0.15
Silty Clay	🟨	15	Mohr-Coulomb	5	32	Water Surface	Automatically Calculated	
Clayey Fill	🟧	14	Mohr-Coulomb	3	35	None		0.15
Clayey sand	🟫	14	Mohr-Coulomb	2	25	Water Surface	Automatically Calculated	

Project	HD1151 - Cross Section 5
Analysis Description	Drained - Static - Ru0.15 - 35 degrees

Drawn By	SSA	*Scale*	1:250	*Company*	HD Geo
Date	12/4/2019, 3:14:50 PM			*File Name*	HD1151 - Cross section 5 - Static - Drained - Ru0.15 - 34 degrees.slmd

SLIDEINTERPRET 8.028



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Ru
Silty Clay (HAF)	🟨	15	Mohr-Coulomb	5	32	None		0.3
Silty Clay	🟨	15	Mohr-Coulomb	5	32	Water Surface	Automatically Calculated	
Clayey Fill	🟧	14	Mohr-Coulomb	3	35	None		0.3
Clayey sand	🟫	14	Mohr-Coulomb	2	25	Water Surface	Automatically Calculated	

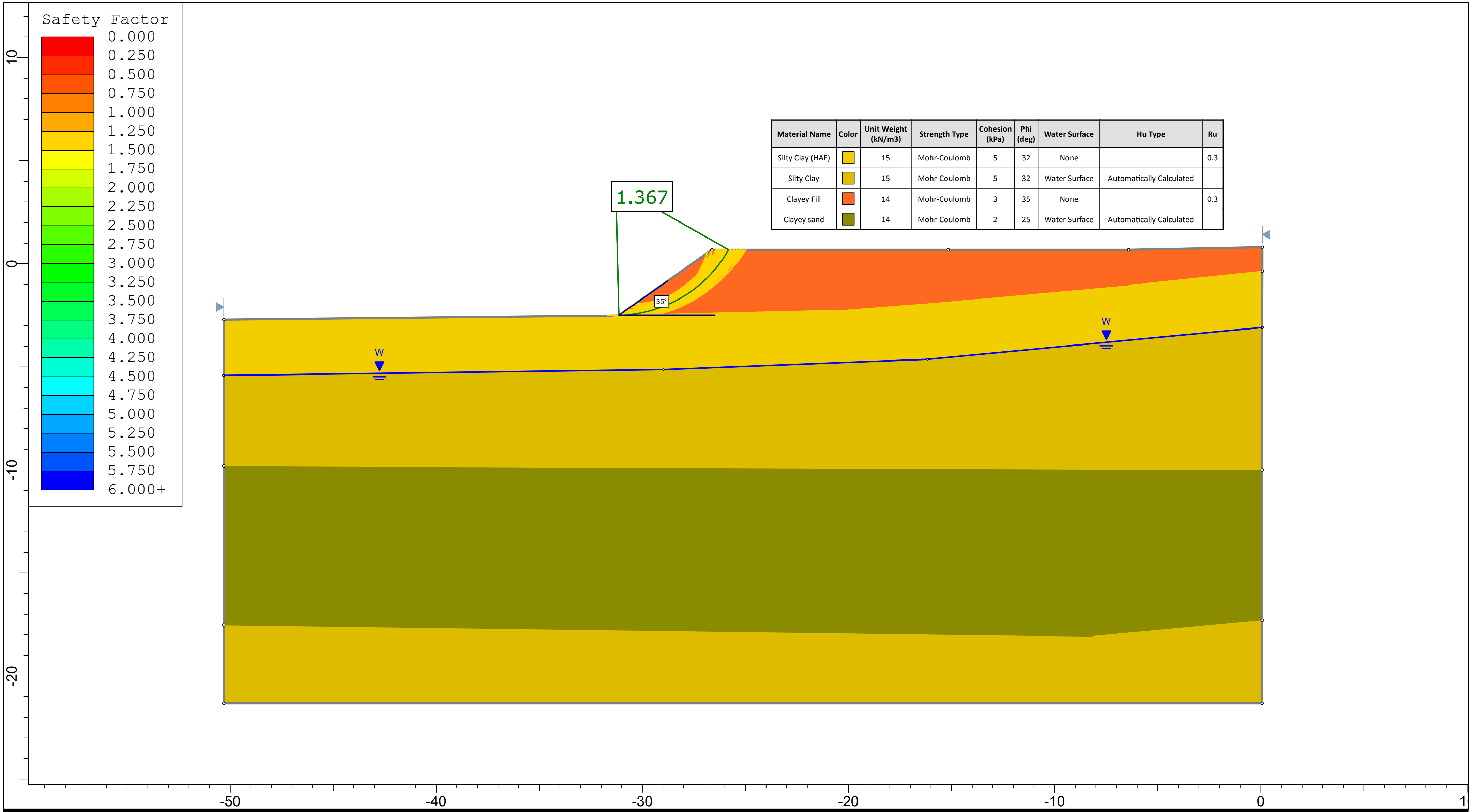
Project
HD1151 - Cross Section 5

Analysis Description
Drained - Elevated GW- Ru0.3 - 30 degrees

Drawn By SSA
Scale 1:250
Company HD Geo

Date 12/4/2019, 3:14:50 PM
File Name HD1151 - Cross section 5 - Elevated GW - Drained - Ru0.3 - 30 degrees slmd

SLIDEINTERPRET 8.028



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Ru
Silty Clay (HAF)	🟨	15	Mohr-Coulomb	5	32	None		0.3
Silty Clay	🟨	15	Mohr-Coulomb	5	32	Water Surface	Automatically Calculated	
Clayey Fill	🟧	14	Mohr-Coulomb	3	35	None		0.3
Clayey sand	🟩	14	Mohr-Coulomb	2	25	Water Surface	Automatically Calculated	

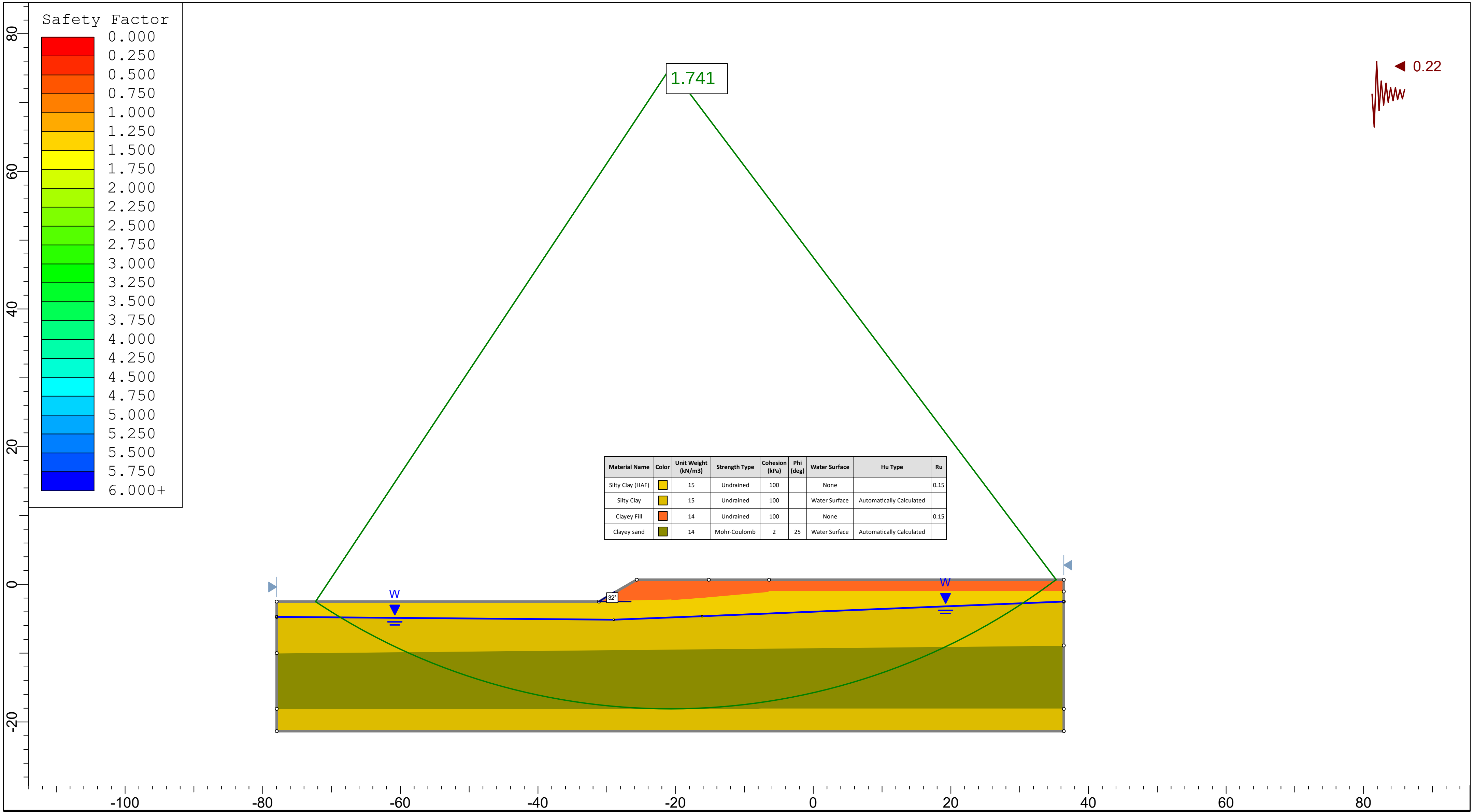
Project
HD1151 - Cross Section 5

Analysis Description
Drained - Elevated GW- Ru0.3 - 35 degrees

Drawn By SSA
Scale 1:250
Company HD Geo

Date 12/4/2019, 3:14:50 PM
File Name HD1151 - Cross section 5 - Elevated GW - Drained - Ru0.3 - 34 degrees slmd

SLIDEINTERPRET 8.028



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Ru
Silty Clay (HAF)	🟨	15	Undrained	100		None		0.15
Silty Clay	🟨	15	Undrained	100		Water Surface	Automatically Calculated	
Clayey Fill	🟧	14	Undrained	100		None		0.15
Clayey sand	🟩	14	Mohr-Coulomb	2	25	Water Surface	Automatically Calculated	

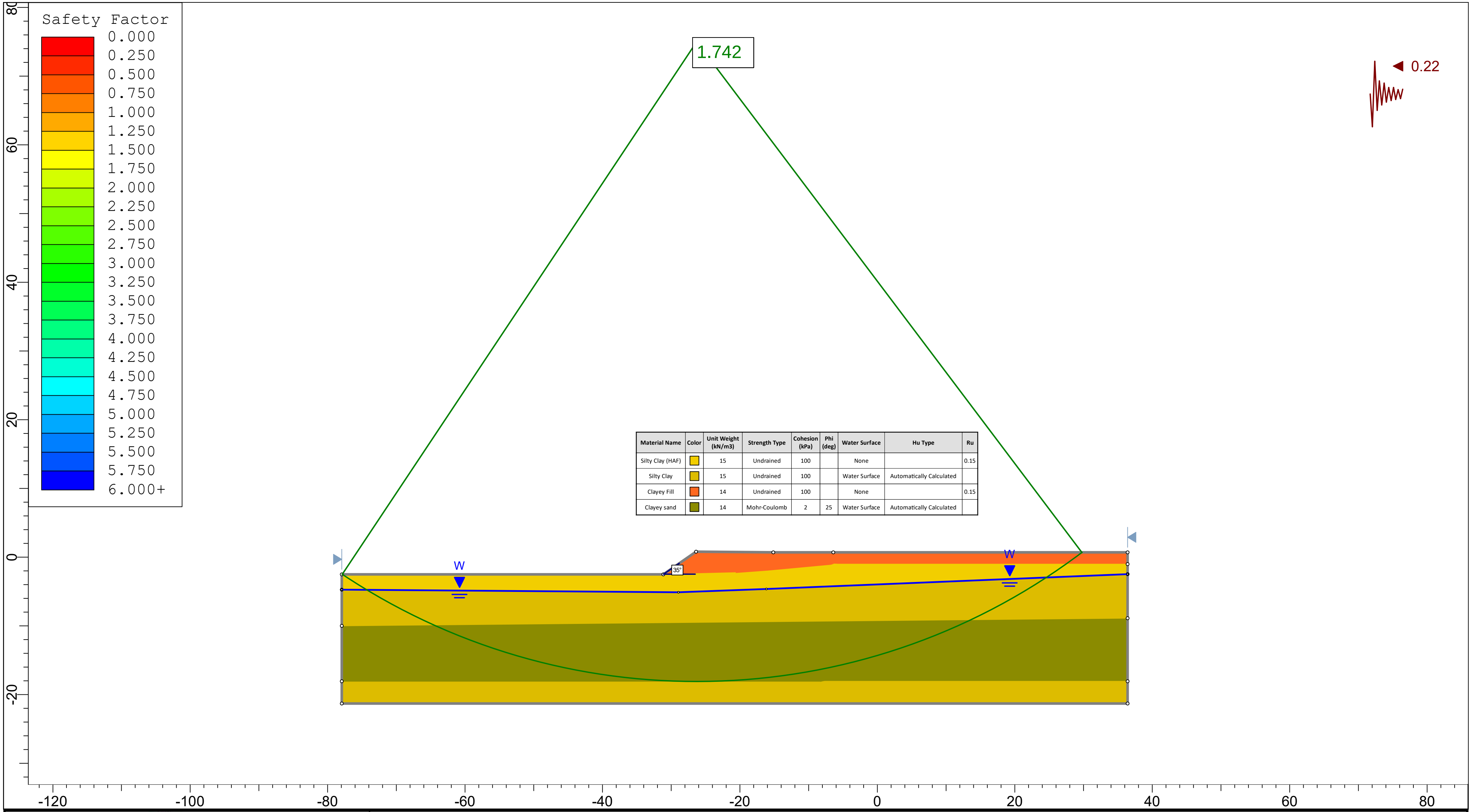
SLIDEINTERPRET 8.028

Project
HD1151 - Cross Section 5

Analysis Description
Undrained - Seismic - Ru0.15 - 30 degrees

Drawn By SSA
Scale 1:750
Company HD Geo

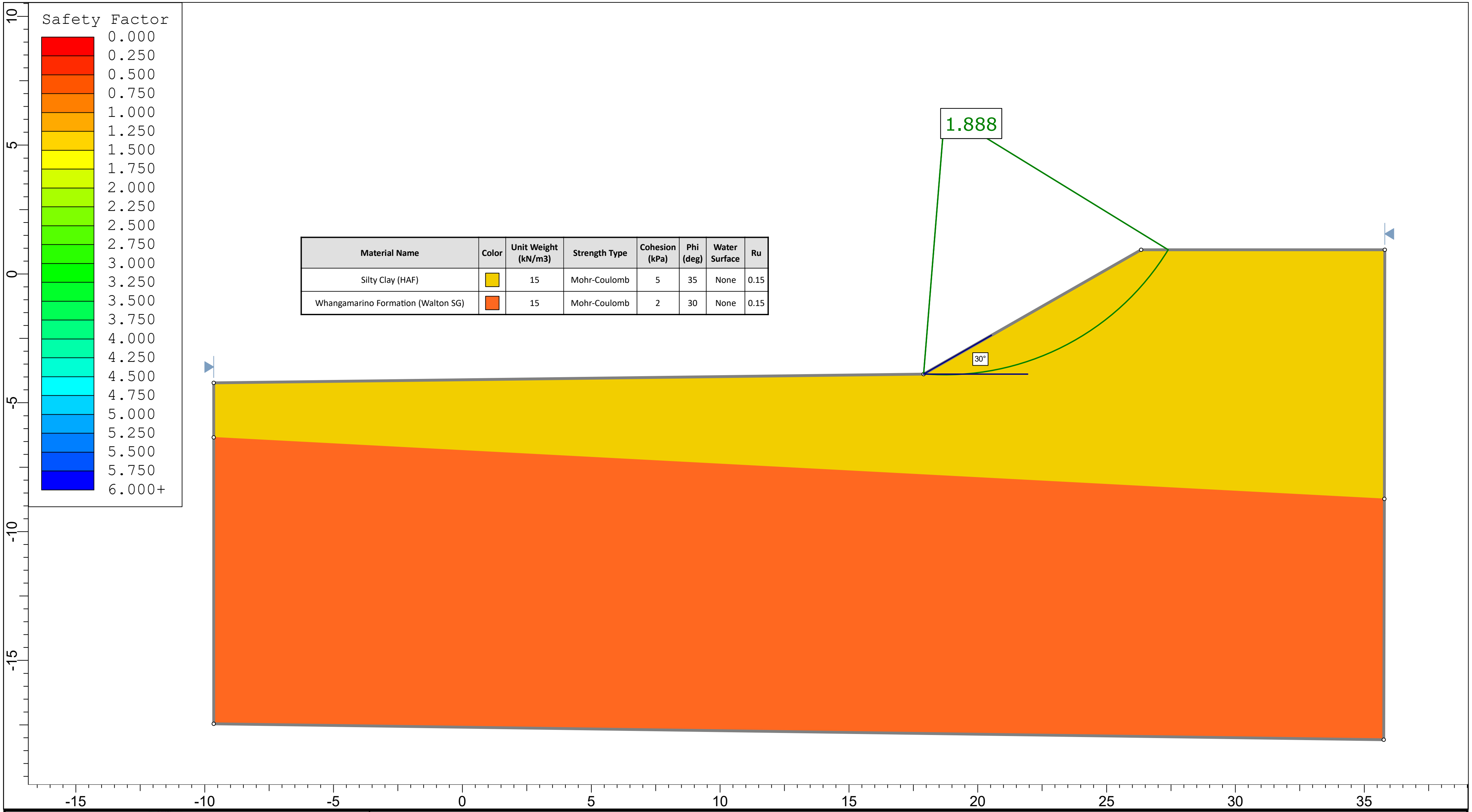
Date 12/4/2019, 3:14:50 PM
File Name HD1151 - Cross section 5 - Seismic - Undrained - Ru0.15 - 30 degrees.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Ru
Silty Clay (HAF)	🟨	15	Undrained	100		None		0.15
Silty Clay	🟨	15	Undrained	100		Water Surface	Automatically Calculated	
Clayey Fill	🟧	14	Undrained	100		None		0.15
Clayey sand	🟫	14	Mohr-Coulomb	2	25	Water Surface	Automatically Calculated	

Project	HD1151 - Cross Section 5
Analysis Description	Undrained - Seismic - Ru0.15 - 35 degrees
Drawn By	SSA
Scale	1:750
Company	HD Geo
Date	12/4/2019, 3:14:50 PM
File Name	HD1151 - Cross section 5 - Seismic - Undrained - Ru0.15 - 34 degrees.slmd

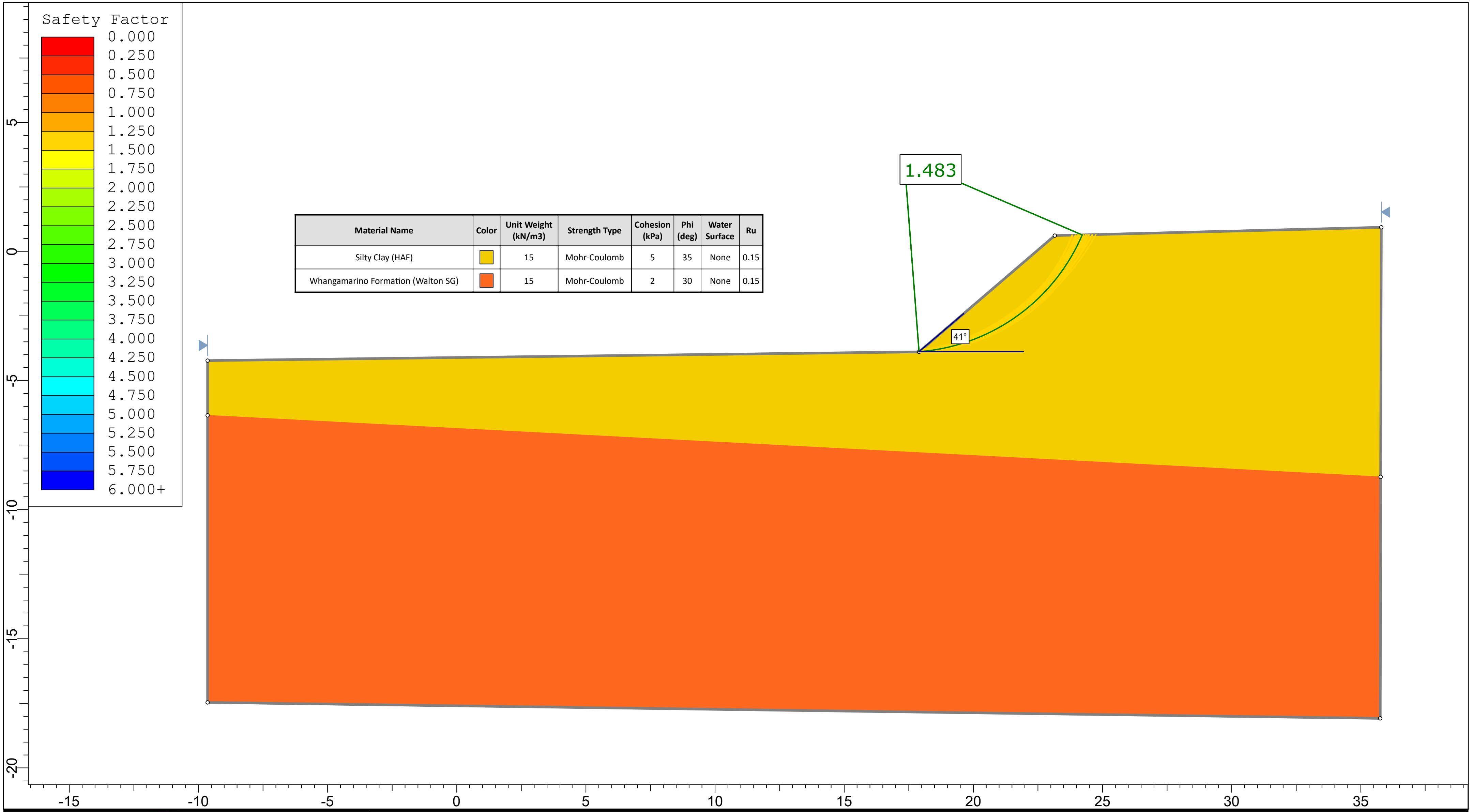
SLIDEINTERPRET 8.028



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Ru
Silty Clay (HAF)	🟨	15	Mohr-Coulomb	5	35	None	0.15
Whangamarino Formation (Walton SG)	🟧	15	Mohr-Coulomb	2	30	None	0.15

