# Memorandum

To: Gordon Litt Farms

From: Nic Lake (Maven Waikato Limited)

Subject: Orchard Grove - Infrastructure Technical Memorandum for Referral [E]

Date: December 2025

## Introduction

Orchard Grove ('the site') is of irregular shape, is approximately 72 hectares, and is situated within the Waikato District directly adjoining the territorial boundary of Hamilton City to the south as shown in Figure 1.


*Figure 1: Site Locality Plan*

The site consists of five parcels held in four Records of Title as identified in the Planning Memorandum prepared by Barker & Associates. The site can be accessed by Reynolds Road to the north, Resolution Drive to the east, Kay Road to the south, and Osborne Road to the west. Kay Road lies within the shared jurisdiction of Waikato District and Hamilton City Councils.

| Address | Lot Description | Area (Ha) |
|---|---|---|
| 115 Kay Road, Flagstaff | Lot 15 DP 327052 | 50.52 |
| - | Lot 2 DP 537963 | 4.56 |
| 40C Reynolds Road, Horsham Downs | Lot 3 DP 353756 | 1.32 |
| 40B Reynolds Road, Horsham Downs | Lot 2 DP 353756 | 1.44 |
| 78 Osborne Road, Horsham Downs | Lot 4 DP 440812 | 10.94 |
| 66 Reynolds Road | Lot 2 DP 356758 | 3.14 |
| | **Total Area (Ha)** | **71.92** |

*Table 1: Lot Description Table*

## Purpose of this Report

The Orchard Grove proposal is for a staged and comprehensively designed residential development, including subdivision, earthworks and land use. The proposal includes a new subdivision to create residential lots, a small neighbourhood centre, open space and recreation areas, roading and walking and cycling facilities, three waters infrastructure, and all associated site and civil works.

Approval is required under the Resource Management Act 1991 from Waikato District Council and Waikato Regional Council and Wildlife Act 1953.

This report will form part of the fast-track application. The purpose of this report is to provide the developer an initial assessment of infrastructure servicing that supports the intended for redeveloping the land.

The design and layout plan (Figure 2: Concept Development Plan prepared by Barker & Associates) has been developed through ongoing consultation and collaboration with the developer.

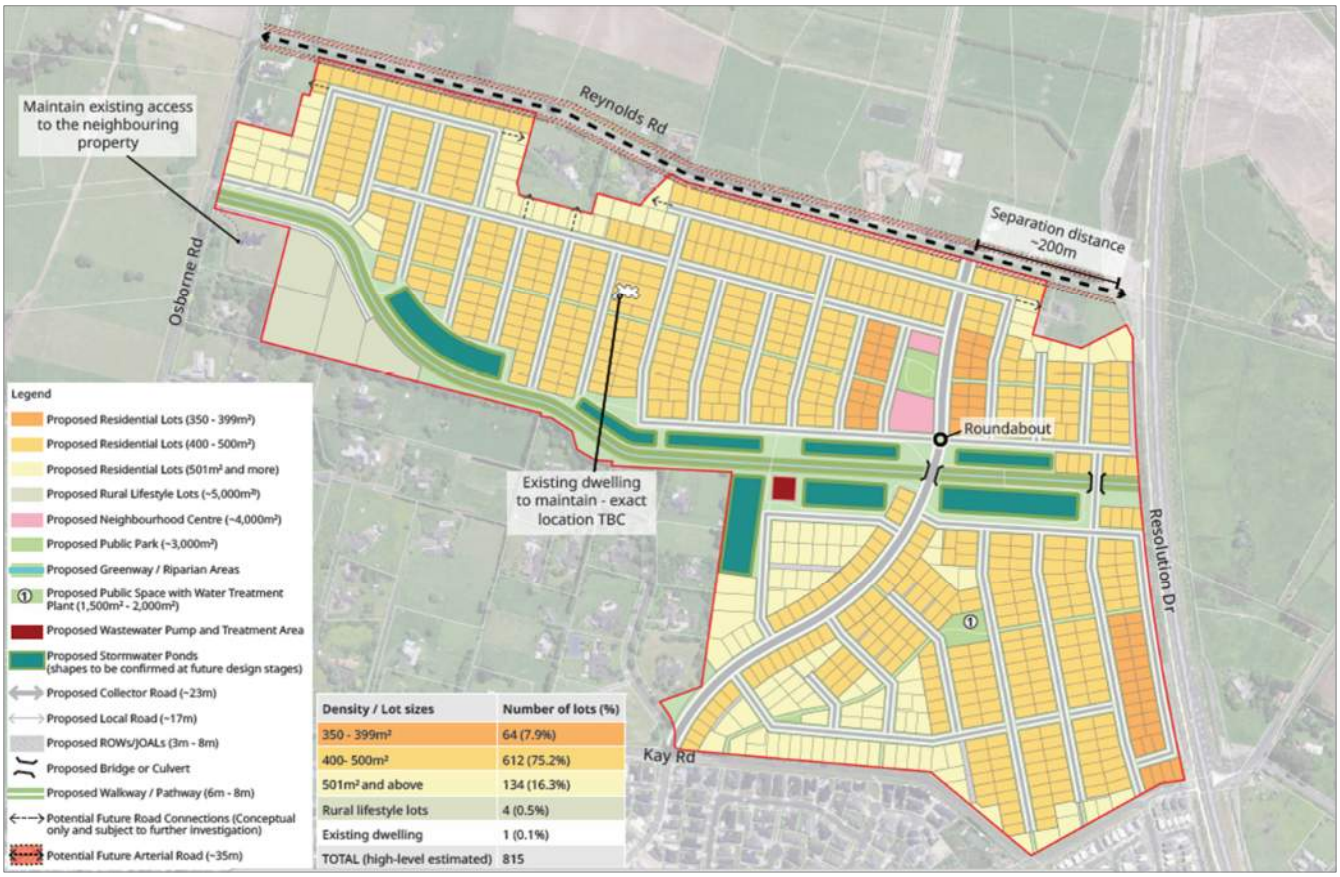



*Figure 2: Concept Development Plan*

## Residential Precinct

The 72-hectare residential community is underpinned by a series of design principles, which focus on creating a well-connected, legible and diverse community on the edge of Hamilton. The proposed ten-stage development is framed around a central greenway which runs from the eastern Resolution Drive boundary to western Osborne Road boundary.

Intersecting this is a proposed collector road connection linking the existing Kay Road residential dwellings with Reynolds Road. The wider residential precinct will be serviced by the proposed commercial area with green spaces as well as the greenway providing common areas for the community.

This transport network, supported by local roads, pedestrian and cycle connections, enables a legible grid structure in the residential area. A range of housing typologies and densities are proposed to meet the growing and changing needs of the housing market to ensure there are options for future residents.

The commercial node located in the heart of the development includes several amenities and services to support the site and wider community. The commercial node comprises an area of 0.55 hectares, half to be constructed in stage 3 and the other half in stage 8.

## Staging

Orchard Grove Development staging will include ten separate stages. The staging yields are summarised in the table below:

| Stage | Lots | Area (Ha) |
|---|---|---|
| Residential/Greenway Stage 1 | 94 | 9.62 |
| Residential/Greenway Stage 2 | 88 | 8.46 |
| Residential/Commercial Stage 3 | 51 | 7.98 |
| Rual/Greenway Stage 4 | 2 | 4.37 |
| Residential Stage 5 | 113 | 7.76 |
| Residential Stage 6 | 105 | 7.71 |
| Residential Stage 7 | 90 | 7.34 |
| Residential/Commercial Stage 8 | 110 | 7.55 |
| Residential Stage 9 | 94 | 7.064 |
| Residential Stage 10 | 59 | 3.9 |

*Table 2: Staging Table*

## Earthworks

Earthworks are required to create building platforms, roading networks, accessways, infrastructure, stormwater network devices, and drainage construction. The extent of earthworks will vary considerably depending on demand and yield driving design considerations such as developable lots, transport corridors, and protection and mitigation from flooding and overland flow.

A geotechnical desktop review for the proposed development of Orchard Grove area was undertaken by CMW Geosciences (CMW) in June 2025 (refer to Appendix B for the GWE report).

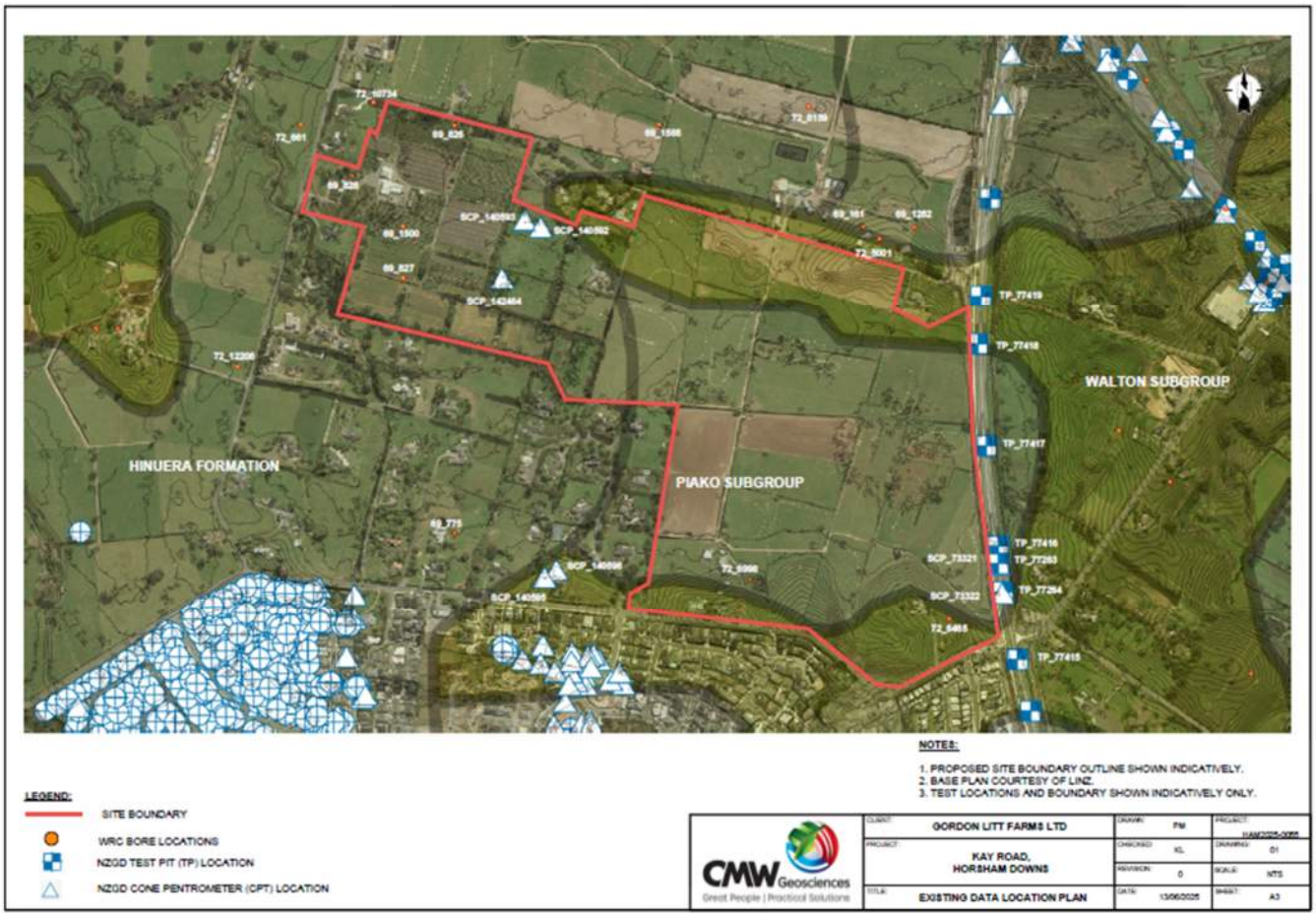



*Figure 3: Existing Data Location Plan*

## Site Geology

Site geology identified in the report shows the approximate distribution of prevailing landforms and geologies for the local area. The published geological maps for the area generally align with the geology encountered onsite as comprised of interbedded sand, silt and gravel from the Hinuera formation. Further geotechnical site investigations will be required to determine the overall ground conditions.

Historical photographs show that the site has been used for agriculture. Published geological maps for the area depict the regional geology as undifferentiated Walton subgroup alluvium, comprising pumiceous sands and silt with thin peat beds. This is overlain by late pleistocene river deposits of the Hinuera formation and subgroup. The Piako subgroup comprising of locally derived gravel, silt and peat while the Hinuera formation is made up of pumice cross bedded sand and silt with interbedded peat. This is illustrated in Figure 4.

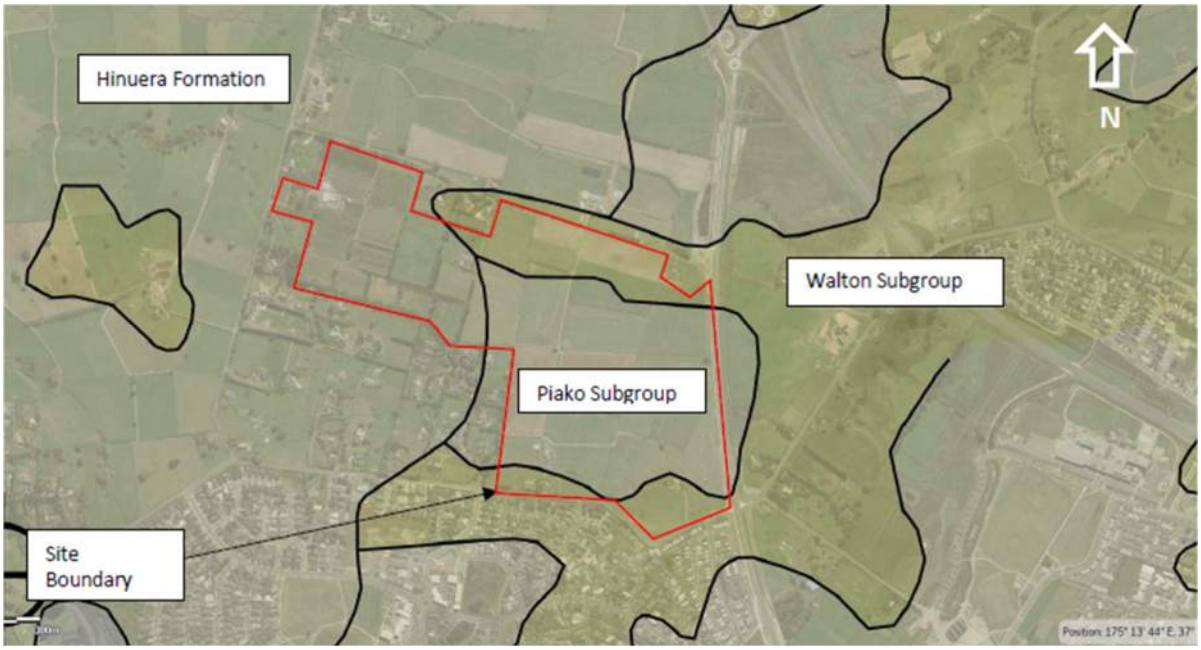



*Figure 4: Existing Prevailing Landforms Plan*

A preliminary earthworks assessment has been undertaken for the proposed development. The proposed design terrain was developed, based on the latest design requirements for roading and stormwater within the RITS guidelines. An earthworks balance was achieved, and it is summarized in Table 3, noting all volumes are solid measure and no bulking/compaction factors were applied.

| Earthworks Volumes |
|---|
| Total Cut = 409,541m³ |
| Total Fill = 395,935m³ |
| Balance (Cut) = 13,605m³ |

*Table 3: Earthworks Volumes*

## Stormwater

A preliminary stormwater strategy for the site is to set out the best practice framework for stormwater management. The stormwater is currently managed by the existing farm drains and culverts to convey the surface runoff through the site.

Refer to Appendix A for the stormwater layout drawing C400 and Appendix D for the stormwater calculations.

The existing stormwater infrastructure within the site is limited to farm/roadside drains discharging into tributary land drain (Asset ID 74644). The development of Orchard Grove will be supported by a proposed new greenway which will supersede the existing tributary land drain, this new greenway will discharge to the same primary land drain as the previous tributary drain approximately 50m further downstream.

A new public stormwater network will be created to service the site and control stormwater flows. The proposed stormwater network will include reticulation via stormwater ponds designed to mitigate flows up to a 10-year ARI event. The stormwater ponds will provide for stormwater water quality treatment for primary and secondary flows.
The future private networks would be developed by the developers. The stormwater infrastructure will need to comply with the conditions for resource consent and engineering approval before being vested with Hamilton

City Council (HCC). Where possible, the stormwater network will be designed and constructed within the roading corridors.

Key stormwater management principles that are applicable for this site can be derived from the WRC Technical Report 2020/07, as follows:

- Provision of stormwater quality treatment.
- Limit peak flow from post development to 80% of pre-development level.
- Any secondary flow paths be design to disposal of stormwater runoff up to 100 years rainfall events.
- Active management of stormwater devices to maintain flood carrying capacity.
- Secondary overland flow path needs to be considered during the design of the developments.

These principles will guide stormwater management for this site and align with regional regulations and requirements.

## Stormwater Management

The site has been divided into five catchment areas of approximately 15Ha, two on the south side of the proposed greenway and three on the northern side of the greenway. Each catchment area will discharge to a new designated stormwater pond located on each side of the greenway. Catchment area sizes have been summarized in Table 4.

| Catchment | Catchment Area (Ha) | Minimum Pond Volume Required ($m^3$) |
|---|---|---|
| A | 15.78 | 7677.37 |
| B | 14.93 | 7717.54 |
| C | 14.96 | 7471.50 |
| D | 14.90 | 7647.24 |
| E | 15.38 | 7592.01 |

*Table 4: Stormwater Catchment Areas*

Stormwater ponds will be designed in accordance with the Waikato Regional Infrastructure Technical Specifications (RITS), other relevant standards including TR20-06 Waikato Stormwater Runoff Modelling Guideline (TR20-06), and TR20-07 Waikato Stormwater Management Guideline (TR20-07). Furthermore, the proposed stormwater ponds will also combine within the pond's stormwater treatment bio retention (water quality treatment), which protects the quality of the discharge from the proposed urbanised areas. This will be designed with planting established post construction allowing treatment of the stormwater but also allows habitats to be formed for ecology.

## Greenway Precinct

The multi-functional greenway will flow from east to west along the entire project site and therefore capturing all runoff from rainfall events. This corridor interconnects infrastructure, ecological wellbeing, connectivity and amenity to support a place-based identity. A number of uses are proposed along this corridor to encourage future

residents to interact with the greenway, such as sheltered rest areas for relaxation and socialisation, active mode pathways, and play areas.

The proposed greenway is sized to accommodate the 100-year ARI stormwater event flows, less the 10-year ARI event flows. The greenway will provide the stormwater attenuation prior to discharging back into the primary land drain.

To provide for future maintenance of the greenway a 3.5m wide maintenance track will be constructed along the northern side of the greenway. The maintenance track will also provide a shared access track for pedestrians and cyclists. The greenway will have widened sections to provide some additional flood storage and to enhance the aesthetics of the greenway. The typical greenway sections are shown below.

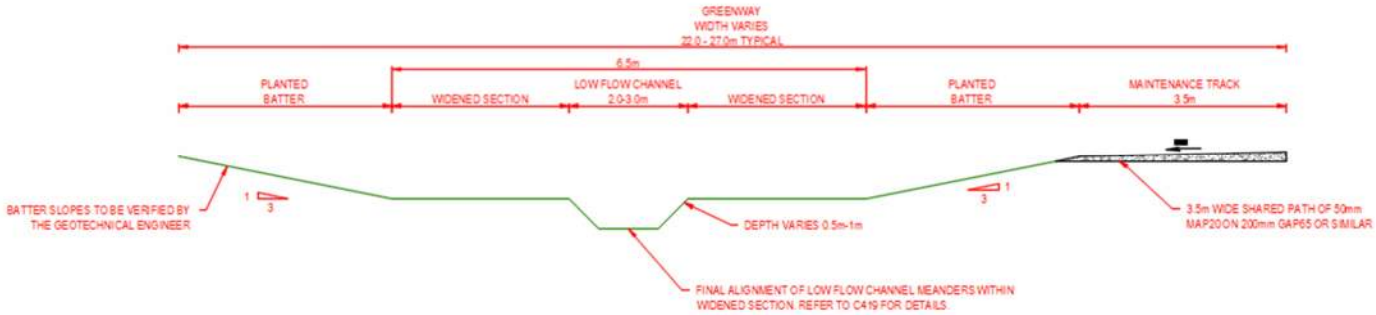



*Figure 5: Greenway Cross Section*

## Wastewater

Maven have undertaken a desktop study to identify the most suitable option for wastewater disposal for the Orchard Grove block. Reticulated, decentralised, and at source solutions have been considered. The site is in a rural location and there is limited existing gravity reticulation within the vicinity of the site to service the proposed development. A staged approach in developing the proposed infrastructure will likely be adopted, with a preference to connect into the existing wastewater infrastructure where possible. Refer to Appendix A for the concept of wastewater layout option drawings.

### Existing Public Wastewater Infrastructure

Hamilton has one centralised wastewater treatment plant in Pukete that currently treats the wastewater for the entire city. The HCC will be spending $56 million to upgrade the existing plant to provide additional capacity and upgrade the secondary treatment process at the plant. The upgrade works to the existing plant started in 2018 and were due to be completed by the end of 2024. The upgraded plant will provide for the quality, capacity, and security of Hamilton's wastewater treatment plant for the next 30 years.


*Figure 6: Pukete Wastewater Treatment Plant (Google Map)*

An existing 1050mmØ wastewater manhole is located at the intersection of Hare Puke Drive and Miharo Crescent (asset ID WWG14035) at a depth of approximately 2.26m with a FGL of RL = 30.00m (HCC GIS), refer to Figure 7. This manhole is connected to a 150mmØ uPVC main that falls towards the south and connects to the 225mmØ trunk main that runs east to west on Borman Road and terminates at the HCC pumpstation on the southern side of Borman Road, approximately 200m to the west of the Borman Road/Hara Puke Drive roundabout, refer to Figure 9.

*Figure 7: HCC Hare Puke Drive Wastewater Network (HCC GIS)*

An existing 1050mmØ wastewater manhole is located at the intersection of Borman Road and Kay Road (asset ID WWG13063) at a depth of approximately 3.4m with a FGL of RL = 29.87m (HCC GIS), refer to Figure 8. This manhole is connected to a 150mmØ uPVC main that falls towards the southeast, connects to the 225mmØ trunk main that runs west to east on Borman Road, and terminates at the HCC pumpstation on the southern side of Borman Road, approximately 200m to the west of the Borman Road/Hara Puke Drive roundabout, refer to Figure 9.

*Figure 8: HCC Kay Road Wastewater Network (HCC GIS)*


*Figure 9: HCC Borman Road Wastewater Pumpstation (HCC GIS)*

## Wastewater Reticulation

The site topography is generally flat, and the site would be predominantly serviced by gravity mains that would drain to a pump station located centrally within the development. A second pump station will transfer wastewater through the site from stage 7 to the main central pump station.

We have noted that all feasible connection points to the site will discharge to the wastewater pump station located on Borman Road. HCC will need to identify available capacity of the existing pumpstation for a final design to be completed. Discharging waste from the proposed pump station on site could be staged to discharge in off-peak times depending on availability. We have calculated the volume of additional flows forecasted by the 72ha development as 8.911 Liters per second at PWWF, refer Table 5 below.

**WW Calculations - Pre Development Catchment Area (Site)**

| | | | |
|---|---|---|---|
| **Project:** | Orchard Grove | Job Number: | 407001 |
| **Client:** | Gordan Litt Farm | | |
| **Calculation by:** | N.D.L | Date: | 26/08/2025 |
| **Checked by:** | D.J.M | | |

| ***Design flow as per 5.2.4.7 Design criteria*** | | | |
|---|---|---|---|
| **Proposed development area:** | | ***Residential Total*** | **71.48** |
| | | ***Commercial Total*** | **0.44** |
| | | ***Project area total*** | **71.92** |
| ***Designed Dwellings total (If known)*** | | | ***815*** |
| **Zones** | **Area (Ha)** | **Population Equivalent (persons per Ha)** | **Sub Total** |
| Residential - General | 28.25 | 70 | 1978 |
| Residential - Medium Density | 8.88 | 120 | 1066 |
| Residential - High Density | 2.47 | 150 | 371 |
| Central City Zone | 0 | 300 | 0 |
| Residential - Large Lot | 0.26 | 45 | 12 |
| Future Urban Zones | | 70 | 0 |
| All Business , Community Facility's, Industrial Zones | 0.44 | 45 | 20 |
| Primary Schools | 0 | 45 | 0 |
| Secondary Schools | 0 | 150 | 0 |
| | **Beds** | **Population Per Bed** | |
| Hospitals | 0 | 3.5 | 0 |
| Motels | 0 | 0.6 | 0 |
| ***Residential Total*** | ***39.86*** | | ***3425.30*** |
| ***Commercial Total*** | ***0.44*** | | ***19.80*** |
| | | ***Total Population*** | ***3445.10*** |

| **Peaking Factor: Refer RITS 5.2.4.6 Table 90** | | |
|---|---|---|
| ***Residential*** | 3425 | 2.6 |
| ***Commercial*** | 20 | 8.5 |

| **PARAMETERS** | | | |
|---|---|---|---|
| Water consumption | 200 | Litres Per person per day | 689020.00 |
| Infiltration allowance | 2250 | Litres Per Hectare per day | 90675.00 |
| Surface water ingress | 16500 | Litres Per Hectare per day | 664950.00 |

| ***Catchment Results*** | | | |
|---|---|---|---|
| Average dry wether flow: (200 liters per day. per person) + (Infiltration allowance X Catchment area) | | | |
| ADF | ***M³ PER Day*** | | ***779.695*** |
| Peak daily flow: ( (Peaking factor X (200 liters per day. per person)) + (Infiltration allowance X Catchment area))/ 86400 | | | |
| PDF | ***LITERS PER SECOND*** | | ***1.155*** |
| Peaking wet weather flow (PWWF or Exceptional PDWF): ( (Peaking factor X (200 liters per day. per person)) + (Infiltration allowance X Catchment area +Surface water ingress))/ 86400 | | | |
| PWWF | ***LITERS PER SECOND*** | | ***8.851*** |

*Table 5: Wastewater Catchment Areas*

## Wastewater Catchments and Management Options

### Option A

Orchard Grove has been divided into three catchment areas; south of Greenway (Catchment A), northwest (Catchment C), and northeast (Catchment B). The first proposed pump station will be located within Catchment A with the second pump to be located within Catchment C.

Catchment A and B will directly discharge into the proposed pump station located in Catchment A via a gravity network.

We have proposed two possible discharge locations for Catchment C due to the site being so flat that a gravity network over the entire development cannot be installed at a reasonable depth.
The first option would be to pump wastewater back into Catchment B and discharge via the proposed gravity network to the Catchment A pump station (Appendix A-Drawing C132A).

### Option B

The second option would be to extend the public network on Kay drive towards Osborne Road and have a second connection point to the public network (Appendix A-Drawing C132B).

The proposed wastewater gravity reticulation network within Catchment A & B, to be gravity feed into the new wastewater pump station within Catchment A, will then be discharged through a new rising main and discharge to the existing public network at manhole Unit ID WWG14035 - Hare Puke Drive.

Catchment C will also discharge to Unit ID WWG14035 - Hare Puke Drive via Catchment B and A or directly to Unit ID WWG13063 - Key Road.

## Option C

Only if the Council confirms there is no capacity in the existing line, we will pursue an alternative option of decentralised treatment.

Recognising the issues and constraints around traditional centralised solutions identified above, Maven have considered "at source" and "decentralised" wastewater treatment solutions as a final solution if a suitable discharge point to the existing network is unachievable.

At source wastewater treatment solutions are being considered, but discounted, as treatment devices will significantly reduce the available yield that can be achieved due to the need for large lot sizes to provide for sufficient secondary treatment area, rendering development in the area unfeasible.

Decentralised treatment would provide a long-term solution for the Gordon Litt Farm.

Recent advances in onsite wastewater treatment plant technology have enabled package plants to be implemented to land development projects elsewhere in New Zealand. (A case study is presented in Appendix C.) The benefits of doing so would avoid capacity constraints on existing infrastructure and enable early release of developable areas. Whilst treated liquid waste is "clean" and can be discharged to a stream environment, consideration would need to be given to the effects of such discharge into the environment for water quality. Other considerations such as ongoing running and maintenance costs, ownership and operation requirements, etc will also need to be considered.

The treated greywater would discharge to the ground prior to entering an artificial wetland. The treated sludge would then be carted offsite using a honey sucker truck and then sent to a nearby approved landfill or worm farm for offsite disposal.

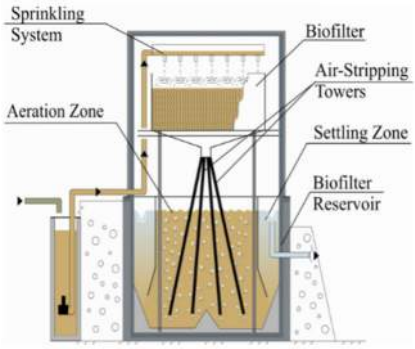



*Figure 10: Wastewater Treatment Plant Process*

## Water supply

Maven have undertaken a desktop study to identify the most suitable option for potable water for the Orchard Grove block area. Reticulated and decentralised solutions have been considered. Refer to Appendix A for the proposed water layout drawing.

### Existing Public Infrastructure

Hamilton has one centralised water treatment plant located at 1A Waiora Terrace, Fitzroy, Hamilton that currently treats the water from the Waikato River that provides water supply for Hamilton city.

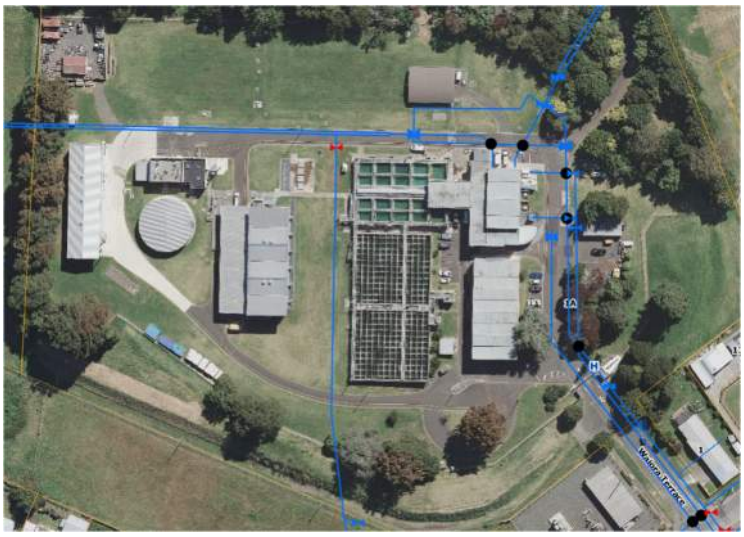


*Figure 11: HCC Water Treatment Plant*

The nearest water reservoir to the Orchard Grove block is the Rototuna water reservoir (asset ID WSUROTOTUNA). The reservoir is located at 77 Ennion Rise, approximately 500m to the east of the proposed development.

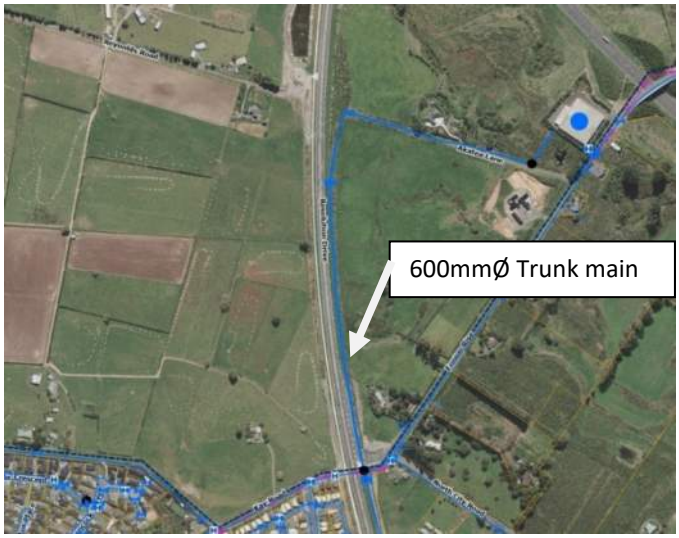



*Figure 12: Rototuna Water Reservoir*

Two 600mm Bulk mains run along the eastern side of Resolution drive passing through the Ennion Rise, Resolution Drive intersection.

An existing HCC 250mmØ uPVC trunk main runs along the southern side of Kay Road from Resolution Drive to the southwest for approximately 270m, before continuing southwest to Borman Road. An existing HCC 50mmØ uPVC rider main continues along the southern side for the remainder of Kay Road to the intersection of Kay Road and Borman Road.

An existing HCC 250mmØ trunk main runs along the northern side of Borman Road, terminating at the intersection with Kay Road. An existing HCC 150mmØ water main runs along the western side of Hare Puke Drive, terminating at the intersection with Kay Road, (note comment below).

While not shown on GIS, it appears that either a 150mm or 250mm bulk main may also run along the southern side of Kay Road. It has been excluded from the desktop study; however additional investigation is recommended.


*Figure 13: Kay Road Trunk Main (HCC GIS)*


*Figure 14: Hare Puke Drive Water Main (HCC GIS)*


*Figure 15: Borman Road Trunk Main (HCC GIS)*

An existing WDC 100mmØ PVC-M water main runs along the northern side of Kay Road, between Oaktree Lane and Avian Place, before transitioning into a 150mmØ PVC-M watermain between Avian Place and Osborne Road, continuing along the eastern side of Osborne Road before transitioning into a 200mmØ PVC-M watermain, and heading east through the existing farm paddocks (approximately 300m to the south of the Reynolds Road intersection).

An existing WDC 63mmØOD MDPE rider main runs from Kay Road, along the western side of Oaktree Lane to the end.

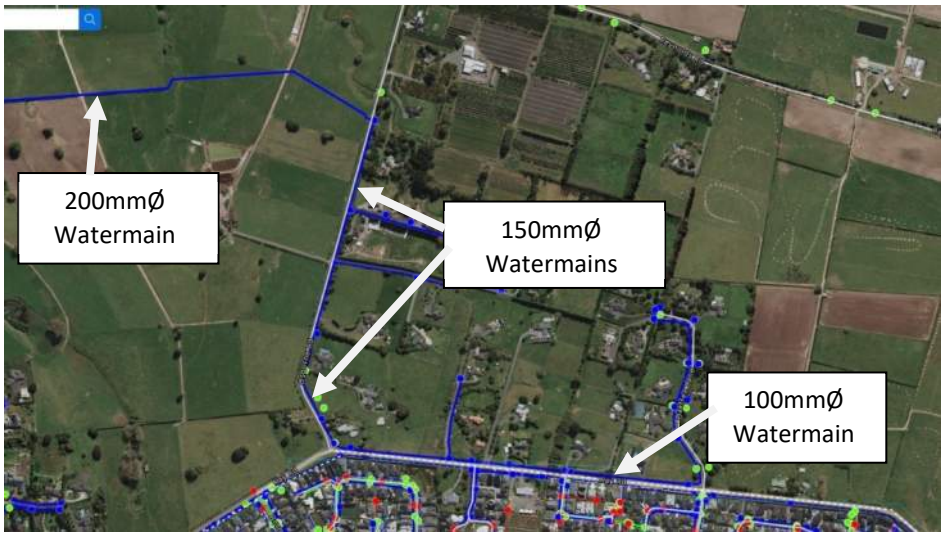
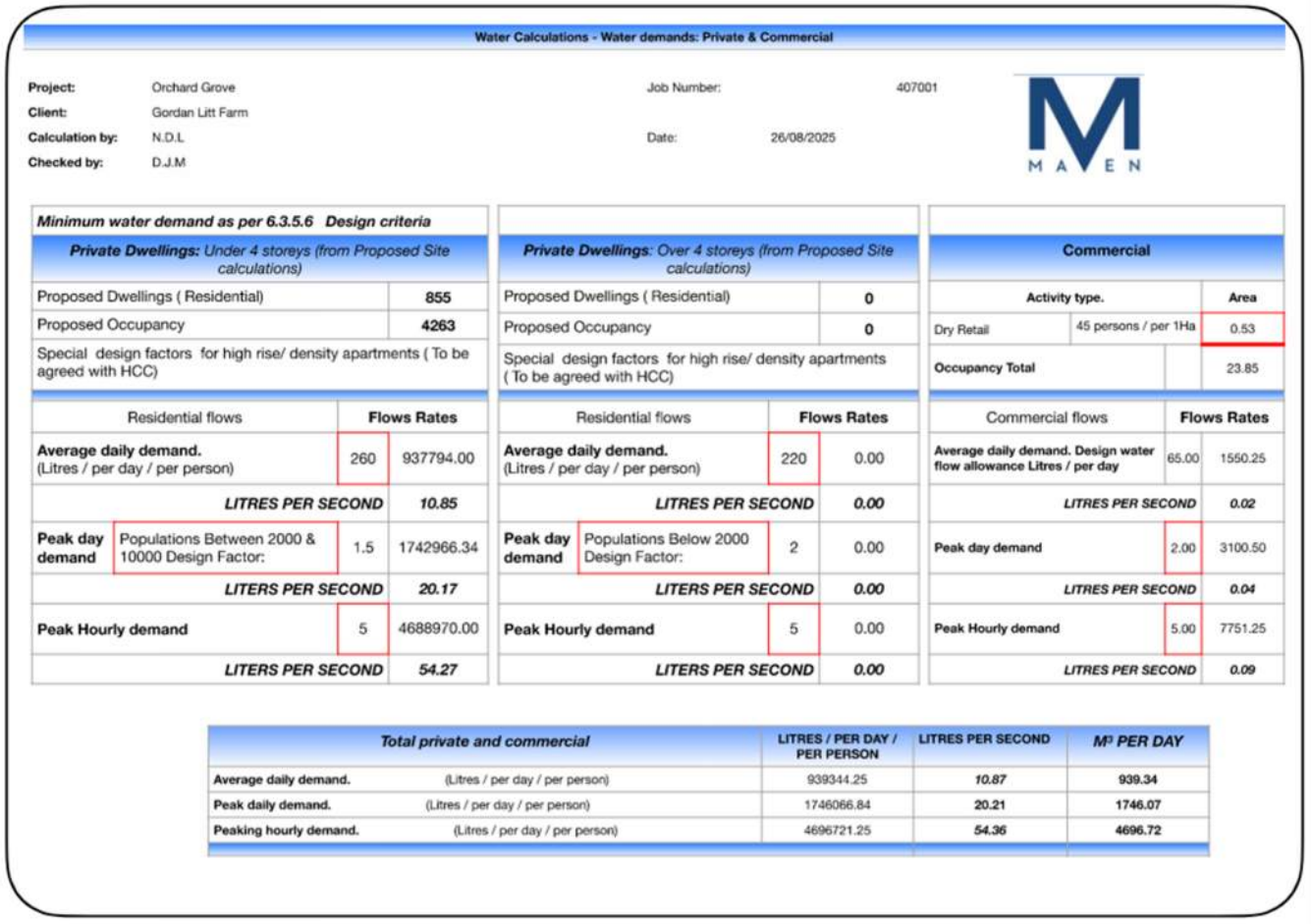



*Figure 16: WDC Water Supply Network (COLAB GIS)*

## Proposed Water Supply

Service the entire development from the public network. Initially looking to extend the existing 250mm trunk main from the intersection located on Key Road into the site to service the stages it can support.

Next construct a new 450OD HDPE portable water bulk main off one of the 600 DI bulk mains near the intersection of Resolution Drive and Ennion Rise. The new 450OD HDPE bulk main will follow Kay Road through to the main entrance of Orchard Grove, it will follow the spine road and will terminate at the intersection of the spine road and Reynolds Road. (Refer Appendix A Drawing C133)



**Water Calculations - Water demands: Private & Commercial**

| | | | |
|---|---|---|---|
| **Project:** | Orchard Grove | Job Number: | 407001 |
| **Client:** | Gordan Litt Farm | | |
| **Calculation by:** | N.D.L | Date: | 26/08/2025 |
| **Checked by:** | D.J.M | | |

***Minimum water demand as per 6.3.5.6 Design criteria***

***Private Dwellings:*** *Under 4 storeys (from Proposed Site calculations)*

| | |
|---|---|
| Proposed Dwellings ( Residential) | **855** |
| Proposed Occupancy | **4263** |
| Special design factors for high rise/ density apartments ( To be agreed with HCC) | |

| Residential flows | | Flows Rates |
|---|---|---|
| **Average daily demand.** (Litres / per day / per person) | 260 | 937794.00 |
| ***LITRES PER SECOND*** | | ***10.85*** |
| **Peak day demand** Populations Between 2000 & 10000 Design Factor: | 1.5 | 1742966.34 |
| ***LITERS PER SECOND*** | | ***20.17*** |
| **Peak Hourly demand** | 5 | 4688970.00 |
| ***LITERS PER SECOND*** | | ***54.27*** |

***Private Dwellings****: Over 4 storeys (from Proposed Site calculations)*

| | |
|---|---|
| Proposed Dwellings ( Residential) | **0** |
| Proposed Occupancy | **0** |
| Special design factors for high rise/ density apartments ( To be agreed with HCC) | |

| Residential flows | | Flows Rates |
|---|---|---|
| **Average daily demand.** (Litres / per day / per person) | 220 | 0.00 |
| ***LITRES PER SECOND*** | | ***0.00*** |
| **Peak day demand** Populations Below 2000 Design Factor: | 2 | 0.00 |
| ***LITERS PER SECOND*** | | ***0.00*** |
| **Peak Hourly demand** | 5 | 0.00 |
| ***LITERS PER SECOND*** | | ***0.00*** |

**Commercial**

| Activity type. | | Area |
|---|---|---|
| Dry Retail | 45 persons / per 1Ha | 0.53 |
| **Occupancy Total** | | 23.85 |

| Commercial flows | | Flows Rates |
|---|---|---|
| **Average daily demand. Design water flow allowance Litres / per day** | 65.00 | 1550.25 |
| ***LITRES PER SECOND*** | | ***0.02*** |
| **Peak day demand** | 2.00 | 3100.50 |
| ***LITRES PER SECOND*** | | ***0.04*** |
| **Peak Hourly demand** | 5.00 | 7751.25 |
| ***LITRES PER SECOND*** | | ***0.09*** |

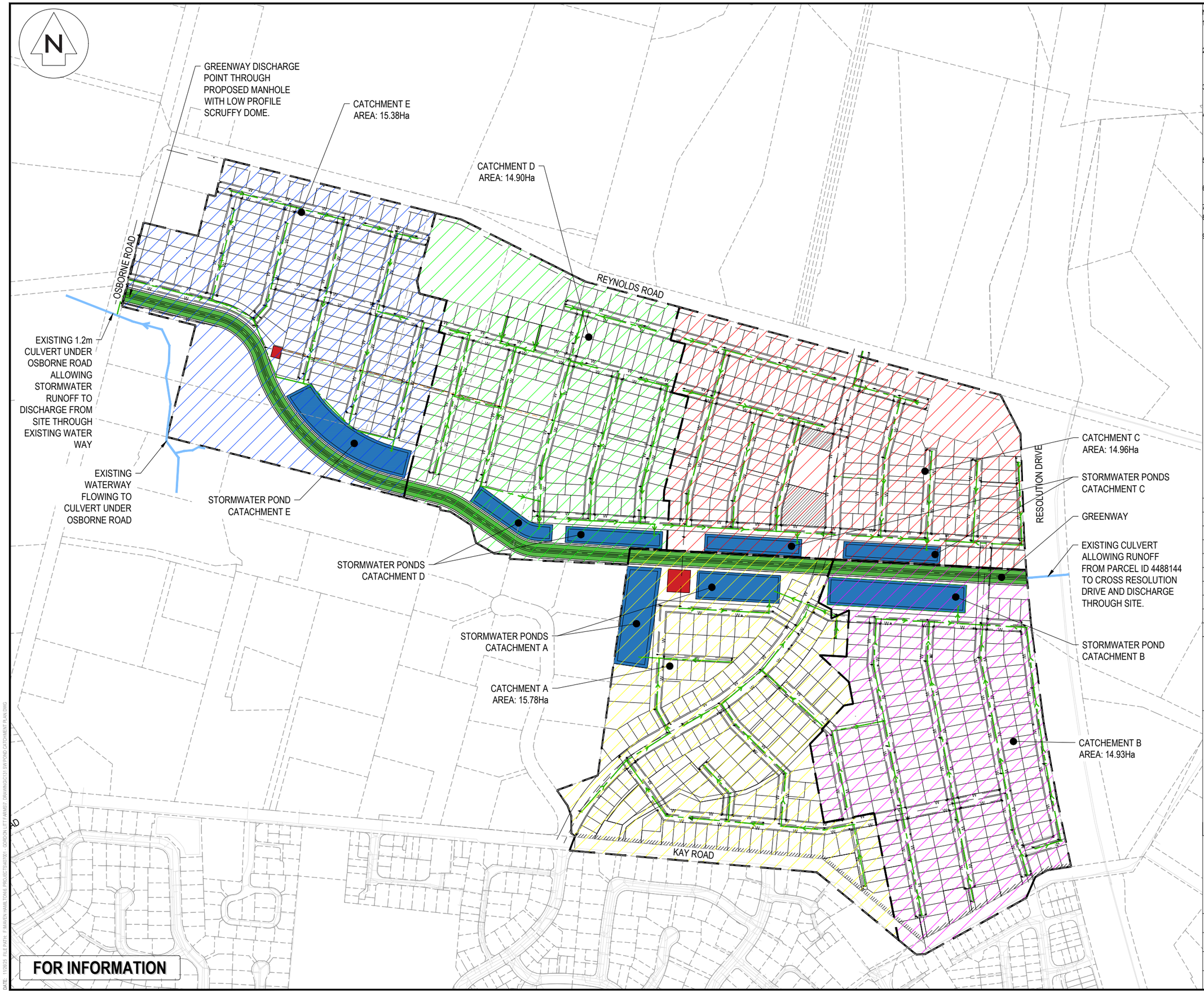
| ***Total private and commercial*** | | **LITRES / PER DAY / PER PERSON** | **LITRES PER SECOND** | ***M³ PER DAY*** |
|---|---|---|---|---|
| **Average daily demand.** | (Litres / per day / per person) | 939344.25 | ***10.87*** | **939.34** |
| **Peak daily demand.** | (Litres / per day / per person) | 1746066.84 | **20.21** | **1746.07** |
| **Peaking hourly demand.** | (Litres / per day / per person) | 4696721.25 | ***54.36*** | **4696.72** |

*Figure 17: WDC Water Supply Network Calculations*

If council believe these is insufficient supply to service the proposed subdivision we would look to connect into the existing network where possible as covered above. If there are areas identified that will not be able to be serviced by the existing water infrastructure, then water bores would be considered.

We would recommend GA to investigate possibility of the central and southern catchment water bores to supply the required water needs. Existing bores could pump the raw ground water to a centralised water treatment for water treatment. The treated water could then be pumped to the new southern water reservoir for servicing the southern catchment. For the northern water bore it would not pass through any water treatment, and the raw water would only provide raw water supply to the industrial areas and firefighting supply.

# APPENDIX A – Maven Overview Plans




NOTES

1. ALL WORKS TO BE IN ACCORDANCE WITH WAIKATO REGIONAL INFRASTRUCTURE TECHNICAL SPECIFICATIONS.
2. CO-ORDINATES IN TERMS OF NZ GEODETIC DATUM MT EDEN 2000. LEVELS IN TERMS OF THE NEW ZEALAND VERTICAL DATUM 2016. CONVERSION TO MOTURIKI 1953 CAN BE ACHIEVED BY ADDING ???m.
3. IT IS THE CONTRACTORS RESPONSIBILITY TO LOCATE ALL SERVICES THAT MAY BE AFFECTED BY HIS OPERATIONS.
4. ALL CONCRETE SW PIPE TO BE INSTALLED IN ACCORDANCE WITH AS/NZS 3725:2007 FOR BURIED CONCRETE PIPES AND AS/NZ 4058:2007 FOR PRECAST CONCRETE PIPES (PRESSURE AND NON-PRESSURE) AS STIPULATED IN THE RITS 2018
5. APPROVED HARDFILL IS TO BE USED IN BACKFILLING OF ALL STORMWATER LINES WITHIN THE ROAD RESERVE.
6. HEAVY DUTY MANHOLE LIDS AND FRAMES TO BE USED IN TRAFFICKED AREAS.
7. ALL CESSPIT LEADS SHALL HAVE MIN COVER 0.9m.
8. ALL LINES ARE TO BE CLASS4 RCRRJ UNLESS SHOWN OTHERWISE.
9. ALL LINES TO BE ABANDONED SHALL BE SEALED AT EACH END. TIMING OF ALL SEALING TO BE COORDINATED WITH COUNCIL STAFF.

LEGEND

- EX BDY
- EX STREAM
- PROP BDY
- STAGE BOUNDARY
- PR STORMWATER
- PR STORMWATER POND
- PR GREENWAY
- PR WASTEWATER PUMP STATION

| Rev | Description | By | Date |
|---|---|---|---|
| B | MASTER PLAN UPDATE | NDL | 11/2025 |
| A | DRAFT | NDL | 07/2025 |

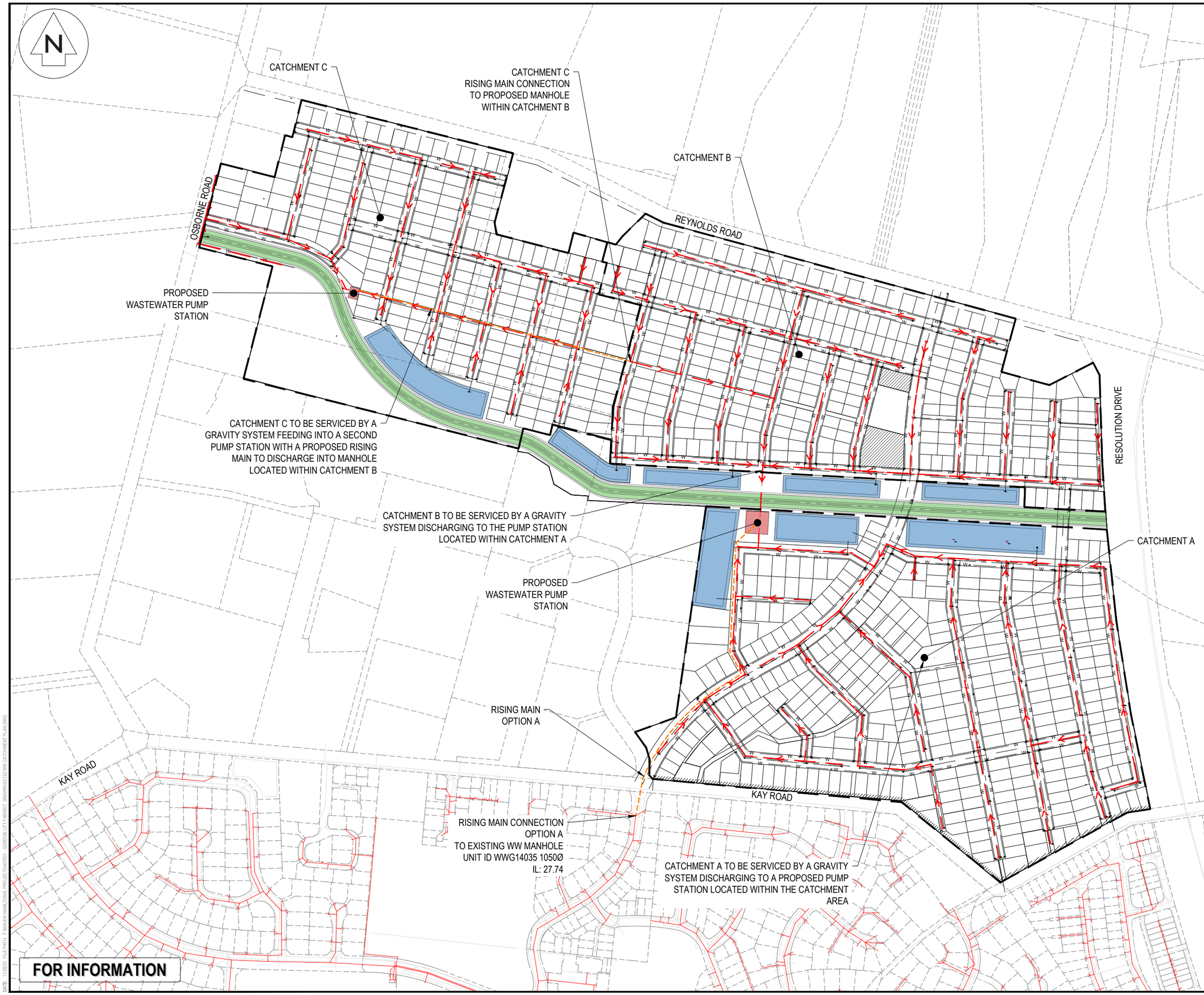
| | By | Date |
|---|---|---|
| Survey | Blue Wallace | 06/2025 |
| Design | NDL | 07/2025 |
| Drawn | NDL | 07/2025 |
| Checked | DJM | 07/2025 |

Maven Waikato
07 242 0601
info@maven.co.nz
www.maven.co.nz
Level 1 286 Victoria Street, Hamilton
New Zealand

Project
# ORCHARD GROVE FOR GORDON LITT FARM

Title
# STORMWATER POND CATCHMENT PLAN

| | |
|---|---|
| Project no. | 407001 HT1 |
| Scale | 1:5000 @ A3 |
| Cad file | C131 SW POND CATCHMENT PLAN.DWG |
| Drawing no. | C131 Rev B |




**FOR INFORMATION**

NOTES
1. ALL WORKS TO BE IN ACCORDANCE WITH WAIKATO REGIONAL INFRASTRUCTURE TECHNICAL SPECIFICATIONS.
2. CO-ORDINATES IN TERMS OF NZ GEODETIC DATUM MT EDEN 2000.
3. LEVELS IN TERMS OF THE NEW ZEALAND VERTICAL DATUM 2016.
4. BOUNDARIES ARE SUBJECT TO FINAL SURVEY.

LEGEND
- EX BDY
- PROP BDY
- STAGE BOUNDARY
- PR WASTEWATER
- PR STORMWATER POND
- PR GREENWAY
- PR WASTEWATER PUMP STATION

| Rev | Description | By | Date |
|---|---|---|---|
| | | | |
| | | | |
| B | MASTER PLAN CHANGE | NDL | 11/2025 |
| A | DRAFT | NDL | 07/2025 |

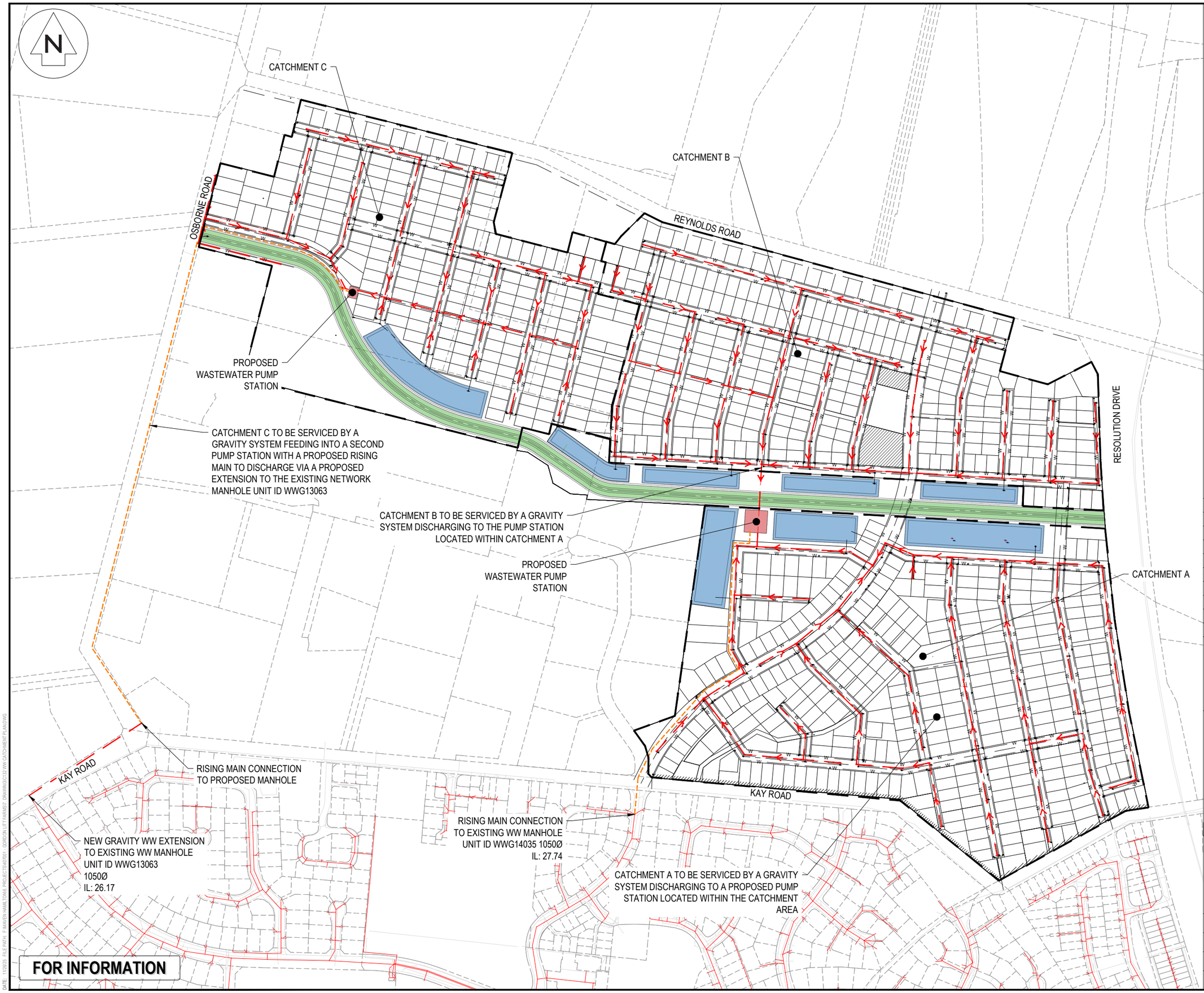
| | By | Date |
|---|---|---|
| Survey | Blue Wallace | 06/2025 |
| Design | NDL | 07/2025 |
| Drawn | NDL | 07/2025 |
| Checked | DJM | 07/2025 |

Maven Waikato
07 242 0601
info@maven.co.nz
www.maven.co.nz
Level 1 286 Victoria Street, Hamilton
New Zealand

Project
**ORCHARD GROVE FOR GORDON LITT FARM**

Title
**PROPOSED WASTEWATER STAGING OVERVIEW PLAN OPTION A**

| | | | |
|---|---|---|---|
| Project no. | 407001 HT1 | | |
| Scale | 1:5000 @ A3 | | |
| Cad file | C132 WW CATCHMENT PLAN.DWG | | |
| Drawing no. | C132A | Rev | B |




NOTES

1. ALL WORKS TO BE IN ACCORDANCE WITH WAIKATO REGIONAL INFRASTRUCTURE TECHNICAL SPECIFICATIONS.
2. CO-ORDINATES IN TERMS OF NZ GEODETIC DATUM MT EDEN 2000.
3. LEVELS IN TERMS OF THE NEW ZEALAND VERTICAL DATUM 2016.
4. BOUNDARIES ARE SUBJECT TO FINAL SURVEY.

LEGEND

- EX BDY
- PROP BDY
- STAGE BOUNDARY
- PR STORMWATER
- PR WASTEWATER
- PR STORMWATER POND
- PR GREENWAY
- PR WASTEWATER PUMP STATION

| Rev | Description | By | Date |
|---|---|---|---|
| B | MASTER PLAN CHANGE | NDL | 11/2025 |
| A | DRAFT | NDL | 07/2025 |

| | By | Date |
|---|---|---|
| Survey | Blue Wallace | 06/2025 |
| Design | NDL | 07/2025 |
| Drawn | NDL | 07/2025 |
| Checked | DJM | 07/2025 |

Maven Waikato
07 242 0601
info@maven.co.nz
www.maven.co.nz
Level 1 286 Victoria Street, Hamilton
New Zealand

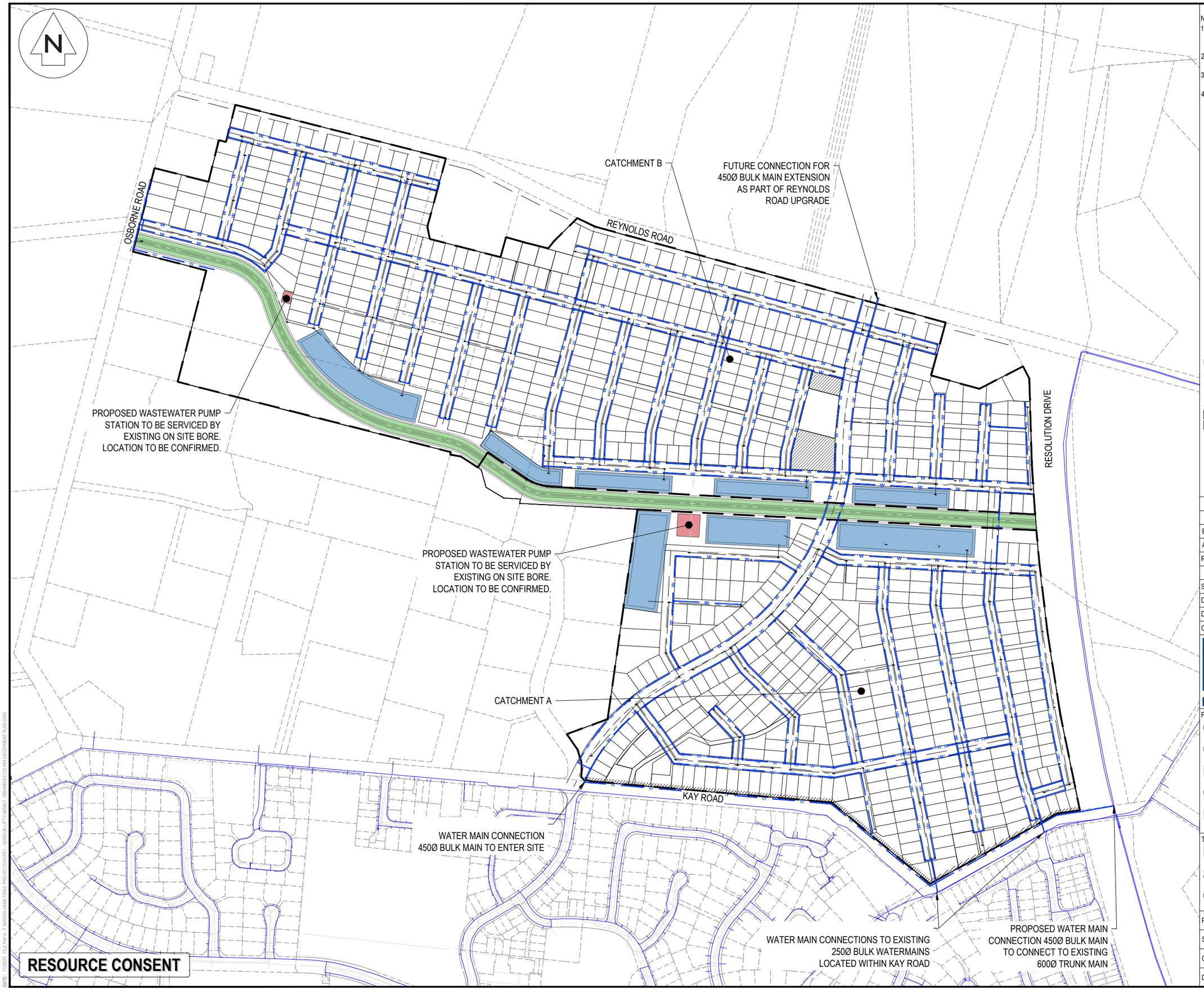
Project

# ORCHARD GROVE FOR GORDON LITT FARM

Title

## PROPOSED WASTEWATER STAGING OVERVIEW PLAN OPTION B

| | | | |
|---|---|---|---|
| Project no. | 407001 HT1 | | |
| Scale | 1:5000 @ A3 | | |
| Cad file | C132 WW CATCHMENT PLAN.DWG | | |
| Drawing no. | C132B | Rev | B |




**RESOURCE CONSENT**

NOTES
1. ALL WORKS TO BE IN ACCORDANCE WITH WAIKATO REGIONAL INFRASTRUCTURE TECHNICAL SPECIFICATIONS.
2. CO-ORDINATES IN TERMS OF NZ GEODETIC DATUM MT EDEN 2000.
3. LEVELS IN TERMS OF THE NEW ZEALAND VERTICAL DATUM 2016.
4. BOUNDARIES ARE SUBJECT TO FINAL SURVEY.