SLIDEINTERPRET 8.028

Project	HD1151 - Cross section 6
Analysis Description	Drained - Static - Ru0.15 - 30 degrees
Drawn By	SSA
Scale	1:200
Company	HD Geo
Date	11/12/19
File Name	HD1151 - Cross section 6 - Static Ru0..15.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Ru
Silty Clay (HAF)	🟨	15	Mohr-Coulomb	5	35	None	0.15
Whangamarino Formation (Walton SG)	🟧	15	Mohr-Coulomb	2	30	None	0.15

SLIDEINTERPRET 8.028

Project
HD1151 - Cross section 6

Analysis Description
Drained - Static - Ru0.15 - 41 degrees

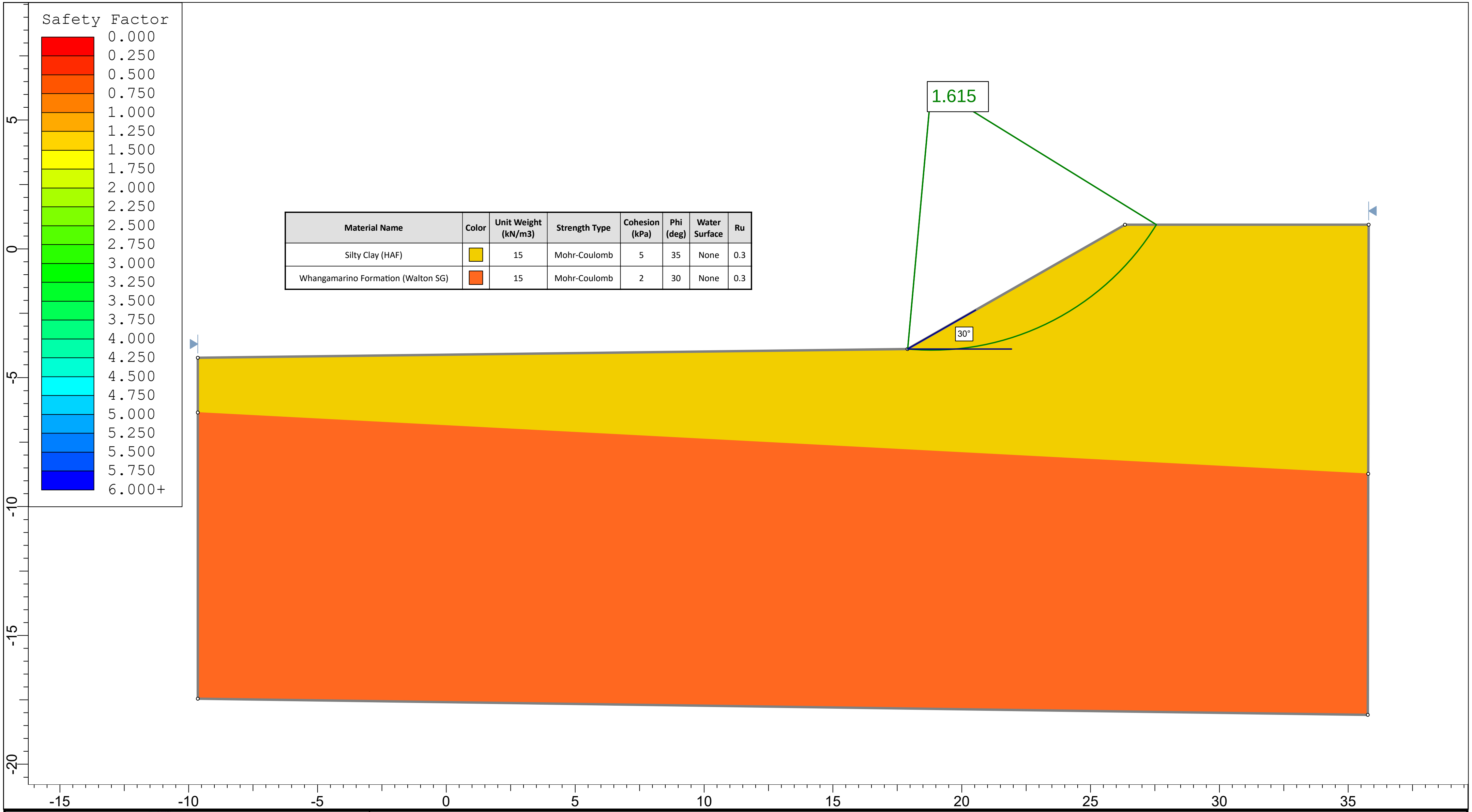
Drawn By SSA

Scale 1:200

Company HD Geo

Date 11/12/19

File Name HD1151 - Cross section 6 - Static Ru0..15.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Ru
Silty Clay (HAF)	🟨	15	Mohr-Coulomb	5	35	None	0.3
Whangamarino Formation (Walton SG)	🟧	15	Mohr-Coulomb	2	30	None	0.3

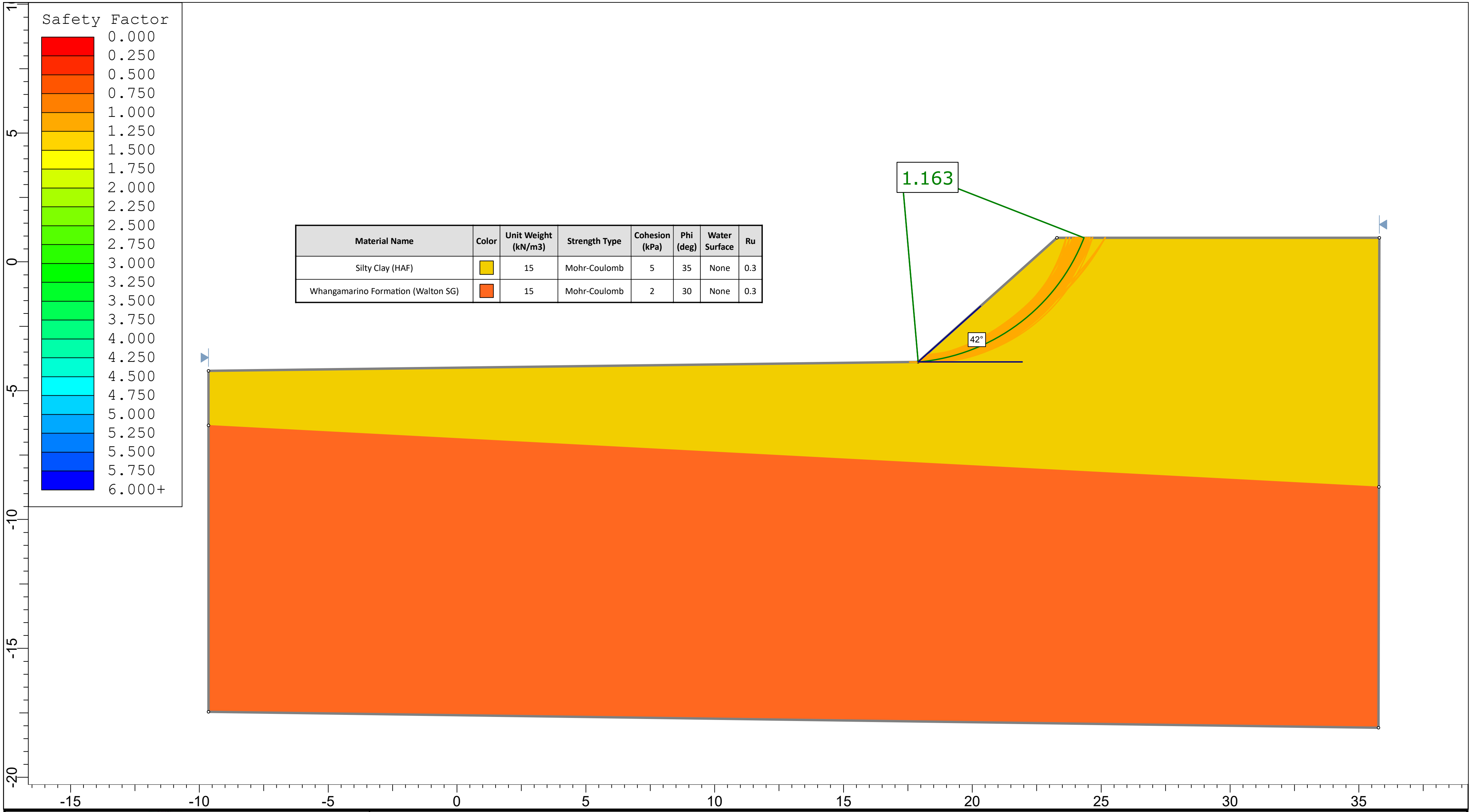
SLIDEINTERPRET 8.028

Project
HD1151 - Cross section 6

Analysis Description
Drained - Elevated GW - Ru0.3 - 30 degrees

Drawn By SSA
Scale 1:200
Company HD Geo

Date 11/12/19
File Name HD1151 - Cross section 6 - Static - Drained - Ru0..3.slmd

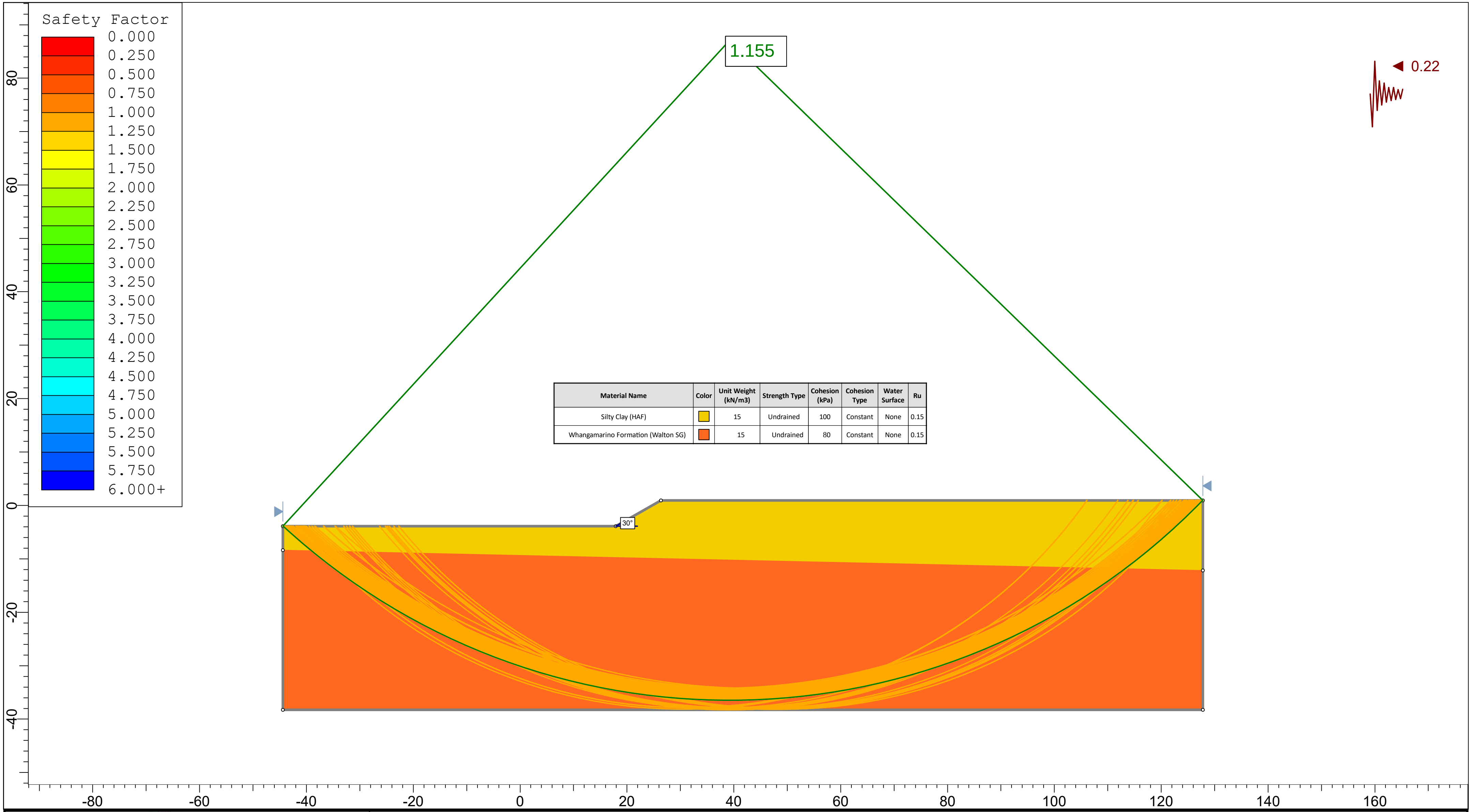


Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Ru
Silty Clay (HAF)	🟨	15	Mohr-Coulomb	5	35	None	0.3
Whangamarino Formation (Walton SG)	🟧	15	Mohr-Coulomb	2	30	None	0.3

Project	HD1151 - Cross section 6		
Analysis Description	Drained - Elevated GW - Ru0.3 - 41 degrees		
Drawn By	SSA	*Scale* 1:200	*Company* HD Geo
Date	11/12/19	*File Name*	HD1151 - Cross section 6 - Static - Drained - Ru0..3.slmd

GEO

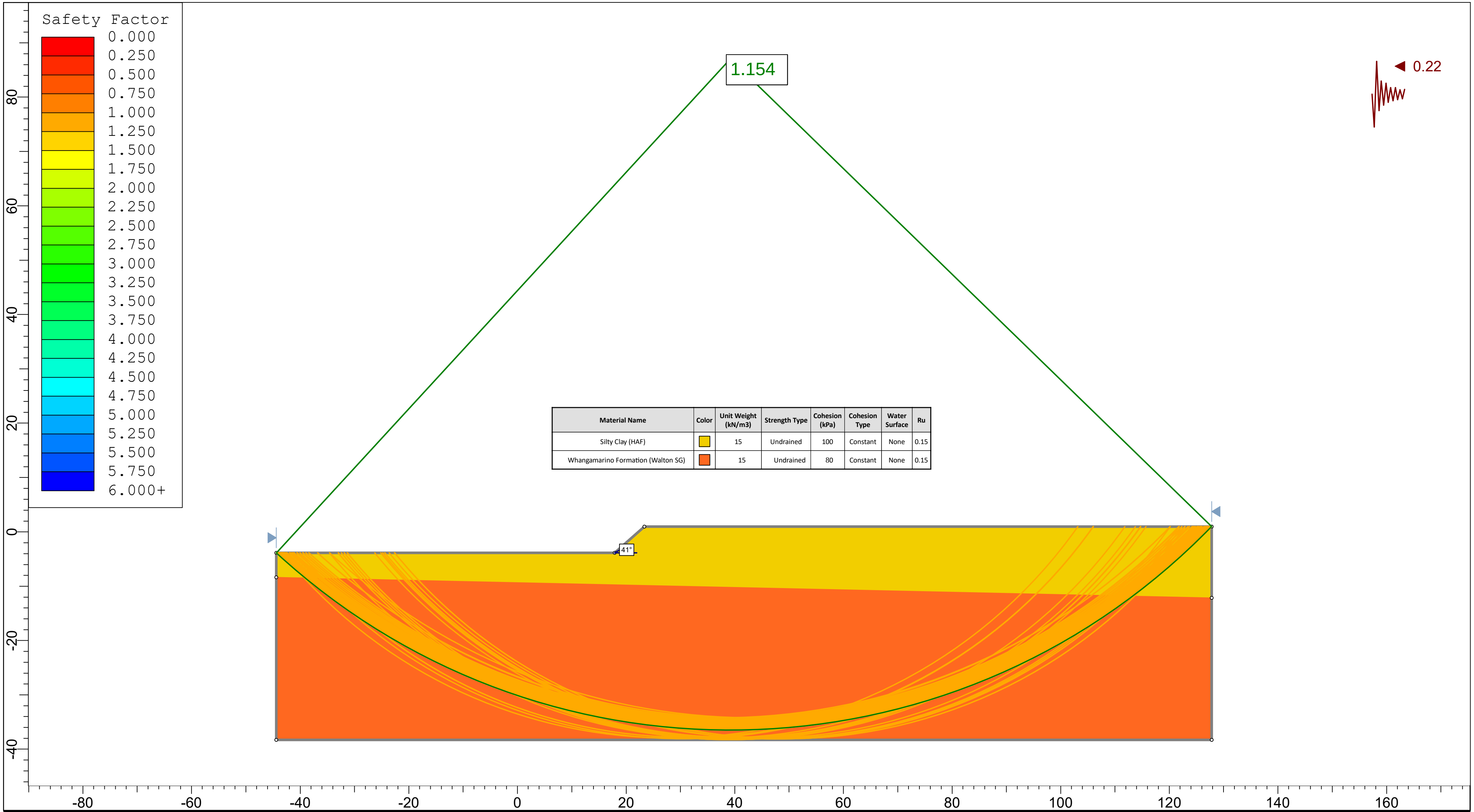
SLIDEINTERPRET 8.028



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Cohesion Type	Water Surface	Ru
Silty Clay (HAF)	🟨	15	Undrained	100	Constant	None	0.15
Whangamarino Formation (Walton SG)	🟧	15	Undrained	80	Constant	None	0.15

Project	HD1151 - Cross section 6		
Analysis Description	Undrained - Seismic - Ru0.15 - 30 degrees		
Drawn By	SSA	*Scale*	1:965
Company	HD Geo		
Date	11/12/19	*File Name*	HD1151 - Cross section 6 - Seismic - Undrained - Ru0..15.slmd

SLIDEINTERPRET 8.028



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Cohesion Type	Water Surface	Ru
Silty Clay (HAF)	🟨	15	Undrained	100	Constant	None	0.15
Whangamarino Formation (Walton SG)	🟧	15	Undrained	80	Constant	None	0.15

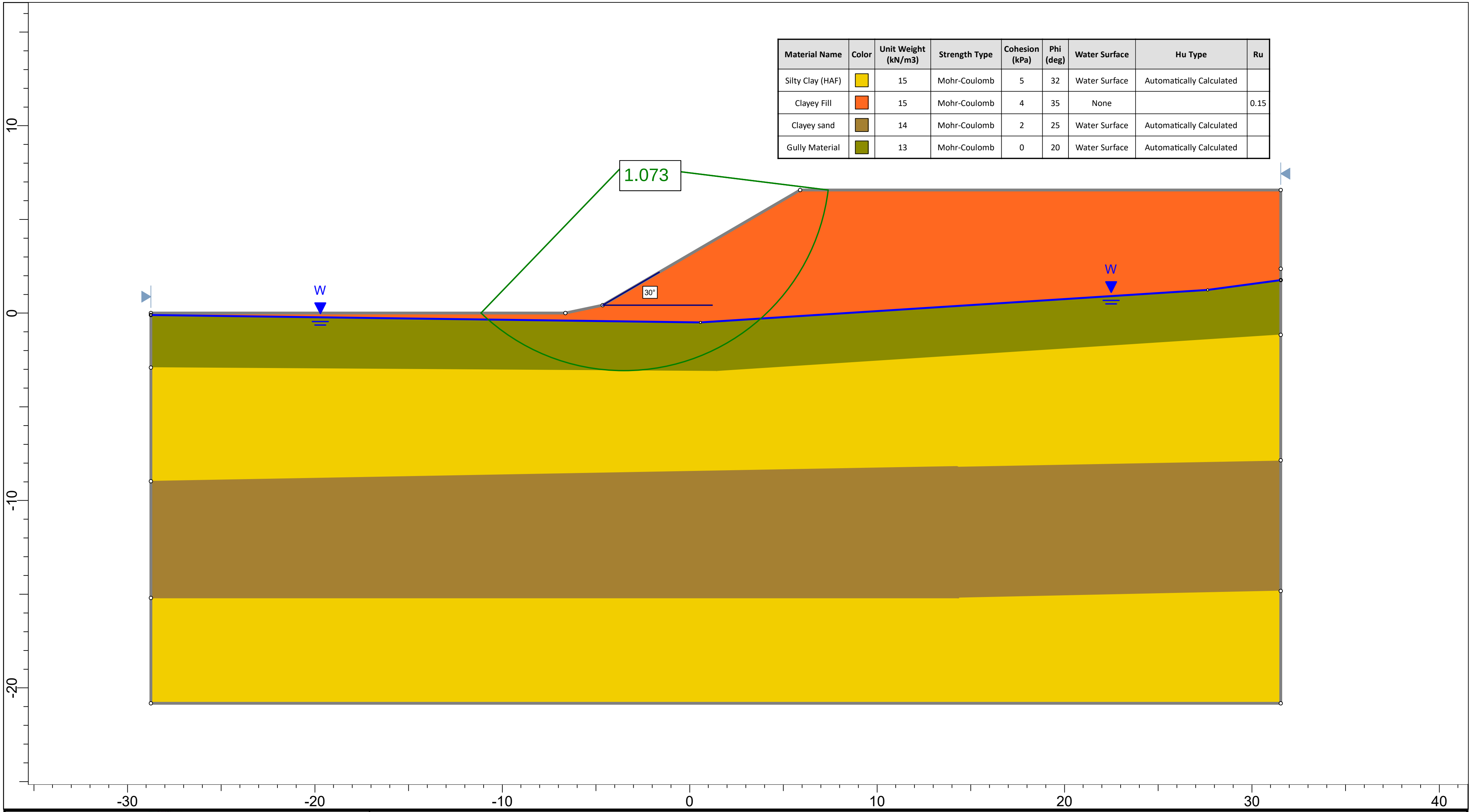
Project
HD1151 - Cross section 6

Analysis Description
Undrained - Seismic - Ru0.15 - 41 degrees

Drawn By SSA
Scale 1:950
Company HD Geo

Date 11/12/19
File Name HD1151 - Cross section 6 - Seismic - Undrained - Ru0.15 - 41 degrees.slmd

SLIDEINTERPRET 8.028



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Ru
Silty Clay (HAF)	🟨	15	Mohr-Coulomb	5	32	Water Surface	Automatically Calculated	
Clayey Fill	🟧	15	Mohr-Coulomb	4	35	None		0.15
Clayey sand	🟫	14	Mohr-Coulomb	2	25	Water Surface	Automatically Calculated	
Gully Material	🟩	13	Mohr-Coulomb	0	20	Water Surface	Automatically Calculated	