LEGEND
- EX BDY
- PROP BDY
- STAGE BOUNDARY
- PR WATER MAINS
- PR STORMWATER POND
- PR GREENWAY
- PR WASTEWATER PUMP STATION

| | | | |
|---|---|---|---|
| | | | |
| | | | |
| B | FAST TRACK APP | NDL | 11/2025 |
| A | DRAFT | NDL | 07/2025 |
| Rev | Description | By | Date |

| | By | Date |
|---|---|---|
| Survey | Blue Wallace | 06/2025 |
| Design | NDL | 07/2025 |
| Drawn | NDL | 07/2025 |
| Checked | DJM | 07/2025 |

Maven Waikato
07 242 0601
info@maven.co.nz
www.maven.co.nz
Level 1 286 Victoria Street, Hamilton
New Zealand

Project
# ORCHARD GROVE FOR GORDON LITT FARM

Title
## PROPOSED WATER SUPPLY STAGING PLAN OPTION A OVERVIEW

| | |
|---|---|
| Project no. | 407001 HT1 |
| Scale | 1:5000 @ A3 |
| Cad file | C133 WM CATCHMENT PLAN.DWG |
| Drawing no. | C133 Rev B |

# APPENDIX B – CMW GIR Report

CMW Geosciences
Great People | Practical Solutions

17 November 2025

Orchard Grove Development

Kay Road, Horsham Downs

# PRELIMINARY GEOTECHNICAL DESKTOP REPORT

Gordon Litt Farms Ltd

Job No. HAM2025-0055AB | Version 3

**Hamilton**

Level 1 | Block C
401 Grey Street
Hamilton 3216
New Zealand

Ph: +64 7 2820 039

www.cmwgeosciences.com

## Version Control

| Document version information | |
|---|---|
| **Job number** | HAM2025-0055AB |
| **Prepared by** | Peta McGiven, Engineering Geologist |
| **Reviewed by** | Dave Sullivan, Principal Geotechnical Engineer CMEngNZ, CPEng |
| **Authorised by** | Kori Lentfer, Associate Engineering Geologist CMEngNZ, PEngGeol |

## Review and Update History

| Revision | Date | Comments |
|---|---|---|
| A | 10 June 2025 | Initial draft for internal review |
| 0 | 16 June 2025 | Report issue |
| 1 | 19 August 2025 | Updated following client's comments to proposed development and further work. |
| 2 | 08 September 2025 | Updated following client's comments to proposed development and further work. |
| 3 | 17 November 2025 | Updated following changes to the masterplan. |

# CONTENTS



## Appendices

# 1.0 INTRODUCTION

## 1.1 Scope

CMW Geosciences (CMW) was engaged by Gordon Litt Farms Ltd to carry out a geotechnical desktop assessment of a site located at Kay Road, Horsham Downs, to support a fast-track referral application for a proposed residential subdivision.

The scope of work and associated terms and conditions of our engagement were detailed in our services proposal letter referenced HAM2025-0055AA, Rev 0 dated 20 May 2025.

This report has been prepared to summarise expected ground conditions and provided preliminary recommendations for possible geohazards, foundation and site-specific geotechnical testing.

# 2.0 SITE DESCRIPTION

## 2.1 Site Location

The proposed development (Orchard Grove) is located on Kay Road, Hamilton, as shown in Figure 1. The site comprises an area of approximately 69ha and is currently used for agricultural and horticultural purposes.

The site is bordered by Osborne Road to the west, Reynolds Road to the north, Resolution Drive to the east, and Kay Road and residential/lifestyle blocks to the south.

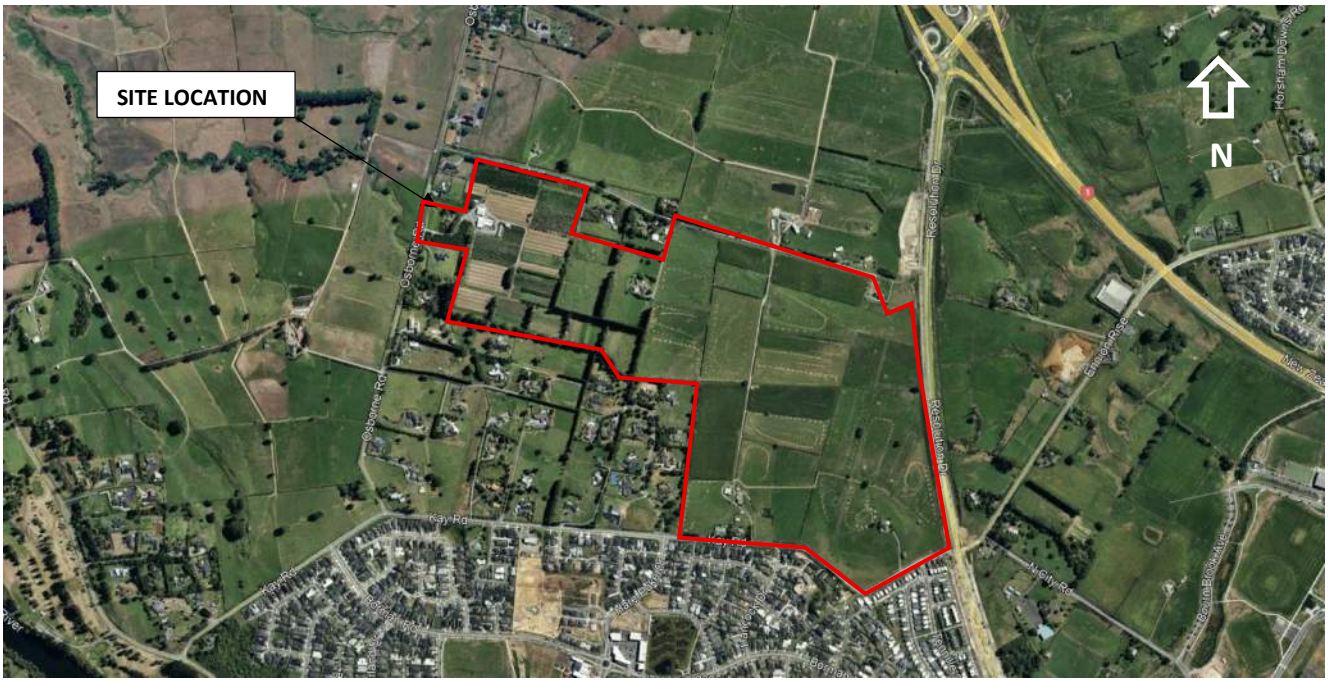



Figure 1: Site Location Plan (Source: Google Earth Pro).

## 2.2 Landform

The landform is predominantly flat in the central part of the site from the eastern boundary to the north-western corner. Two moderately steep hills are present at the site. One is along Kay Road, which has a gradient of up to 1v:2h sloping to the southeast and one at Renyolds Road with a gradient of up to 1v:5.5h sloping to

the northeast. Existing ground levels ranging from RL44m in the southern corner along Kay Road to RL26m in the gully along the western boundary.

A shallow gully system runs along near western boundary and flows via a culvert beneath Osborne Road. The gully system feeds into the Waikato River, approximately 1.5km west of the proposed subdivision. Farm drains that run through the site also connect to this gully system.

## 2.3 Proposed Development

The Orchard Grove development is a proposed residential development as shown in Figure 2. The development includes residential lots, a neighbourhood centre, recreational areas, roading and walking and cycling facilities, and associated three waters infrastructure.

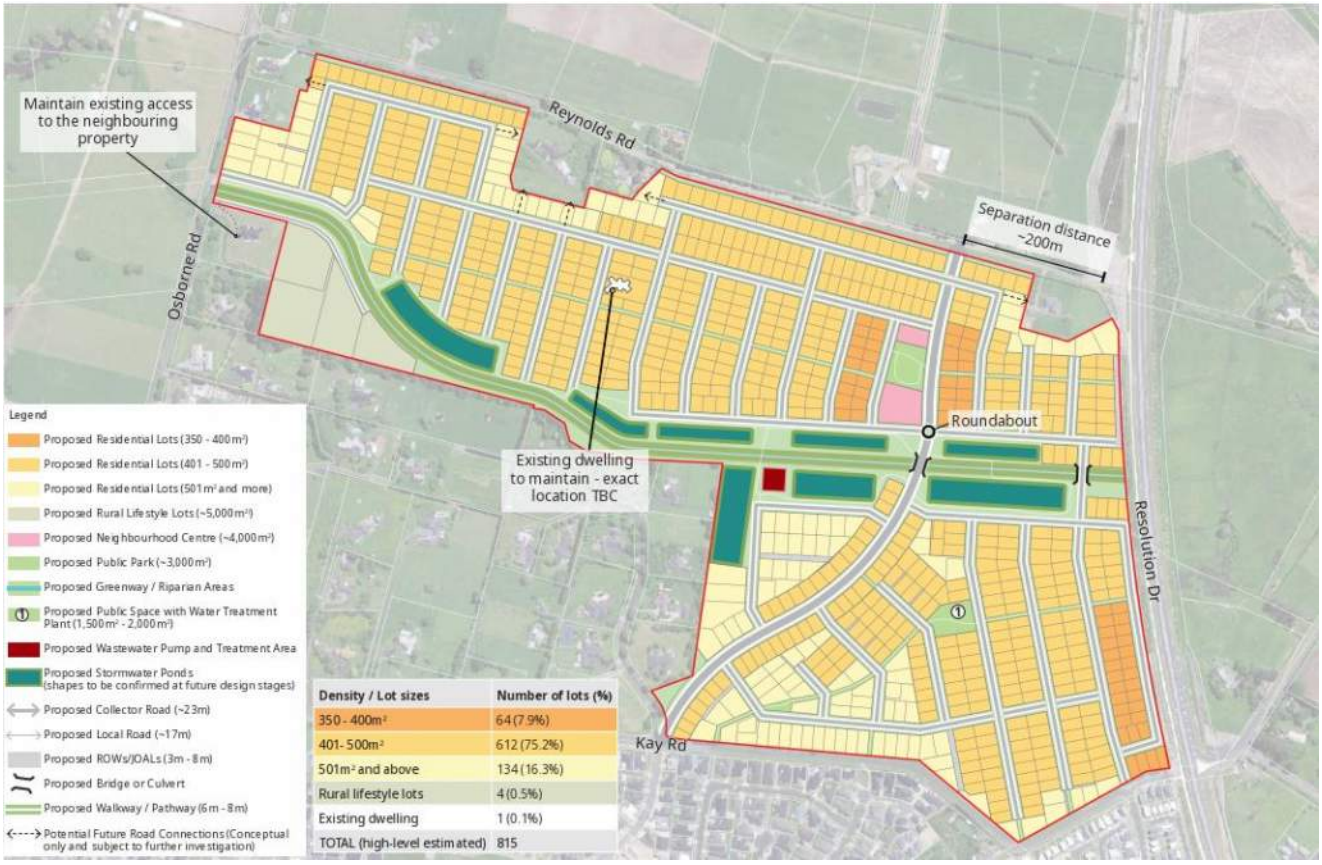



Figure 2: Orchard Grove Masterplan (Source: Barker & Associates).

# 3.0 CONCEPTUAL GROUND MODEL

## 3.1 Geology

Published geological maps[1] for the area depict the regional geology as undifferentiated Walton Subgroup alluvium comprising pumiceous sands and silt with thin peat beds. This is overlain by late Pleistocene River deposits of the Hinuera Formation and Piako Subgroup. The Piako Subgroup made up of locally derived gravel,

[1] GNS Geological Map 1:250,000 scale Geological Map No 4 'Waikato'. SW Edbrooke et al.

silt and peat while the Hinuera Formation is made up of pumice cross bedded sand and silt with interbedded peat. This is illustrated in Figure 3 below.

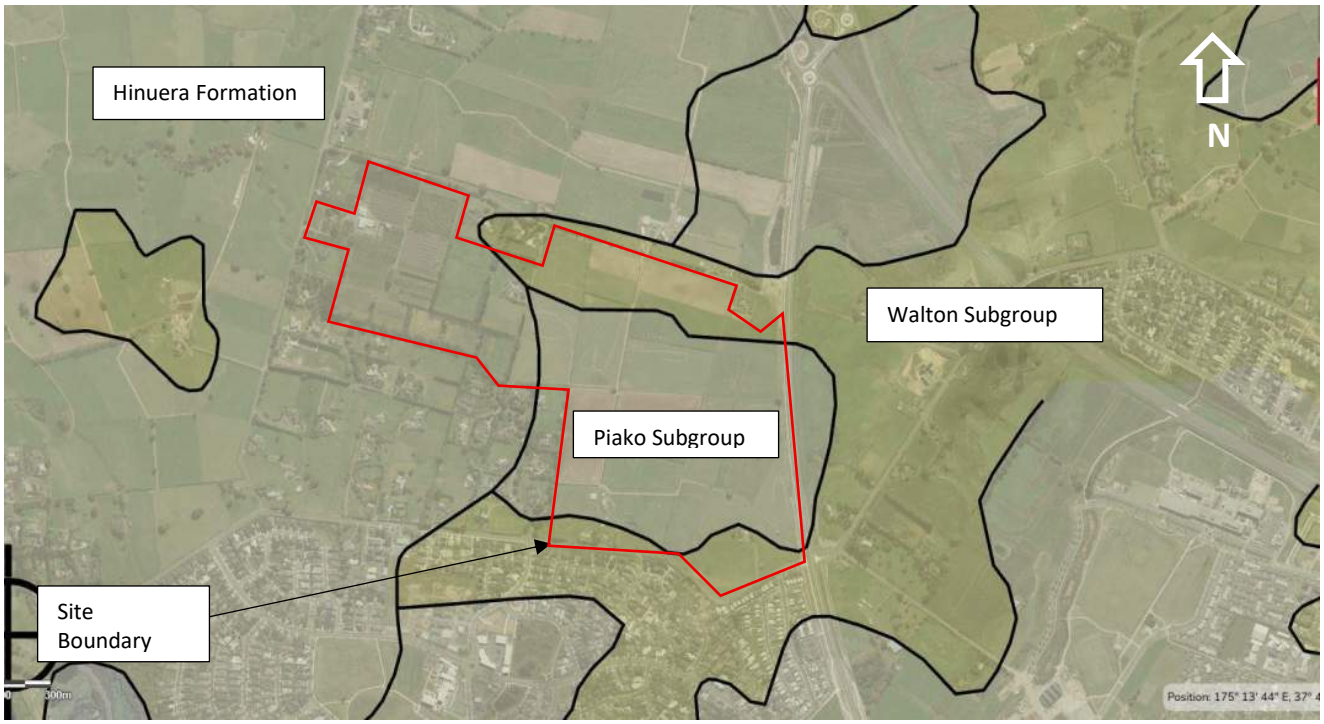



Figure 3: Regional Geology (GNS Geology Map)[1].

## 3.2 Nearby Geotechnical Data

A review of nearby geotechnical logs from the New Zealand Geotechnical Database (NZGD) confirms the geology present in the published geological maps. Relevant plans and engineering logs are presented in ***Appendix A***.

Several bores are also in or near the site. Eight of these bores have a recorded lithology which have also been attached to ***Appendix A.***

The ground conditions presented in geotechnical data logged by others, can be generalised according to the following units in Table 1. Topsoil had not been recorded in the NZGD logs or the bore logs.

Table 1: Summary of Strata Encountered in Publicly Available Logs.

| Unit | Depth to Base of Unit (m) | | Assessed Thickness (m) |
|---|---|---|---|
| | Min | Max | |
| Firm to Stiff SILT with interbedded Organic Silt (Piako Subgoup)* | >1.8 | | - |
| Medium Dense to Dense SAND with interbedded SILT (Hinuera Formation) | 6.5 | 9 | 9 |
| Stiff to Very Stiff CLAY (Hamilton Ash) | 1.2 | 16.5 | 7 |
| Soft to Firm Clayey SILT (Puketoka Formation) | 3.1 | 3.9 | 0.5 |
| Dense to Very Dense SAND (Walton Subgroup)* | >20 | | - |
| Notes: *Base of units not encountered in limited available investigation logs. | | | |

## 3.3 Laboratory Test Results

Laboratory testing was conducted in January 2015 along the Hamilton section of the Waikato Expressway. Results[2][3][4] of the laboratory tests provided in ***Appendix B*** are summarised in Table 2.

Table 2: Laboratory Testing from TP_77263.

| Test Location | Depth (m bgl) | Sand (%) | Fines (%) | LL (%) | PL (%) | PI (%) | MC (%) | OMC (%) | MMDD (t/m²) |
|---|---|---|---|---|---|---|---|---|---|
| TP_77263 | 1.6 – 4.5 | 25 | 75 | 49 | 34 | 15 | 75.7 | 37 | 1.24 |
| Note: Gravel, sand and fines percentages are by weight, LL = liquid limit, PL = plasticity limit, PI = plasticity index, MC = Natural Moisture Content, OMC = Optimum Moisture Content, MMDD = Modified Maximum Dry Density | | | | | | | | | |

## 3.4 Groundwater

Nearby NZGD data have logged groundwater between 1.7m below ground level (bgl) to 5.5m bgl. Google Street view shows water in the gully on the other side of Osborne Road which had been captured in February 2025.

# 4.0 DESKTOP FINDINGS

## 4.1 Historical Photos

Historical photographs dating back to 1941 have been reviewed and are attached in ***Appendix C.*** The historical photographs show that the site has been used for agriculture. In 1963 the orchard had been established in the northwestern corner of the site. In 1979, earthworks along the future Resolution Drive road alignment had begun along the eastern boundary. In an image from 2022 an area of rubbish can be seen in part of the Orchard behind 40B Reynolds Road.

## 4.2 Regional Hazards

A review of the Waikato Regional Council Natural Hazards Portal[5] was undertaken.

The Hazard Portal addresses potential flooding, coastal hazards, volcanic and seismic hazards.

No river flooding risk had been identified, but the site is part of the Waikato Central Drainage Scheme and has a Waikato Regional Council drain to remove water after a rainfall event. This demonstrates that the site is potentially prone to flooding after a heavy rainfall event.

The nearest active volcanoes are Rotorua and Mayor Island, both of which are approximately 100km away and are currently at alert level 0. Hazard Maps have been presented in ***Appendix D.***

[2] Opus International Consultants Ltd. (*2015*). Plasticity Index for Soils Test Report, Lab Ref No: 15/803/006a. Hamilton.
[3] Opus International Consultants Ltd. (*2015*). Particle Size Analysis (Wet Sieve Method) Test Report, Lab Ref No: 15/803/006. Hamilton.
[4] Opus International Consultants Ltd. (*2015*). Dry Density/Water Content Relationship Standard Compaction, Lab Ref No: 15/803/006. Hamilton.
[5] Waikato Regional Council. Waikato Regional Hazards Portal.
https://waikatoregion.maps.arcgis.com/apps/MapSeries/index.html?appid=f2b48398f93146e8a5cf0aa3fddce92c

## 4.3 Fault Rupture

This site is not considered to be at risk of fault rupture on the basis that there are no mapped active faults in the area. The GNS Active Fault Database[6] Indicates the nearest active fault is the Kerepehi Fault which is approximately 50km to the east of the site and has a recurrence interval of 2,000 to 3,500 years.

## 4.4 Liquefaction and Lateral Spread

Liquefaction occurs in loose saturated cohesionless soils that are subject to cyclic shear loading during an earthquake. This process leads to pore pressure build-up, soil grains moving into suspension and temporary loss of strength causing vertical and lateral ground deformation. A liquefaction hazard map from the Waikato Regional Council is presented in ***Appendix D***. The majority of the site is classed as undetermined, and the hills are classed as unlikely.

Based on our local knowledge, the Hinuera Formation and Piako Subgroup deposits are susceptible to liquefaction when below the groundwater table. Free-field liquefaction induced settlement may be significant during a ULS seismic event. The magnitude of liquefaction induced settlement is likely to vary across the site and differential settlement should be anticipated, should there be a large seismic event.

Following the onset of liquefaction, liquefied soils will behave as a very weak undrained material, which can give rise to lateral spreading where a free face is present within the vicinity of the site or where proposed cut or fill batters are proposed over or within the zone of influence of liquefied soils. The Waikato Regional Council drain/gully and the existing farm drains present as a free face where the risk of lateral spreading must be considered. Lateral spreading will also need to be considered when constructing stormwater basins, as this will create a free face.

The extent and magnitude if lateral spread that may occur during liquefaction is dependent of the groundwater levels present beneath the site and the depth of liquefiable soils. These will need to be assessed once a site investigation has taken place.

## 4.5 Cyclic Softening

While not liquefiable due to their high plasticity, the fine-grained soils in the Walton Subgroup may be susceptible to some strength loss, during a ULS seismic event. On account of the typically high shear strengths of these soils this is often not a significant geotechnical issue for land development projects.

## 4.6 Slope Stability

Based on the site topography, it is considered that the site is not generally considered to be at risk of slope instability. Slumping or subsidence has not been observed in the historical photographs, partially around the gully and hill slopes. A site walkover by experienced engineering geologist will be required to confirm slope stability conditions.

The inclusion of high or steep slopes for swales or cuts will need an assessment of slope stability as part of the design process.

## 4.7 Load Induced Settlement

Given the site geology is predominantly alluvial deposits, there may be localised zones of soft and compressible soils. This is particularly likely within the Piako Subgroup soils. In these instances, significant primary consolidation and long-term secondary creep settlements may occur as a response to the placement

[6] GNS NZ Active Fault Database https://data.gns.cri.nz/af/

of fill and building loads. Site specific geotechnical investigations will need to be carried out to better characterise the soils across the site.

Future reporting will provide advice concerning frequency of site observations during construction to ensure soft areas are appropriately managed.

## 4.8 Earthworks

Hamilton Ash clays are generally suitable for reuse as engineered fill with moisture conditioning during normal summer conditions. However, the Puketoka Formation and Hinuera Formation silts can be sensitive and may lose strength with they are disturbed and allowed to get wet.

Soft or organic soils near the ground surface may be encountered during excavation particularly within the Piako Subgroup soils.

Geotechnical site investigation a future reporting will provide advice on how to treat soft soils. This may include removal and replacement or ground improvement methods, such as preloading.

Groundwater may be encountered at shallow depth on the low-lying areas. Future reporting may consider underfill subsoil drains or granular drainage blanket layers as mitigation measures.

## 4.9 Preliminary Foundation Options

Depending on the magnitude of liquefaction induced settlement, engineered foundation solutions may be required. This may include foundation options such as TC2 or TC3 type raft foundations. Deep pile foundations may also be required for larger loads expected in commercial buildings.

Settlement magnitudes can be estimated once the required geotechnical investigation data is available and the earthworks design and building loads are known. Depending on the nature of the proposed development and the finished ground levels, ground improvement of some kind may be required to manage static load induced settlement.

Ground improvement options that could be considered include undercut and reworking of soft ground (static settlement only); temporary surcharge fills (static settlement only), deep soil mixing and/or vibro-stone columns (liquefaction and static settlement). Confirmation of options would require detailed geotechnical investigation and design.

# 5.0 FURTHER WORK

Based on the assessment presented in this report, there are no unusual features or geotechnical constraints observed for this site that would prevent urban develop from proceeding. We have identified the following additional scope of work that is considered necessary to further assess the risk profile for the scheme and to support a substantive consent application. This additional scope of work is typical for urban development of this scale, and includes the following:

- Geotechnical investigation to inform ground model development, detailed geohazard assessment, selection of geotechnical design parameters, and design and construction recommendations.
- Geotechnical analysis and reporting, suitable to support future project stages including resource consent application, detailed design, and building consent applications (if any).
- Design of ground improvement if necessary to mitigate load or liquefaction induced settlement, or lateral spread.
- Geotechnical completion reporting of subdivision earthworks.

# 6.0 CLOSURE

This report has been prepared for use by Gordon Litt Farms Ltd in relation to the proposed Orchard Grove development at Kay Road, Horsham Downs project in accordance with the scope, proposed uses and limitations described in the report. Should you have further questions relating to the use of your report please do not hesitate to contact us.

Where a party other than Gordon Litt Farms Ltd seeks to rely upon or otherwise use this report, the consent of CMW should be sought prior to any such use. CMW can then advise whether the report and its contents are suitable for the intended use by the other party.

## USING YOUR CMW GEOTECHNICAL REPORT

Geotechnical reporting relies on interpretation of facts and collected information using experience, professional judgement, and opinion. As such it generally has a level of uncertainty attached to it, which is often far less exact than other engineering design disciplines. The notes below provide general advice on what can be reasonably expected from your report and the inherent limitations of a geotechnical report.

**Preparation of your report**

Your geotechnical report has been written for your use on your project. The contents of your report may not meet the needs of others who may have different objectives or requirements. The report has been prepared using generally accepted Geotechnical Engineering and Engineering Geology practices and procedures. The opinions and conclusions reached in your report are made in accordance with these accepted principles. Specific items of geotechnical or geological importance are highlighted in the report.

In producing your report, we have relied on the information which is referenced or summarised in the report. If further information becomes available or the nature of your project changes, then the findings in this report may no longer be appropriate. In such cases the report must be reviewed, and any necessary changes must be made by us.

**Your geotechnical report is based on your project's requirements**

Your geotechnical report has been developed based on your specific project requirements and only applies to the site in this report. Project requirements could include the type of works being undertaken; project locality, size and configuration; the location of any structures on or around the site; the presence of underground utilities; proposed design methodology; the duration or design life of the works; and construction method and/or sequencing.

The information or advice in your geotechnical report should not be applied to any other project given the intrinsic differences between different projects and site locations. Similarly geotechnical information, data and conclusions from other sites and projects may not be relevant or appropriate for your project.

**Interpretation of geotechnical data**

Site investigations identify subsurface conditions at discrete locations. Additional geotechnical information (e.g. literature and external data source review, laboratory testing etc) are interpreted by Geologists or Engineers to provide an opinion about a site specific ground models, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist due to the variability of geological environments. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. Interpretation of factual data can be influenced by design and/or construction methods. Where these methods change review of the interpretation in the report may be required.

**Subsurface conditions can change**

Subsurface conditions are created by natural processes and then can be altered anthropically or over time. For example, groundwater levels can vary with time or activities adjacent to your site, fill may be placed on a site, or the consistency of near surface conditions might be susceptible to seasonal changes. The report is based on conditions which existed at the time of investigation. It is important to confirm whether conditions may have changed, particularly when large periods of time have elapsed since the investigations were performed.

**Interpretation and use by other design professionals**

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a geotechnical report. To help avoid misinterpretations, it is important to retain the assistance of CMW to work with other project design professionals who are affected by the contents of your report. CMW staff can explain the report implications to design professionals and then review design plans and specifications to see that they have correctly incorporated the findings of this report.

**Your report's recommendations require confirmation during construction**

Your report is based on site conditions as revealed through selective point sampling. Engineering judgement is then applied to assess how indicative of actual conditions throughout an area the point sampling might be. Any assumptions made cannot be substantiated until construction is complete. For this reason, you should retain geotechnical services throughout the construction stage, to identify variances from previous assumption, conduct additional tests if required and recommend solutions to problems encountered on site.

A Geotechnical Engineer, who is fully familiar with the site and the background information, can assess whether the report's recommendations remain valid and whether changes should be considered as the project develops. An unfamiliar party using this report increases the risk that the report will be misinterpreted.

**Environmental matters are not covered**

Unless specifically discussed in your report environmental matters are not covered by a CMW Geotechnical Report. Environmental matters might include the level of contaminants present of the site covered by this report, potential uses or treatment of contaminated materials or the disposal of contaminated materials. These matters can be complex and are often governed by specific legislation.

The personnel, equipment, and techniques used to perform an environmental study can differ significantly from those used in this report. For that reason, our report does not provide environmental recommendations. Unanticipated subsurface environmental problems can have large consequences for your site. If you have not obtained your own environmental information about the project site, ask your CMW contact about how to find environmental risk-management guidance.

CMW Geosciences
Great People | Practical Solutions

# APPENDIX A
## NZGD and Bore Logs


**NOTES:**

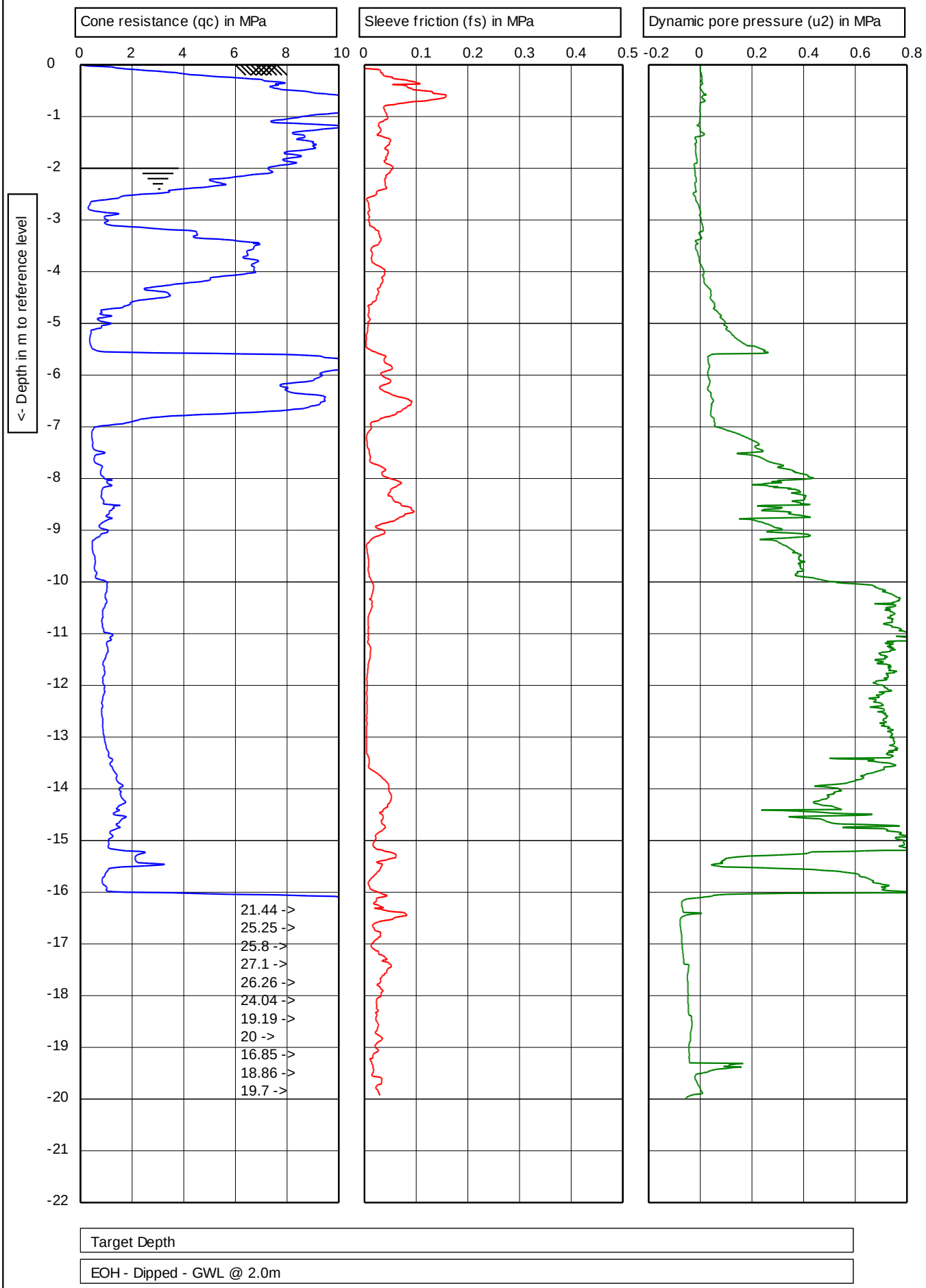
1. PROPOSED SITE BOUNDARY OUTLINE SHOWN INDICATIVELY.
2. BASE PLAN COURTESY OF LINZ.
3. TEST LOCATIONS AND BOUNDARY SHOWN INDICATIVELY ONLY.

**LEGEND:**

- SITE BOUNDARY
- WRC BORE LOCATIONS
- NZGD TEST PIT (TP) LOCATION
- NZGD CONE PENTROMETER (CPT) LOCATION

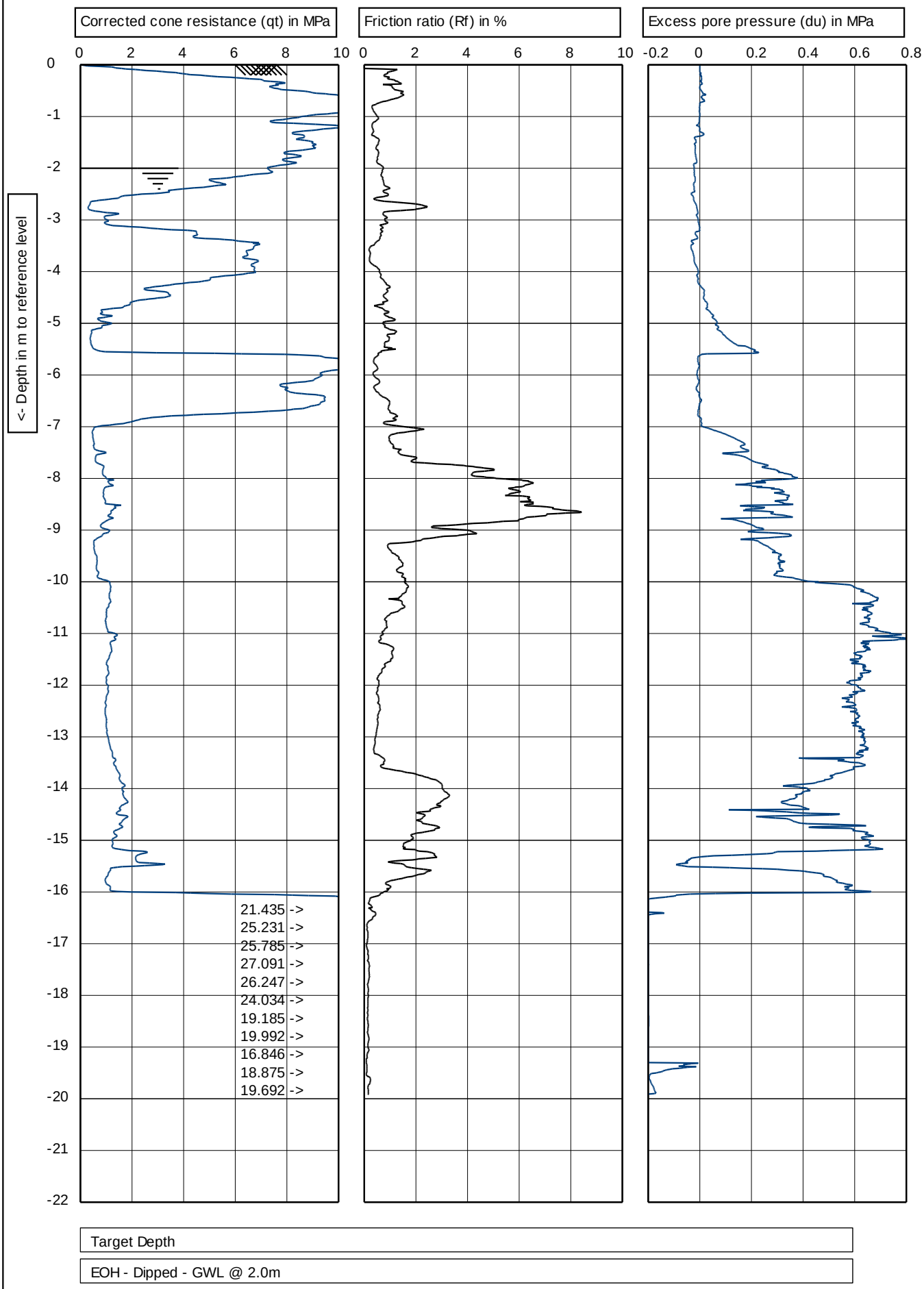
CMW Geosciences
Great People | Practical Solutions

| | | | |
|---|---|---|---|
| CLIENT: GORDON LITT FARMS LTD | | DRAWN: PM | PROJECT: HAM2025-0055 |
| PROJECT: KAY ROAD, HORSHAM DOWNS | | CHECKED: KL | DRAWING: 01 |
| | | REVISION: 0 | SCALE: NTS |
| TITLE: EXISTING DATA LOCATION PLAN | | DATE: 13/06/2025 | SHEET: A3 |




| | | | |
|---|---|---|---|
| WSP / IANZ ACCREDITED LABORATORY — Graphs indicated as not accredited are outside the scope of the laboratory's accreditation | u2 150 cm² 10 cm² | Test according ASTM D5778-12 & ISO 22476-1:2012 | Predrill: **0.00 m Predrilled** |
| | | G.L.: **0.00 m MSL** — W.L.: **-2.00 m** | Date: **24/02/2020** |
| | Project: | **40B Reynolds Rd** | Cone no.: **C10CFIP.C18488** |
| | Location: | **Hamilton ( 19-0959 )** | Project no.: **2-68000.00_HA5601** |
| | Position: | **1797511, 5823968 NZTM** | CPT no.: **01** — **1/6** |

1.47




Graphs on this page are not IANZ accredited

u2
150 cm²
10 cm²

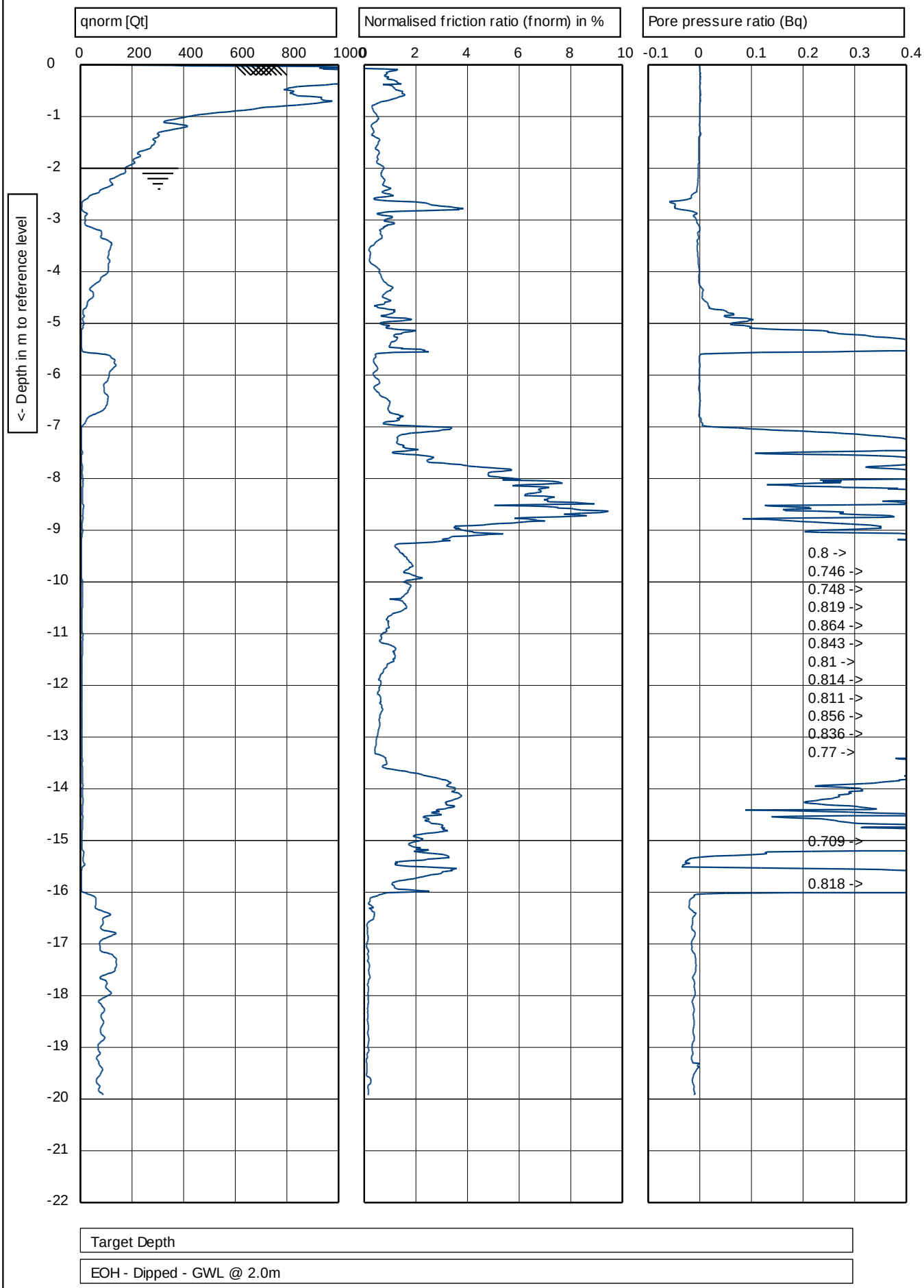
Test according ASTM D5778-12 & ISO 22476-1:2012

G.L.: **0.00 m MSL** W.L.: **-2.00 m**

Project: **40B Reynolds Rd**
Location: **Hamilton ( 19-0959 )**
Position: **1797511, 5823968 NZTM**

| | |
|---|---|
| Predrill: | **0.00 m Predrilled** |
| Date: | **24/02/2020** |
| Cone no.: | **C10CFIIP.C18488** |
| Project no.: | **2-68000.00_HA5601** |
| CPT no.: | **01** **2/6** |

1.47




Graphs on this page are not IANZ accredited

u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012

G.L.: **0.00 m MSL** W.L.: **-2.00 m**

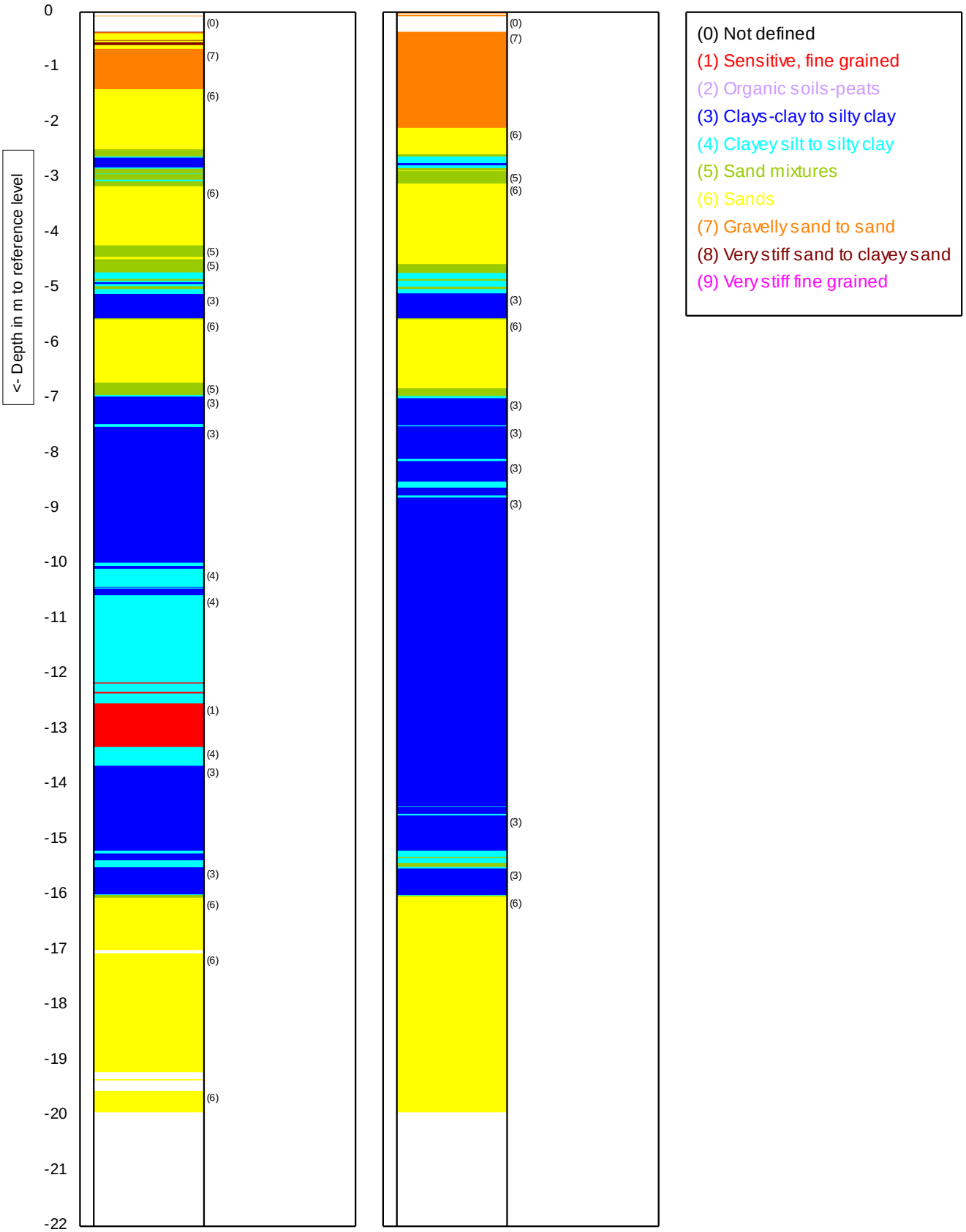
Project: **40B Reynolds Rd**
Location: **Hamilton ( 19-0959 )**
Position: **1797511, 5823968 NZTM**

| | |
|---|---|
| Predrill: | **0.00 m Predrilled** |
| Date: | **24/02/2020** |
| Cone no.: | **C10CFIIP.C18488** |
| Project no.: | **2-68000.00_HA5601** |
| CPT no.: | **01** **3/6** |

1.47

Soil Classification (using Fr)

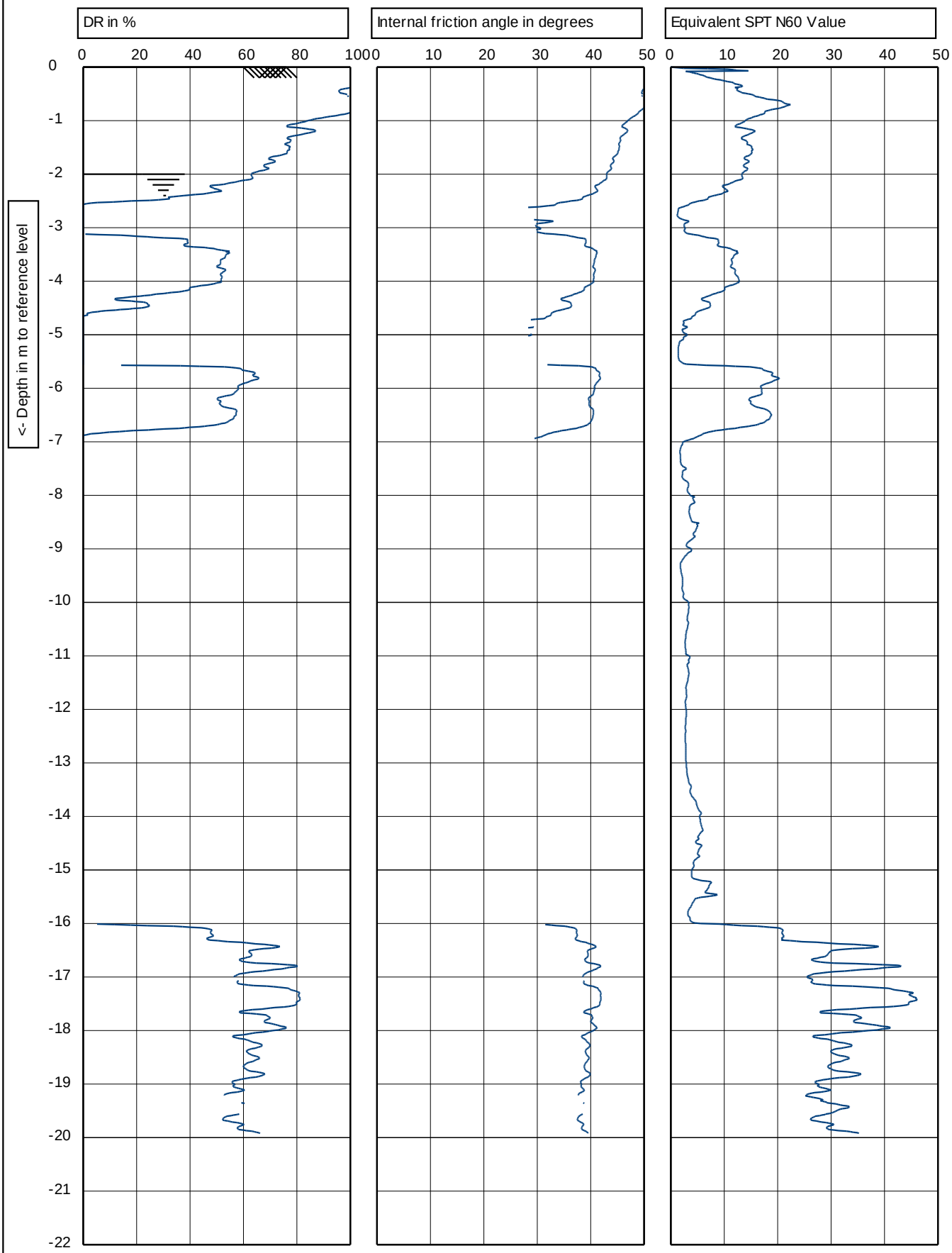
Soil Classification (using Bq)




Graphs on this page are not IANZ accredited

| | | | |
|---|---|---|---|
| Test according ASTM D5778-12 & ISO 22476-1:2012 | | Predrill: | **0.00 m Predrilled** |
| G.L.: **0.00 m MSL** | W.L.: **-2.00 m** | Date: | **24/02/2020** |
| Project: **40B Reynolds Rd** | | Cone no.: | **C10CFIIP.C18488** |
| Location: **Hamilton ( 19-0959 )** | | Project no.: | **2-68000.00_HA5601** |
| Position: **1797511, 5823968 NZTM** | | CPT no.: | **01** **4/6** |

1.47




Target Depth

EOH - Dipped - GWL @ 2.0m

Graphs on this page are not IANZ accredited

u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012

G.L.: **0.00 m MSL**

W.L.: **-2.00 m**

Project: **40B Reynolds Rd**

Location: **Hamilton ( 19-0959 )**

Position: **1797511, 5823968 NZTM**

Predrill: **0.00 m Predrilled**

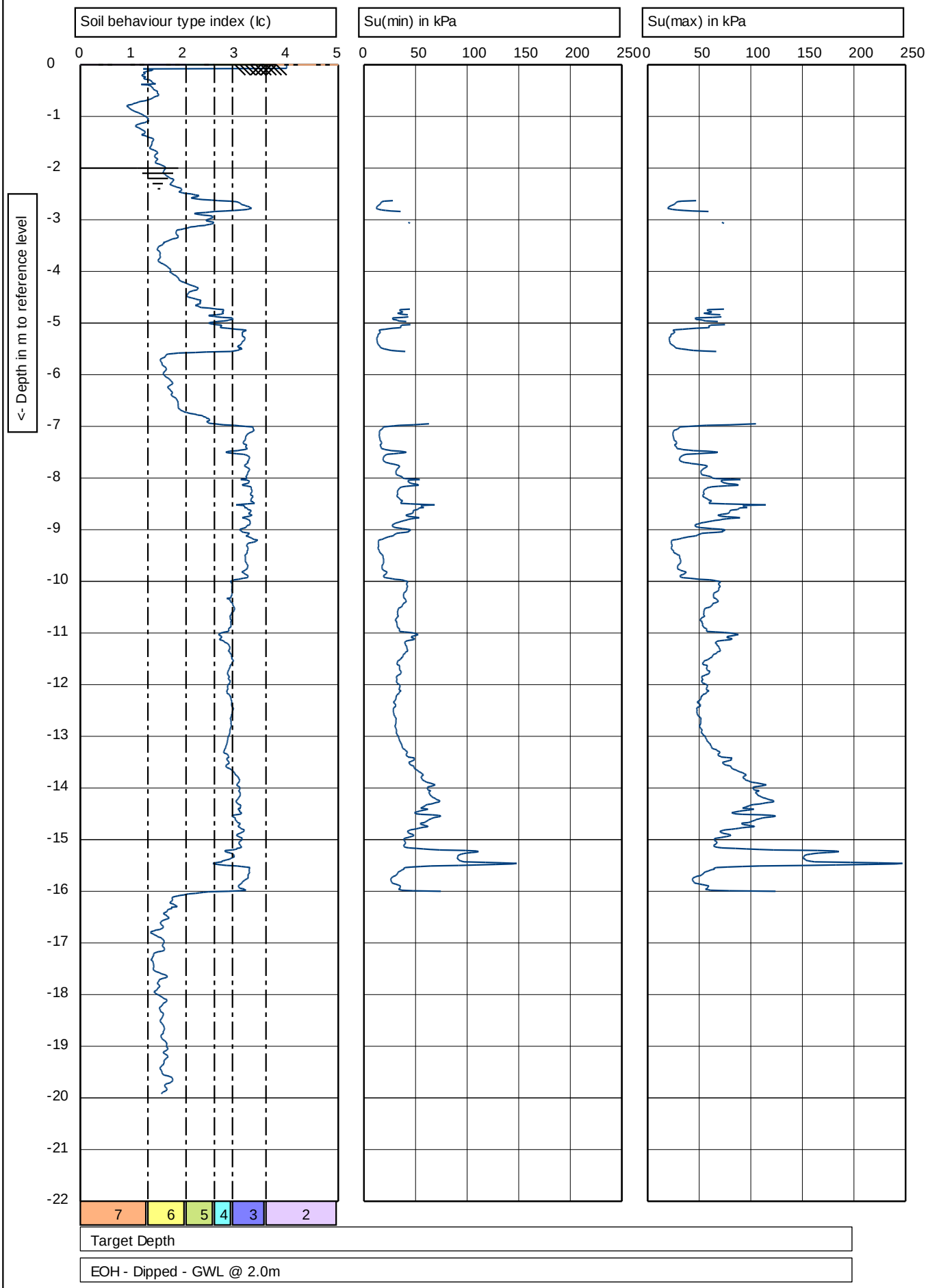
Date: **24/02/2020**

Cone no.: **C10CFIIP.C18488**

Project no.: **2-68000.00_HA5601**

CPT no.: **01** **5/6**

1.47



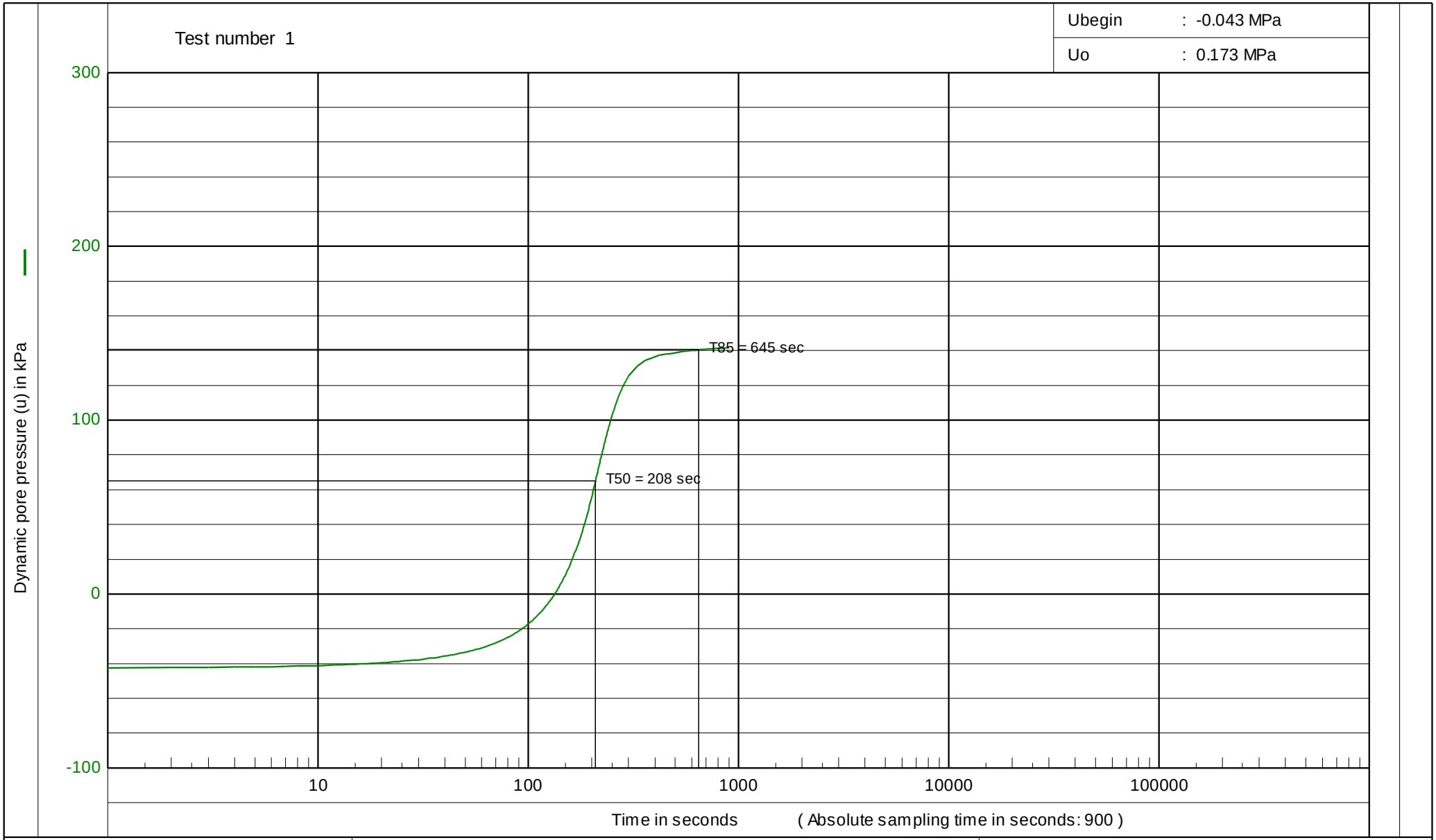

Graphs on this page are not IANZ accredited

| | | | |
|---|---|---|---|
| Test according ASTM D5778-12 & ISO 22476-1:2012 | | Predrill: | 0.00 m Predrilled |
| G.L.: 0.00 m MSL | W.L.: -2.00 m | Date: | 24/02/2020 |
| Project: 40B Reynolds Rd | | Cone no.: | C10CFIIP.C18488 |
| Location: Hamilton ( 19-0959 ) | | Project no.: | 2-68000.00_HA5601 |
| Position: 1797511, 5823968 NZTM | | CPT no.: | 01 6/6 |

1.47

Test number 1

| | |
|---|---|
| Ubegin | : -0.043 MPa |
| Uo | : 0.173 MPa |



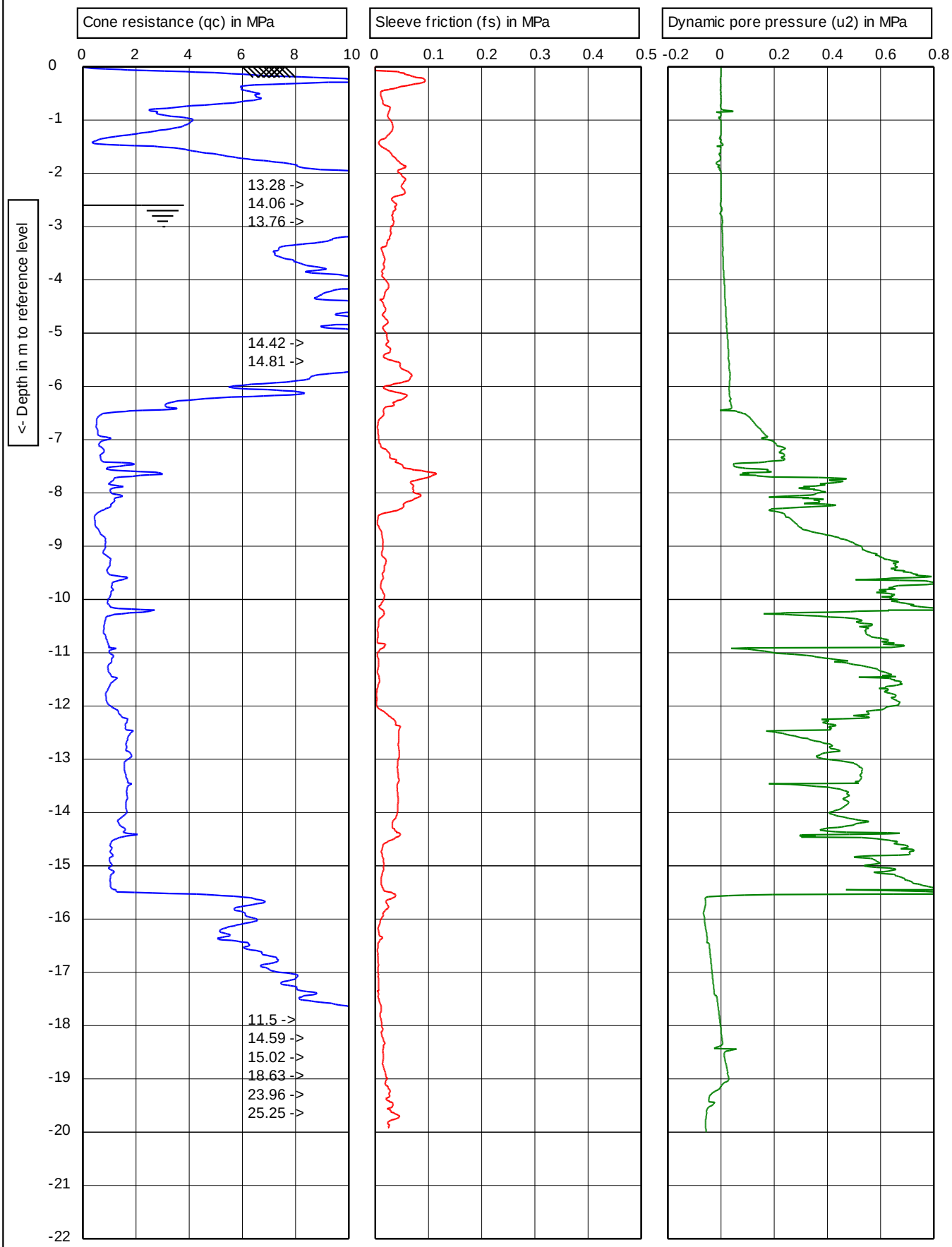

Graphs on this page are not IANZ accredited

Test according ASTM D5778-12 & ISO 22476-1:2012

Project : 40B Reynolds Rd

Location : Hamilton ( 19-0959 )

| | | |
|---|---|---|
| Date | : 24/02/2020 | |
| Project no. | : 2-68000.00_HA5601 | |
| CPT no. | : 01 | |
| Test depth | : 19.30 | [m] - G.L. |
| Water level | : -2.00 | [m] - G.L. |