Project HD1151 - Critical section slope sitting on gully

Analysis Description Drained - Static - Ru0.15 - 30 degrees

Drawn By SSA

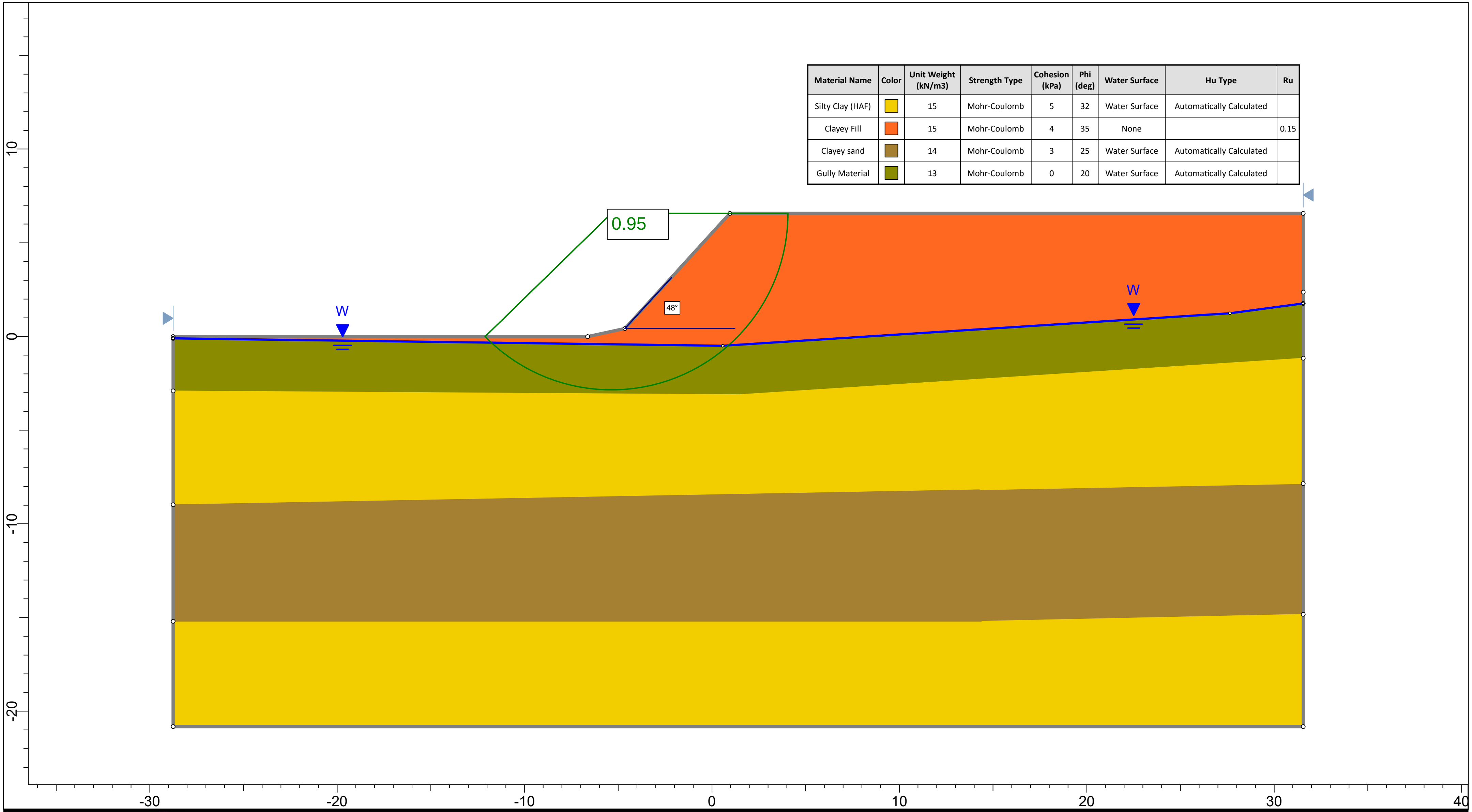
Scale 1:275

Company HD Geo

Date 12/4/2019, 3:01:32 PM

File Name HD1151 - critical section - Static -Drained - Ru0.15 - 30 degrees.slmd

SLIDEINTERPRET 8.028



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Clayey Fill	🟧	15	Mohr-Coulomb	4	35	None		0.15
Clayey sand	🟫	14	Mohr-Coulomb	3	25	Water Surface	Automatically Calculated	
Gully Material	🟩	13	Mohr-Coulomb	0	20	Water Surface	Automatically Calculated	

Project HD1151 - Critical section slope sitting on gully

Analysis Description Drained - Static - Ru0.15 - 48 degrees

Drawn By SSA

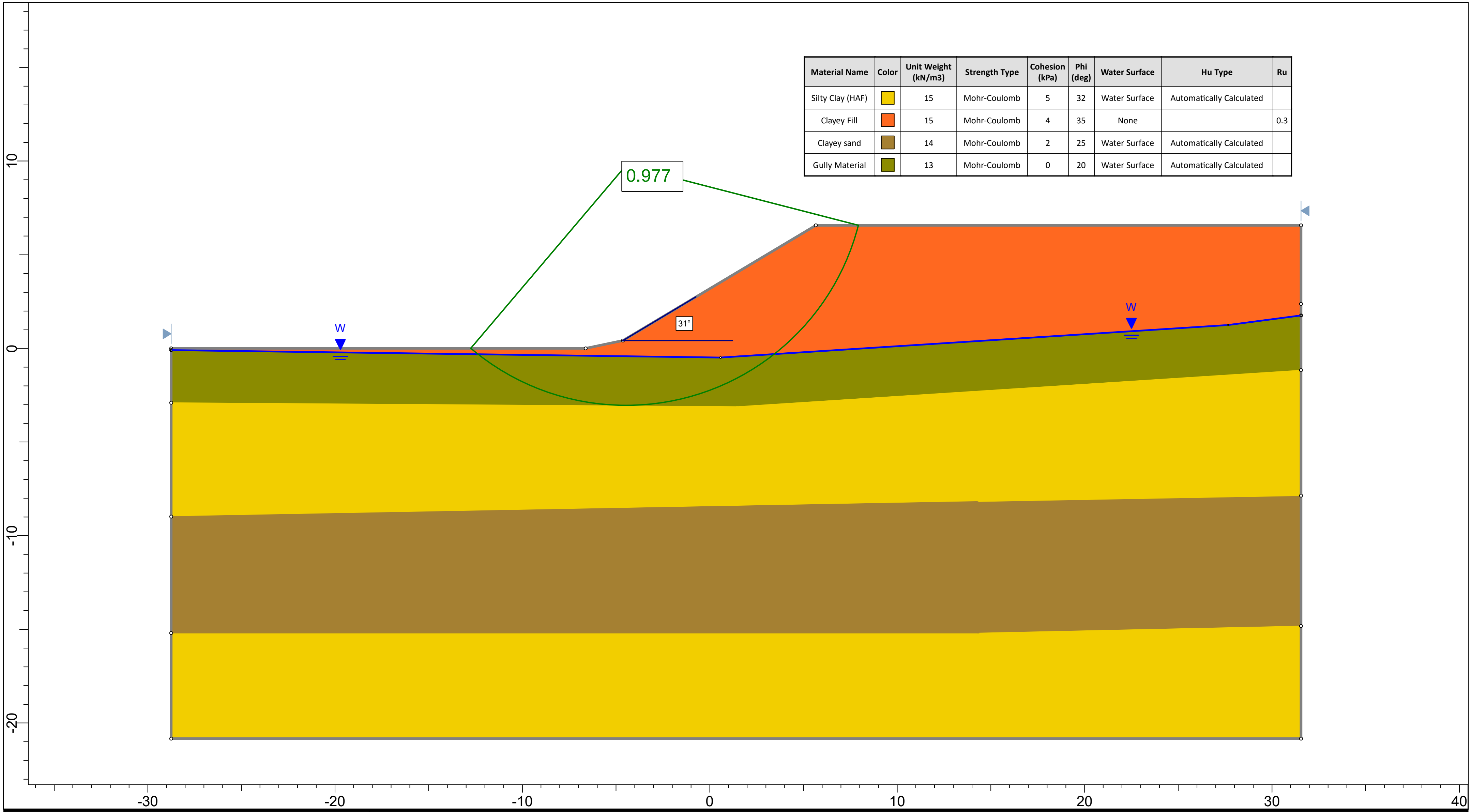
Scale 1:275

Company HD Geo

Date 12/4/2019, 3:01:32 PM

File Name HD1151 - critical section - Static -Drained - Ru0.15 - 48 degrees.slmd

SLIDEINTERPRET 8.028



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Ru
Silty Clay (HAF)	🟨	15	Mohr-Coulomb	5	32	Water Surface	Automatically Calculated	
Clayey Fill	🟧	15	Mohr-Coulomb	4	35	None		0.3
Clayey sand	🟫	14	Mohr-Coulomb	2	25	Water Surface	Automatically Calculated	
Gully Material	🟩	13	Mohr-Coulomb	0	20	Water Surface	Automatically Calculated	

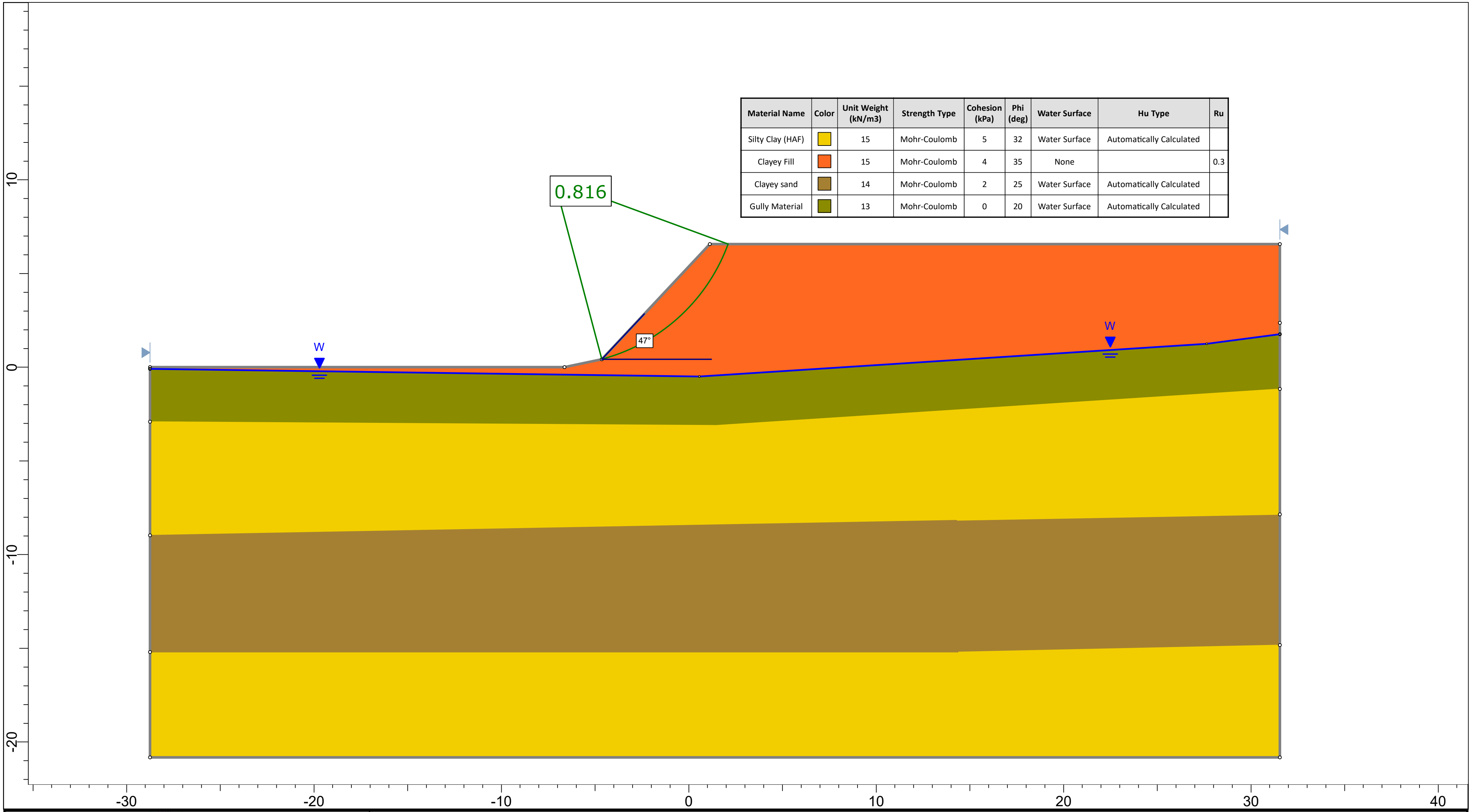
SLIDEINTERPRET 8.028

Project
HD1151 - Critical section sitting on gully

Analysis Description
Drained - Elevated GW - Ru0.3 - 30 degrees

Drawn By SSA
Scale 1:275
Company HD Geo

Date 12/4/2019, 3:01:32 PM
File Name HD1151 - critical section - elevated GW -Drained - Ru0.3 - 30 degrees slmd



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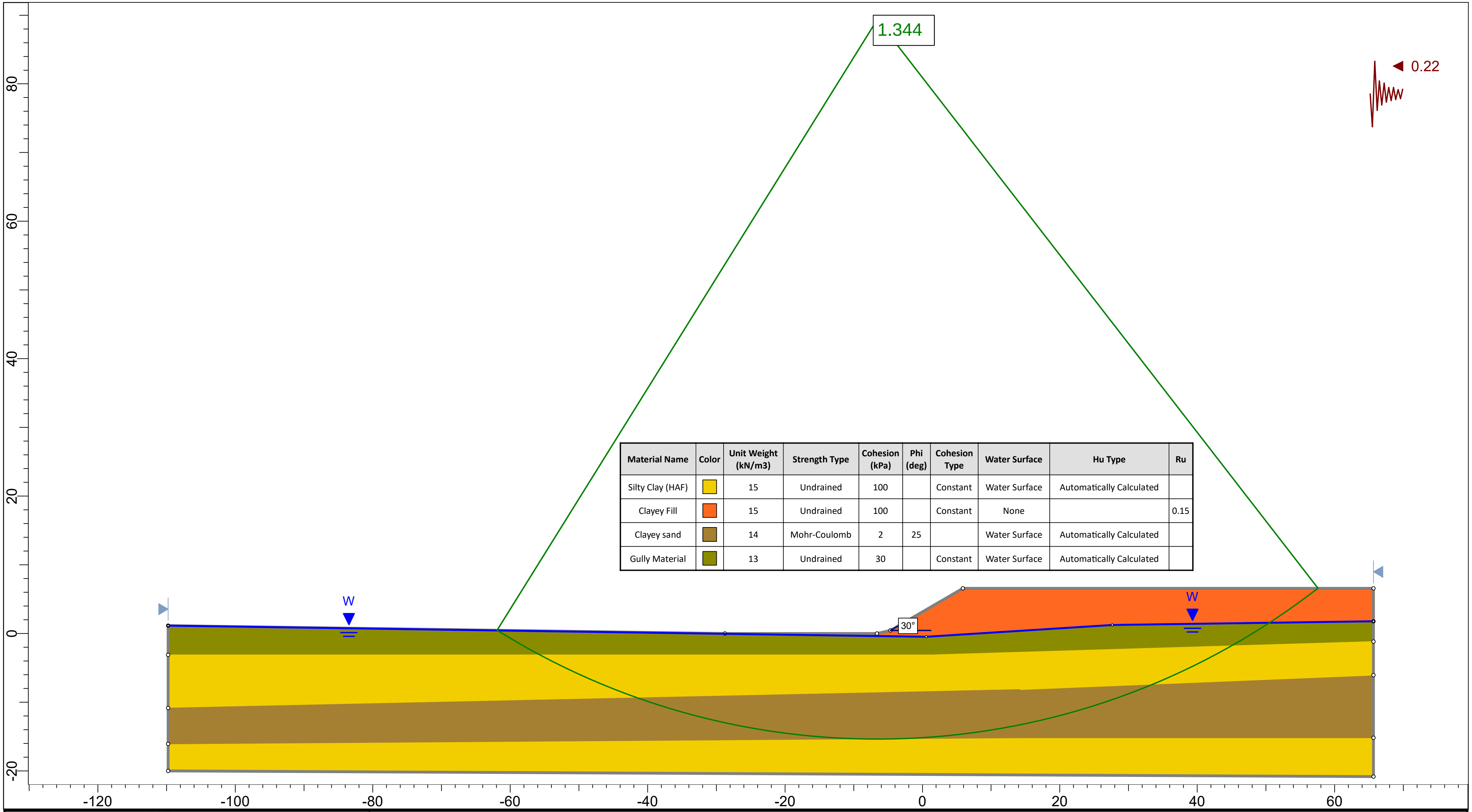
Silty Clay (HAF)	🟨	15	Mohr-Coulomb	5	32	Water Surface	Automatically Calculated	
Clayey Fill	🟧	15	Mohr-Coulomb	4	35	None		0.3
Clayey sand	🟫	14	Mohr-Coulomb	2	25	Water Surface	Automatically Calculated	
Gully Material	🟩	13	Mohr-Coulomb	0	20	Water Surface	Automatically Calculated	

Project	HD1151 - Critical section sitting on gully		
Analysis Description	Drained - Elevated GW - Ru0.3 - 48 degrees		
Drawn By SSA	*Scale* 1:275	*Company*	HD Geo
Date 12/4/2019, 3:01:32 PM		*File Name*	HD1151 - critical section - elevated GW -Drained - Ru0.3 - 48 degrees.slmd

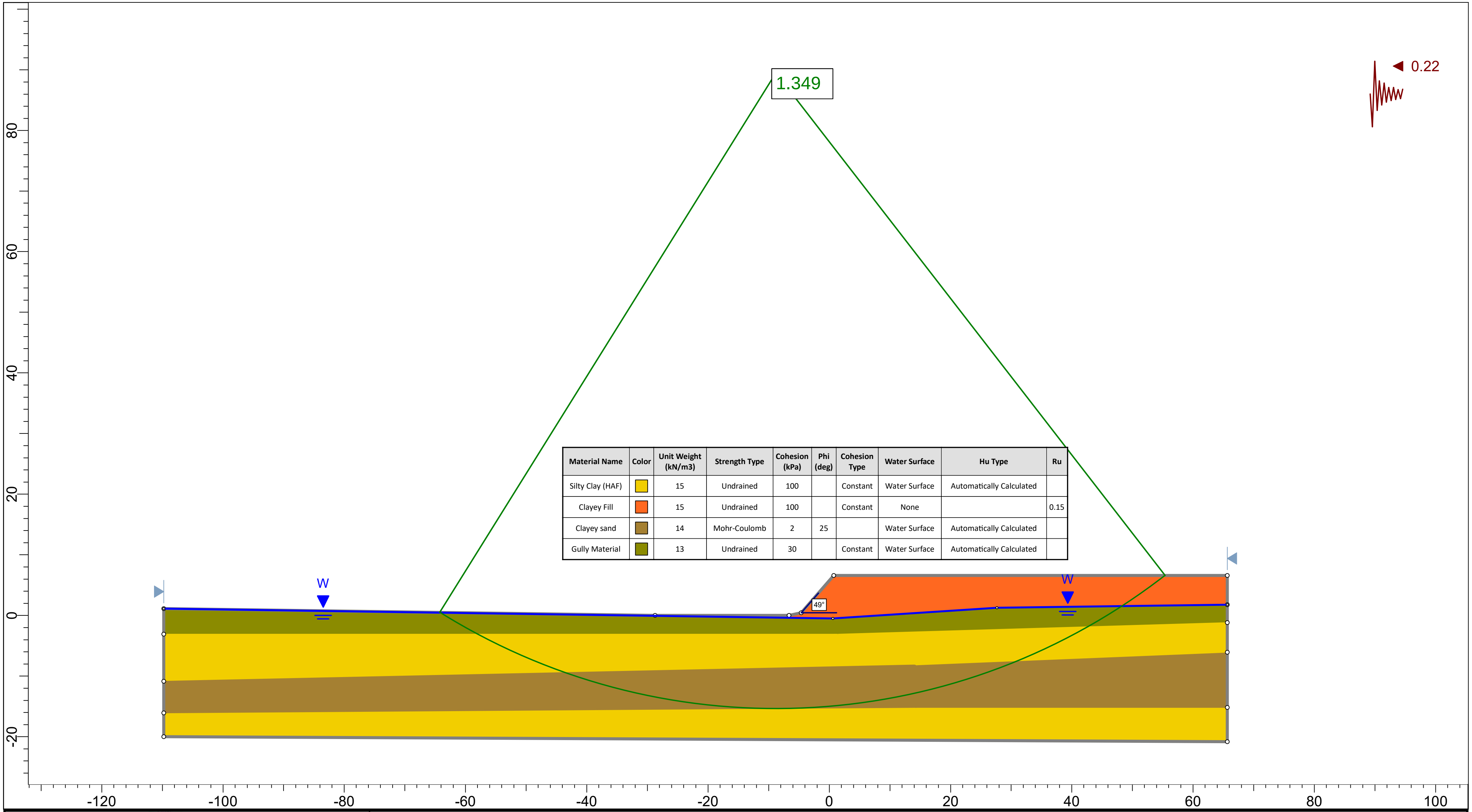
SLIDEINTERPRET 8.028



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Water Surface	Hu Type	Ru
Silty Clay (HAF)	🟨	15	Undrained	100		Constant	Water Surface	Automatically Calculated	
Clayey Fill	🟧	15	Undrained	100		Constant	None		0.15
Clayey sand	🟫	14	Mohr-Coulomb	2	25		Water Surface	Automatically Calculated	
Gully Material	🟩	13	Undrained	30		Constant	Water Surface	Automatically Calculated	

Project	HD1151 - Critical section sitting on gully
Analysis Description	Undrained - Seismic - Ru0.15 - 30 degrees
Drawn By	SSA
Scale	1:750
Company	HD Geo
Date	12/4/2019, 3:01:32 PM
File Name	HD1151 - critical section - seismic -Undrained - Ru0.15 - 30 degrees.slmd

SLIDEINTERPRET 8.028



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Water Surface	Hu Type	Ru
Silty Clay (HAF)	🟨	15	Undrained	100		Constant	Water Surface	Automatically Calculated	
Clayey Fill	🟧	15	Undrained	100		Constant	None		0.15
Clayey sand	🟫	14	Mohr-Coulomb	2	25		Water Surface	Automatically Calculated	
Gully Material	🟩	13	Undrained	30		Constant	Water Surface	Automatically Calculated	

SLIDEINTERPRET 8.028

Project
HD1151 - Critical section sitting on gully

Analysis Description
Undrained - Seismic - Ru0.15 - 48 degrees

Drawn By SSA
Scale 1:850
Company HD Geo

Date 12/4/2019, 3:01:32 PM
File Name HD1151 - critical section - seismic -Undrained - Ru0.15 - 48 degrees.slmd

Exhibit F: Western Wetland Geotech Review

26 London Street
Hamilton 3204
PO Box 9266
Hamilton 3240
New Zealand
64 (0)7 957 2727

16 AUGUST 2019

Te Kauwhata Land Ltd

c/- Ian McAlley

Email: ian.mcalley@mcalleygroup.co.nz

HD356 – Wayside Road – Geotechnical review of stormwater wetland

Dear Ian,

I have undertaken a high level review of the stormwater wetland plans for Te Kauwhata Land's proposed subdivision on Wayside Road, Te Kauwhata. Based on my review, there are unlikely to be significant changes needed following detailed design due to geotechnical considerations. Any changes I see as likely should be able to be accommodated within the current footprint without impacting on safety or storage.

The plans I have reviewed are from Wainui Environmental and included:

- Bragato Way Wetland Concept Plan (WE1713-01-750 Rev E)
- Bragato Way Wetland Concept Cross Sections (WE1713-01-310 Rev D)

During detailed design of the wetland, the following geotechnical design tasks will be needed:

- Slope stability assessment
- Retaining wall design (3 walls shown, max 3m high, differing geometries and surcharge situations)
- Details for the dam bund
- Details for penetrations (outlet and inlet pipe)
- Input to need for liner and/or liner details[1]

Please let me know if you have any questions.
Kind regards,

ANDREW HOLLAND, CPENG
Technical Director, Principal Engineer
Andrew@hdgeo.co.nz
Tel 022 048 8441

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[1] *The need for a liner will be governed by ground conditions and summer and winter water tables. Determination of the need (or not) for a liner is best undertaken at detailed design phase when all applicable information is available.*

Exhibit G: Remediation Action Plan

Blue Wallace Surveyors Limited

24 Wayside Road Development - Remediation Action Plan

Blue Wallace Surveyors Limited

24 Wayside Road Development - Remediation Action Plan

Prepared By

Ken Read
Principal Engineering Geologist

Reviewed By

Debbie Dewar
Environmental Scientist

Opus International Consultants Ltd
Hamilton Office
Opus House, Princes Street
Private Bag 3057, Waikato Mail Centre,
Hamilton 3240
New Zealand

Telephone: +64 7 838 9344
Facsimile: +64 7 838 9324

Date: 18 Augustl 2016
Reference: 3-38720.01/04GEO
Status: Final

Contents

Executive Summary

Opus International Consultants has been engaged by Blue Wallace Surveyors Limited (Blue Wallace) to undertake contaminated land investigations, and prepare an Environmental Site Assessment (ESA) and Remediation Action Plan (RAP) for the Wayside Road Development, Te Kauwhata by Te Kauwhata Land Limited (TKL) development.

The proposed development will comprise the subdivision of the site into approximately 130 residential lots of approximately 800 m^2 each. New road and stormwater infrastructure will be constructed which will tie in with the existing local infrastructure and services. Copies of proposed earthworks and development plans at the time of preparing this RAP are presented in Appendix A. The site has a history of pastoral use and since 1963 for use in growing vines for grape juice production.

Previous sampling by Contaminated Site Investigation Ltd (CSI) had shown elevated concentrations of arsenic in soils immediately adjacent to CCA treated posts within the vineyard area. Opus collected additional soil samples with the aim of delineating the arsenic concentrations in soils associated with the posts. The results from these samples have shown arsenic concentrations dramatically decrease away from the posts (both vertically and laterally~~).~~

Based on the combined results we consider that arsenic leaching from the posts is confined to soil immediately adjacent to the posts.

The main identified exposure pathways within the proposed subdivision would be produce consumption from arsenic contaminated soil, and to maintenance and excavation workers from ingestion/inhalation from soil.

We therefore propose to achieve an acceptable level of arsenic in the topsoil by soil mixing/blending to 'dilute' any localised arsenic locations to an acceptable level.

The proposed remedial strategy is to reduce concentrations of arsenic by blending/mixing the topsoil in the areas of the site with a history of vine growing which is effectively the majority of the site.

In the area around the stockyards, for the concrete pad associated with chemical storage, soils from around the perimeter of the pad will be removed to landfill and the remaining soils tested to determine arsenic, copper and zinc levels are below our target levels.

Wooden structures in the stockyard area will also be removed with immediately adjacent soil excavated and removed to landfill, with selected locations to be validated for arsenic.

Validation sampling of the general vineyard area will be carried out and will consist of sampling topsoil stockpiles and placed topsoil on an individual section basis after completion of the earthworks.

1 Introduction

Opus International Consultants has been engaged by Blue Wallace Surveyors Limited (Blue Wallace) to undertake contaminated land investigations, and prepare an Environmental Site Assessment (ESA) and Remediation Action Plan (RAP) for the Wayside Road Development, Te Kauwhata by Te Kauwhata Land Limited (TKL) development.

The proposed development will comprise the subdivision of the site into approximately 130 residential lots of approximately 800 m^2 each. New road and stormwater infrastructure will be constructed which will tie in with the existing local infrastructure and services. Copies of proposed earthworks and development plans at the time of preparing this RAP are presented in Appendix A.

The site has a history of pastoral use and since 1963 for use in growing vines for grape juice production.

2 Site Identification

The site is located approximately 1.8 km northeast of the Waikato River, 950 m north of Lake Kopuera and approximately 1.5 km west of the Te Kauwhata Township. The surrounding areas consist of farmland and lifestyle properties (Figure 1).

Figure 1: Close up of site showing neighbouring properties

A summary of the site details is provided in Table 1 below.

Table 1 – Site Details

Item	Site Detail
Site Address	24 Wayside Road, Te Kauwhata
Legal Description	LOT 2 DP 385781
VRNs	04390/714/02
Approximate total site area	17 ha
Territorial Authority	Waikato District Council
District Plan Zoning	Residential
Current Site Use	Currently awaiting development
Adjoining Sites Uses	Residential, rural residential and pastoral

3 Site History

The history of the site is described in more detail in the ESA[1]. Previous investigations have also been undertaken by others (Groundwater and Environmental Services[2] (GES) and Contaminated Site Investigations[3] (CSI)) and this report should be read in conjunction with all previous reports.

In summary the site has a long history of vine cultivation originally starting in the west and progressively extending eastwards. The current site usage is vines in the west and pasture in the east. The whole of the site appears to have been used at some time for the growing of vines.

4 Site Condition and Surrounding Environment

The site is dominated by a north to south trending ridgeline in the centre of the site. This ridgeline is the dominant feature of the development area, with slopes either side of the ridge reaching maximum slopes of 15-30 degrees.

In the western half of the site ground level falls from Wayside Road and the central ridge to form a north facing valley which 'ends' in a wetland/pond on the northern site boundary.

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[1] Opus, 2016. Additional Environmental Site Assessment – 24 Wayside Road. Prepared for Blue Wallace Surveyors, dated April 2016

[2] GES, 2007. Environmental Assessment – Proposed Lot 2 – 16 Wayside Road, Te Kauwhata. Prepared for Silverstone Capital Limited, dated 19 June 2007.

[3] CSI, 2016. Detailed Site Investigation – 24 Wayside Road, Te Kauwhata. Prepared for Te Kauwhata Land Limited, dated 25 January 2016.

In the eastern half of the site the ground level predominately slopes to the east from the ridge and towards the north from the southern boundary forming a hollow with a wetland again on the northern boundary.

There are areas of soil creep on the steeper slopes adjacent to the site, on the north eastern face of the ridgeline. The lower parts of the basins contain low lying boggy areas with the start of small streams.

There was a spring noted on the western side of the site. This was possibly created by surface run off from the adjacent processing buildings, which has caused small scale localised surface creep of the soil.

Neighbouring properties at the time of the investigation were predominately rural land use, lifestyle blocks to the north and pasture to the south. Property adjacent to the north east boundary is being subdivided and developed for domestic housing.

5 Geology and Hydrogeology

5.1 Soils

The 1:250,000 and 1:63,360 scale geological maps[4] show the site to be underlain by pumiceous clays with lignite, gravel, and some pure pumice silt and sand from Pliocene epoch.

These soils are volcanic in origin and deposited as alluvium with interbedded peat materials and are part of the Whangamarino and Puketoka Formations.

Ground investigations by Opus[5] and others[6] have proved the site to be underlain by interbedded clayey silt/silty clay and sandy soils with varying proportions of silt in them.

On the hill sides and ridgeline the topsoil is underlain by low permability clay rich soils. In the vallyes the topsoil is underlain by thick silt rich soils which we expect to have a low to intermedate permeability.

5.2 Ground and Surface Water

Groundwater was not encountered in any of the trial pits or hand auger holes along the ridgeline.

Interpretation of the site investigation data indicates groundwater potentially ranging from 6 m to 16 m depth below ground level.

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[4] Edbrooke, S.W. (compiler) 2001: Geology of the Auckland Area. Institute of Geological and Nuclear Sciences 1:250,000 geological map 3. 1 sheet + 74p. Lower Hutt, New Zealand. Institute of Geological and Nuclear Sciences Limited.
Kear, D, Schofield, J.C, N52 Te Kauwhata (1st Edition) Geological Map of New Zealand, 1:63,360, Department of Scientific and Industrial Research. Wellington, New Zealand.

[5] Te Kauwhata Land Development Ltd, Development Stages 1,2,3A Slope Stability and Earthworks Design Report. Opus Geotechnical Report 16/003 Dated 4/ 03/2016

[6] Preliminary Geotechnical Appraisal on Proposed Residential Development at Lot 2 (DP 385781) Wayside Road, Te Kauwhata, Coffey Geotechnics (NZ) Ltd, Project no 13453, dated July 2007.

This variability of groundwater level may indicate perched water tables within the soil profile, one of which may also be the source of the spring on the eastern face of the ridgeline. Groundwater levels will fluctuate seasonally.

The primary surface water features on the site are two ponds and wetland areas on the northern site boundary at the bottom of two wide valleys.

6 Contaminants of Concern

The site has had a number of phases of contamination investigation undertaken by different consultants and practitioners (GES and CSI, refer to Section 3 for more information).

The sampling and testing undertaken has been targeted at known contaminants associated with the sites historic land use for vine growing, that is pesticides (e.g. organochlorine pesticides) and metals/metalloids associated with pesticides (copper, lead, arsenic), wood treatment (arsenic possibly leaching from the posts supporting the vines and within the stockyard and facial eczema treatment for cattle (zinc).

Generally, investigations undertaken to date did not identify elevated metal/metalloid or pesticide concentrations within the general vineyard area (including the area that has been converted to pastoral land). One composite sample (sample A) collected by CSI exceeded the NES standard (20 mg/kg) for arsenic (40 mg/kg) with respect to the proposed residential land use. The exceedance in this sample is thought to include a core from adjacent to a CCA treated post (Guy Sowry, *pers. comm.*).

Investigations undertaken by CSI show soil samples collected from immediately adjacent to CCA treated posts have elevated arsenic concentrations.

Based on the results of the testing to date we consider that arsenic is the sole contaminant of concern on this site in relation to the vineyard area.

The CSI investigation also identified elevated arsenic, copper and zinc associated with the stockyard area which also includes a chemical storage area and chemical disposal area. Soil samples collected by CSI adjacent to CCA treated posts within the stockyard area also reported elevated arsenic concentrations.

Opus collected additional soil samples with the aim of delineating the arsenic concentrations in the soils at a range of locations and in relation to the different kinds of posts present (strainer posts, ‘half round’ posts) and in both the older and younger parts of the vineyard.

These samples have shown arsenic concentrations dramatically decrease away from the posts (both vertically and laterally). Overall the natural arsenic concentrations at the site appear to be relatively low, typically less than 6 mg/kg in the sub soil and typically less than 15 mg/kg in topsoil samples.

Based on the combined results we consider that arsenic leaching from the posts is relatively confined to soil immediately adjacent to the posts (within 100 mm). Of the 173 samples Opus collected, only three were above the SGVs for arsenic under the proposed residential land use.

The main identified exposure pathways within the proposed subdivision would likely to be produce consumption from arsenic contaminated soil, maintenance and excavation workers and ingestion/inhalation from soil (chronic risk).

7 Basis for selected Soil Contaminant Standards

The site is to be developed for domestic housing.

7.1 Whole Site

We have adopted a maximum value of 20 mg/kg for arsenic based on the NES[7] Soil Contaminant Standard (SCS) for residential land use with 10% produce consumption.

7.2 Stock yard area

The NES SCS for copper is >10,000 mg/kg (non limiting) and does not have criteria for zinc. Therefore, additional criteria have been selected following the hierarchy laid out in the Ministry for the Environment's Guideline documentation[8].

We have adopted the Canadian Soil Quality Guideline[9] values with respect to a residential/parkland land use (both human health and ecological protection) which are:

- 63 mg/kg for copper
- 200 mg/kg for zinc

8 Remedial Goals

Our remedial goals are:

- To excavate, mix and blend the topsoil in areas historically used for vine growing so as to achieve a 'product' that has arsenic concentrations consistently below, or at most equal to, 20 mg/kg so that the soils can be retained on site and re-used for the domestic properties proposed.

- To excavate all topsoil and subsoils with arsenic, copper and zinc concentrations above our selected SGVs from around the concrete pad in the stockyard area and remove them to a suitably consented landfill site. Leaving this part of the site in an acceptable condition for domestic housing.

---

[7] National Environmental Standard for Assessing and Managing Contaminants in Soil to Manage Human Health.

[8] Ministry for the Environment, 2003 (revised 2011). Contaminated land management guidelines No. 2: Hierarchy and application in New Zealand of environmental guideline values.

[9] Canadian Council of Ministers of the Environment, 1999. Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health.

9 Remediation Philosophy

9.1 Vine Areas Past and Present

We consider the primary source of the arsenic contamination on the site to be leaching of wood treatment preservatives from the posts and strainers supporting wires that support the vines.

These posts and strainers will be removed as part of the general site clearance.

Initial testing of 22 topsoil samples within 200 mm of fence posts by CSI recorded significantly above the proposed SCS (between 2 and 11 times higher than the proposed SCS). In conversation the author of the CSI report confirmed that these samples were taken from immediately adjacent to the posts and not within 200 mm as reported (Guy Sowry, *pers.comm*.).

Repeat testing by Opus did not obtain similar values of those. From 30 samples taken from within 200 mm of posts only three samples exceeded the proposed SCS, with two values of 25 mg/kg and one of 39mg/kg obtained.

Opus test data compares well to the wide area sampling undertaken by GES and CSI across the vineyard general area and suggests that the CSI test results collected adjacent to CCA treated posts are unrepresentative of the general site conditions (Ref Opus ESA report).

We therefore propose to achieve the desired levels of arsenic in the topsoil by soil mixing/blending to ‘dilute’ any localised arsenic locations to an acceptable level. In doing so we have taken cognisance of guidelines for remediation of contaminated land by soil mixing prepared for Hawkes Bay Regional Council[10].

We note these guidelines recommend this methodology does not allow for sites with hotspots and also that maximum concentrations should be less than twice the target SCS. We consider the proposed mixing methodology is still appropriate for this site, as the natural background levels of the site are very low and the hotpots are minor (less than 200 mm wide) and are not representative over the vast majority of the site.

The elevated arsenic levels (identified predominantly by CSI in immediate vicinity of the posts) are typically all within topsoil.

Following discussion with an earthmoving contractor the topsoil is considered to be of a texture ideal for mixing as is it expected to be relatively easy to homogenise.

Depending on when the works are undertaken, some consideration will need to be given to the moisture content of the soils as it is not recommended to mix the soils when they are wet or saturated.

Given most of the topsoil will be stripped and stockpiled for levelling of the site, we expect that mixing works of stockpiled soils can be delayed until there is a more suitable moisture content within the soil.

---

[10] Guideline for Remediation of Contaminated Land by Soil Mixing, Pattle Delamore Partners Ltd, October 2015.

Topsoil and subsoils will not be mixed together and will be treated separately for mixing purposes and also to allow for topsoil to be reused for the proposed residential land use.

We note the underlying subsoil will be slightly harder to fully homogenise based on soil type (typically clayey silts), but do not consider this to be of potential risk based on the very few elevated arsenic levels in the subsoil. With filing of the site much of the near surface subsoils that will be excavated are to be placed at depth in fills and are unlikely to come into contact with residents under a typical residential land use scenario.

Based on the majority of the elevated arsenic levels being identified within topsoil, we do not consider that depth to groundwater will impact on the proposed methodology.

Our proposed methodology for topsoil mixing is a combination of in-situ and ex-situ blending.

Testing of subsoils below the posts and strainers in the vine growing areas has consistently found levels of arsenic below the selected SCS. Over much of the site the subsoil will be excavated and used as fill to create the desired ground profiles. By the nature of this operation soils that are excavated as near surface soils tend to be placed at the base of fills. However to give added confidence we propose to mix and blend the upper 500mm of subsoils before placing as fill.

We have considered alternative methodologies, such as removal of all contaminated hotspots to landfill. We consider this is impractical based on the very small volume of soil that reports elevated arsenic concentrations and the overall risk to human health. (A conservative estimate would be less than 0.03 m^3 per fence post).

We consider that mixing of the soil is the most appropriate response and expect that if some soils should not be able to be sufficiently homogenised, this will be noted during the work and the the sampling of the stockpiles. Further mixing can then be carried out if necessary.

As it is proposed to sample and test each proposed residential lot individually (as described further in Section 10) we consider that this will provide a suitable ‘safeguard’ for the overall risk to human health and the environment.

9.2 Stockyard area

Investigation and testing of soils on the 4 corners of the concrete pad in stockyard has found significantly elevated levels of arsenic above the selected SCS for residential land use. Copper and zinc concentrations were also elevated in this area.

We believe these to be limited in area to the immediate perimeter of the pad and therefore propose to excavate and remove to landfill those soils with contaminant levels above our proposed SGV from the vicinity of the pad.

Soil samples collected adjacent to two fence posts by CSI also reported elevated arsenic concentrations in soil (141 mg/kg and 1630 mg/kg respectively). Based on our delineation regarding arsenic leaching from the posts within the vineyard area, we consider this likely to be localised but conservatively propose to remove all wooden structures from within the stockyard area and remove to landfill soils immediately adjacent to any wooden structures.

All excavation works would be followed by validation sampling to ensure the area was fully remediated for residential land use.

10 Proposed Remedial Works

10.1 Vine Areas Past and Present

Proposed procedure

Topsoil strip and storage

1. Remove all vines, vegetation and posts.

2. Use earthworks discs to rip up the topsoil, this will be carried out in at least 2 different directions to get a good mix and rip of the soil and grass.

3. Use power harrows to further mix/blend the topsoil – these are like a rotary hoe but spin around horizontally whereas rotary hoe works vertically.

4. Uplift topsoil to stockpile using conventional earthworks plant, ensuring that the topsoil gets further mixed during the pickup from the ground to the stockpile.

Underlying subsoils: Once the topsoil is removed

5. Use the rippers on a dozer to rip up the soil.

6. Use the earthworks disc to further breakup and blend the soil – likely 2-3 passes at different angles to best achieve this.

7. Uplift the soil from the ground with earthworks plant.

8. Lay the fill out and re-disc and then compact using the large (long) sheep foot type feet on the earthworks roller

9. On completion at final level repeat insitu blending of surface soils or remove to landfill as necessary following results of verification testing.

Topsoil re-spread

10. Utilising the earthworks plant - take a layer off the stockpile and re-spread over sections/lots in layers.

11. Use the power harrows to do a further mix of all topsoil prior planting/sowing of grass.

12. Repeat insitu blending of top soils or remove to landfill as necessary following results of verification testing.

10.2 Stockyard Area

Proposed procedure

1. Clear site of all associated structures and above ground features.
2. Break up concrete and hard surfacing and remove to landfill.
3. Excavate and remove to landfill all topsoil and 300 mm depth of subsoil for a 2 m strip around the perimeter of the concrete pad. Excavate and remove to landfill all soil within 200 mm of soil that was in contact with CCA treated posts.
4. Repeat/extend excavation and removal as necessary following results of verification testing.

11 Proposed Monitoring and Validation Testing

11.1 Vine Areas Past and Present

11.1.1 Proposed Validation Testing - Topsoil

We propose two phases of validation testing:

1. Phase 1 – Stockpile sampling and testing for total recoverable arsenic concentrations.

   We propose to obtain and test one topsoil sample per 100 m^3 of topsoil stockpiled. Where possible these samples will be obtained during stockpile creation. If we are unable to do so samples will be obtained from within the stockpile once formed.

   This testing is intended to give an early indication of the adequacy of the initial mixing/blending. The test results will be assessed to determine if, or what level of, further mixing/blending is required to ensure remediation targets are achieved.

   We note that should a stockpile not be able to be mixed sufficiently enough to meet the prescribed SCS, we may be able to consider placement of this material within sections of roads and associated berms, as this would only need to meet the recreational land use assessment criteria. This approach will need to be discussed and agreed with WDC and WRC prior to being undertaken. This approach would only be considered if the sample results were below the recreational land use SCS.

- Phase 2 – Post placement testing of topsoil on a section by section basis

  We propose to obtain and test one topsoil sample per section. This testing is intended to verify the adequacy of overall mixing/blending process.

  If a sample fails to meet the specified SCS then depending upon the test result a decision will be made to either repeat the blending procedure insitu and re-test the soil, or remove the topsoil to landfill.

  As only one sample per property is proposed, we do not consider using 95% upper confidence limits to demonstrate compliance with the relevant SCSs. The exception to this may be in the stockyard areas, where multiple samples will likely be collected from one or two proposed lots, potentially allowing for statistical analysis. We do not anticipate using statistical analysis for across multiple lots in relation to elevated arsenic results from treated timber.

11.1.2 Proposed Validation Testing - subsoil

We propose one phase of validation testing of the subsoil.

We propose to obtain and test one subsoil sample per section for arsenic analysis. This testing is intended to verify the level of arsenic in the sub soil at each location.

If a sample fails to meet the specified SCS then depending upon the test result a decision will be made to either repeat the blending procedure insitu and re-test the soil, or remove 150 mm of the sub soil to landfill and replace with suitable material.

11.1.3 Proposed Validation Testing – Stockyard

We propose one phase of validation testing of the stockyard area.