WSP

IANZ ACCREDITED LABORATORY

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

u2 150 cm² 10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012

G.L.: **0.00 m MSL** W.L.: **-2.60 m**

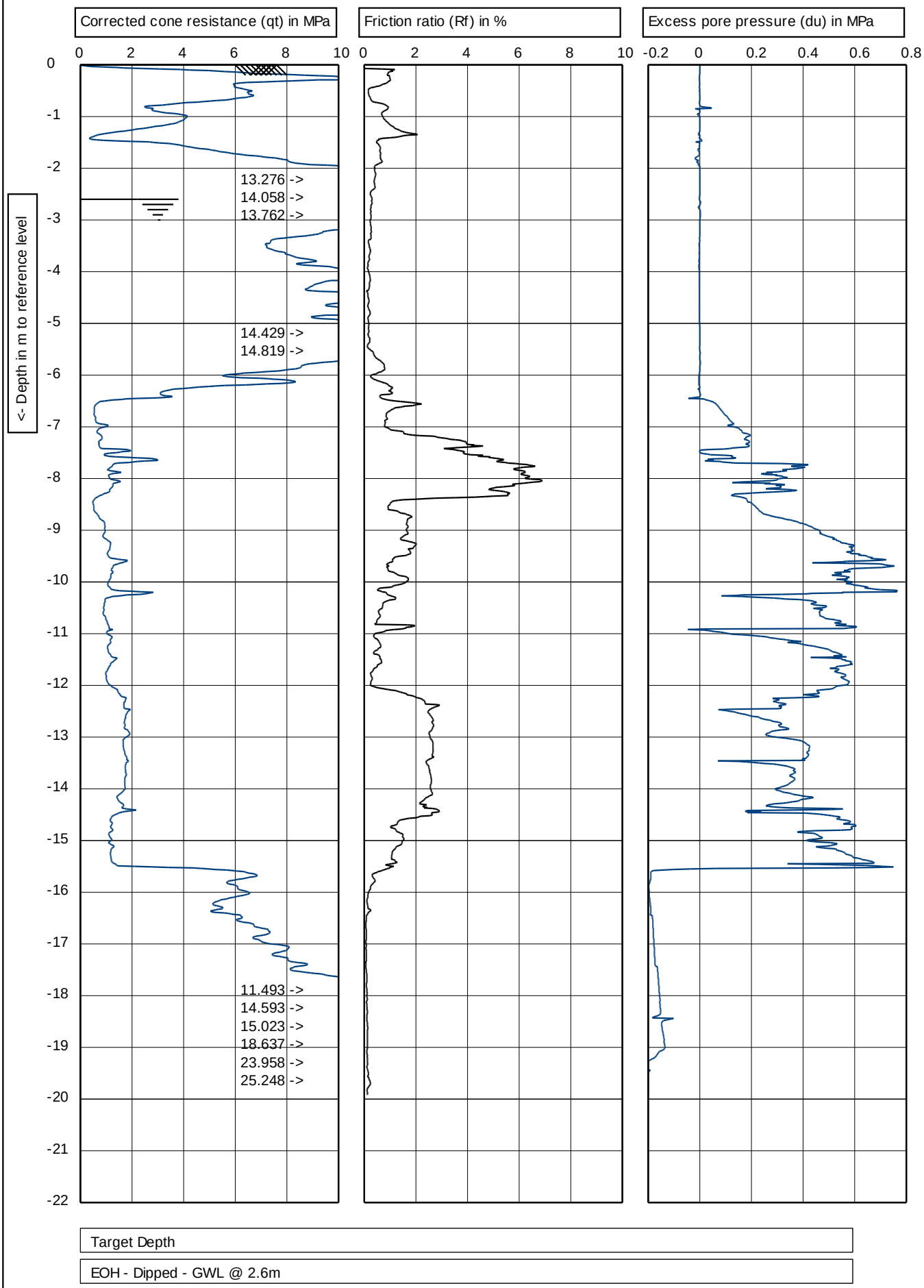
Project: **40B Reynolds Rd**

Location: **Hamilton ( 19-0959 )**

Position: **1797479, 5823983 NZTM**

| | |
|---|---|
| Predrill: | **0.00 m Predrilled** |
| Date: | **24/02/2020** |
| Cone no.: | **C10CFIIP.C15211** |
| Project no.: | **2-68000.00_HA5601** |
| CPT no.: | **02** **1/6** |

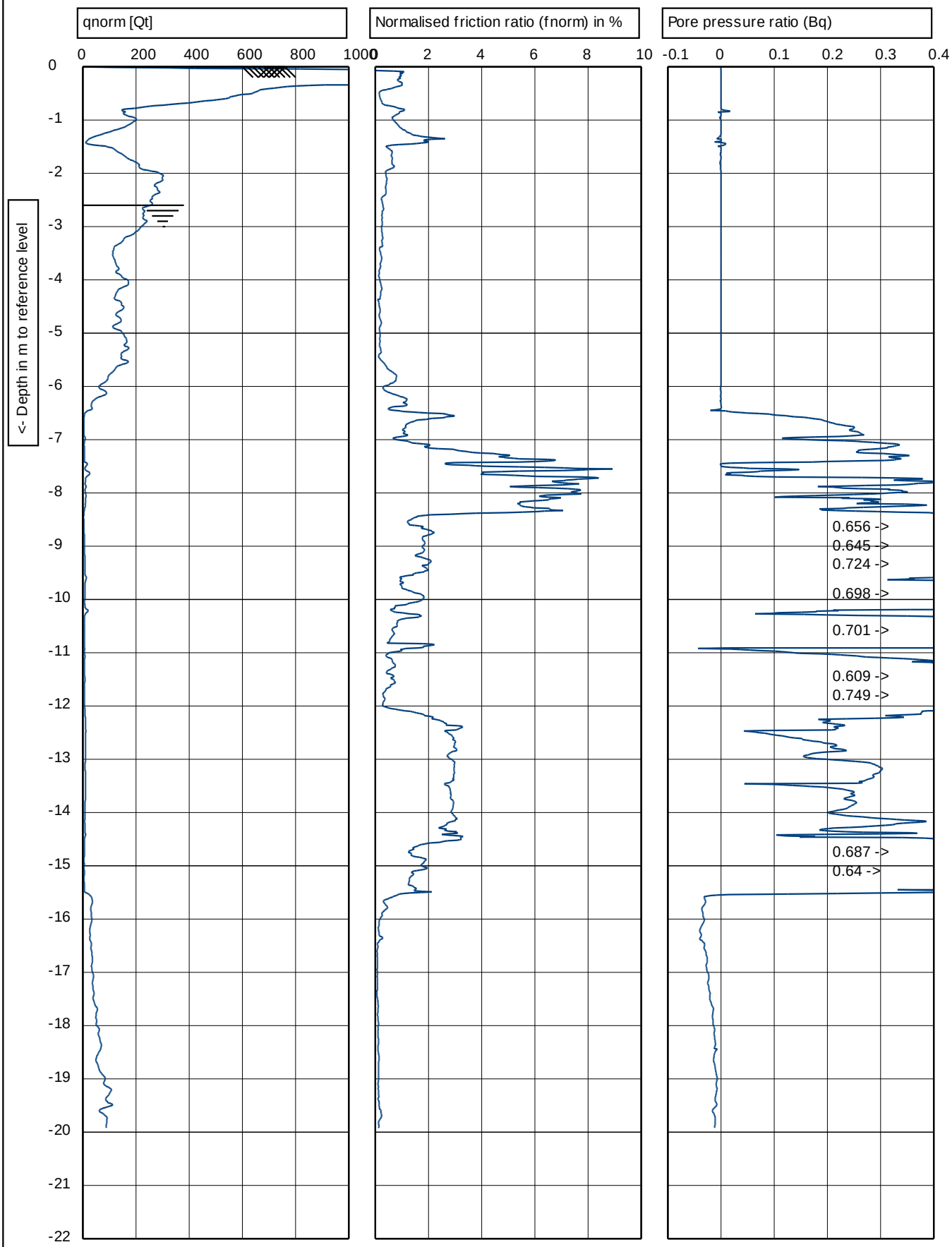
1.47




Graphs on this page are not IANZ accredited

| | | | |
|---|---|---|---|
| Test according ASTM D5778-12 & ISO 22476-1:2012 | | Predrill: | **0.00 m Predrilled** |
| G.L.: **0.00 m MSL** | W.L.: **-2.60 m** | Date: | **24/02/2020** |
| Project: **40B Reynolds Rd** | | Cone no.: | **C10CFIIP.C15211** |
| Location: **Hamilton ( 19-0959 )** | | Project no.: | **2-68000.00_HA5601** |
| Position: **1797479, 5823983 NZTM** | | CPT no.: | **02** **2/6** |

1.47




Graphs on this page are not IANZ accredited

u2
150 cm²
10 cm²

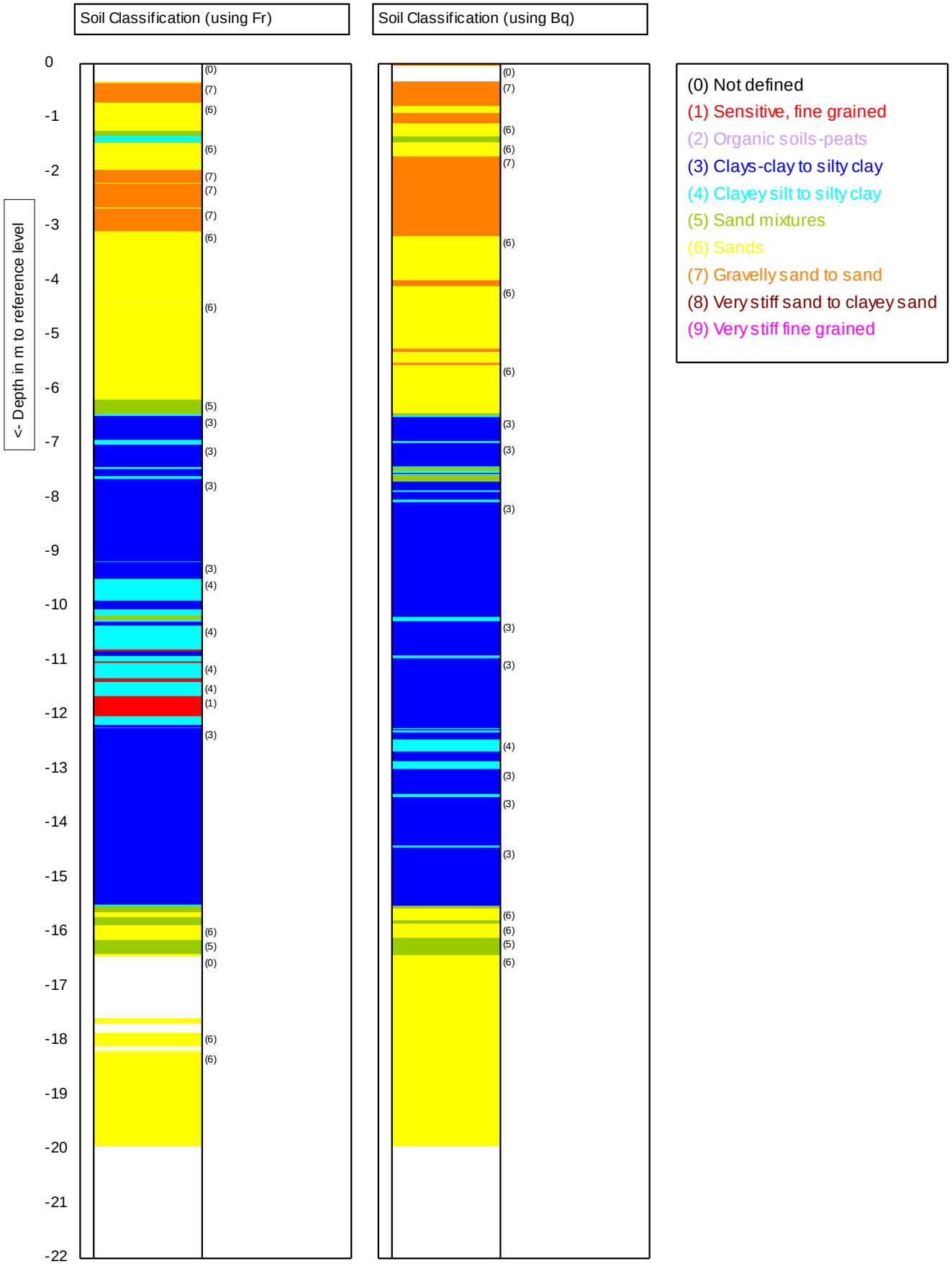
Test according ASTM D5778-12 & ISO 22476-1:2012

G.L.: **0.00 m MSL** W.L.: **-2.60 m**

Project: **40B Reynolds Rd**
Location: **Hamilton ( 19-0959 )**
Position: **1797479, 5823983 NZTM**

| | |
|---|---|
| Predrill: | **0.00 m Predrilled** |
| Date: | **24/02/2020** |
| Cone no.: | **C10CFIIP.C15211** |
| Project no.: | **2-68000.00_HA5601** |
| CPT no.: | **02** **3/6** |

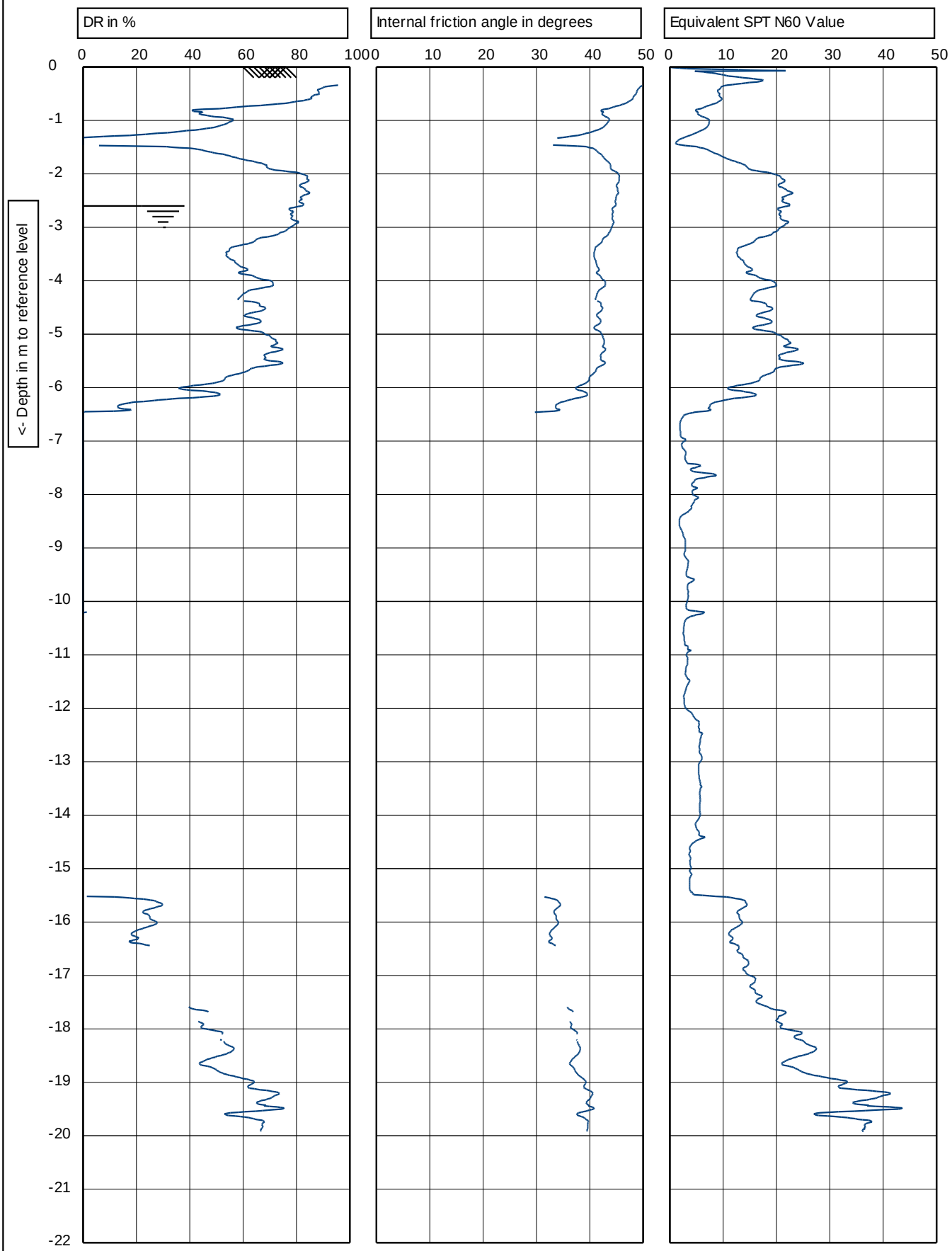
1.47




Graphs on this page are not IANZ accredited

1.47

| | | | |
|---|---|---|---|
| qu2 150 cm² / 10 cm² | Test according ASTM D5778-12 & ISO 22476-1:2012 | Predrill: | **0.00 m Predrilled** |
| | G.L.: **0.00 m MSL** W.L.: **-2.60 m** | Date: | **24/02/2020** |
| Project: | **40B Reynolds Rd** | Cone no.: | **C10CFIIP.C15211** |
| Location: | **Hamilton ( 19-0959 )** | Project no.: | **2-68000.00_HA5601** |
| Position: | **1797479, 5823983 NZTM** | CPT no.: | **02** **4/6** |




Target Depth

EOH - Dipped - GWL @ 2.6m

Graphs on this page are not IANZ accredited

u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012

G.L.: **0.00 m MSL**

W.L.: **-2.60 m**

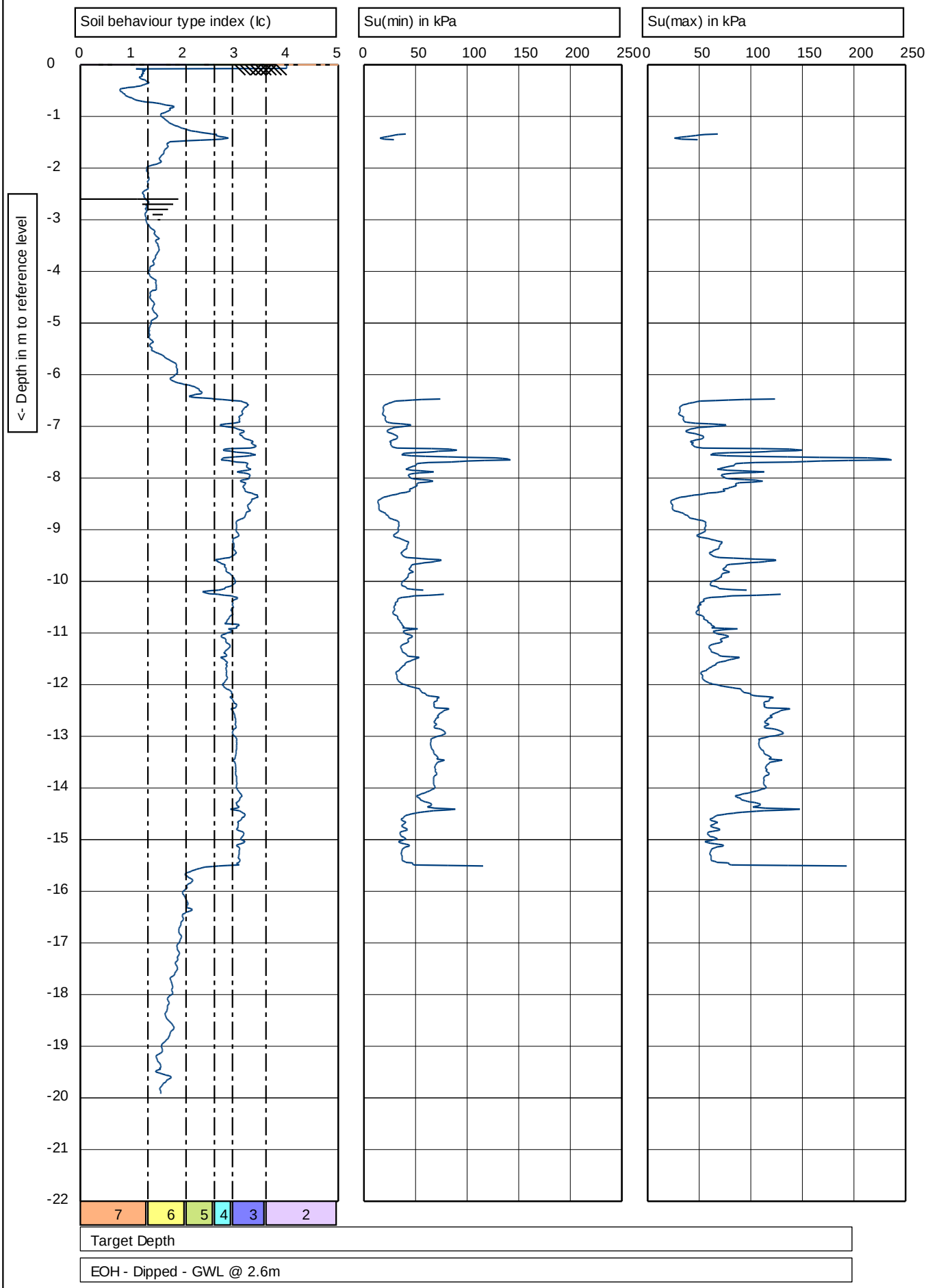
Project: **40B Reynolds Rd**

Location: **Hamilton ( 19-0959 )**

Position: **1797479, 5823983 NZTM**

| | |
|---|---|
| Predrill: | **0.00 m Predrilled** |
| Date: | **24/02/2020** |
| Cone no.: | **C10CFIIP.C15211** |
| Project no.: | **2-68000.00_HA5601** |
| CPT no.: | **02** **5/6** |

1.47




Graphs on this page are not IANZ accredited

u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012

G.L.: **0.00 m MSL** W.L.: **-2.60 m**

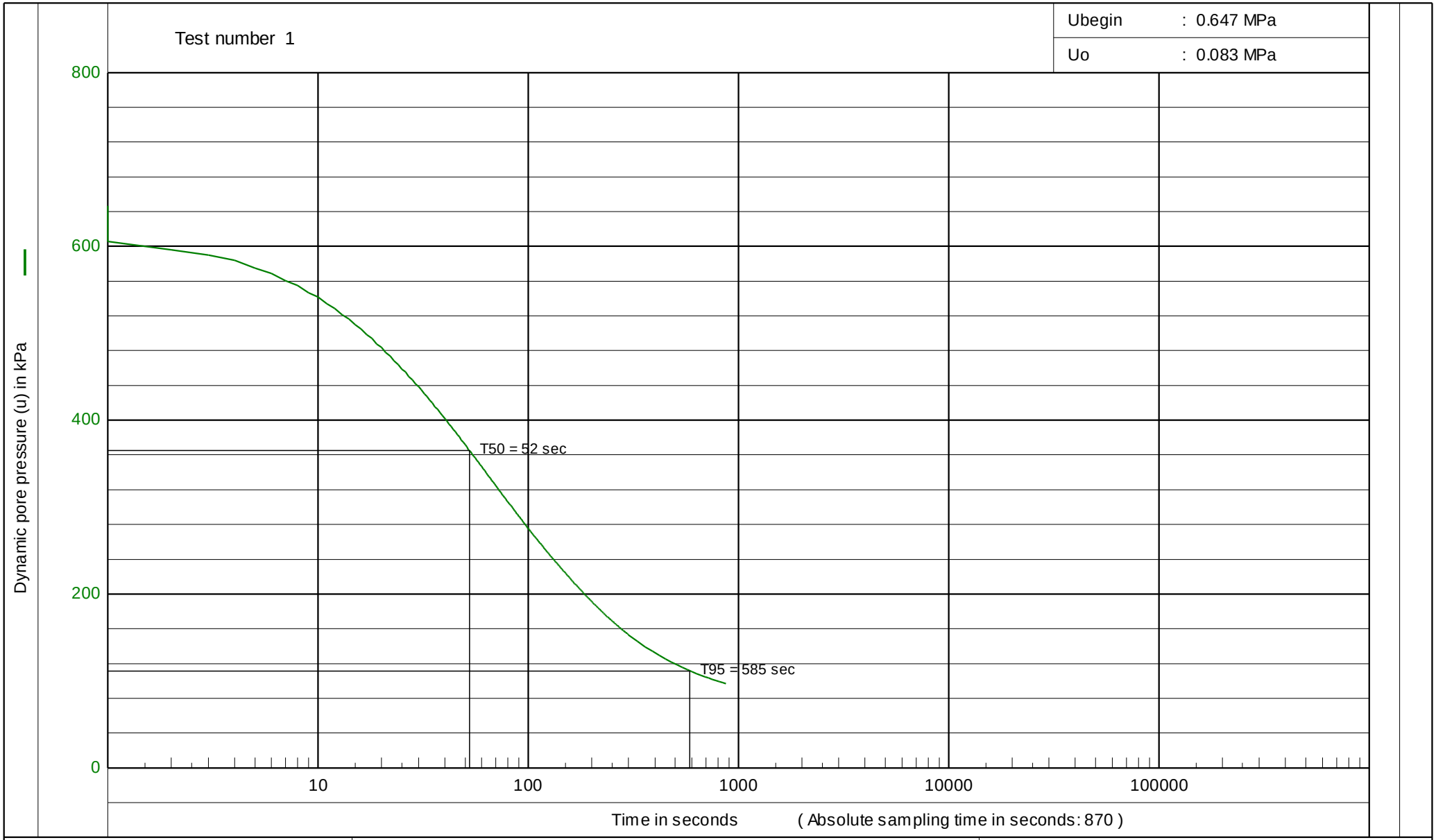
Project: **40B Reynolds Rd**
Location: **Hamilton ( 19-0959 )**
Position: **1797479, 5823983 NZTM**

| | |
|---|---|
| Predrill: | **0.00 m Predrilled** |
| Date: | **24/02/2020** |
| Cone no.: | **C10CFIIP.C15211** |
| Project no.: | **2-68000.00_HA5601** |
| CPT no.: | **02** **6/6** |