We propose to obtain and test ten samples associated with the concrete pad (topsoil and subsoil) and analyse these samples for arsenic, copper and zinc. Selected locations associated with CCA treated posts and building structures will be analysed for arsenic.

If a sample fails to meet the specified SCS then further excavation and validation testing will be undertaken.

12 Assessment of Environmental Effects

12.1 Dust

The earthworks will generate areas of bare silty soils with the potential to create a dust hazard.

The potential contamination is largely within the topsoil which we expect to be root bound and damp during excavation and placement limiting the potential for offsite migration of contaminants by windblown dust.

Wind intensity will be considered during the works and the effects of vehicle movement monitored. Water sprays will be applied if a dust nuisance occurs.

12.2 Odour

We do not anticipate any odour issues arising from the work.

12.3 Sediment Controls

Erosion and sediment controls will be implemented throughout the works in accordance with WRC guidance and recommendations and in accordance with any site specific earthworks consent conditions.

Sediment collecting in sedimentation ponds will be tested or Arsenic prior to disposal or spreading on site.

13 Conclusions

The various investigations on the site have identified arsenic at concentrations that are likely to pose a risk to future residential occupants, although it is noted that these concentrations are localised in nature associated with CCA treated posts.

The proposed remedial strategy is to reduce concentrations of arsenic by blending/mixing the topsoil in the areas of the site with a history of vine growing.

In the area around the stockyards, for the concrete pad associated with chemical storage, soils from around the perimeter of the pad will be removed to landfill and the remaining soils tested to determine arsenic, copper and zinc levels are below our target levels. Wooden structures in the stockyard area will also be removed with immediately adjacent soil excavated and removed to landfill, with selected locations to be analysed for arsenic.

Validation sampling of the general vineyard area will be carried out and will consist of sampling topsoil stockpiles and placed topsoil on an individual section basis after completion of the earthworks.

14 Recommendations

We recommend that this RAP is submitted to both WDC and WRC for approval.

At the completion of the works, a soil validation report should be submitted to both WDC and WRC for approval and appropriate reclassification of the site on their Land Use Information Register(s).

15 Limitations

This RAP has been produced on behalf of Blue Wallace Surveyors Limited and no responsibility is accepted to any third party for all or any part. This report should not be relied upon or transferred to any other parties without the express written authorisation of Opus. If any unauthorised third party comes into possession of this report, they rely on it at their own risk and the authors owe them no duty of care or skill. This report should only be reproduced in full.

This RAP has been prepared for a specific purpose, as agreed between Opus and the Client. A tailored scope of works has been used to achieve the objectives, and the report should therefore not be used for different objectives.

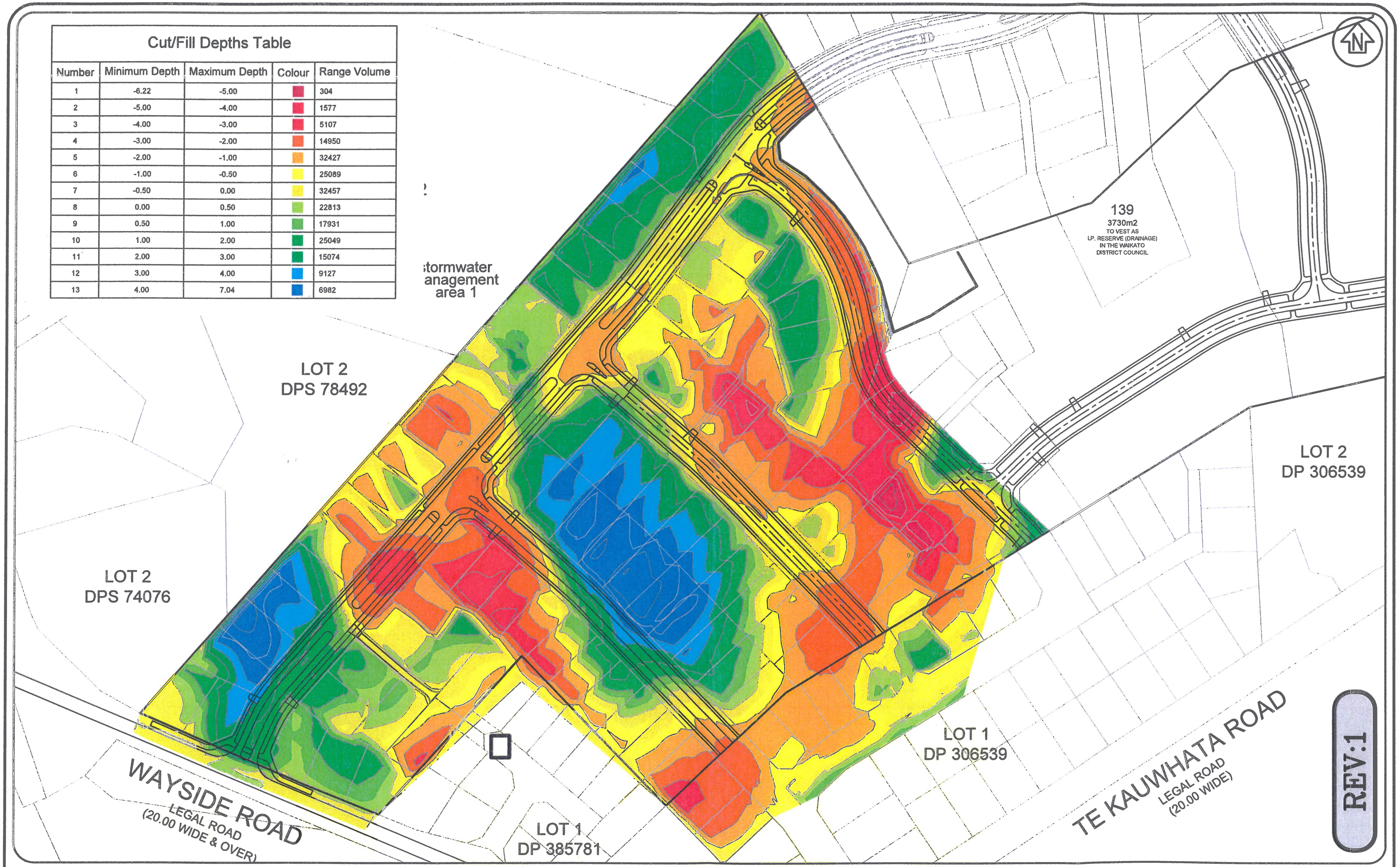
This RAP has been prepared by Opus with all reasonable skill and care within the terms of the Contract with the Client, and taking account of the information made available by the Client, as well as the staff and resources devoted to it by agreement with the Client. The findings and opinions conveyed via this report are based on information obtained from a variety of sources, as detailed, which Opus believes are reliable. Nevertheless, Opus cannot and does not guarantee the authenticity or reliability of any information supplied by other parties.

The characterisation of site conditions is an interpretation of information collected during assessment, in accordance with industry practice. Should further data be obtained that differs from that presented in this report, then conclusions and recommendations may no longer be valid.

The report is valid at the date of release. The condition of the site may change with time so that the results and interpretation are no longer valid. In addition, guidelines and legislation may change, making assessment of results and recommendations invalid.

Appendix A

Proposed Earthworks and Development Plans



Cut/Fill Depths Table

Number	Minimum Depth	Maximum Depth	Colour	Range Volume
1	-6.22	-5.00	🟥	304
2	-5.00	-4.00	🟥	1577
3	-4.00	-3.00	🟥	5107
4	-3.00	-2.00	🟧	14950
5	-2.00	-1.00	🟧	32427
6	-1.00	-0.50	🟨	25089
7	-0.50	0.00	🟨	32457
8	0.00	0.50	🟩	22813
9	0.50	1.00	🟩	17931
10	1.00	2.00	🟩	25049
11	2.00	3.00	🟩	15074
12	3.00	4.00	🟦	9127
13	4.00	7.04	🟦	6982

SCALE: 1:2000 @A3, 1:1000 @A1 DATE: JANUARY 2015

No.	Amendment	Init.	Date.	
				Designed. SM
1	For ENG Approval	SM	12/15	Drawn. SM 14 JAN 2015
2				Checked.
3				Approved.

S:\2014\14012 - SILVERSPUR\CAD\ENGINEERING\14012 ROADING AND GRADING DESIGN REV 1.DWG

PROPOSED ENGINEERING WORKS - STAGE 1 - 3A
PROPOSED CUT & FILL DESIGN

Firm's Name

Blue Wallace
Surveyors Ltd.
25 Harwood Street, P O Box 38,
Hamilton Central, HAMILTON.
Phone (07) 839 7799, Fax (07) 839 4455

File Reference
14/012

Drawing No.
14012-EN-1-203-1

Opus International Consultants Ltd
Opus House, Princes Street
Private Bag 3057, Waikato Mail Centre,
Hamilton 3240
New Zealand

t: +64 7 838 9344
f: +64 7 838 9324
w: www.opus.co.nz

Exhibit H: Site Validation Report

Te Kauwhata Land Limited

24 Wayside Road Interim Soil Validation Report

Contaminated Land Assessment

Te Kauwhata Land Limited

24 Wayside Road Interim Soil Validation Report

Contaminated Land Assessment

Prepared By

Debbie Dewar
Senior Environmental Scientist

Reviewed By

Ken Read
Principal Engineering Geologist

Opus International Consultants Ltd
Hamilton Office
Opus House, Princes Street
Private Bag 3057, Waikato Mail Centre,
Hamilton 3240
New Zealand

Telephone: +64 7 838 9344
Facsimile: +64 7 838 9324

Date: 3 April 2017
Reference: 2-32713.00
Status: Draft 2

Contents

Executive Summary

The proposed development at 24 Wayside Road, Te Kauwhata will comprise the subdivision of the site into approximately 130 residential lots of approximately 800 m^2 each. New road and stormwater infrastructure will be constructed which will tie in with the existing local infrastructure and services.

The site has a history of pastoral use and since 1963 has been used as a vineyard.

Vine cultivation originally started in the west and progressively extended eastwards. The site usage at the time of initial investigations was vines in the west and pasture in the east. The whole of the site appeared to have been used at some time for the growing of vines.

Through several phases of investigation elevated arsenic concentrations were identified in soils immediately adjacent to the treated timber poles used for supporting the vines. Metals contamination was also observed in soils adjacent to former stockyards in the southern part of the site.

The agreed remediation works to make the soils for domestic residential development has comprised mixing and blending topsoil and subsoil to create an acceptable materials to be retained on site.

A soil guideline value (SGV) for Arsenic of 20mg/kg was agreed and has been adopted throughout the works for verification testing.

Topsoil in the development area has been excavated mixed and blended by Shick Construction to an agreed methodology. A total of 335 samples were then obtained by Opus from stockpiles of the blended and mixed topsoil. This is approximately one sample per 100 m3 of topsoil.

With one exception all test results were below the agreed SGV. The area (200 m^3) around where that sample was collected was remixed/blended, sampled and retested. Test results from the re-mixed soils were below the selected SGV.

We therefore consider that the treated soil is acceptable for use on the residential development.

As there is a surplus of topsoil on the site offsite disposal of remediated topsoil to the adjacent Rangiriri Section of the Waikato Expressway was agreed and has been carried out.

Verification testing soils in the area former stockyards where excavation and offsite disposal to landfill is the remedial action will reported on separately.

Final confirmation/validation testing of blended/mixed topsoil placed on individual development sections on completion of the earthworks will also be reported on separately.

1 Introduction

Opus International Consultants Limited (Opus) was commissioned by Blue Wallace Surveyors Limited (Blue Wallace) on behalf of Te Kauwhata Land Limited (TKL) to prepare a Remediation Action Plan[1] (RAP) for a proposed residential subdivision at 24 Wayside Road, Te Kauwhata (the "site"). The current legal description for the site is Lot 2 DP 385781.

After preparation and issue of the RAP it was revised[2] to cover offsite disposal of remediated and validated soils to the Rangiriri Section of the Waikato Expressway. Recording of the final location of these the soils within the Rangiriri Section was the responsibility of Fletcher Construction Ltd.

Opus have since been commissioned by TKL directly to undertake soil validation sampling at the site, in accordance with the revised RAP and to prepare this Interim Soil Validation Report.

The proposed development will comprise the subdivision of the site into approximately 130 residential lots of approximately 800 m^2 each. New road and stormwater infrastructure will be constructed which will tie in with the existing local infrastructure and services.

The site has a history of pastoral use and since 1963 has been used as a vineyard.

The history of the site is described in more detail in the Opus Environmental Site Assessment (ESA)[3]. Previous investigations have also been undertaken by others (Groundwater and Environmental Services[4] (GES) and Contaminated Site Investigations[5] (CSI)) and this report should be read in conjunction with those previous reports.

In summary the site has a long history of vine cultivation originally starting in the west and progressively extending eastwards. The site usage at the time of the ESA was vines in the west and pasture in the east. The whole of the site appeared to have been used at some time for the growing of vines.

Elevated arsenic concentrations were identified in soils immediately adjacent to the treated timber poles used for supporting the vines.

Metals contamination was observed in soils adjacent to former stockyards in the southern part of the site.

---

[1] Opus, 2016. 24 Wayside Road Development – Remediation Action Plan. Prepared for Blue Wallace Surveyors, dated 18 August 2016.

[2] Opus, 2016. 27 Wayside Road Development – Remediation Action Plan (Rev 3). Prepared for Te Kauwhata Land Limited, dated 1 December 2016.

[3] Opus, 2016. Additional Environmental Site Assessment – 24 Wayside Road. Prepared for Blue Wallace Surveyors, dated April 2016

[4] GES, 2007. Environmental Assessment – Proposed Lot 2 – 16 Wayside Road, Te Kauwhata. Prepared for Silverstone Capital Limited, dated 19 June 2007.

[5] CSI, 2016. Detailed Site Investigation – 24 Wayside Road, Te Kauwhata. Prepared for Te Kauwhata Land Limited, dated 25 January 2016.

2 Scope of Works

As described in the RAP, the scope of remedial works was in three stages.

Stage 1: The area around the stockyards and a concrete pad was to be remediated by excavation and removal of contaminated soils to an appropriately consented landfill with soil validation being undertaken following remedial works.

Stage 2: The remainder of the site, was identified to have very small arsenic 'hotspots' associated with the treated timber posts and we proposed remediation by mixing and blending the topsoils with verification sampling and the subsoil also to be mixed and blended but with no validation sampling.

Stage 3: The third stage will be addressed once the subdivision is finalised, when individual validation samples are proposed for each lot.

This interim report only addresses the soil mixing aspect of the RAP (Stage 2), the stockyard area will be addressed in a separate document.

The individual lot sampling will be carried out at the end of the earthworks once individual properties have been surveyed.

3 Site Identification

The site is located approximately 1.8 km northeast of the Waikato River, 950 m north of Lake Kopuera and approximately 1.5 km west of the Te Kauwhata Township. The surrounding areas consist of farmland and lifestyle properties (Figure 1).

Figure 1: Close up of site showing neighbouring properties

A summary of the site details is provided in Table 1 below.

Table 1 – Site Details

Item	Site Detail
Site Address	24 Wayside Road, Te Kauwhata
Legal Description	LOT 2 DP 385781
VRNs	04390/714/02
Approximate total site area	17 ha
Territorial Authority	Waikato District Council
District Plan Zoning	Residential
Current Site Use	Currently awaiting development
Adjoining Sites Uses	Residential, rural residential and pastoral

4 Site Condition and Surrounding Environment

The site is dominated by a north to south trending ridgeline in the centre of the site. This ridgeline is the dominant feature of the development area, with slopes either side of the ridge reaching maximum slopes of 15-30 degrees.

In the western half of the site ground level falls from Wayside Road and the central ridge to form a north facing valley which 'ends' in a wetland/pond on the northern site boundary.

In the eastern half of the site the ground level predominately slopes to the east from the ridge and towards the north from the southern boundary forming a hollow with a wetland again on the northern boundary.

There are areas of soil creep on the steeper slopes adjacent to the site, on the north eastern face of the ridgeline. The lower parts of the basins contain low lying boggy areas with the start of small streams.

There was a spring noted on the western side of the site. This was possibly created by surface run off from the adjacent processing buildings, which has caused small scale localised surface creep of the soil.

Neighbouring properties at the time of the investigation were predominately rural land use, lifestyle blocks to the north and pasture to the south. Property adjacent to the north east boundary is being subdivided and developed for domestic housing.

5 Contaminants of Concern

The site has had a number of phases of contamination investigation undertaken by different consultants and practitioners (GES and CSI, refer to Section 3 for more information).

The sampling and testing undertaken has been targeted at known contaminants associated with the sites historic land use for vine growing, that is pesticides (e.g. organochlorine pesticides) and metals/metalloids associated with pesticides (copper, lead, arsenic), wood treatment (arsenic possibly leaching from the posts supporting the vines and within the stockyard and facial eczema treatment for cattle (zinc).

Generally, investigations undertaken to date did not identify elevated metal/metalloid or pesticide concentrations within the general vineyard area (including the area that has been converted to pastoral land). One composite sample (sample A) collected by CSI exceeded the NES standard (20 mg/kg) for arsenic (40 mg/kg) with respect to the proposed residential land use. The exceedance in this sample is thought to include a core from adjacent to a CCA treated post (Guy Sowry, *pers. comm.*).

Investigations undertaken by CSI show soil samples collected from immediately adjacent to CCA treated posts have elevated arsenic concentrations.

Based on the results of the testing to date we consider that arsenic is the sole contaminant of concern on this site in relation to the vineyard area.

The CSI investigation also identified elevated arsenic, copper and zinc associated with the stockyard area which also includes a chemical storage area and chemical disposal area. Soil samples collected by CSI adjacent to CCA treated posts within the stockyard area also reported elevated arsenic concentrations.

Opus collected additional soil samples with the aim of delineating the arsenic concentrations in the soils at a range of locations and in relation to the different kinds of posts present (strainer posts, ‘half round’ posts) and in both the older and younger parts of the vineyard.

These samples have shown arsenic concentrations dramatically decrease away from the posts (both vertically and laterally). Overall the natural arsenic concentrations at the site appear to be relatively low, typically less than 6 mg/kg in the sub soil and typically less than 15 mg/kg in topsoil samples.

Based on the combined results we considered that arsenic leaching from the posts was relatively confined to soil immediately adjacent to the posts (within 100 mm). Of the 173 samples Opus collected, only three were above the SGVs for arsenic under the proposed residential land use.

The main identified exposure pathways within the proposed subdivision would likely to be produce consumption from arsenic contaminated soil, maintenance and excavation workers and ingestion/inhalation from soil (chronic risk).

6 Basis for selected Soil Contaminant Standards

The site is to be developed for domestic housing.

For the soil mixing and blending action in Stage 2 we have adopted a maximum value of 20 mg/kg for arsenic based on the NES[6] Soil Contaminant Standard (SCS) for residential land use with 10% produce consumption.

7 Remedial Goals

Our remedial goals for the wider vineyard site were:

- To excavate, mix and blend the topsoil in areas historically used for vine growing so as to achieve a 'product' that has arsenic concentrations consistently below, or at most equal to, 20 mg/kg so that the soils can be retained on site and re-used for the domestic properties proposed.
- The majority of the soil has been proposed to be relocated to the Rangiriri Section of the Waikato Expressway (25,000 m3 of an estimated 33,000 m3). The balance of topsoil will be retained on site.

8 Remedial Actions

This is the first phase of remediation carried out for the proposed residential subdivision.

The other phases (the stockyards area and the final validation of the individual lots at completion) will be reported separately.

This phase covers the soil mixing of both the topsoil and the subsoil.

The works were undertaken in accordance with the RAP by Schick Civil Construction (Schick).

The following procedures were undertaken by Schick.

Topsoil strip and storage

1. Removal of all vines, vegetation and posts.
2. Used earthworks discs to rip up the topsoil, this was be carried out in at least 2 different directions to get a good mix and rip of the soil and grass.
3. Used power harrows to further mix/blend the topsoil – these are like a rotary hoe but spin around horizontally whereas rotary hoe works vertically.
4. Uplift topsoil to stockpile using conventional earthworks plant, ensuring that the topsoil gets further mixed during the pickup from the ground to the stockpile.

---

[6] National Environmental Standard for Assessing and Managing Contaminants in Soil to Manage Human Health.

Underlying subsoils: Once the topsoil was removed

5. Use the rippers on a dozer to rip up the soil.

6. Use the earthworks disc to further breakup and blend the soil – using 2-3 passes at different angles to best achieve this.

7. Uplift the soil from the ground with earthworks plant.

8. Lay the fill out and re-disc and then compact using the large (long) sheep foot type feet on the earthworks roller

Topsoil Export

9. Sampled stockpiles with analysis showing it to be below residential land use criteria will be exported from the site to be used within road berms in the Rangiriri section of the Waikato Expressway. This was proposed to be an estimated volume of 25,000 m^3.

Work was staged and stockpiles were established roughly in the same location on the site (refer to sample plan in Appendix A). Schick surveyed all stockpiles and calculated the volumes of soil. Schick undertook the separate mixing of both the topsoil and subsoil.

Opus visited the site during the works, predominantly to collect soil samples.

Opus did not supervise the entirety of the soil mixing, but observed mixing operations being undertaken while we were on site sampling and those we witnessed were compliant with the RAP procedures.

Opus visited the site on 29 November 2016, 7 December 2016, 16 December 2016 and 12 January 2017 to collect soil samples of the mixed soil samples.

As per the RAP, Opus collected one sample per 100 m3 of the stockpiles over the staged works.

A total of 335 soil samples were collected during the works.

Photos of the stockpiles and the soil mixing at the site are supplied in Appendix B.

9 Soil Test Results

With one exception all soil samples were compliant with the selected SCGs.

One sample (TKW74) collected from stockpile 5 returned an arsenic concentration of 44 mg/kg. The area (200 m^3) around where the sample was collected was remixed, sampled and retested. Test results from the re-mixed soils were below the selected SGV.

All other samples reported arsenic concentrations below the SGV of 20 mg/kg, indicating that the mixing of the small 'arsenic' hotspots associated with the timber posts and the natural low background arsenic values were successful.

Soil test results are attached in Appendix C (along with comparison to the SGVs) with the laboratory results supplied in Appendix D.

10 Site Management and Monitoring

TKL and their subcontractor have been responsible for all site management and monitoring.

11 Conclusions

Soil mixing has been undertaken at the Wayside Road property to include both the topsoil and the immediately underlying subsoils.

Our goal was to mix the soils on site to meet residential land use with respect to arsenic concentrations that were previously reported as elevated in soils on site.

The elevated arsenic was in relation to treated timber posts which created small 'hotspots' in the immediate vicinity (within 100 mm) of the posts.

Soil analytical results indicate that soil mixing was a successful remedial option with all soil samples representative of soil remaining on site (including that soil that was removed to the Rangiruru section of the Waikato Expressway) reporting arsenic concentrations below the selected SGVs for residential land use.

12 Recommendations

We recommend that this interim SVR is submitted to both WDC and WRC for approval.

Further soil validation reporting will be required for both the stockyard area and for each lot once the subdivision has been finalised to allow for appropriate reclassification of the site on their respective Land Use Information Registers.

13 Limitations

This Interim SVR has been produced on behalf of Te Kauwhata Land Limited and no responsibility is accepted to any third party for all or any part. This report should not be relied upon or transferred to any other parties without the express written authorisation of Opus. If any unauthorised third party comes into possession of this report, they rely on it at their own risk and the authors owe them no duty of care or skill. This report should only be reproduced in full.

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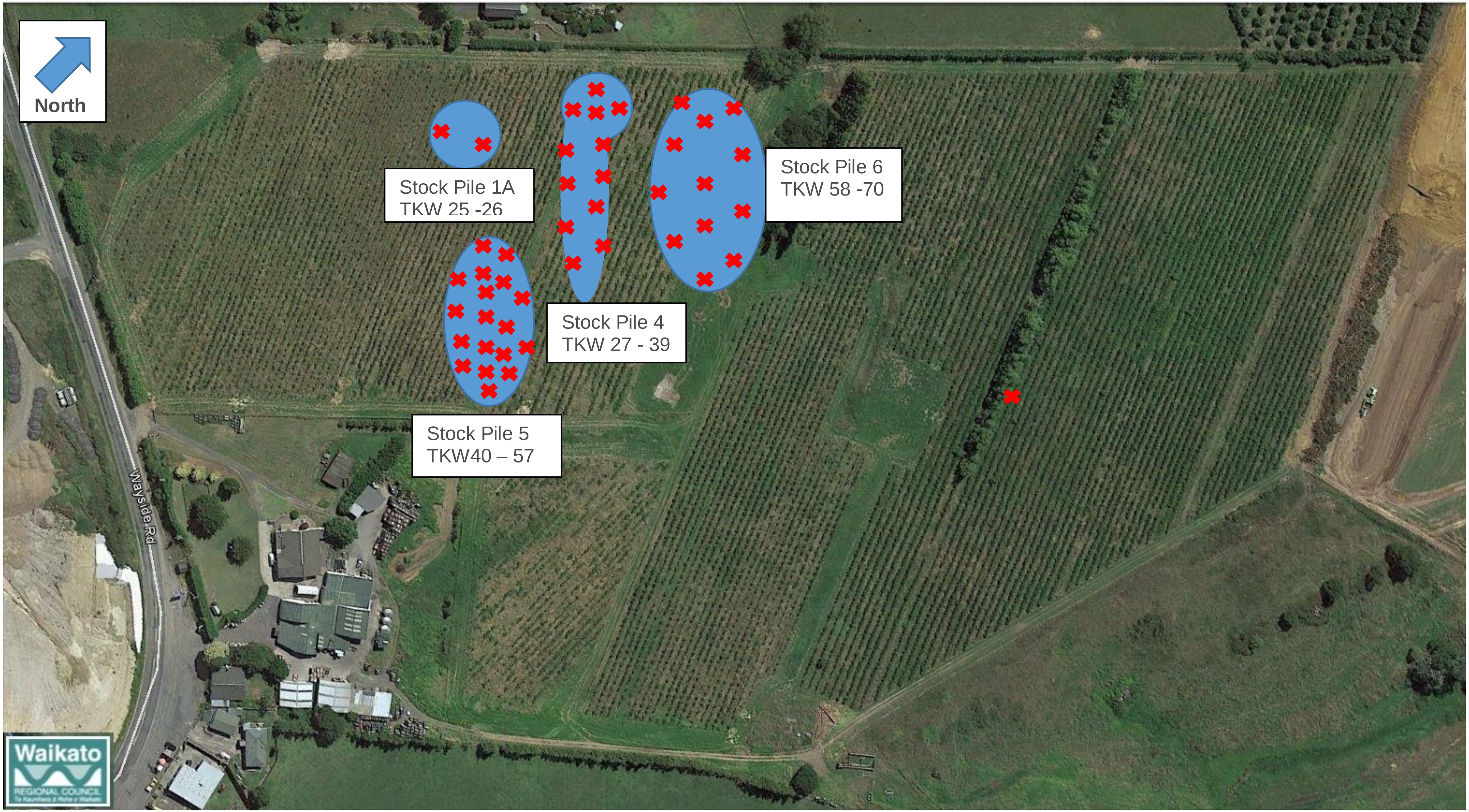
The characterisation of site conditions is an interpretation of information collected during assessment, in accordance with industry practice. Should further data be obtained that differs from that presented in this report, then conclusions and recommendations may no longer be valid.

The report is valid at the date of release. The condition of the site may change with time so that the results and interpretation are no longer valid. In addition, guidelines and legislation may change, making assessment of results and recommendations invalid.

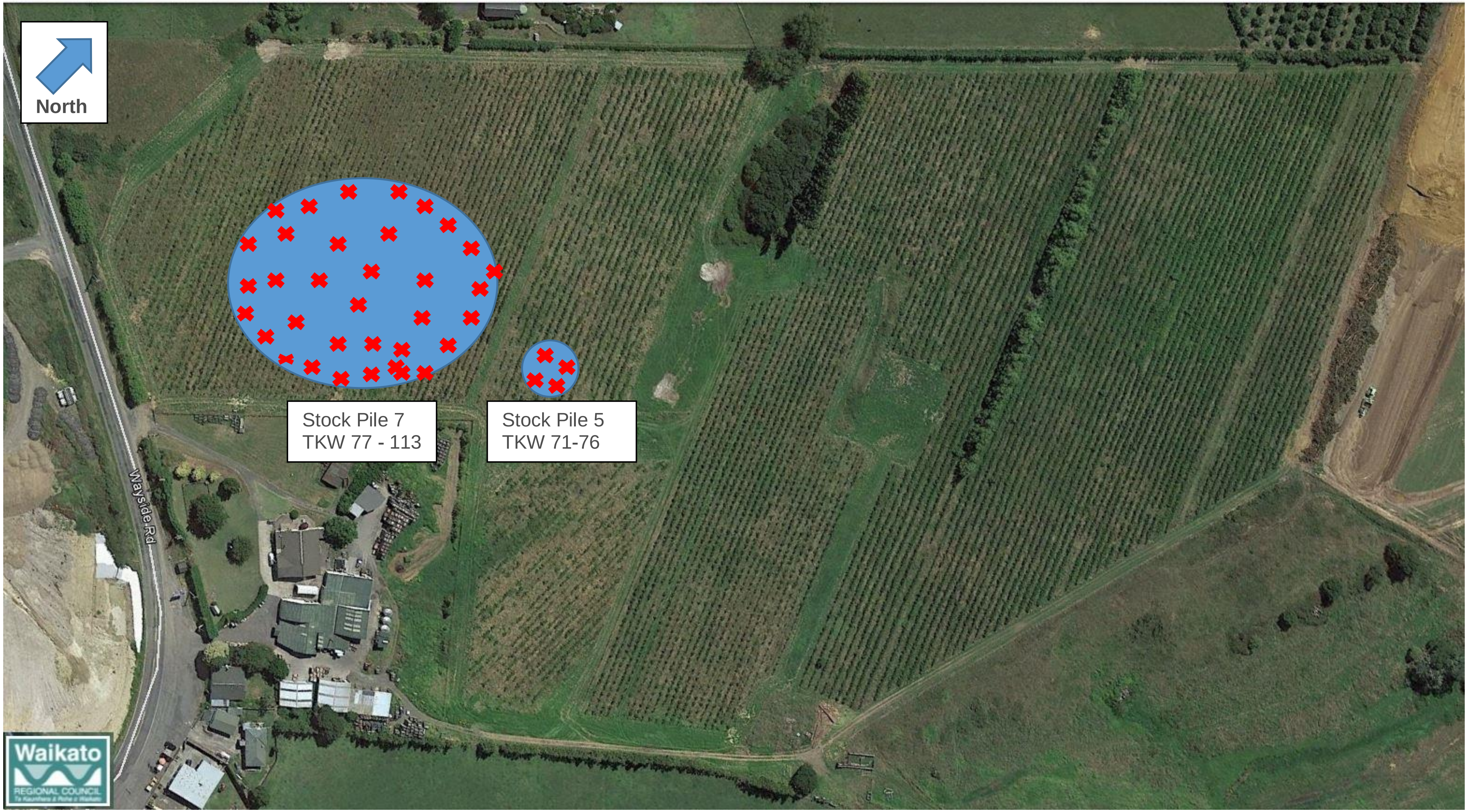
Appendix A

Stockpile sample location plan

29 November 2017



7 December 2016



16 December 2016

Stock Pile 8
TKW114 – 213,
TKW214B, TKW314,
TKW214A, TKW215 –
TKW241, TKW287

Stock Pile 9
TKW242 – 286,
TKW 295 - 310

12 January 2017

(Samples too numerous to display on stockpiles)

Appendix B

Site photos during soil mixing

Photo 1: Mixing of topsoil stockpile

Photo 2: Mixing of topsoil

Photo 3: Collecting samples from topsoil stockpile

Photo 4: Collecting samples from topsoil stockpile with machinery undertaking the mixing in the background

Photo 5: Portion of the site with topsoil cleared

Photo 6: Collecting soil samples from the mixed topsoil stockpile

Photo 7: Topsoil stockpile to left of photo with site cleared of topsoil in background

Photo 8: Mixing of the subsoils (Photo supplied by TKL)

Photo 9: Mixing of subsoil in background with remaining topsoil stockpile in foreground

Photo 10: Mixing of subsoil (Photo supplied by TKL)

Photo 11: Mixing of subsoil (Photo supplied by TKL)

Photo 12 : Mixing of subsoil (Photo supplied by TKL)

Appendix C

Laboratory analysis results compared with SGVs

Table No:	1
Site:	24 Wayside Road
Project No:	2-32713.00 / 002CL
Sample media:	Soil
Analysis:	Total Recoverable Concentrations
End-Use:	Rural Residential / Lifestyle Block 25% Produce
Date:	5/12/2016
Revision:	1

Sample Name	TKW01	TKW02	TKW03	TKW05	TKW06	TKW07	TKW09	TKW10	TKW11	TKW12	TKW13	TKW14	Assessment Criteria (mg/kg)			
Date Sampled	29-Nov-16	29-Nov-16	29-Nov-16	29-Nov-16	29-Nov-16	29-Nov-16	29-Nov-16	29-Nov-16	29-Nov-16	29-Nov-16	29-Nov-16	29-Nov-16				
Location	Stockpile 1			Stockpile 2									**Protection of Human Health**		**Application of NES Regulation 5(9)**	**Protection of Groundwater for Potable Use**
Soil Type	Silt	Silt	Silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	NZRB SCS (Health) Rural / Lifestyle 25% Produce[1]	IRB NEPM SGV[2]	Waikato Background soil Level Farmed Average[3]	IRB - US EPA SSL Values Dilution Factor x20[4]
Metals (mg/kg)																
Arsenic	9	9	9	10	9	11	**17**	9	11	8	15	15	17	-	8.6	29

Sample Name	TKW15	TKW16	TKW18	TKW19	TKW20	TKW22	TKW23	TKW24	TKW 25	TKW 26	TKW 27	TKW 28	Assessment Criteria (mg/kg)			
Date Sampled	29-Nov-16	29-Nov-16	29-Nov-16	29-Nov-16	29-Nov-16	29-Nov-16	29-Nov-16	29-Nov-16	7-Dec-16	7-Dec-16	7-Dec-16	7-Dec-16				
Natural / Fill?	Stockpile 2				Stockpile 3				Stockpile 1-A		Stockpile 4		**Protection of Human Health**		**Application of NES Regulation 5(9)**	**Protection of Groundwater for Potable Use**
Soil Type	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	NZRB SCS (Health) Rural / Lifestyle 25% Produce[1]	IRB NEPM SGV[2]	Waikato Background soil Level Farmed Average[3]	IRB - US EPA SSL Values Dilution Factor x20[4]
Metals (mg/kg)																
Arsenic	13	10	16	14	15	13	11	14	10	12	10	11	17	-	8.6	29

Sample Name	TKW 29	TKW 30	TKW 31	TKW 32	TKW 33	TKW 34	TKW 35	TKW 36	TKW 37	TKW 38	TKW 39	TKW 40	Assessment Criteria (mg/kg)			
Date Sampled	7-Dec-16	7-Dec-16	7-Dec-16	7-Dec-16	7-Dec-16	7-Dec-16	7-Dec-16	7-Dec-16	7-Dec-16	7-Dec-16	7-Dec-16	7-Dec-16				
Natural / Fill?	Stockpile 4											Stockpile 5	**Protection of Human Health**		**Application of NES Regulation 5(9)**	**Protection of Groundwater for Potable Use**
Soil Type	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	NZRB SCS (Health) Rural / Lifestyle 25% Produce[1]	IRB NEPM SGV[2]	Waikato Background soil Level Farmed Average[3]	IRB - US EPA SSL Values Dilution Factor x20[4]
Metals (mg/kg)																
Arsenic	10	9	10	11	9	8	10	12	10	10	11	8	17	-	8.6	29

Sample Name	TKW 41	TKW 42	TKW 43	TKW 44	TKW 45	TKW 46	TKW 47	TKW 48	TKW 49	TKW 50	TKW 51	TKW 52	Assessment Criteria (mg/kg)			
Date Sampled	7-Dec-16	7-Dec-16	7-Dec-16	7-Dec-16	7-Dec-16	7-Dec-16	7-Dec-16	7-Dec-16	7-Dec-16	7-Dec-16	7-Dec-16	7-Dec-16				
Natural / Fill?	Stockpile 5												**Protection of Human Health**		**Application of NES Regulation 5(9)**	**Protection of Groundwater for Potable Use**
Soil Type	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	NZRB SCS (Health) Rural / Lifestyle 25% Produce[1]	IRB NEPM SGV[2]	Waikato Background soil Level Farmed Average[3]	IRB - US EPA SSL Values Dilution Factor x20[4]
Metals (mg/kg)																
Arsenic	5	7	6	6	6	8	8	9	10	8	7	7	17	-	8.6	29

Numerals in **Bold and Red** Indicate an Exceedance of One or More of the Acceptance Criteria

The Acceptance Criteria that has been Exceeded is also Highlighted

All concentrations are in mg/kg

Abbreviations:

SCS = Soil contaminant standard

SGV = Soil guideline value

NZRB = New Zealand Risk Based

IRB = International risk based

ND = Not derived

SSL = Soil screening level

m bgl = meters below ground level

Notes:

1. Users Guide National Environmental Standard (NES) For Assessing and Managing Contaminants in Soil to Protect Human Health. New Zealand. 2012
2. National Environmental Protection (Assessment of Site Contamination) Measure 1999 (Australia); Schedule B1 (as amended May 2013) - Guideline on Investigation Levels For Soil and Groundwater, Federal Register of Legislative Instruments F2013C00288, National Environmental Protection Council. (HIL - Health Investigation Level).
3. Taylor, M.D. and Kim, N.D. (2009)Dealumination as a mechanism for increased acid recoverable aluminium in Waikato mineral soils. Australian Journal of Soil Research. 47, pp 828-838.
4. Supplemental Guidance for Developing Soil Screening Levels (human health) at Superfund Sites (US EPA, 2002) based on soil pH 6.8. Figures derived for protection of potable water supply, but are also used as a guideline figure for protection of ecological receptors in waterbodies in the absence of an alternative.

Table No:	2
Site:	24 Wayside Road
Project No:	2-32713.00 / 002CL
Sample media:	Soil
Analysis:	Total Recoverable Concentrations
End-Use:	Rural Residential / Lifestyle Block 25% Produce
Date:	5/12/2016
Revision:	1

Sample Name	TKW 53	TKW 54	TKW 55	TKW 56	TKW 57	TKW 58	TKW 59	TKW 60	TKW 61	TKW 62	TKW 63	TKW 64	Assessment Criteria (mg/kg)			
Date Sampled	7-Dec-16	7-Dec-16	7-Dec-16	7-Dec-16	7-Dec-16	7-Dec-16	7-Dec-16	7-Dec-16	7-Dec-16	7-Dec-16	7-Dec-16	7-Dec-16				
Location	Stockpile 5					Stockpile 6							**Protection of Human Health**		**Application of NES Regulation 5(9)**	**Protection of Groundwater for Potable Use**
Soil Type	Sandy Silt	Sandy Silt	Sandy Silt	Sandy Silt	Sandy Silt	Sandy Silt	Sandy Silt	Sandy Silt	Sandy Silt	Sandy Silt	Sandy Silt	Sandy Silt	NZRB SCS (Health) Rural / Lifestyle 25% Produce^1	IRB NEPM SGV^2	Waikato Background soil Level Farmed Average^3	IRB - US EPA SSL Values Dilution Factor x20^4
Metals (mg/kg)																
Arsenic	7	9	7	8	7	15	5	6	6	7	7	6	17	-	8.6	29

Sample Name	TKW 65	TKW 66	TKW 67	TKW 68	TKW 69	TKW 70	TKW 71	TKW72	TKW 73	TKW 74	TKW 75	TKW 76	Assessment Criteria (mg/kg)			
Date Sampled	7-Dec-16	7-Dec-16	7-Dec-16	7-Dec-16	7-Dec-16	7-Dec-16	7-Dec-16	7-Dec-16	7-Dec-16	7-Dec-16	16-Dec-16	16-Dec-16				
Location	Stockpile 6						Stockpile 5				Stockpile 5 (After remixing)		**Protection of Human Health**		**Application of NES Regulation 5(9)**	**Protection of Groundwater for Potable Use**
Soil Type	Sandy Silt	Sandy Silt	Sandy Silt	Sandy Silt	Sandy Silt	Sandy Silt	Sandy Silt	Sandy Silt	Sandy Silt	Sandy Silt	Sandy Silt	Sandy Silt	NZRB SCS (Health) Rural / Lifestyle 25% Produce^1	IRB NEPM SGV^2	Waikato Background soil Level Farmed Average^3	IRB - US EPA SSL Values Dilution Factor x20^4
Metals (mg/kg)																
Arsenic	6	15	8	11	9	9	11	11	7	**44**	12	13	17	-	8.6	29

Sample Name	TKW 77	TKW 78	TKW 79	TKW 80	TKW 81	TKW 82	TKW 83	TKW 84	TKW 85	TKW 86	TKW 87	TKW88	Assessment Criteria (mg/kg)			
Date Sampled	16-Dec-16	16-Dec-16	16-Dec-16	16-Dec-16	16-Dec-16	16-Dec-16	16-Dec-16	16-Dec-16	16-Dec-16	16-Dec-16	16-Dec-16	16-Dec-16				
location	Stockpile 7 (North Side)												**Protection of Human Health**		**Application of NES Regulation 5(9)**	**Protection of Groundwater for Potable Use**
Soil Type	Sandy Silt	Sandy Silt	Sandy Silt	Sandy Silt	Sandy Silt	Sandy Silt	Sandy Silt	Sandy Silt	Sandy Silt	Sandy Silt	Sandy Silt	Sandy Silt	NZRB SCS (Health) Rural / Lifestyle 25% Produce^1	IRB NEPM SGV^2	Waikato Background soil Level Farmed Average^3	IRB - US EPA SSL Values Dilution Factor x20^4
Metals (mg/kg)																
Arsenic	5	9	6	7	7	7	7	6	7	5	6	11	17	-	8.6	29

Sample Name	TKW 89	TKW 90	TKW 91	TKW 92	TKW93	TKW 94	TKW 95	TKW 96	TKW	TKW 98	TKW 99	TKW 100	Assessment Criteria (mg/kg)			
Date Sampled	16-Dec-16	16-Dec-16	16-Dec-16	16-Dec-16	16-Dec-16	16-Dec-16	16-Dec-16	16-Dec-16	16-Dec-16	16-Dec-16	16-Dec-16	16-Dec-16				
Location	Stockpile 7 (North Side)					Stockpile 7 (South Side)							**Protection of Human Health**		**Application of NES Regulation 5(9)**	**Protection of Groundwater for Potable Use**
Soil Type	Sandy Silt	Sandy Silt	Sandy Silt	Sandy Silt	Sandy Silt	Sandy Silt	Sandy Silt	Sandy Silt	Sandy Silt	Sandy Silt	Sandy Silt	Sandy Silt	NZRB SCS (Health) Rural / Lifestyle 25% Produce^1	IRB NEPM SGV^2	Waikato Background soil Level Farmed Average^3	IRB - US EPA SSL Values Dilution Factor x20^4
Metals (mg/kg)																
Arsenic	6	5	6	6	5	5	9	7	11	12	6	5	17	-	8.6	29

Numerals in **Bold and Red** Indicate an Exceedance of One or More of the Acceptance Criteria

The Acceptance Criteria that has been Exceeded is also Highlighted

All concentrations are in mg/kg

Abbreviations:

SCS = Soil contaminant standard

SGV = Soil guideline value

NZRB = New Zealand Risk Based

IRB = International risk based

ND = Not derived

SSL = Soil screening level

m bgl = meters below ground level

Notes:

1. Users Guide National Environmental Standard (NES) For Assessing and Managing Contaminants in Soil to Protect Human Health. New Zealand. 2012
2. National Environmental Protection (Assessment of Site Contamination) Measure 1999 (Australia); Schedule B1 (as amended May 2013) - Guideline on Investigation Levels For Soil and Groundwater, Federal Register of Legislative Instruments F2013C00288, National Environmental Protection Council. (HIL - Health Investigation Level).
3. Taylor, M.D. and Kim, N.D. (2009)Dealumination as a mechanism for increased acid recoverable aluminium in Waikato mineral soils. Australian Journal of Soil Research. 47, pp 828-838.
4. Supplemental Guidance for Developing Soil Screening Levels (human health) at Superfund Sites (US EPA, 2002) based on soil pH 6.8. Figures derived for protection of potable water supply, but are also used as a guideline figure for protection of ecological receptors in waterbodies in the absence of an alternative.