1.47

Test number 1

| | | |
|---|---|---|
| Ubegin | : | 0.647 MPa |
| Uo | : | 0.083 MPa |



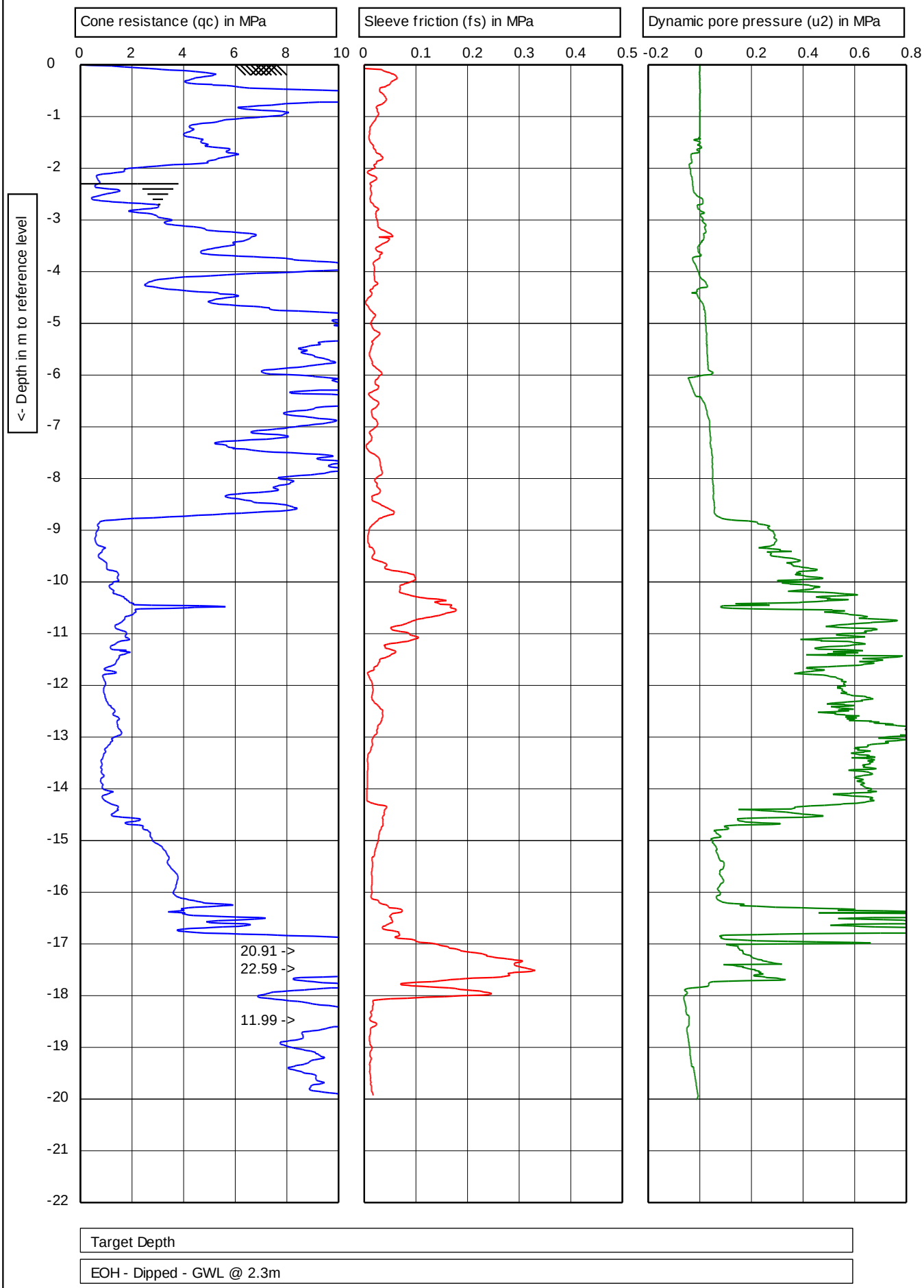

Graphs on this page are not IANZ accredited

Test according ASTM D5778-12 & ISO 22476-1:2012

Project : 40B Reynolds Rd

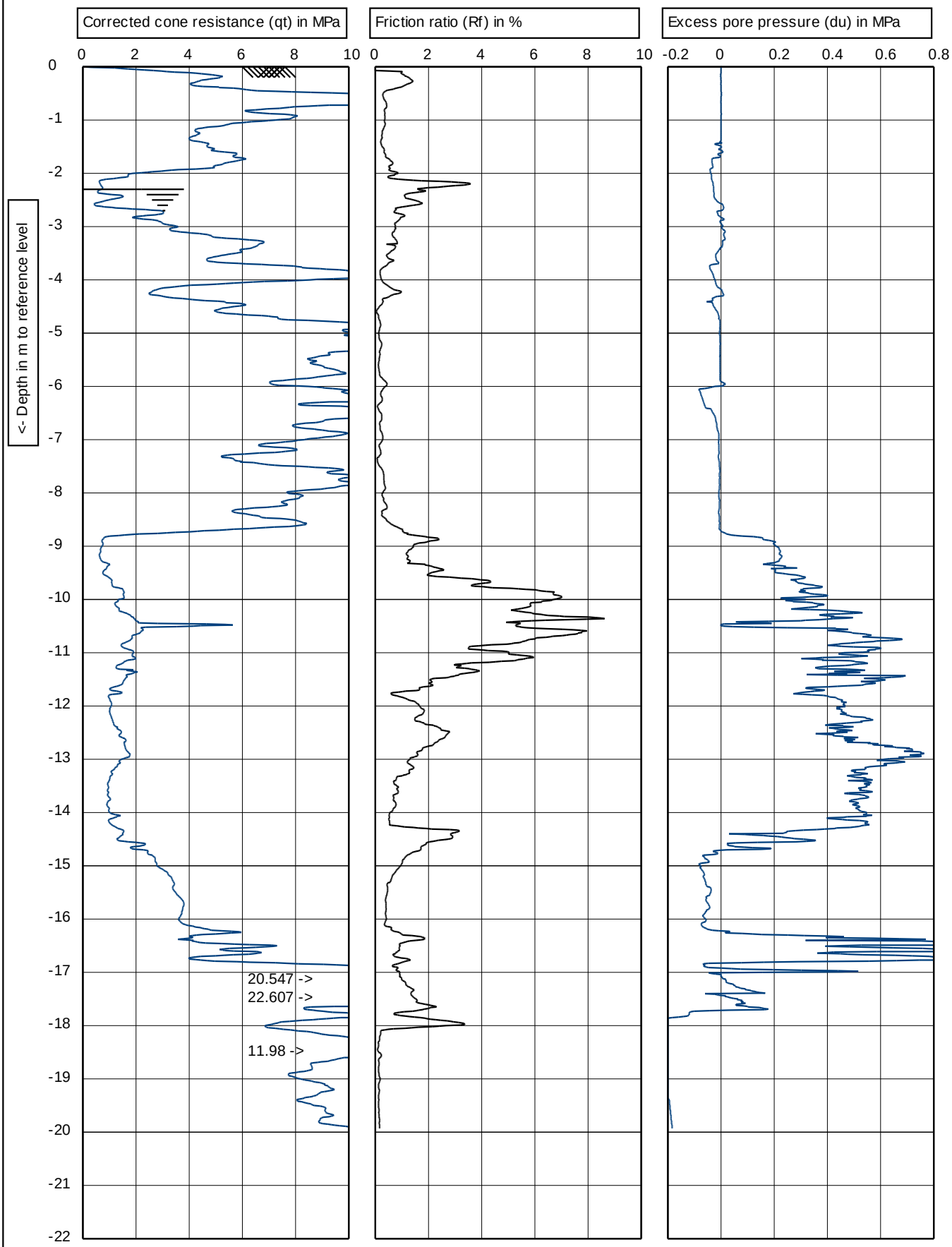
Location : Hamilton ( 19-0959 )

| | | |
|---|---|---|
| Date | : | 24/02/2020 |
| Project no. | : | 2-68000.00_HA5601 |
| CPT no. | : | 02 |
| Test depth | : | 10.90 [m] - G.L. |
| Water level | : | -2.60 [m] - G.L. |




| | | | |
|---|---|---|---|
| WSP / IANZ ACCREDITED LABORATORY — Graphs indicated as not accredited are outside the scope of the laboratory's accreditation | u2 150 cm² / 10 cm² | Test according ASTM D5778-12 & ISO 22476-1:2012 | Predrill: **0.00 m Predrilled** |
| | | G.L.: **0.00 m MSL** — W.L.: **-2.30 m** | Date: **24/02/2020** |
| | Project: **40B Reynolds Rd** | | Cone no.: **C10CFIIP.C15211** |
| | Location: **Hamilton ( 19-0959 )** | | Project no.: **2-68000.00_HA5601** |
| | Position: **1797435, 5823868 NZTM** | | CPT no.: **03** — **1/6** |

1.47




Target Depth

EOH - Dipped - GWL @ 2.3m

Graphs on this page are not IANZ accredited

u2
150 cm²
10 cm²

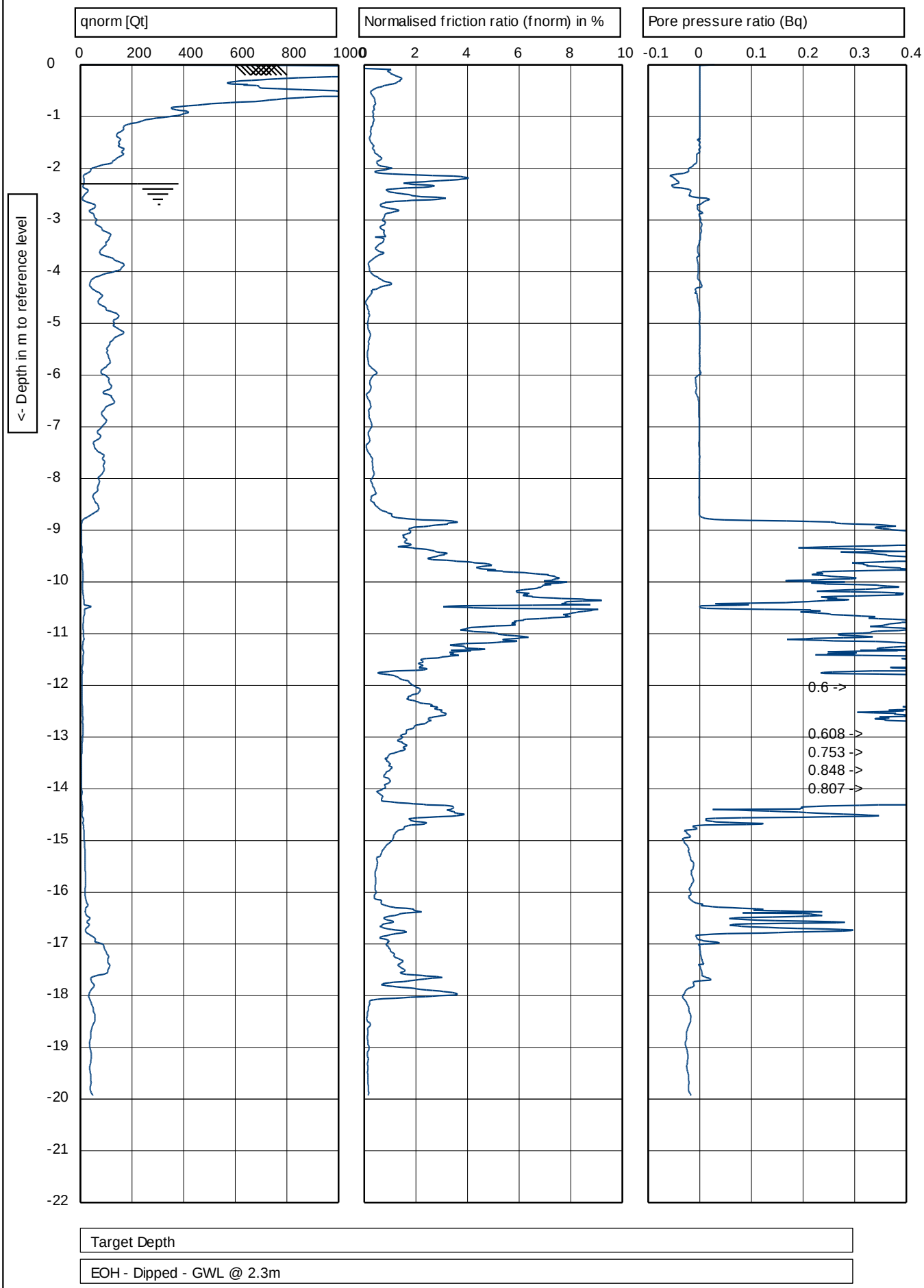
Test according ASTM D5778-12 & ISO 22476-1:2012

G.L.: **0.00 m MSL** W.L.: **-2.30 m**

Project: **40B Reynolds Rd**
Location: **Hamilton ( 19-0959 )**
Position: **1797435, 5823868 NZTM**

Predrill: **0.00 m Predrilled**
Date: **24/02/2020**
Cone no.: **C10CFIIP.C15211**
Project no.: **2-68000.00_HA5601**
CPT no.: **03** **2/6**

1.47




Graphs on this page are not IANZ accredited

u2
150 cm²
10 cm²

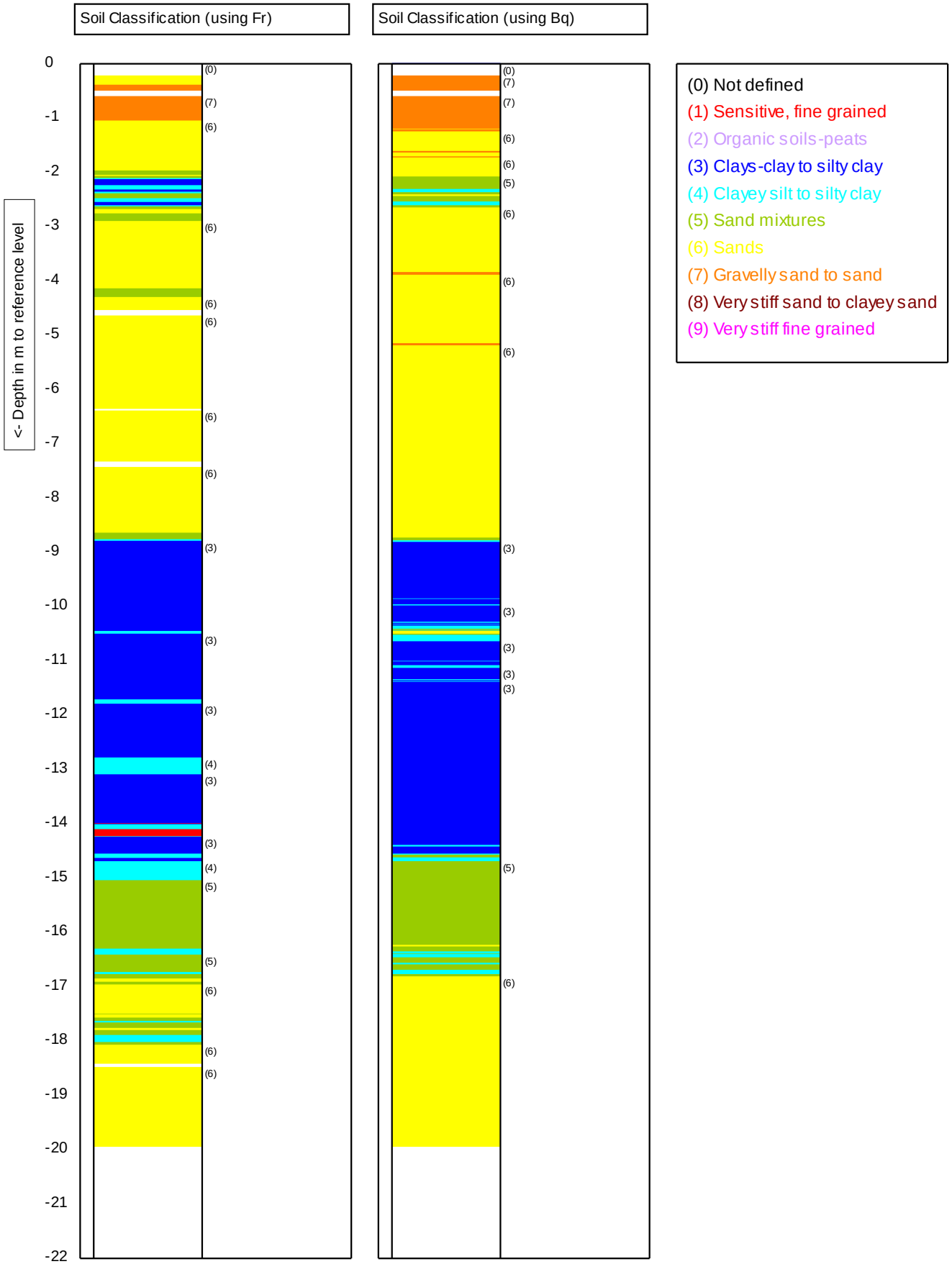
Test according ASTM D5778-12 & ISO 22476-1:2012

G.L.: **0.00 m MSL** W.L.: **-2.30 m**

Project: **40B Reynolds Rd**
Location: **Hamilton ( 19-0959 )**
Position: **1797435, 5823868 NZTM**

| | |
|---|---|
| Predrill: | **0.00 m Predrilled** |
| Date: | **24/02/2020** |
| Cone no.: | **C10CFIIP.C15211** |
| Project no.: | **2-68000.00_HA5601** |
| CPT no.: | **03** **3/6** |

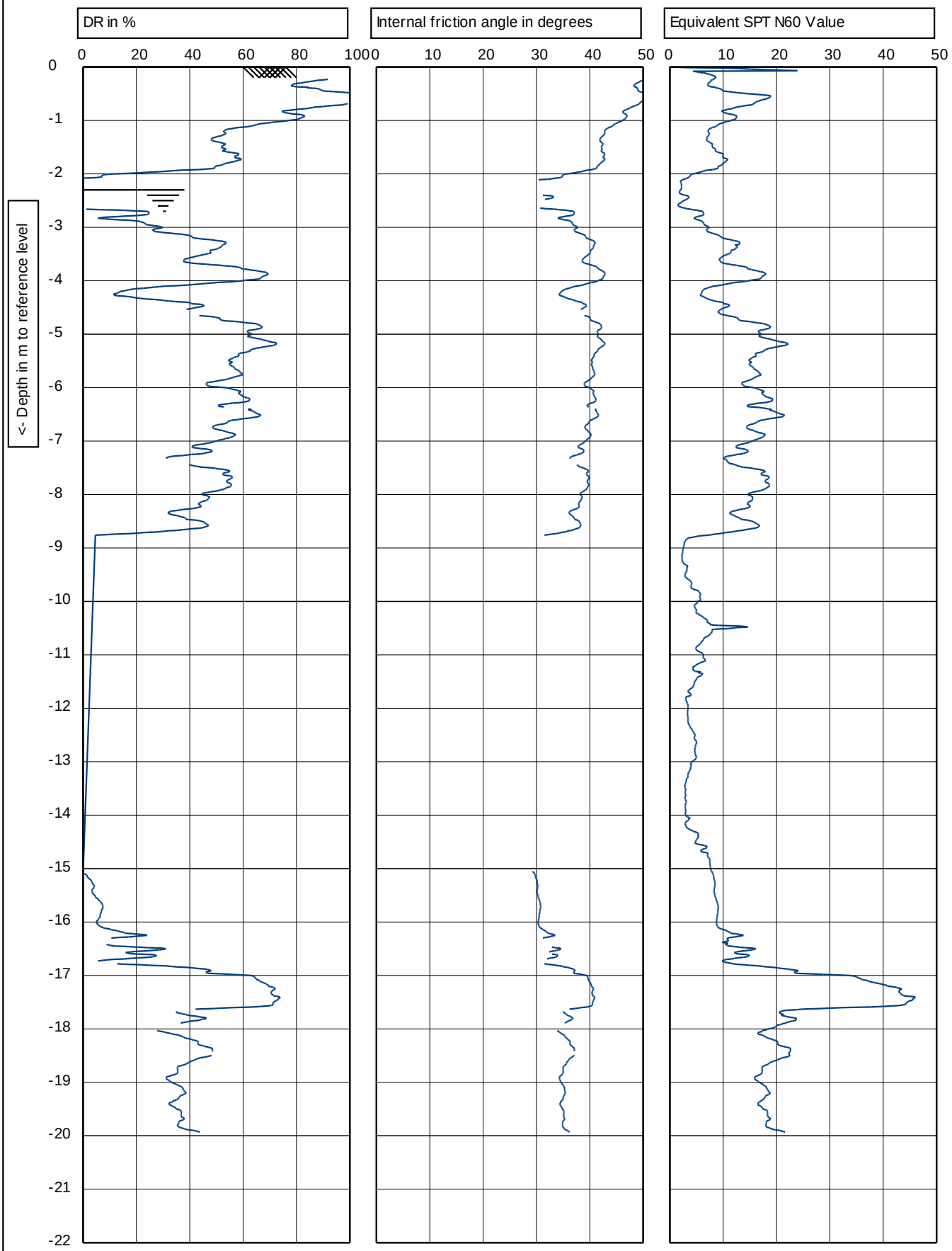
1.47




Graphs on this page are not IANZ accredited

| | | | |
|---|---|---|---|
| Test according ASTM D5778-12 & ISO 22476-1:2012 | | Predrill: | **0.00 m Predrilled** |
| G.L.: **0.00 m MSL** | W.L.: **-2.30 m** | Date: | **24/02/2020** |
| Project: **40B Reynolds Rd** | | Cone no.: | **C10CFIIP.C15211** |
| Location: **Hamilton ( 19-0959 )** | | Project no.: | **2-68000.00_HA5601** |
| Position: **1797435, 5823868 NZTM** | | CPT no.: | **03** **4/6** |

1.47




Target Depth

EOH - Dipped - GWL @ 2.3m

Graphs on this page are not IANZ accredited

u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012

G.L.: **0.00 m MSL**

W.L.: **-2.30 m**

Project: **40B Reynolds Rd**

Location: **Hamilton ( 19-0959 )**

Position: **1797435, 5823868 NZTM**

Predrill: **0.00 m Predrilled**

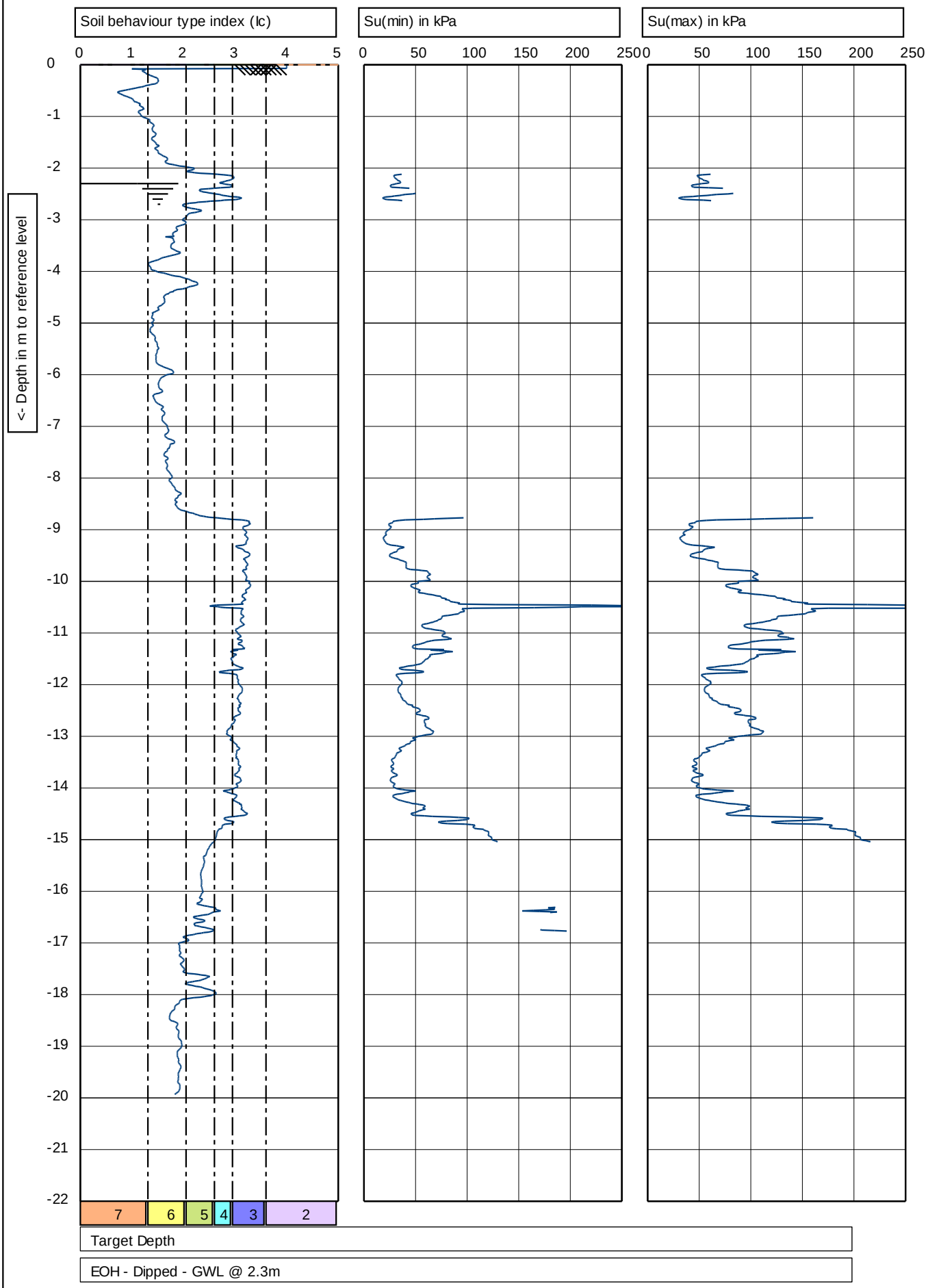
Date: **24/02/2020**

Cone no.: **C10CFIIP.C15211**

Project no.: **2-68000.00_HA5601**

CPT no.: **03** **5/6**

1.47




Graphs on this page are not IANZ accredited

u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012

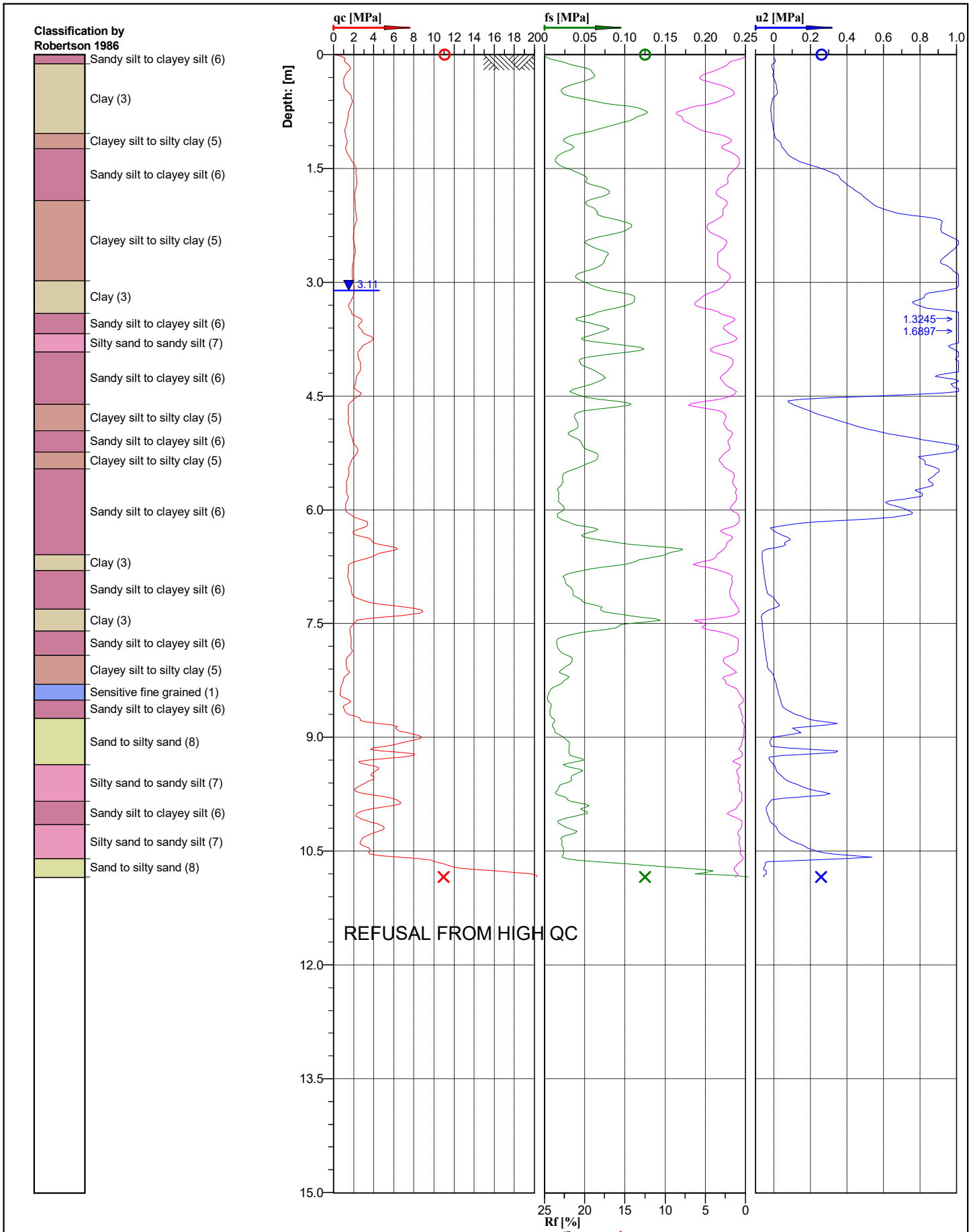
G.L.: **0.00 m MSL** W.L.: **-2.30 m**

Project: **40B Reynolds Rd**
Location: **Hamilton ( 19-0959 )**
Position: **1797435, 5823868 NZTM**

| | |
|---|---|
| Predrill: | **0.00 m Predrilled** |
| Date: | **24/02/2020** |
| Cone no.: | **C10CFIIP.C15211** |
| Project no.: | **2-68000.00_HA5601** |
| CPT no.: | **03** **6/6** |

1.47

NZGD ID: 140595



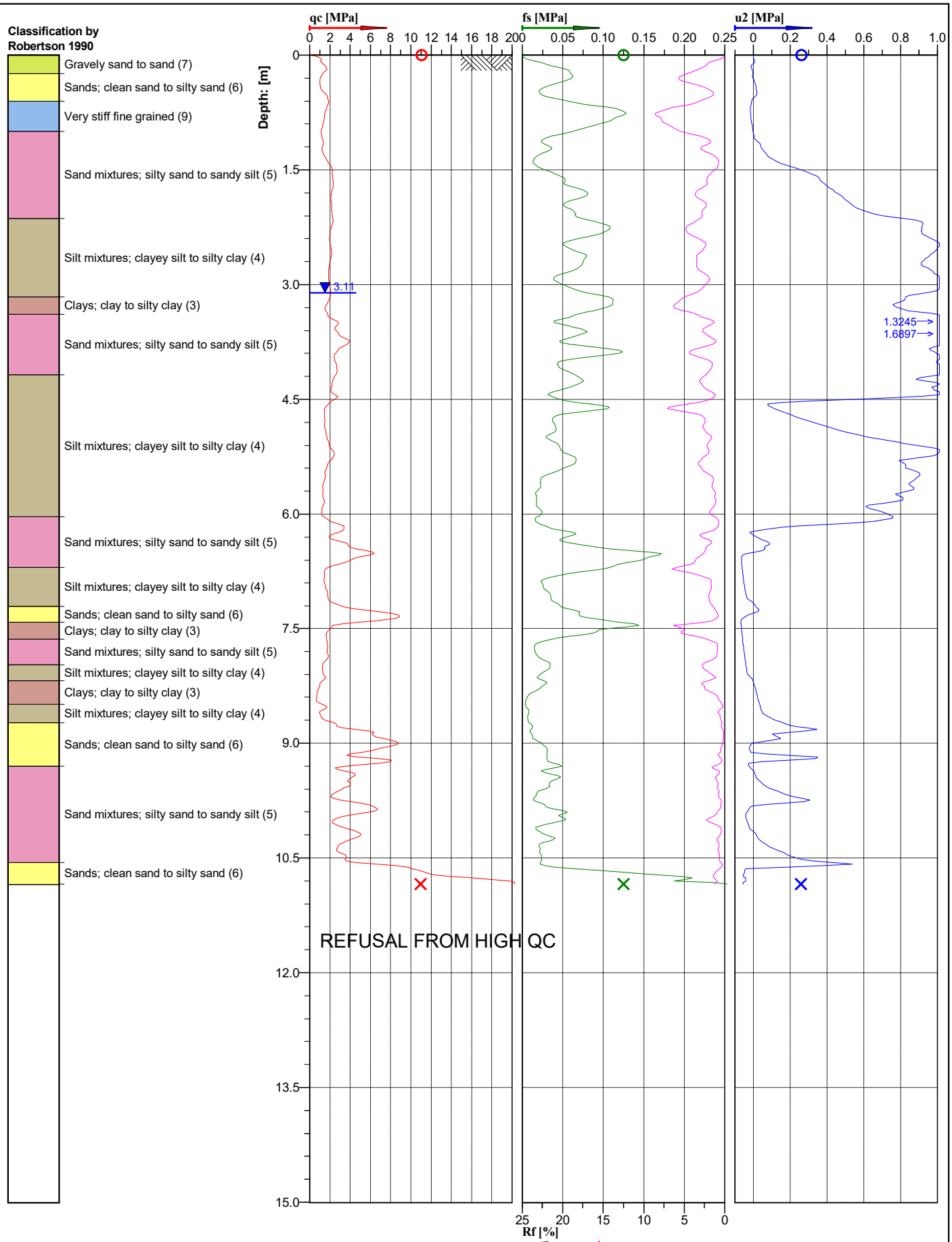


Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

| | | | |
|---|---|---|---|
| Location: HAMILTON | Position: X: 0.00 m, Y: 0.00 m | Ground level: 0.00 | Test No.: CPT01 |
| Project ID: | Client: KIRK ROBERTS | Date: 18/12/2018 | Scale: 1 : 67 |
| Project: 11 OAKTREE LANE - FLAGSTAFF | | Page: 1/1 | Fig.: |
| S 37.71643, E 175.24098 | | File: CPT01.cpt | |