Table No:	3
Site:	24 Wayside Road
Project No:	2-32713.00 / 002CL
Sample media:	Soil
Analysis:	Total Recoverable Concentrations
End-Use:	Rural Residential / Lifestyle Block 25% Produce
Date:	5/12/2016
Revision:	1

OPUS

Sample Name	TKW 101	TKW 102	TKW 103	TKW 104	TKW 105	TKW 106	TKW 107	TKW 108	TKW 109	TKW 110	TKW 111	TKW 112	Assessment Criteria (mg/kg)			
Date Sampled	16-Dec-16	16-Dec-16	16-Dec-16	16-Dec-16	16-Dec-16	16-Dec-16	16-Dec-16	16-Dec-16	16-Dec-16	16-Dec-16	16-Dec-16	16-Dec-16				
Location	Stockpile 7 (South side)												**Protection of Human Health**		**Application of NES Regulation 5(9)**	**Protection of Groundwater for Potable Use**
Soil Type	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	NZRB SCS (Health) Rural / Lifestyle 25% Produce[1]	IRB NEPM SGV[2]	Waikato Background soil Level Farmed Average[3]	IRB - US EPA SSL Values Dilution Factor x20[4]
Metals (mg/kg)																
Arsenic	6	6	5	7	7	6	**12**	6	5	4	7	5	17	-	8.6	29

Sample Name	TKW 113	TKW 114	TKW 115	TKW 116	TKW 117	TKW 118	TKW 119	TKW 120	TKW 121	TKW 122	TKW 123	TKW 124	Assessment Criteria (mg/kg)			
Date Sampled	16-Dec-16	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17				
Location	Stockpile 7	Stockpile 8											**Protection of Human Health**		**Application of NES Regulation 5(9)**	**Protection of Groundwater for Potable Use**
Soil Type	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	NZRB SCS (Health) Rural / Lifestyle 25% Produce[1]	IRB NEPM SGV[2]	Waikato Background soil Level Farmed Average[3]	IRB - US EPA SSL Values Dilution Factor x20[4]
Metals (mg/kg)																
Arsenic	6	5	5	5	4	4	5	6	5	6	5	5	17	-	8.6	29

Sample Name	TKW 125	TKW 126	TKW 127	TKW 128	TKW 129	TKW 130	TKW 131	TKW 132	TKW 133	TKW 134	TKW135	TKW 136	Assessment Criteria (mg/kg)			
Date Sampled	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17				
location	Stockpile 8												**Protection of Human Health**		**Application of NES Regulation 5(9)**	**Protection of Groundwater for Potable Use**
Soil Type	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	NZRB SCS (Health) Rural / Lifestyle 25% Produce[1]	IRB NEPM SGV[2]	Waikato Background soil Level Farmed Average[3]	IRB - US EPA SSL Values Dilution Factor x20[4]
Metals (mg/kg)																
Arsenic	5	6	4	5	6	4	5	5	5	6	8	4	17	-	8.6	29

Sample Name	TKW 137	TKW 138	TKW 139	TKW 140	TKW 141	TKW 142	TKW 143	TKW 144	TKW 145	TKW 146	TKW 147	TKW148	Assessment Criteria (mg/kg)			
Date Sampled	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17				
Location	Stockpile 8												**Protection of Human Health**		**Application of NES Regulation 5(9)**	**Protection of Groundwater for Potable Use**
Soil Type	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	NZRB SCS (Health) Rural / Lifestyle 25% Produce[1]	IRB NEPM SGV[2]	Waikato Background soil Level Farmed Average[3]	IRB - US EPA SSL Values Dilution Factor x20[4]
Metals (mg/kg)																
Arsenic	5	5	6	6	6	7	5	6	6	6	6	7	17	-	8.6	29

Numerals in **Bold and Red** Indicate an Exceedance of One or More of the Acceptance Criteria

The Acceptance Criteria that has been Exceeded is also Highlighted

All concentrations are in mg/kg

Abbreviations:

SCS = Soil contaminant standard
SGV = Soil guideline value
NZRB = New Zealand Risk Based
IRB = International risk based
ND = Not derived
SSL = Soil screening level
m bgl = meters below ground level

Notes:

1. Users Guide National Environmental Standard (NES) For Assessing and Managing Contaminants in Soil to Protect Human Health. New Zealand. 2012
2. National Environmental Protection (Assessment of Site Contamination) Measure 1999 (Australia); Schedule B1 (as amended May 2013) - Guideline on Investigation Levels For Soil and Groundwater, Federal Register of Legislative Instruments F2013C00288, National Environmental Protection Council. (HIL - Health Investigation Level).
3. Taylor, M.D. and Kim, N.D. (2009)Dealumination as a mechanism for increased acid recoverable aluminium in Waikato mineral soils. Australian Journal of Soil Research. 47, pp 828-838.
4. Supplemental Guidance for Developing Soil Screening Levels (human health) at Superfund Sites (US EPA, 2002) based on soil pH 6.8. Figures derived for protection of potable water supply, but are also used as a guideline figure for protection of ecological receptors in waterbodies in the absence of an alternative.

Table No:	4
Site:	24 Wayside Road
Project No:	2-32713.00 / 002CL
Sample media:	Soil
Analysis:	Total Recoverable Concentrations
End-Use:	Rural Residential / Lifestyle Block 25% Produce
Date:	5/12/2016
Revision:	1

Sample Name	TKW 149	TKW 150	TKW 151	TKW 152	TKW 153	TKW 154	TKW 155	TKW 156	TKW 157	TKW 158	TKW 159	TKW160	Assessment Criteria (mg/kg)			
Date Sampled	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17				
Location	Stockpile 8												**Protection of Human Health**		**Application of NES Regulation 5(9)**	**Protection of Groundwater for Potable Use**
Soil Type	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	NZRB SCS (Health) Rural / Lifestyle 25% Produce[1]	IRB NEPM SGV[2]	Waikato Background soil Level Farmed Average[3]	IRB - US EPA SSL Values Dilution Factor x20[4]
Metals (mg/kg)																
Arsenic	5	6	6	6	5	7	**6**	7	6	7	6	7	17	-	8.6	29

Sample Name	TKW 161	TKW 162	TKW 163	TKW 164	TKW 165	TKW 166	TKW 167	TKW 168	TKW 169	TKW 170	TKW 171	TKW172	Assessment Criteria (mg/kg)			
Date Sampled	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17				
Location	Stockpile 8												**Protection of Human Health**		**Application of NES Regulation 5(9)**	**Protection of Groundwater for Potable Use**
Soil Type	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	NZRB SCS (Health) Rural / Lifestyle 25% Produce[1]	IRB NEPM SGV[2]	Waikato Background soil Level Farmed Average[3]	IRB - US EPA SSL Values Dilution Factor x20[4]
Metals (mg/kg)																
Arsenic	6	7	6	6	7	6	5	7	6	7	7	7	17	-	8.6	29

Sample Name	TKW 173	TKW 174	TKW 175	TKW 176	TKW177	TKW 178	TKW 179	TKW 180	TKW 181	TKW 182	TKW 183	TKW 184	Assessment Criteria (mg/kg)			
Date Sampled	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17				
location	Stockpile 8												**Protection of Human Health**		**Application of NES Regulation 5(9)**	**Protection of Groundwater for Potable Use**
Soil Type	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	NZRB SCS (Health) Rural / Lifestyle 25% Produce[1]	IRB NEPM SGV[2]	Waikato Background soil Level Farmed Average[3]	IRB - US EPA SSL Values Dilution Factor x20[4]
Metals (mg/kg)																
Arsenic	8	7	6	6	6	6	6	7	5	7	5	8	17	-	8.6	29

Sample Name	TKW 185	TKW 186	TKW 187	TKW 188	TKW 189	TKW 190	TKW 191	TKW 192	TKW 193	TKW 194	TKW 195	TKW 196	Assessment Criteria (mg/kg)			
Date Sampled	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17				
Location	Stockpile 8												**Protection of Human Health**		**Application of NES Regulation 5(9)**	**Protection of Groundwater for Potable Use**
Soil Type	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	NZRB SCS (Health) Rural / Lifestyle 25% Produce[1]	IRB NEPM SGV[2]	Waikato Background soil Level Farmed Average[3]	IRB - US EPA SSL Values Dilution Factor x20[4]
Metals (mg/kg)																
Arsenic	6	7	7	5	5	7	6	6	6	7	6	6	17	-	8.6	29

Numerals in **Bold and Red** Indicate an Exceedance of One or More of the Acceptance Criteria

The Acceptance Criteria that has been Exceeded is also Highlighted

All concentrations are in mg/kg

Abbreviations:

SCS = Soil contaminant standard
SGV = Soil guideline value
NZRB = New Zealand Risk Based
IRB = International risk based
ND = Not derived
SSL = Soil screening level
m bgl = meters below ground level

Notes:

1. Users Guide National Environmental Standard (NES) For Assessing and Managing Contaminants in Soil to Protect Human Health. New Zealand. 2012
2. National Environmental Protection (Assessment of Site Contamination) Measure 1999 (Australia); Schedule B1 (as amended May 2013) - Guideline on Investigation Levels For Soil and Groundwater, Federal Register of Legislative Instruments F2013C00288, National Environmental Protection Council. (HIL - Health Investigation Level).
3. Taylor, M.D. and Kim, N.D. (2009)Dealumination as a mechanism for increased acid recoverable aluminium in Waikato mineral soils. Australian Journal of Soil Research. 47, pp 828-838.
4. Supplemental Guidance for Developing Soil Screening Levels (human health) at Superfund Sites (US EPA, 2002) based on soil pH 6.8. Figures derived for protection of potable water supply, but are also used as a guideline figure for protection of ecological receptors in waterbodies in the absence of an alternative.

Table No:	5
Site:	24 Wayside Road
Project No:	2-32713.00 / 002CL
Sample media:	Soil
Analysis:	Total Recoverable Concentrations
End-Use:	Rural Residential / Lifestyle Block 25% Produce
Date:	5/12/2016
Revision:	1

Sample Name	TKW 197	TKW 198	TKW 199	TKW 200	TKW 201	TKW 202	TKW 203	TKW 204	TKW 205	TKW206	TKW 207	TKW 208	Assessment Criteria (mg/kg)			
Date Sampled	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17				
Location	Stockpile 8												**Protection of Human Health**		**Application of NES Regulation 5(9)**	**Protection of Groundwater for Potable Use**
Soil Type	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	NZRB SCS (Health) Rural / Lifestyle 25% Produce^1	IRB NEPM SGV^2	Waikato Background soil Level Farmed Average^3	IRB - US EPA SSL Values Dilution Factor x20^4
Metals (mg/kg)																
Arsenic	5	6	5	5	6	4	**4**	4	3	4	3	6	17	-	8.6	29

Sample Name	TKW 209	TKW 210	TKW 211	TKW 212	TKW 213	TKW 214 A	TKW 214 B	TKW 215	TKW 216	TKW 217	TKW 218	TKW 219	Assessment Criteria (mg/kg)			
Date Sampled	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17				
Location	Stockpile 8					Stockpile 8 (West Corner)							**Protection of Human Health**		**Application of NES Regulation 5(9)**	**Protection of Groundwater for Potable Use**
Soil Type	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	NZRB SCS (Health) Rural / Lifestyle 25% Produce^1	IRB NEPM SGV^2	Waikato Background soil Level Farmed Average^3	IRB - US EPA SSL Values Dilution Factor x20^4
Metals (mg/kg)																
Arsenic	6	5	5	3	3	6	5	5	6	7	7	10	17	-	8.6	29

Sample Name	TKW 220	TKW 221	TKW 222	TKW 223	TKW 224	TKW 225	TKW 226	TKW 227	TKW 228	TKW 229	TKW 230	TKW 231	Assessment Criteria (mg/kg)			
Date Sampled	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17				
location	Stockpile 8 (West Corner)												**Protection of Human Health**		**Application of NES Regulation 5(9)**	**Protection of Groundwater for Potable Use**
Soil Type	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	NZRB SCS (Health) Rural / Lifestyle 25% Produce^1	IRB NEPM SGV^2	Waikato Background soil Level Farmed Average^3	IRB - US EPA SSL Values Dilution Factor x20^4
Metals (mg/kg)																
Arsenic	6	5	6	6	5	6	6	6	5	5	5	6	17	-	8.6	29

Sample Name	TKW 232	TKW 233	TKW 234	TKW 235	TKW 236	TKW 237	TKW 238	TKW 239	TKW 240	TKW 241	TKW 242	TKW 243	Assessment Criteria (mg/kg)			
Date Sampled	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17				
Location	Stockpile 8 (West Corner)								Stockpile 8 (South Corner)		Stockpile 9		**Protection of Human Health**		**Application of NES Regulation 5(9)**	**Protection of Groundwater for Potable Use**
Soil Type	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	NZRB SCS (Health) Rural / Lifestyle 25% Produce^1	IRB NEPM SGV^2	Waikato Background soil Level Farmed Average^3	IRB - US EPA SSL Values Dilution Factor x20^4
Metals (mg/kg)																
Arsenic	6	5	5	5	6	5	6	5	5	5	8	7	17	-	8.6	29

Numerals in **Bold and Red** Indicate an Exceedance of One or More of the Acceptance Criteria

The Acceptance Criteria that has been Exceeded is also Highlighted

All concentrations are in mg/kg

Abbreviations:

SCS = Soil contaminant standard

SGV = Soil guideline value

NZRB = New Zealand Risk Based

IRB = International risk based

ND = Not derived

SSL = Soil screening level

m bgl = meters below ground level

Notes:

1. Users Guide National Environmental Standard (NES) For Assessing and Managing Contaminants in Soil to Protect Human Health. New Zealand. 2012
2. National Environmental Protection (Assessment of Site Contamination) Measure 1999 (Australia); Schedule B1 (as amended May 2013) - Guideline on Investigation Levels For Soil and Groundwater, Federal Register of Legislative Instruments F2013C00288, National Environmental Protection Council. (HIL - Health Investigation Level).
3. Taylor, M.D. and Kim, N.D. (2009)Dealumination as a mechanism for increased acid recoverable aluminium in Waikato mineral soils. Australian Journal of Soil Research. 47, pp 828-838.
4. Supplemental Guidance for Developing Soil Screening Levels (human health) at Superfund Sites (US EPA, 2002) based on soil pH 6.8. Figures derived for protection of potable water supply, but are also used as a guideline figure for protection of ecological receptors in waterbodies in the absence of an alternative.

Table No:	6
Site:	24 Wayside Road
Project No:	2-32713.00 / 002CL
Sample media:	Soil
Analysis:	Total Recoverable Concentrations
End-Use:	Rural Residential / Lifestyle Block 25% Produce
Date:	5/12/2016
Revision:	1

Sample Name	TKW 244	TKW 245	TKW 246	TKW 247	TKW 248	TKW 249	TKW 250	TKW 251	TKW 252	TKW 253	TKW 254	TKW 255	Assessment Criteria (mg/kg)			
Date Sampled	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17				
Location	Stockpile 9 (North West Side)												**Protection of Human Health**		**Application of NES Regulation 5(9)**	**Protection of Groundwater for Potable Use**
Soil Type	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	NZRB SCS (Health) Rural / Lifestyle 25% Produce[1]	IRB NEPM SGV[2]	Waikato Background soil Level Farmed Average[3]	IRB - US EPA SSL Values Dilution Factor x20[4]
Metals (mg/kg)																
Arsenic	9	7	6	6	5	7	**6**	6	5	4	5	5	17	-	8.6	29

Sample Name	TKW 256	TKW 257	TKW 258	TKW 259	TKW 260	TKW 261	TKW 262	TKW 263	TKW 264	TKW 265	TKW 266	TKW 267	Assessment Criteria (mg/kg)			
Date Sampled	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17				
Location	Stockpile 9 (North West Side)						Stockpile 9 (South East Side)						**Protection of Human Health**		**Application of NES Regulation 5(9)**	**Protection of Groundwater for Potable Use**
Soil Type	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	NZRB SCS (Health) Rural / Lifestyle 25% Produce[1]	IRB NEPM SGV[2]	Waikato Background soil Level Farmed Average[3]	IRB - US EPA SSL Values Dilution Factor x20[4]
Metals (mg/kg)																
Arsenic	5	6	7	6	5	6	5	8	7	4	7	7	17	-	8.6	29

Sample Name	TKW 268	TKW 269	TKW 270	TKW 271	TKW 272	TKW 273	TKW 274	TKW 275	TKW 276	TKW 277	TKW 278	TKW 279	Assessment Criteria (mg/kg)			
Date Sampled	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17				
location	Stockpile 9 (South East Side)						Stockpile 9 (Top)						**Protection of Human Health**		**Application of NES Regulation 5(9)**	**Protection of Groundwater for Potable Use**
Soil Type	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	NZRB SCS (Health) Rural / Lifestyle 25% Produce[1]	IRB NEPM SGV[2]	Waikato Background soil Level Farmed Average[3]	IRB - US EPA SSL Values Dilution Factor x20[4]
Metals (mg/kg)																
Arsenic	8	6	7	6	5	7	6	6	6	6	6	8	17	-	8.6	29

Sample Name	TKW 280	TKW 281	TKW 282	TKW 283	TKW 284	TKW 285	TKW 286	TKW 287	TKW 288	TKW 289	TKW 290	TKW 291	Assessment Criteria (mg/kg)			
Date Sampled	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17	12-Jan-17				
Location	Stockpile 9 (Top)						Stockpile 8 (South Corner)						**Protection of Human Health**		**Application of NES Regulation 5(9)**	**Protection of Groundwater for Potable Use**
Soil Type	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	Sandy silt	NZRB SCS (Health) Rural / Lifestyle 25% Produce[1]	IRB NEPM SGV[2]	Waikato Background soil Level Farmed Average[3]	IRB - US EPA SSL Values Dilution Factor x20[4]
Metals (mg/kg)																
Arsenic	10	6	6	5	5	6	6	10	5	5	5	4	17	-	8.6	29

Numerals in **Bold and Red** Indicate an Exceedance of One or More of the Acceptance Criteria

The Acceptance Criteria that has been Exceeded is also Highlighted

All concentrations are in mg/kg

Abbreviations:

SCS = Soil contaminant standard
SGV = Soil guideline value
NZRB = New Zealand Risk Based
IRB = International risk based
ND = Not derived
SSL = Soil screening level
m bgl = meters below ground level

Notes:

1. Users Guide National Environmental Standard (NES) For Assessing and Managing Contaminants in Soil to Protect Human Health. New Zealand. 2012
2. National Environmental Protection (Assessment of Site Contamination) Measure 1999 (Australia); Schedule B1 (as amended May 2013) - Guideline on Investigation Levels For Soil and Groundwater, Federal Register of Legislative Instruments F2013C00288, National Environmental Protection Council. (HIL - Health Investigation Level).
3. Taylor, M.D. and Kim, N.D. (2009)Dealumination as a mechanism for increased acid recoverable aluminium in Waikato mineral soils. Australian Journal of Soil Research. 47, pp 828-838.
4. Supplemental Guidance for Developing Soil Screening Levels (human health) at Superfund Sites (US EPA, 2002) based on soil pH 6.8. Figures derived for protection of potable water supply, but are also used as a guideline figure for protection of ecological receptors in waterbodies in the absence of an alternative.

Appendix D

Laboratory Analysis Results

Hill Laboratories
BETTER TESTING **BETTER RESULTS**

R J Hill Laboratories Limited
1 Clyde Street
Private Bag 3205
Hamilton 3240, New Zealand

Tel +64 7 858 2000
Fax +64 7 858 2001
Email mail@hill-labs.co.nz
Web www.hill-labs.co.nz

ANALYSIS REPORT

Client:	OPUS International Consultants	**Lab No:**	1688149 SDSPv1
Contact:	D Dewar	**Date Received:**	29-Nov-2016
	C/- OPUS International Consultants	**Date Reported:**	30-Nov-2016
	Private Bag 3057	**Quote No:**	82340
	Hamilton 3240	**Order No:**	
		Client Reference:	
		Submitted By:	Rachael Forrest

Analysis Results

Sample Name:	Lab Number	Total Recoverable Arsenic mg/kg dry wt
TKW01 29-Nov-2016 12:34 pm	1688149.1	9
TKW02 29-Nov-2016 12:35 pm	1688149.2	9
TKW03 29-Nov-2016 12:40 pm	1688149.3	9
TKW05 29-Nov-2016 12:47 pm	1688149.5	10
TKW06 29-Nov-2016 12:51 pm	1688149.6	9
TKW07 29-Nov-2016 12:54 pm	1688149.7	11
TKW09 29-Nov-2016 12:59 pm	1688149.9	17
TKW10 29-Nov-2016 1:03 pm	1688149.10	9
TKW11 29-Nov-2016 12:47 pm	1688149.11	11
TKW12 29-Nov-2016 12:47 pm	1688149.12	8
TKW13 29-Nov-2016 12:27 pm	1688149.13	15
TKW14 29-Nov-2016 12:48 pm	1688149.14	15
TKW15 29-Nov-2016	1688149.15	13
TKW16 29-Nov-2016 1:04 pm	1688149.16	10
TKW18 29-Nov-2016 1:06 pm	1688149.18	16
TKW19 29-Nov-2016 1:08 pm	1688149.19	14
TKW20 29-Nov-2016 1:15 pm	1688149.20	15
TKW22 29-Nov-2016 1:25 pm	1688149.22	13
TKW23 29-Nov-2016 1:30 pm	1688149.23	11
TKW24 29-Nov-2016 1:32 pm	1688149.24	14

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Soil

Test	**Method Description**	**Default Detection Limit**	**Sample No**
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation. May contain a residual moisture content of 2-5%.	-	1-3, 5-7, 9-16, 18-20, 22-24
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	1-3, 5-7, 9-16, 18-20, 22-24
Total Recoverable Arsenic	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	1-3, 5-7, 9-16, 18-20, 22-24

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

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Graham Corban MSc Tech (Hons)
Client Services Manager - Environmental

Hill Laboratories
BETTER TESTING **BETTER RESULTS**

R J Hill Laboratories Limited
1 Clyde Street
Private Bag 3205
Hamilton 3240, New Zealand

Tel +64 7 858 2000
Fax +64 7 858 2001
Email mail@hill-labs.co.nz
Web www.hill-labs.co.nz

ANALYSIS REPORT

Client:	OPUS International Consultants	**Lab No:**	1693566 SPv1
Contact:	D Dewar	**Date Received:**	08-Dec-2016
	C/- OPUS International Consultants	**Date Reported:**	14-Dec-2016
	Private Bag 3057	**Quote No:**	72291
	Hamilton 3240	**Order No:**	
		Client Reference:	TKW - 2 -32713.00/002 CL
		Submitted By:	Rachael Forrest