NZGD ID: 140595

NZGD ID: 140595



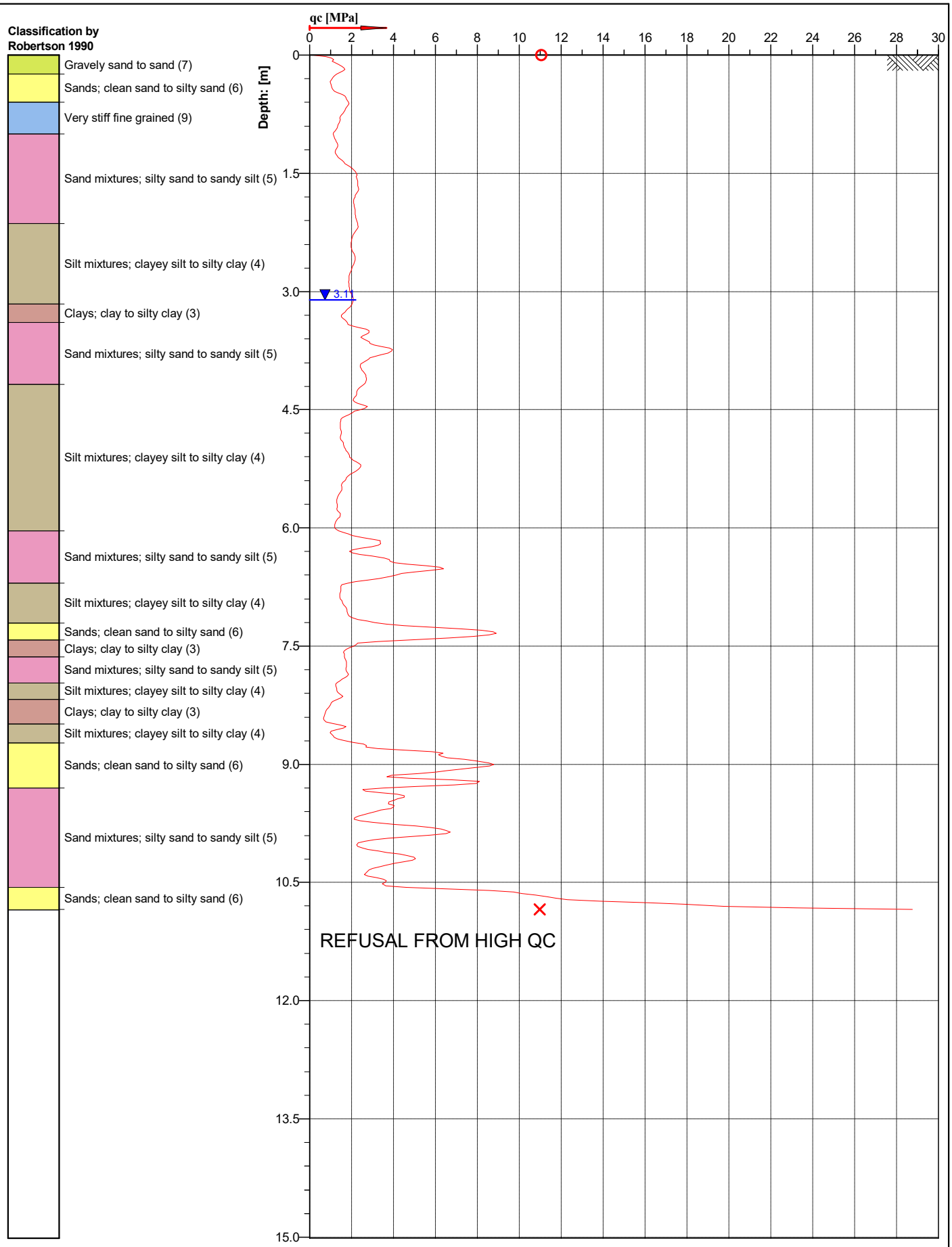

| | | | |
|---|---|---|---|
| Location: HAMILTON | Position: X: 0.00 m, Y: 0.00 m | Ground level: 0.00 | Test No.: CPT01 |
| Project ID: | Client: KIRK ROBERTS | Date: 18/12/2018 | Scale: 1 : 67 |
| Project: 11 OAKTREE LANE - FLAGSTAFF | | Page: 1/1 | Fig.: |
| S 37.71643, E 175.24098 | | File: CPT01.cpt | |

GEOTECH DRILLING

Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

NZGD ID: 140595

NZGD ID: 140595




| | | | |
|---|---|---|---|
| Location: HAMILTON | Position: X: 0.00 m, Y: 0.00 m | Ground level: 0.00 | Test No.: CPT01 |
| Project ID: | Client: KIRK ROBERTS | Date: 18/12/2018 | Scale: 1 : 65 |
| Project: 11 OAKTREE LANE - FLAGSTAFF | | Page: 1/1 | Fig.: |
| S 37.71643, E 175.24098 | | File: CPT01.cpt | |

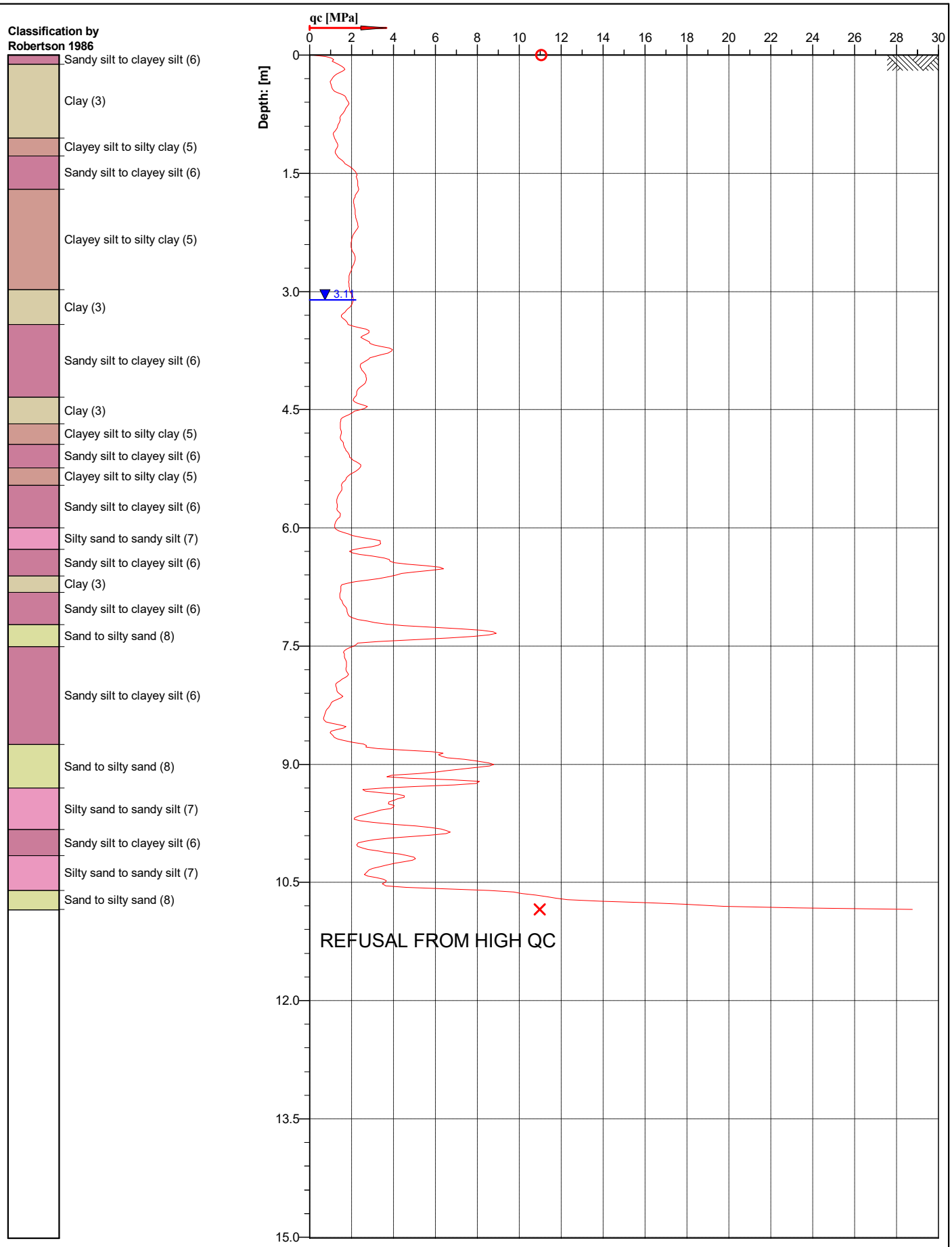
GEOTECH DRILLING

u2

Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

NZGD ID: 140595

NZGD ID: 140595

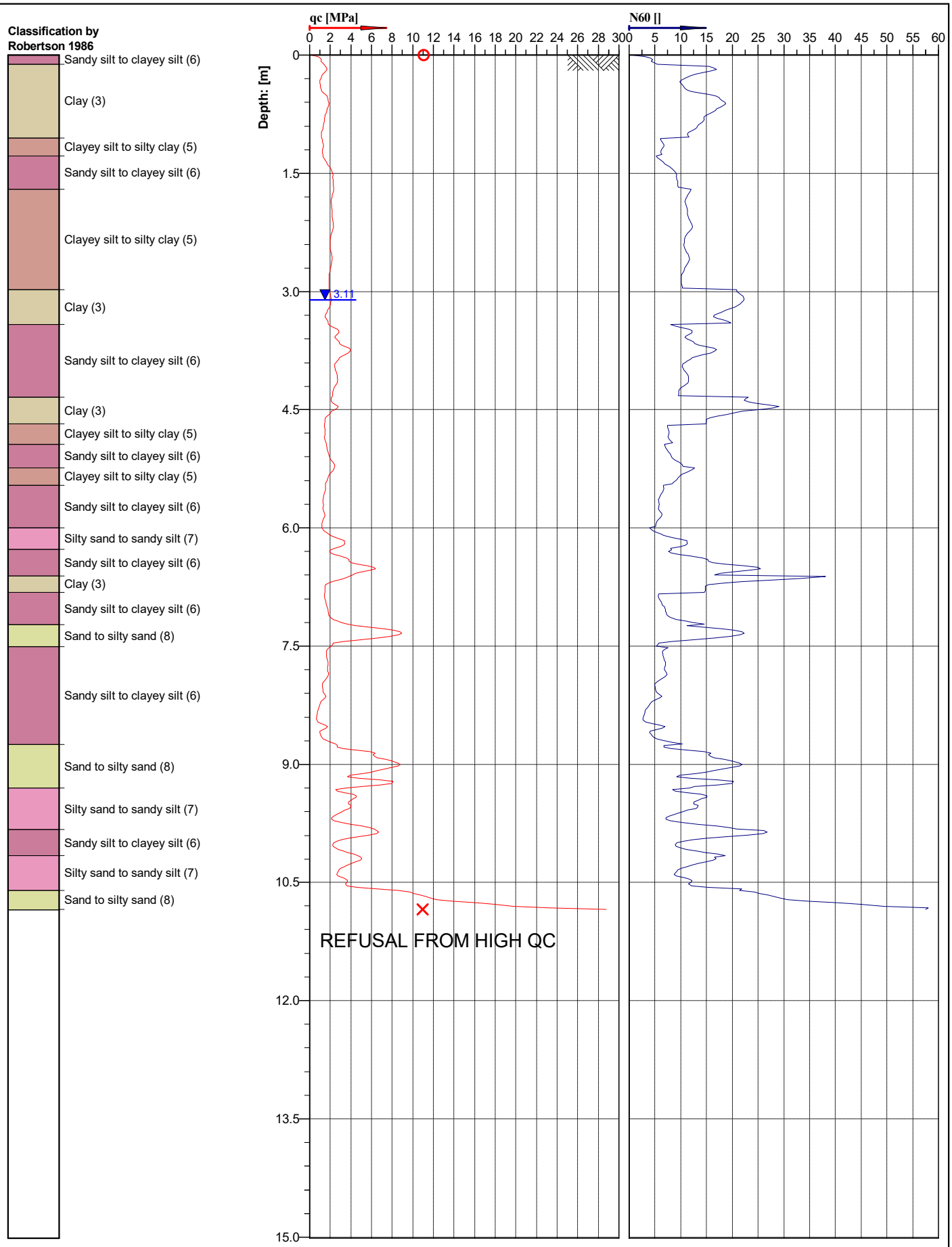



u2

Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

| | | | |
|---|---|---|---|
| Location: HAMILTON | Position: X: 0.00 m, Y: 0.00 m | Ground level: 0.00 | Test No.: CPT01 |
| Project ID: | Client: KIRK ROBERTS | Date: 18/12/2018 | Scale: 1 : 65 |
| Project: 11 OAKTREE LANE - FLAGSTAFF | | Page: 1/1 | Fig.: |
| S 37.71643, E 175.24098 | | File: CPT01.cpt | |

NZGD ID: 140595




| | | | |
|---|---|---|---|
| Location: HAMILTON | Position: X: 0.00 m, Y: 0.00 m | Ground level: 0.00 | Test No.: CPT01 |
| Project ID: | Client: KIRK ROBERTS | Date: 18/12/2018 | Scale: 1 : 65 |
| Project: 11 OAKTREE LANE - FLAGSTAFF | | Page: 1/1 | Fig.: |
| S 37.71643, E 175.24098 | | File: CPT01.cpt | |

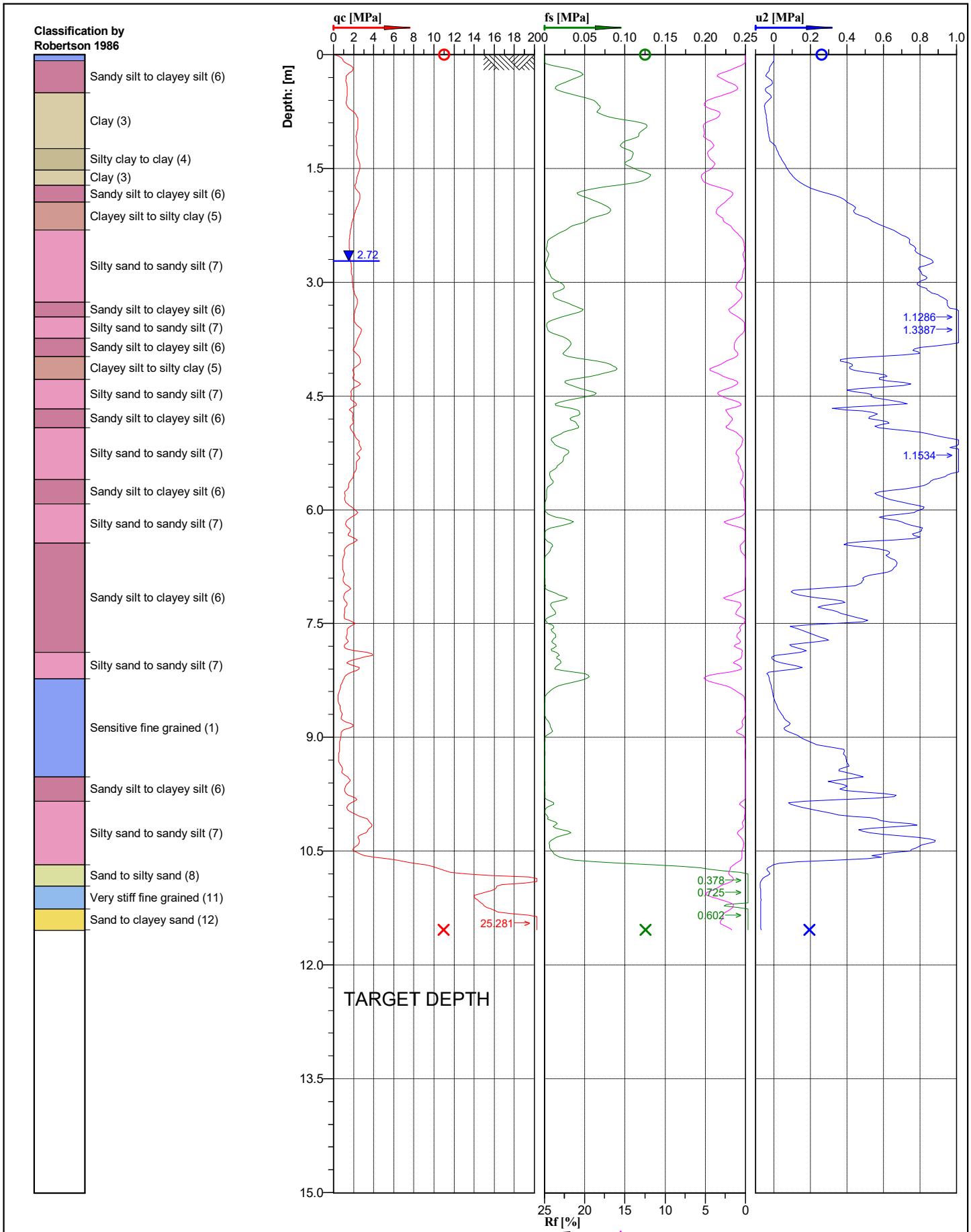
GEOTECH DRILLING

u2

Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

NZGD ID: 140595

NZGD ID: 140596



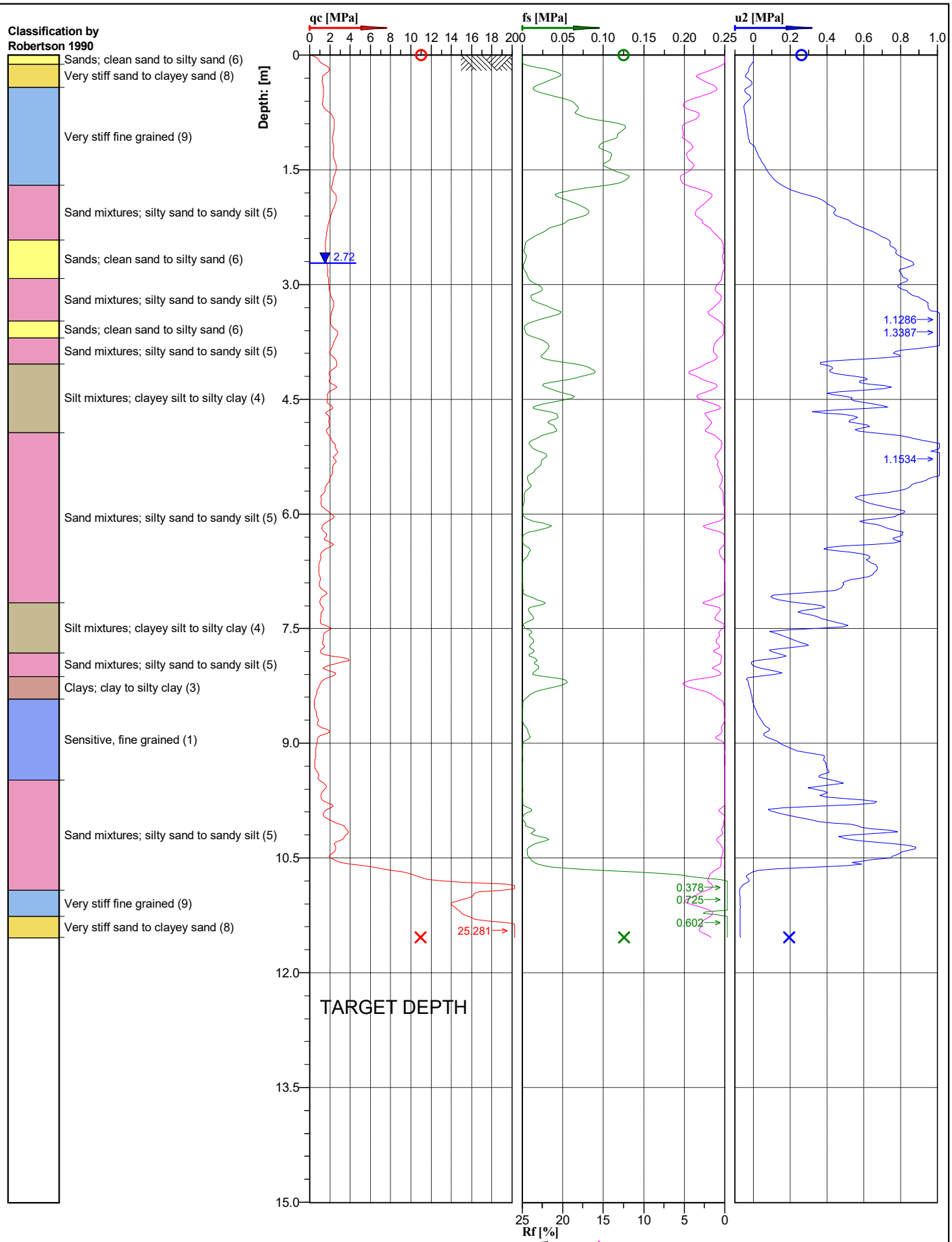

| | | | |
|---|---|---|---|
| Location: HAMILTON | Position: X: 0.00 m, Y: 0.00 m | Ground level: 0.00 | Test No.: CPT02 |
| Project ID: | Client: KIRK ROBERTS | Date: 18/12/2018 | Scale: 1 : 67 |
| Project: 11 OAKTREE LANE - FLAGSTAFF | | Page: 1/1 | Fig.: |
| S 37.71629, E 175.24124 | | File: CPT02.cpt | |

GEOTECH DRILLING

Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

NZGD ID: 140596

NZGD ID: 140596



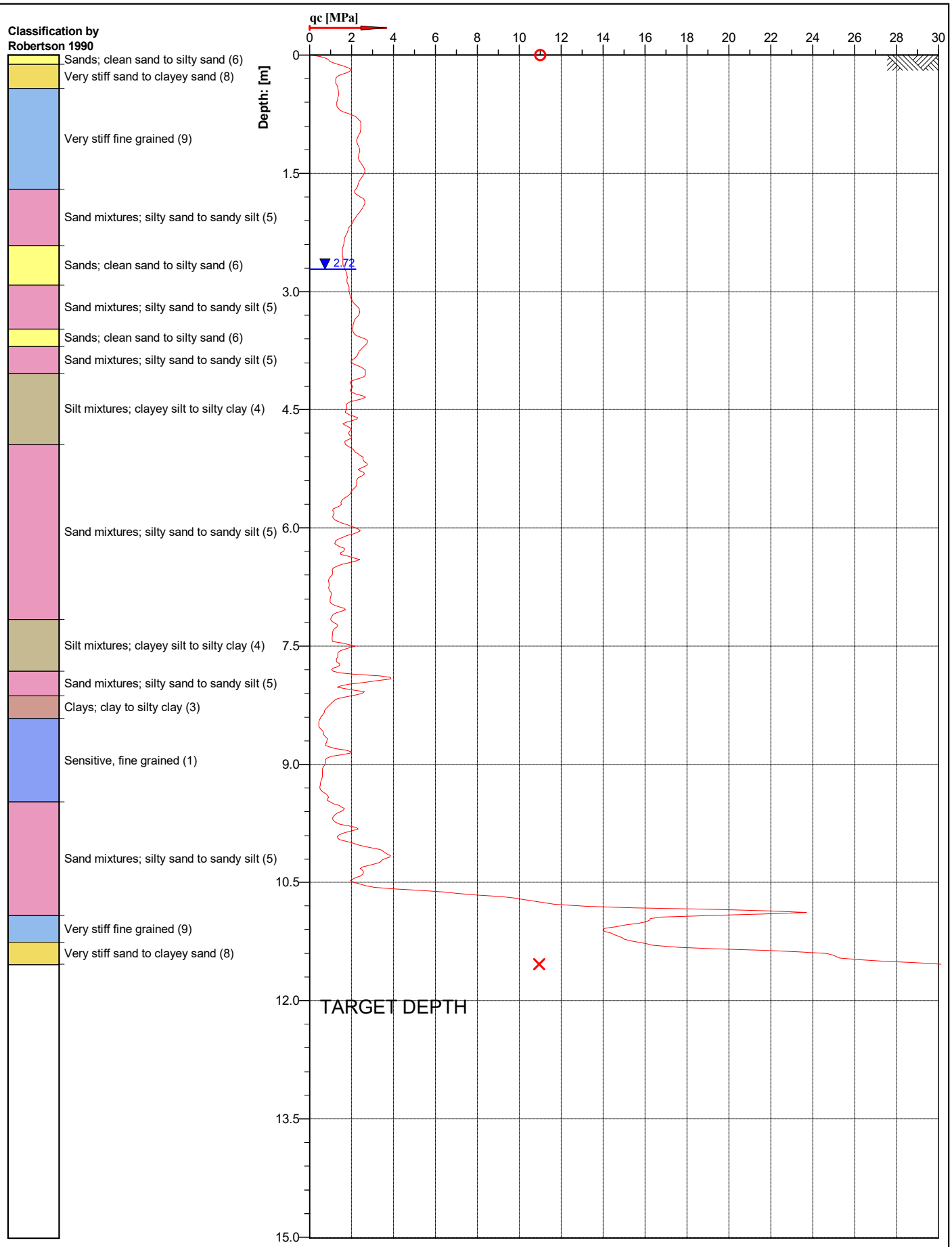

| | | | |
|---|---|---|---|
| Location: HAMILTON | Position: X: 0.00 m, Y: 0.00 m | Ground level: 0.00 | Test No.: CPT02 |
| Project ID: | Client: KIRK ROBERTS | Date: 18/12/2018 | Scale: 1 : 67 |
| Project: 11 OAKTREE LANE - FLAGSTAFF | | Page: 1/1 | Fig.: |
| S 37.71629, E 175.24124 | | File: CPT02.cpt | |

GEOTECH DRILLING

Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

NZGD ID: 140596

NZGD ID: 140596




| | | | |
|---|---|---|---|
| Location: HAMILTON | Position: X: 0.00 m, Y: 0.00 m | Ground level: 0.00 | Test No.: CPT02 |
| Project ID: | Client: KIRK ROBERTS | Date: 18/12/2018 | Scale: 1 : 65 |
| Project: 11 OAKTREE LANE - FLAGSTAFF | | Page: 1/1 | Fig.: |
| S 37.71629, E 175.24124 | | File: CPT02.cpt | |

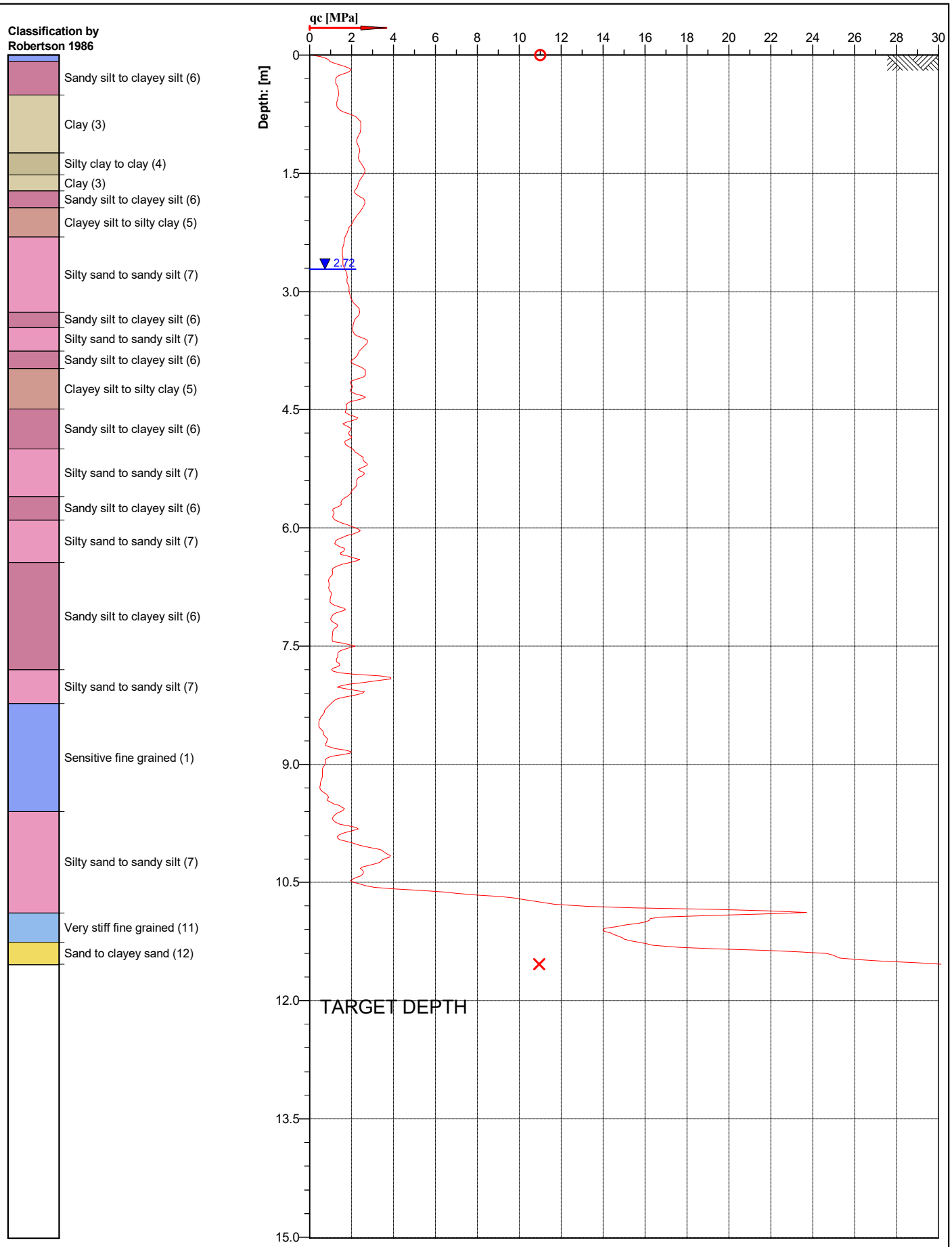
GEOTECH DRILLING

u2

Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

NZGD ID: 140596

NZGD ID: 140596



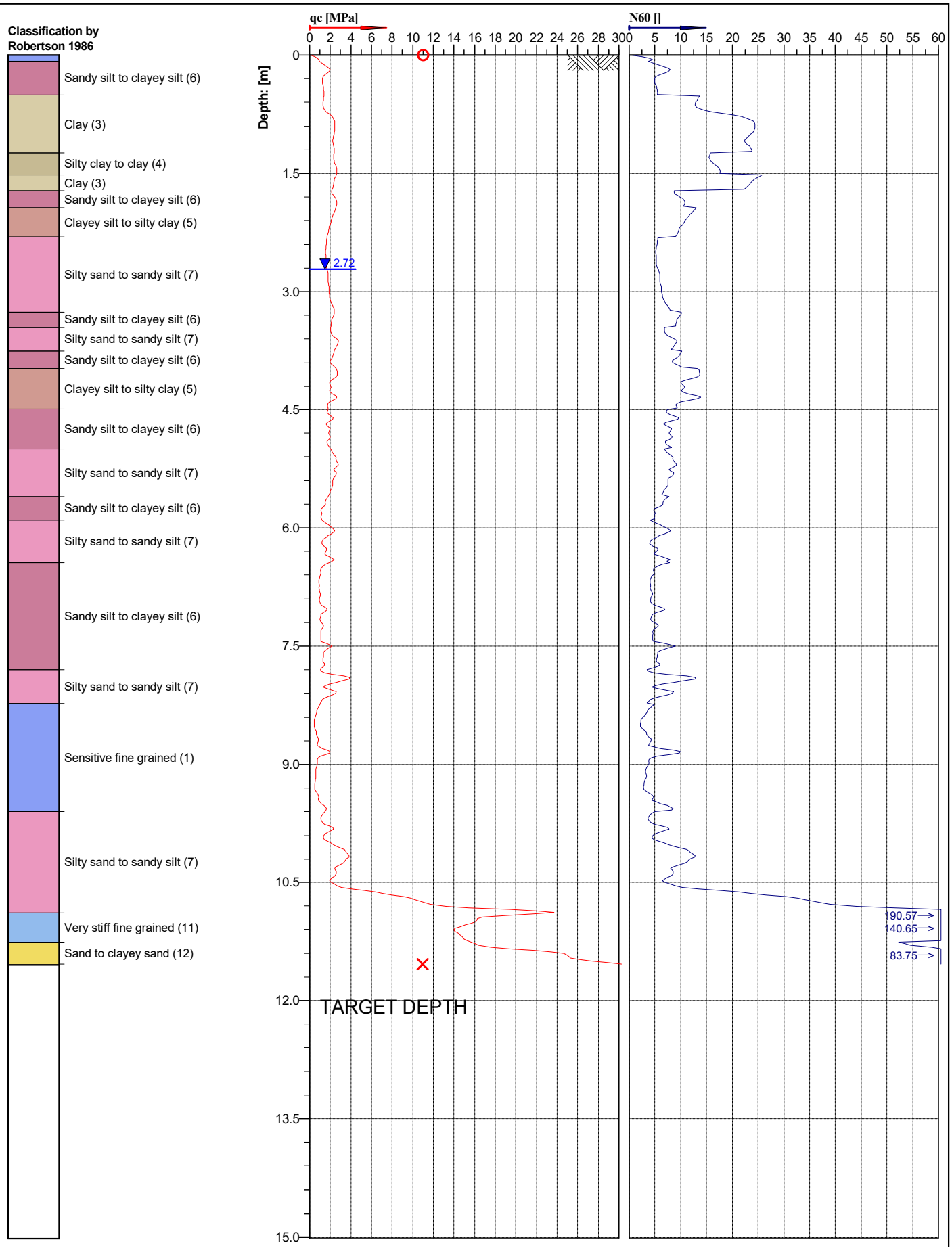


Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

| | | | |
|---|---|---|---|
| Location: HAMILTON | Position: X: 0.00 m, Y: 0.00 m | Ground level: 0.00 | Test No.: CPT02 |
| Project ID: | Client: KIRK ROBERTS | Date: 18/12/2018 | Scale: 1 : 65 |
| Project: 11 OAKTREE LANE - FLAGSTAFF | | Page: 1/1 | Fig.: |
| S 37.71629, E 175.24124 | | File: CPT02.cpt | |