Sample Type: Soil

	Sample Name:	TKW25 07-Dec-2016 2:30 pm	TKW26 07-Dec-2016 2:30 pm	TKW27 07-Dec-2016	TKW28 07-Dec-2016	TKW29 07-Dec-2016
	Lab Number:	1693566.1	1693566.2	1693566.3	1693566.4	1693566.5
Total Recoverable Arsenic	mg/kg dry wt	10	12	10	11	10

	Sample Name:	TKW30 07-Dec-2016	TKW31 07-Dec-2016	TKW32 07-Dec-2016	TKW33 07-Dec-2016	TKW34 07-Dec-2016
	Lab Number:	1693566.6	1693566.7	1693566.8	1693566.9	1693566.10
Total Recoverable Arsenic	mg/kg dry wt	9	10	11	9	8

	Sample Name:	TKW35 07-Dec-2016	TKW36 07-Dec-2016	TKW37 07-Dec-2016	TKW38 07-Dec-2016	TKW39 07-Dec-2016
	Lab Number:	1693566.11	1693566.12	1693566.13	1693566.14	1693566.15
Total Recoverable Arsenic	mg/kg dry wt	10	12	10	10	11

	Sample Name:	TKW40 07-Dec-2016	TKW41 07-Dec-2016	TKW42 07-Dec-2016	TKW43 07-Dec-2016	TKW44 07-Dec-2016
	Lab Number:	1693566.16	1693566.17	1693566.18	1693566.19	1693566.20
Total Recoverable Arsenic	mg/kg dry wt	8	5	7	6	6

	Sample Name:	TKW45 07-Dec-2016	TKW46 07-Dec-2016	TKW47 07-Dec-2016	TKW48 07-Dec-2016	TKW49 07-Dec-2016
	Lab Number:	1693566.21	1693566.22	1693566.23	1693566.24	1693566.25
Total Recoverable Arsenic	mg/kg dry wt	6	8	8	9	10

	Sample Name:	TKW50 07-Dec-2016	TKW51 07-Dec-2016	TKW52 07-Dec-2016	TKW53 07-Dec-2016	TKW54 07-Dec-2016
	Lab Number:	1693566.26	1693566.27	1693566.28	1693566.29	1693566.30
Total Recoverable Arsenic	mg/kg dry wt	8	7	7	7	9

	Sample Name:	TKW55 07-Dec-2016	TKW56 07-Dec-2016	TKW57 07-Dec-2016	TKW58 07-Dec-2016	TKW59 07-Dec-2016
	Lab Number:	1693566.31	1693566.32	1693566.33	1693566.34	1693566.35
Total Recoverable Arsenic	mg/kg dry wt	7	8	7	15	5

	Sample Name:	TKW60 07-Dec-2016	TKW61 07-Dec-2016	TKW62 07-Dec-2016	TKW63 07-Dec-2016	TKW64 07-Dec-2016
	Lab Number:	1693566.36	1693566.37	1693566.38	1693566.39	1693566.40
Total Recoverable Arsenic	mg/kg dry wt	6	6	7	7	6

	Sample Name:	TKW65 07-Dec-2016	TKW66 07-Dec-2016	TKW67 07-Dec-2016	TKW68 07-Dec-2016	TKW69 07-Dec-2016
	Lab Number:	1693566.41	1693566.42	1693566.43	1693566.44	1693566.45
Total Recoverable Arsenic	mg/kg dry wt	6	15	8	11	9

Sample Type: Soil						
	Sample Name:	TKW70 07-Dec-2016	TKW71 07-Dec-2016	TKW72 07-Dec-2016	TKW73 07-Dec-2016	TKW74 07-Dec-2016
	Lab Number:	1693566.46	1693566.47	1693566.48	1693566.49	1693566.50
Total Recoverable Arsenic	mg/kg dry wt	9	11	11	7	44

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Soil

Test	Method Description	Default Detection Limit	Sample No
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation. May contain a residual moisture content of 2-5%.	-	1-50
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	1-50
Total Recoverable Arsenic	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	1-50

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

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Ara Heron BSc (Tech)
Client Services Manager - Environmental

Hill Laboratories
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R J Hill Laboratories Limited
1 Clyde Street Hamilton 3216
Private Bag 3205
Hamilton 3240 New Zealand

T 0508 HILL LAB (44 555 22)
T +64 7 858 2000
E mail@hill-labs.co.nz
W www.hill-laboratories.com

ANALYSIS REPORT

SDSPv1

Client:	OPUS International Consultants	**Lab No:**	1698575
Contact:	D Dewar C/- OPUS International Consultants Private Bag 3057 Hamilton 3240	**Date Received:**	16-Dec-2016
		Date Reported:	23-Dec-2016
		Quote No:	82748
		Order No:	2-32713.00/002CL
		Client Reference:	TKW
		Submitted By:	Rachael Forrest

Analysis Results

Sample Name:	Lab Number	Total Recoverable Arsenic mg/kg dry wt
TKW 75 16-Dec-2016	1698575.1	12
TKW 76 16-Dec-2016	1698575.2	13
TKW 77 16-Dec-2016	1698575.3	5
TKW 78 16-Dec-2016	1698575.4	9
TKW 79 16-Dec-2016	1698575.5	6
TKW 80 16-Dec-2016	1698575.6	7
TKW 81 16-Dec-2016	1698575.7	7
TKW 82 16-Dec-2016	1698575.8	7
TKW 83 16-Dec-2016	1698575.9	7
TKW 84 16-Dec-2016	1698575.10	6
TKW 85 16-Dec-2016	1698575.11	7
TKW 86 16-Dec-2016	1698575.12	5
TKW 87 16-Dec-2016	1698575.13	6
TKW 88 16-Dec-2016	1698575.14	11
TKW 89 16-Dec-2016	1698575.15	6
TKW 90 16-Dec-2016	1698575.16	5
TKW 91 16-Dec-2016	1698575.17	6
TKW 92 16-Dec-2016	1698575.18	6
TKW 93 16-Dec-2016	1698575.19	5
TKW 94 16-Dec-2016	1698575.20	5
TKW 95 16-Dec-2016	1698575.21	9
TKW 96 16-Dec-2016	1698575.22	7
TKW 97 16-Dec-2016	1698575.23	11
TKW 98 16-Dec-2016	1698575.24	12
TKW 99 16-Dec-2016	1698575.25	6
TKW 100 16-Dec-2016	1698575.26	5
TKW 101 16-Dec-2016	1698575.27	6
TKW 102 16-Dec-2016	1698575.28	6
TKW 103 16-Dec-2016	1698575.29	5
TKW 104 16-Dec-2016	1698575.30	7
TKW 105 16-Dec-2016	1698575.31	7
TKW 106 16-Dec-2016	1698575.32	6
TKW 107 16-Dec-2016	1698575.33	12
TKW 108 16-Dec-2016	1698575.34	6
TKW 109 16-Dec-2016	1698575.35	5
TKW 110 16-Dec-2016	1698575.36	4
TKW 111 16-Dec-2016	1698575.37	7
TKW 112 16-Dec-2016	1698575.38	5
TKW 113 16-Dec-2016	1698575.39	6
TKW 114 16-Dec-2016	1698575.40	5

Analysis Results

Sample Name:	Lab Number	Total Recoverable Arsenic mg/kg dry wt
TKW 115 16-Dec-2016	1698575.41	5
TKW 116 16-Dec-2016	1698575.42	5
TKW 117 16-Dec-2016	1698575.43	4
TKW 118 16-Dec-2016	1698575.44	4
TKW 119 16-Dec-2016	1698575.45	5
TKW 120 16-Dec-2016	1698575.46	6
TKW 121 16-Dec-2016	1698575.47	5
TKW 122 16-Dec-2016	1698575.48	6
TKW 123 16-Dec-2016	1698575.49	5
TKW 124 16-Dec-2016	1698575.50	5
TKW 125 16-Dec-2016	1698575.51	5
TKW 126 16-Dec-2016	1698575.52	6
TKW 127 16-Dec-2016	1698575.53	4
TKW 128 16-Dec-2016	1698575.54	5
TKW 129 16-Dec-2016	1698575.55	6
TKW 130 16-Dec-2016	1698575.56	4
TKW 131 16-Dec-2016	1698575.57	5
TKW 132 16-Dec-2016	1698575.58	5
TKW 133 16-Dec-2016	1698575.59	5
TKW 134 16-Dec-2016	1698575.60	6
TKW 135 16-Dec-2016	1698575.61	8
TKW 136 16-Dec-2016	1698575.62	4

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Soil

Test	**Method Description**	**Default Detection Limit**	**Sample No**
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation. May contain a residual moisture content of 2-5%.	-	1-62
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	1-62
Total Recoverable Arsenic	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	1-62

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

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Martin Cowell - BSc
Client Services Manager - Environmental

R J Hill Laboratories Limited
1 Clyde Street Hamilton 3216
Private Bag 3205
Hamilton 3240 New Zealand

T 0508 HILL LAB (44 555 22)
T +64 7 858 2000
E mail@hill-labs.co.nz
W www.hill-laboratories.com

ANALYSIS REPORT

Client:	OPUS International Consultants	**Lab No:**	1707606 SDSPv1
Contact:	D Dewar	**Date Received:**	13-Jan-2017
	C/- OPUS International Consultants	**Date Reported:**	18-Jan-2017
	Private Bag 3057	**Quote No:**	82748
	Hamilton 3240	**Order No:**	
		Client Reference:	232713.00 Te Kauwhata
		Submitted By:	Rachael Forrest

Analysis Results

Sample Name:	Lab Number	Total Recoverable Arsenic mg/kg dry wt
TKW 114 12-Jan-2017	1707606.1	6
TKW 115 12-Jan-2017	1707606.2	7
TKW 116 12-Jan-2017	1707606.3	6
TKW 117 12-Jan-2017	1707606.4	7
TKW 118 12-Jan-2017	1707606.5	6
TKW 119 12-Jan-2017	1707606.6	5
TKW 120 12-Jan-2017	1707606.7	6
TKW 121 12-Jan-2017	1707606.8	6
TKW 122 12-Jan-2017	1707606.9	7
TKW 123 12-Jan-2017	1707606.10	5
TKW 124 12-Jan-2017	1707606.11	7
TKW 125 12-Jan-2017	1707606.12	4
TKW 126 12-Jan-2017	1707606.13	8
TKW 127 12-Jan-2017	1707606.14	6
TKW 128 12-Jan-2017	1707606.15	6
TKW 129 12-Jan-2017 11:40 am	1707606.16	6
TKW 130 12-Jan-2017	1707606.17	6
TKW 131 12-Jan-2017	1707606.18	6
TKW 132 12-Jan-2017	1707606.19	6
TKW 133 12-Jan-2017	1707606.20	5
TKW 134 12-Jan-2017	1707606.21	6
TKW 135 12-Jan-2017 12:28 pm	1707606.22	7
TKW 136 12-Jan-2017 12:31 pm	1707606.23	6
TKW 137 12-Jan-2017 12:34 pm	1707606.24	5
TKW 138 12-Jan-2017 12:26 pm	1707606.25	5
TKW 139 12-Jan-2017 12:38 pm	1707606.26	6
TKW 140 12-Jan-2017 12:41 pm	1707606.27	6
TKW 141 12-Jan-2017 12:45 pm	1707606.28	6
TKW 142 12-Jan-2017 12:47 pm	1707606.29	7
TKW 143 12-Jan-2017 12:50 pm	1707606.30	5
TKW 144 12-Jan-2017 12:52 pm	1707606.31	6
TKW 145 12-Jan-2017 12:54 pm	1707606.32	6
TKW 146 12-Jan-2017 12:57 pm	1707606.33	6
TKW 147 12-Jan-2017 12:58 pm	1707606.34	6
TKW 148 12-Jan-2017 1:03 pm	1707606.35	7
TKW 149 12-Jan-2017 1:06 pm	1707606.36	5
TKW 150 12-Jan-2017 1:06 pm	1707606.37	6
TKW 151 12-Jan-2017 1:07 pm	1707606.38	6
TKW 152 12-Jan-2017 1:31 pm	1707606.39	6
TKW 153 12-Jan-2017 1:35 pm	1707606.40	5

ilac-MRA IANZ ACCREDITED LABORATORY

This Laboratory is accredited by International Accreditation New Zealand (IANZ), which represents New Zealand in the International Laboratory Accreditation Cooperation (ILAC). Through the ILAC Mutual Recognition Arrangement (ILAC-MRA) this accreditation is internationally recognised.
The tests reported herein have been performed in accordance with the terms of accreditation, with the exception of tests marked *, which are not accredited.

Analysis Results

Sample Name:	Lab Number	Total Recoverable Arsenic mg/kg dry wt
TKW 154 12-Jan-2017 1:37 pm	1707606.41	7
TKW 155 12-Jan-2017 1:53 pm	1707606.42	6
TKW 156 12-Jan-2017 1:56 pm	1707606.43	7
TKW 157 12-Jan-2017 1:59 pm	1707606.44	6
TKW 158 12-Jan-2017 2:00 pm	1707606.45	7
TKW 159 12-Jan-2017	1707606.46	6
TKW 160 12-Jan-2017 2:07 pm	1707606.47	7
TKW 161 12-Jan-2017 2:09 pm	1707606.48	6
TKW 162 12-Jan-2017 2:11 pm	1707606.49	7
TKW 163 12-Jan-2017	1707606.50	6
TKW 164 12-Jan-2017 2:16 pm	1707606.51	6
TKW 165 12-Jan-2017 2:20 pm	1707606.52	7
TKW 166 12-Jan-2017 2:18 pm	1707606.53	6
TKW 167 12-Jan-2017 2:25 pm	1707606.54	5
TKW 168 12-Jan-2017 2:27 pm	1707606.55	7
TKW 169 12-Jan-2017 2:04 pm	1707606.56	6
TKW 170 12-Jan-2017 2:30 pm	1707606.57	7
TKW 171 12-Jan-2017 2:53 pm	1707606.58	7
TKW 172 12-Jan-2017 2:55 pm	1707606.59	7
TKW 173 12-Jan-2017	1707606.60	8
TKW 174 12-Jan-2017	1707606.61	7
TKW 175 12-Jan-2017 3:00 pm	1707606.62	6
TKW 176 12-Jan-2017 3:03 pm	1707606.63	6
TKW 177 12-Jan-2017 3:04 pm	1707606.64	6
TKW 178 12-Jan-2017 3:06 pm	1707606.65	6
TKW 179 12-Jan-2017	1707606.66	6
TKW 180 12-Jan-2017	1707606.67	7
TKW 181 12-Jan-2017 3:10 pm	1707606.68	5
TKW 182 12-Jan-2017 3:13 pm	1707606.69	7
TKW 183 12-Jan-2017 3:15 pm	1707606.70	5
TKW 184 12-Jan-2017 3:16 pm	1707606.71	8
TKW 185 12-Jan-2017	1707606.72	6
TKW 186 12-Jan-2017	1707606.73	7
TKW 187 12-Jan-2017	1707606.74	7
TKW 188 12-Jan-2017	1707606.75	5
TKW 189 12-Jan-2017	1707606.76	5
TKW 190 12-Jan-2017	1707606.77	7
TKW 191 12-Jan-2017	1707606.78	6
TKW 192 12-Jan-2017	1707606.79	6
TKW 193 12-Jan-2017	1707606.80	6
TKW 194 12-Jan-2017	1707606.81	7
TKW 195 12-Jan-2017	1707606.82	6
TKW 196 12-Jan-2017	1707606.83	6
TKW 197 12-Jan-2017	1707606.84	5
TKW 198 12-Jan-2017	1707606.85	6
TKW 199 12-Jan-2017	1707606.86	5
TKW 200 12-Jan-2017	1707606.87	5
TKW 201 12-Jan-2017	1707606.88	6
TKW 202 12-Jan-2017	1707606.89	4
TKW 203 12-Jan-2017	1707606.90	4
TKW 204 12-Jan-2017	1707606.91	4
TKW 205 12-Jan-2017	1707606.92	3
TKW 206 12-Jan-2017	1707606.93	4
TKW 207 12-Jan-2017	1707606.94	3
TKW 208 12-Jan-2017	1707606.95	6
TKW 209 12-Jan-2017	1707606.96	6
TKW 210 12-Jan-2017	1707606.97	5

Analysis Results

Sample Name:	Lab Number	Total Recoverable Arsenic mg/kg dry wt
TKW 211 12-Jan-2017	1707606.98	5
TKW 212 12-Jan-2017	1707606.99	3
TKW 213 12-Jan-2017	1707606.100	3
TKW 214 A 12-Jan-2017	1707606.101	6
TKW 214 B 12-Jan-2017	1707606.102	5
TKW 215 12-Jan-2017	1707606.103	5
TKW 216 12-Jan-2017	1707606.104	6
TKW 217 12-Jan-2017	1707606.105	7
TKW 218 12-Jan-2017	1707606.106	7
TKW 219 12-Jan-2017	1707606.107	10
TKW 220 12-Jan-2017	1707606.108	6
TKW 221 12-Jan-2017	1707606.109	5
TKW 222 12-Jan-2017	1707606.110	6
TKW 223 12-Jan-2017	1707606.111	6
TKW 224 12-Jan-2017	1707606.112	5
TKW 225 12-Jan-2017	1707606.113	6
TKW 226 12-Jan-2017	1707606.114	6
TKW 227 12-Jan-2017	1707606.115	6
TKW 228 12-Jan-2017	1707606.116	5
TKW 229 12-Jan-2017	1707606.117	5
TKW 230 12-Jan-2017	1707606.118	5
TKW 231 12-Jan-2017	1707606.119	6
TKW 232 12-Jan-2017	1707606.120	6
TKW 233 12-Jan-2017	1707606.121	5
TKW 234 12-Jan-2017	1707606.122	5
TKW 235 12-Jan-2017	1707606.123	5
TKW 236 12-Jan-2017	1707606.124	6
TKW 237 12-Jan-2017	1707606.125	5
TKW 238 12-Jan-2017	1707606.126	6
TKW 239 12-Jan-2017	1707606.127	5
TKW 240 12-Jan-2017	1707606.128	5
TKW 241 12-Jan-2017	1707606.129	5
TKW 242 12-Jan-2017	1707606.130	8
TKW 243 12-Jan-2017	1707606.131	7
TKW 244 12-Jan-2017	1707606.132	9
TKW 245 12-Jan-2017	1707606.133	7
TKW 246 12-Jan-2017	1707606.134	6
TKW 247 12-Jan-2017	1707606.135	6
TKW 248 12-Jan-2017	1707606.136	5
TKW 249 12-Jan-2017	1707606.137	7
TKW 250 12-Jan-2017	1707606.138	6
TKW 251 12-Jan-2017	1707606.139	6
TKW 252 12-Jan-2017	1707606.140	5
TKW 253 12-Jan-2017	1707606.141	4
TKW 254 12-Jan-2017	1707606.142	5
TKW 255 12-Jan-2017	1707606.143	5
TKW 256 12-Jan-2017	1707606.144	5
TKW 257 12-Jan-2017	1707606.145	6
TKW 258 12-Jan-2017	1707606.146	7
TKW 259 12-Jan-2017	1707606.147	6
TKW 260 12-Jan-2017	1707606.148	5
TKW 261 12-Jan-2017	1707606.149	6
TKW 262 12-Jan-2017	1707606.150	5
TKW 263 12-Jan-2017	1707606.151	8
TKW 264 12-Jan-2017	1707606.152	7
TKW 265 12-Jan-2017	1707606.153	4
TKW 266 12-Jan-2017	1707606.154	7

Analysis Results

Sample Name:	Lab Number	Total Recoverable Arsenic mg/kg dry wt
TKW 267 12-Jan-2017	1707606.155	7
TKW 268 12-Jan-2017	1707606.156	8
TKW 269 12-Jan-2017	1707606.157	6
TKW 270 12-Jan-2017	1707606.158	7
TKW 271 12-Jan-2017	1707606.159	6
TKW 272 12-Jan-2017	1707606.160	5
TKW 273 12-Jan-2017	1707606.161	7
TKW 274 12-Jan-2017	1707606.162	6
TKW 275 12-Jan-2017	1707606.163	6
TKW 276 12-Jan-2017	1707606.164	6
TKW 277 12-Jan-2017	1707606.165	6
TKW 278 12-Jan-2017	1707606.166	6
TKW 279 12-Jan-2017	1707606.167	8
TKW 280 12-Jan-2017	1707606.168	10
TKW 281 12-Jan-2017	1707606.169	6
TKW 282 12-Jan-2017	1707606.170	6
TKW 283 12-Jan-2017	1707606.171	5
TKW 284 12-Jan-2017	1707606.172	5
TKW 285 12-Jan-2017	1707606.173	6
TKW 286 12-Jan-2017	1707606.174	6
TKW 287 12-Jan-2017	1707606.175	10
TKW 288 12-Jan-2017	1707606.176	5
TKW 289 12-Jan-2017	1707606.177	5
TKW 290 12-Jan-2017	1707606.178	5
TKW 291 12-Jan-2017	1707606.179	4
TKW 292 12-Jan-2017	1707606.180	6
TKW 293 12-Jan-2017	1707606.181	5
TKW 294 12-Jan-2017	1707606.182	9
TKW 295 12-Jan-2017	1707606.183	5
TKW 296 12-Jan-2017	1707606.184	6
TKW 297 12-Jan-2017	1707606.185	7
TKW 298 12-Jan-2017	1707606.186	7
TKW 299 12-Jan-2017	1707606.187	6
TKW 300 12-Jan-2017	1707606.188	6
TKW 301 12-Jan-2017	1707606.189	7
TKW 302 12-Jan-2017	1707606.190	8
TKW 303 12-Jan-2017	1707606.191	6
TKW 304 12-Jan-2017	1707606.192	7
TKW 305 12-Jan-2017	1707606.193	6
TKW 306 12-Jan-2017	1707606.194	6
TKW 307 12-Jan-2017	1707606.195	6
TKW 308 12-Jan-2017	1707606.196	6
TKW 309 12-Jan-2017	1707606.197	6
TKW 310 12-Jan-2017	1707606.198	7
TKW 314 12-Jan-2017	1707606.199	5

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Soil

Test	Method Description	Default Detection Limit	Sample No
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation. May contain a residual moisture content of 2-5%.	-	1-199
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	1-199
Total Recoverable Arsenic	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	2 mg/kg dry wt	1-199

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

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Ara Heron BSc (Tech)
Client Services Manager - Environmental

Opus International Consultants Ltd
Opus House, Princes Street
Private Bag 3057, Waikato Mail Centre,
Hamilton 3240
New Zealand

t: +64 7 838 9344
f: +64 7 838 9324
w: www.opus.co.nz