NZGD ID: 140596

NZGD ID: 140596



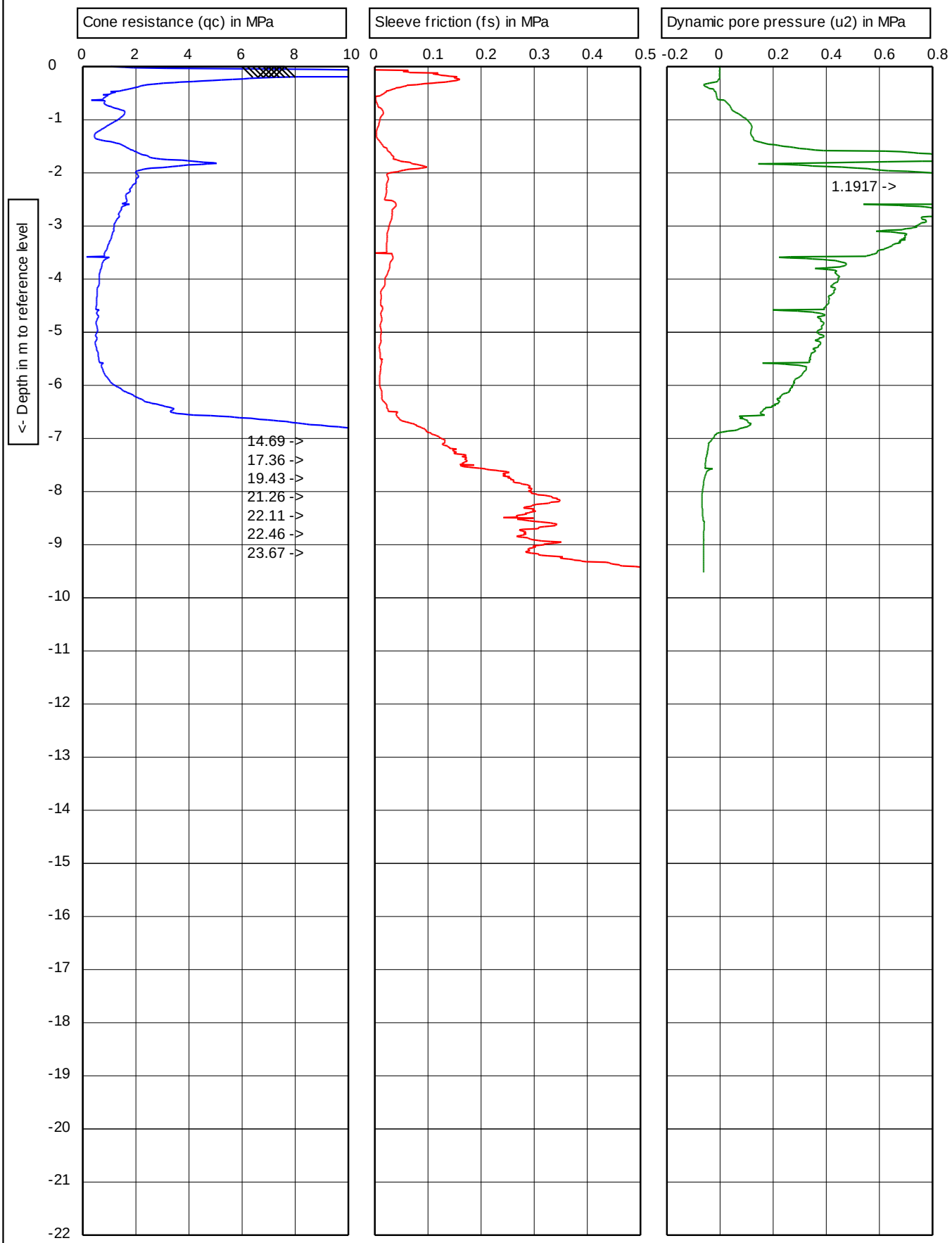

| | | | |
|---|---|---|---|
| Location: HAMILTON | Position: X: 0.00 m, Y: 0.00 m | Ground level: 0.00 | Test No.: CPT02 |
| Project ID: | Client: KIRK ROBERTS | Date: 18/12/2018 | Scale: 1 : 65 |
| Project: 11 OAKTREE LANE - FLAGSTAFF | | Page: 1/1 | Fig.: |
| S 37.71629, E 175.24124 | | File: CPT02.cpt | |

GEOTECH DRILLING

Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

NZGD ID: 140596

NZGD ID: 73321




OPUS IANZ ACCREDITED LABORATORY

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

1.40

r u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL | W.L.: **-0.6**

Project: **Waikato Expressway:Hamilton Sect.**

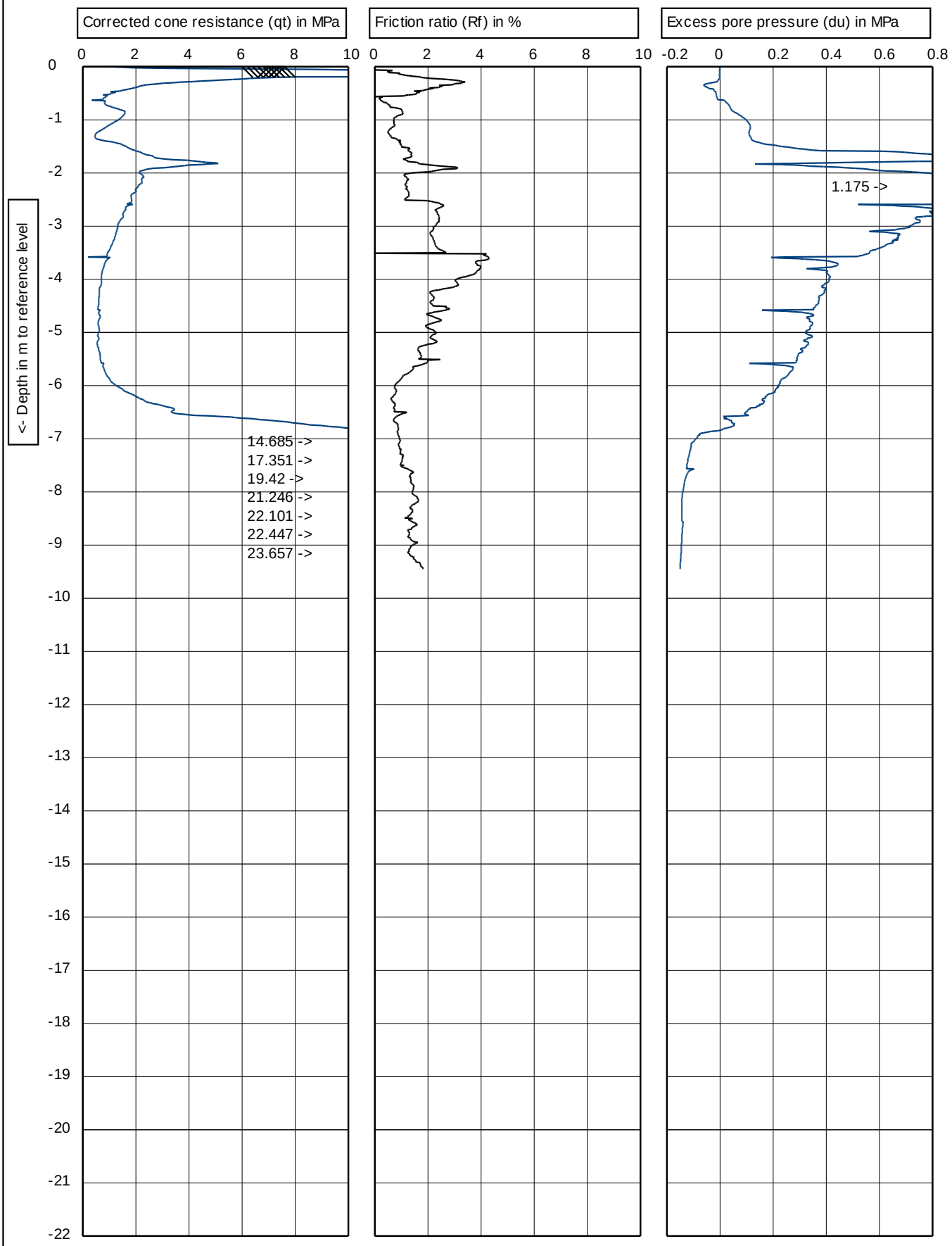
Location: **Kay Rd**

Position: **1798409, 5823310 NZTM**

| | |
|---|---|
| Predrill : | **0 m Predrilled** |
| Date: | **12/8/2014** |
| Cone no.: | **C10CFIIP.C11284** |
| Project no.: | **231695.00_027** |
| CPT no.: | **728** **1/6** |

NZGD ID: 73321

NZGD ID: 73321




OPUS

Graphs on this page are not IANZ accredited

1.40

r u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL | W.L.: **-0.6**

Project: **Waikato Expressway:Hamilton Sect.**

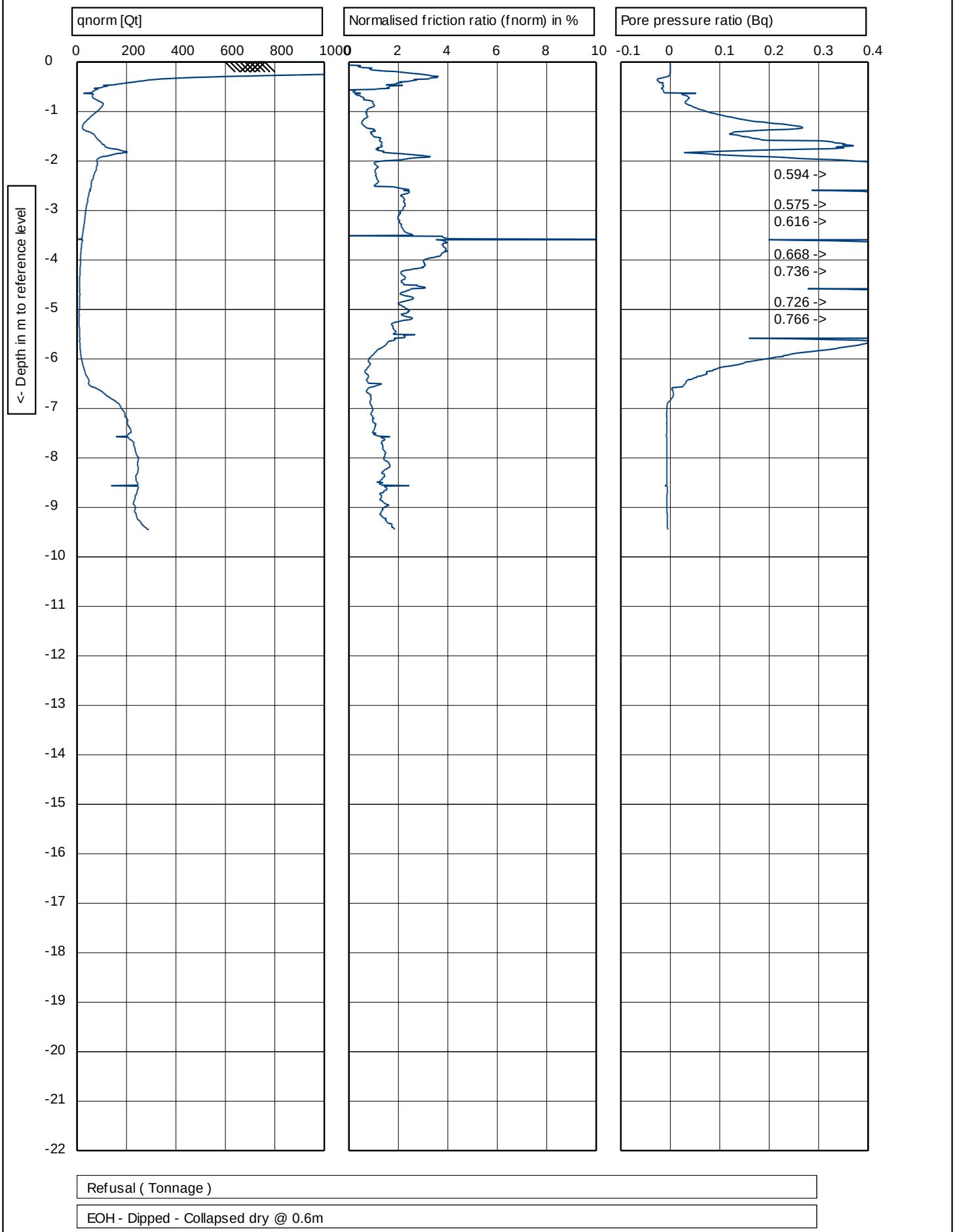
Location: **Kay Rd**

Position: **1798409, 5823310 NZTM**

| | |
|---|---|
| Predrill : | **0 m Predrilled** |
| Date: | **12/8/2014** |
| Cone no.: | **C10CFIIP.C11284** |
| Project no.: | **231695.00_027** |
| CPT no.: | **728** **2/6** |

NZGD ID: 73321

NZGD ID: 73321




OPUS

Graphs on this page are not IANZ accredited

1.40

r u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL | W.L.: **-0.6**

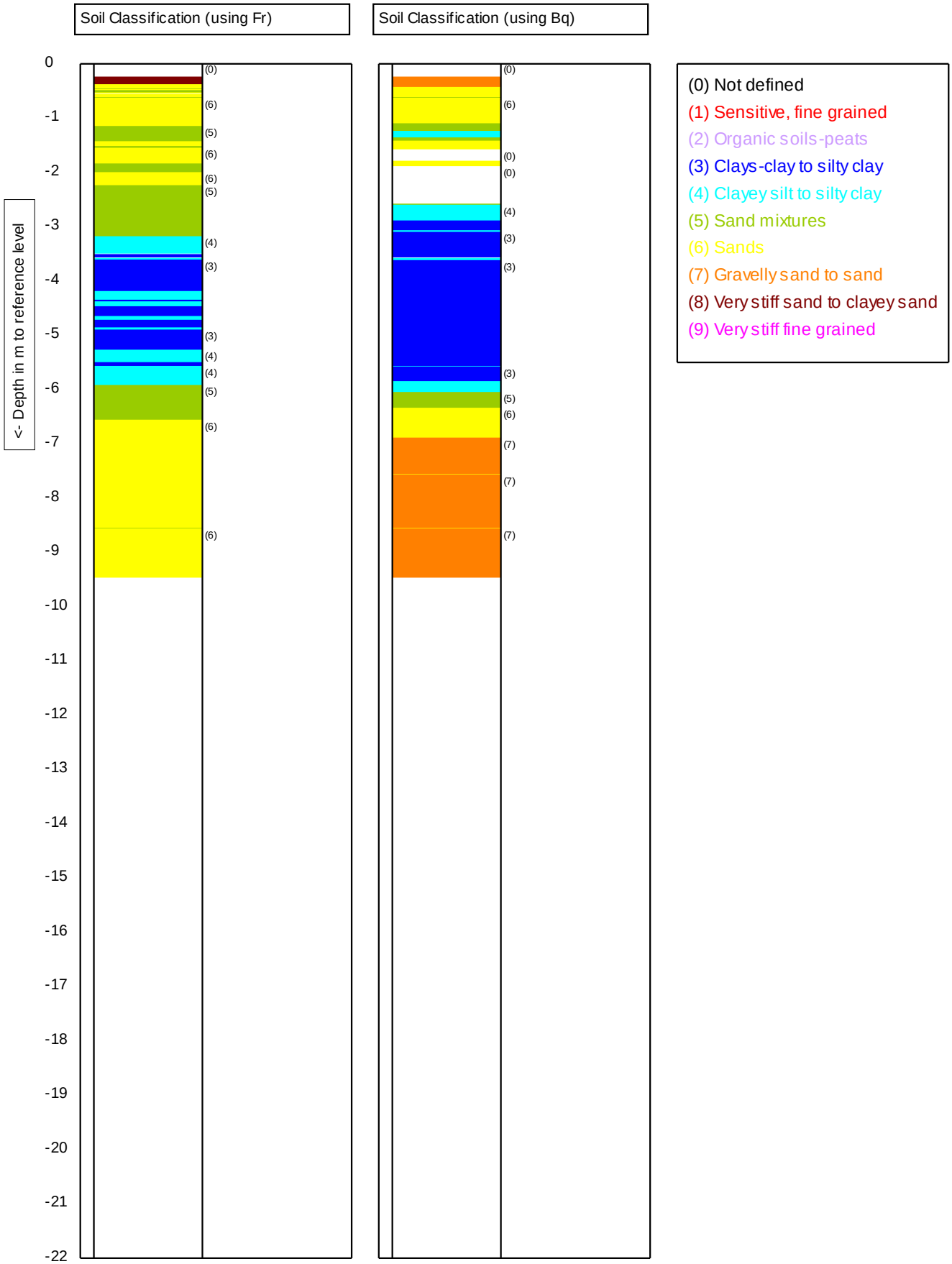
Project: **Waikato Expressway:Hamilton Sect.**

Location: **Kay Rd**

Position: **1798409, 5823310 NZTM**

| | |
|---|---|
| Predrill : | **0 m Predrilled** |
| Date: | **12/8/2014** |
| Cone no.: | **C10CFIIP.C11284** |
| Project no.: | **231695.00_027** |
| CPT no.: | **728** **3/6** |

NZGD ID: 73321



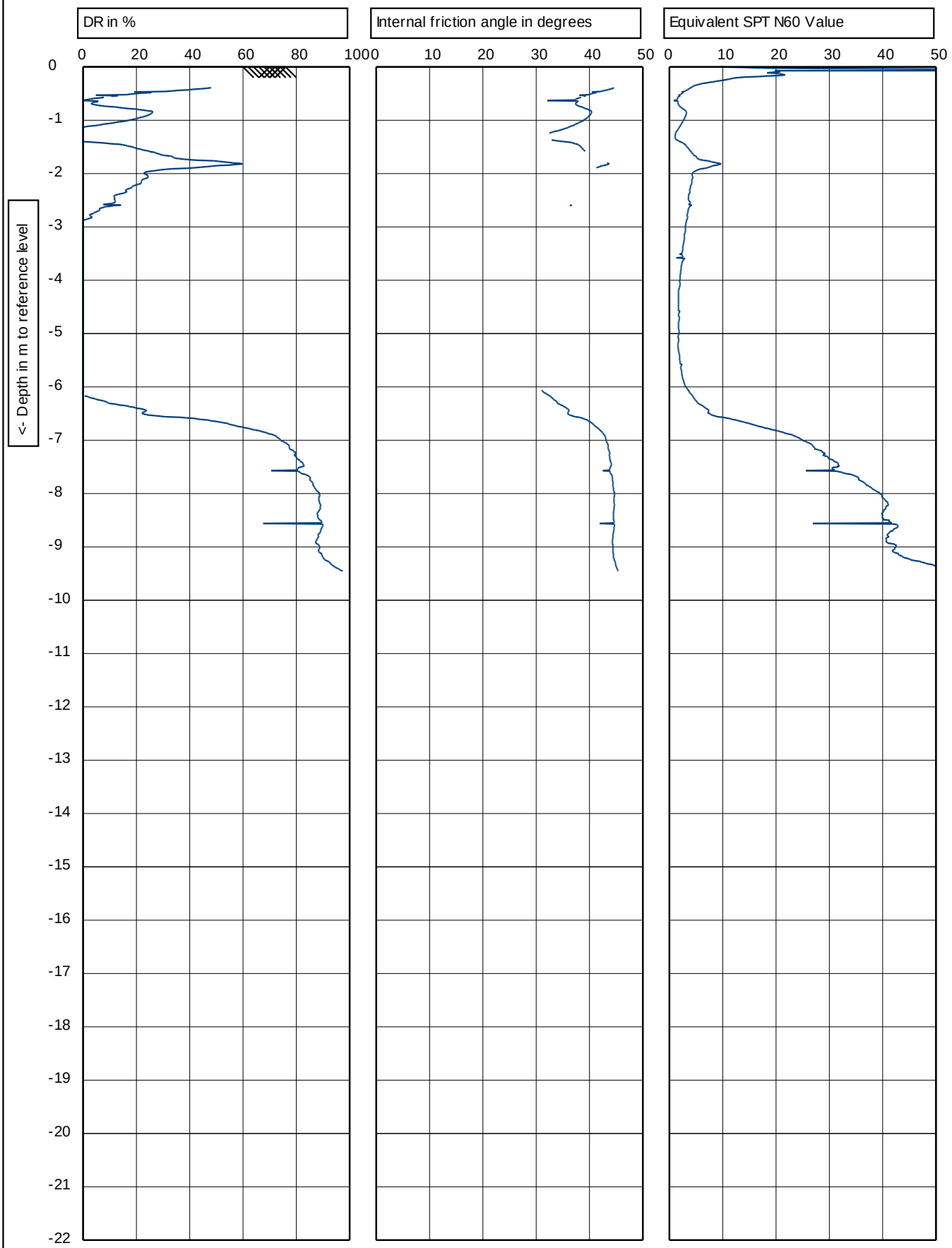

OPUS

Graphs on this page are not IANZ accredited

1.40

| | | | |
|---|---|---|---|
| r 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: | **12/8/2014** |
| Project: | **Waikato Expressway:Hamilton Sect.** | Cone no.: | **C10CFIIP.C11284** |
| Location: | **Kay Rd** | Project no.: | **231695.00_027** |
| Position: | **1798409, 5823310 NZTM** | CPT no.: | **728** 4/6 |

NZGD ID: 73321




Refusal ( Tonnage )

EOH - Dipped - Collapsed dry @ 0.6m

OPUS

Graphs on this page are not IANZ accredited

1.40

r u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL | W.L.: **-0.6**

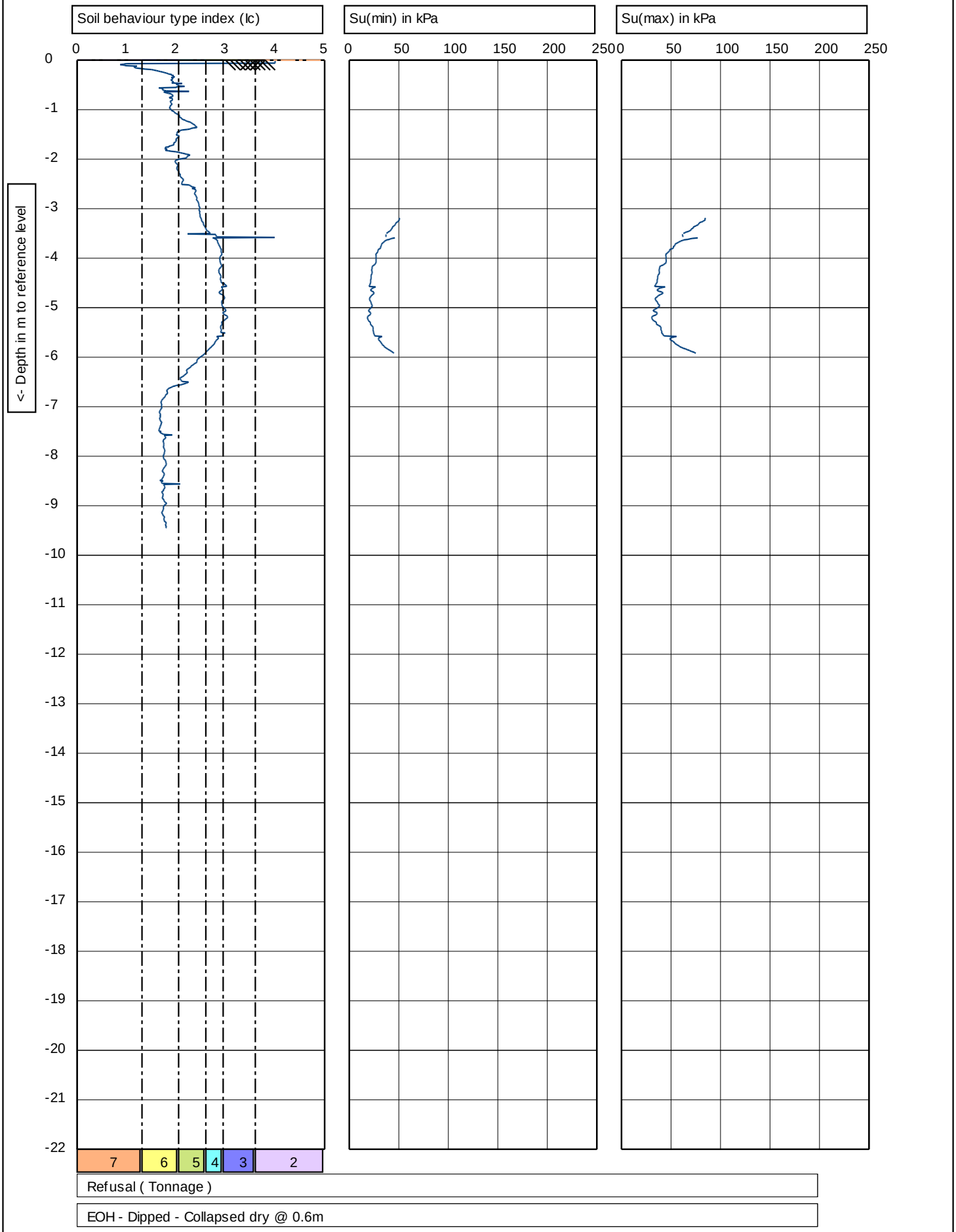
Project: **Waikato Expressway:Hamilton Sect.**

Location: **Kay Rd**

Position: **1798409, 5823310 NZTM**

| | |
|---|---|
| Predrill : | **0 m Predrilled** |
| Date: | **12/8/2014** |
| Cone no.: | **C10CFIIP.C11284** |
| Project no.: | **231695.00_027** |
| CPT no.: | **728** 5/6 |

NZGD ID: 73321




OPUS

Graphs on this page are not IANZ accredited

1.40

r u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL | W.L.: **-0.6**

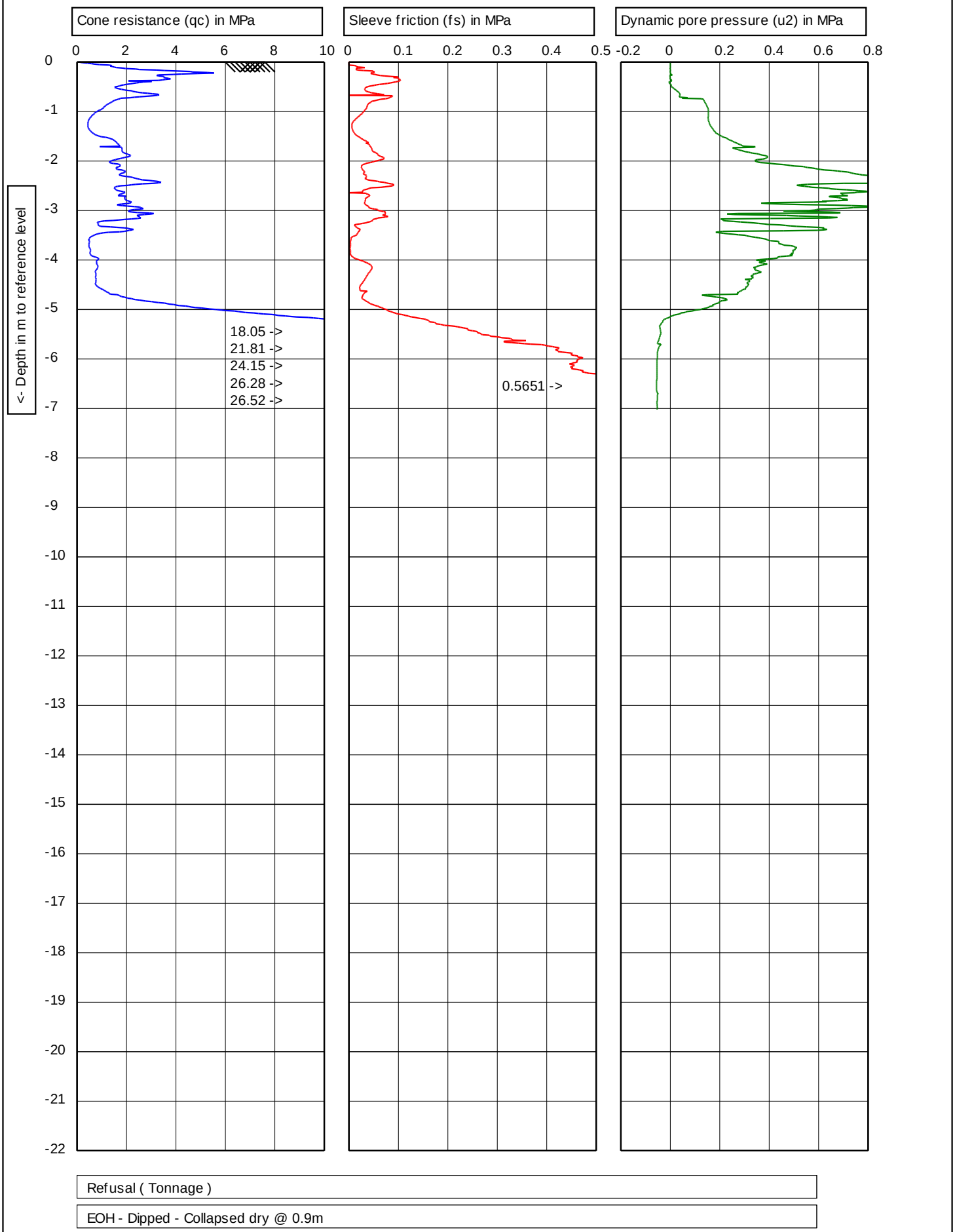
Project: **Waikato Expressway:Hamilton Sect.**

Location: **Kay Rd**

Position: **1798409, 5823310 NZTM**

| | |
|---|---|
| Predrill : | **0 m Predrilled** |
| Date: | **12/8/2014** |
| Cone no.: | **C10CFIIP.C11284** |
| Project no.: | **231695.00_027** |
| CPT no.: | **728** **6/6** |

NZGD ID: 73321




OPUS
IANZ ACCREDITED LABORATORY
Graphs indicated as not accredited are outside the scope of the laboratory's accreditation

r u2
L 150 cm²
10 cm²

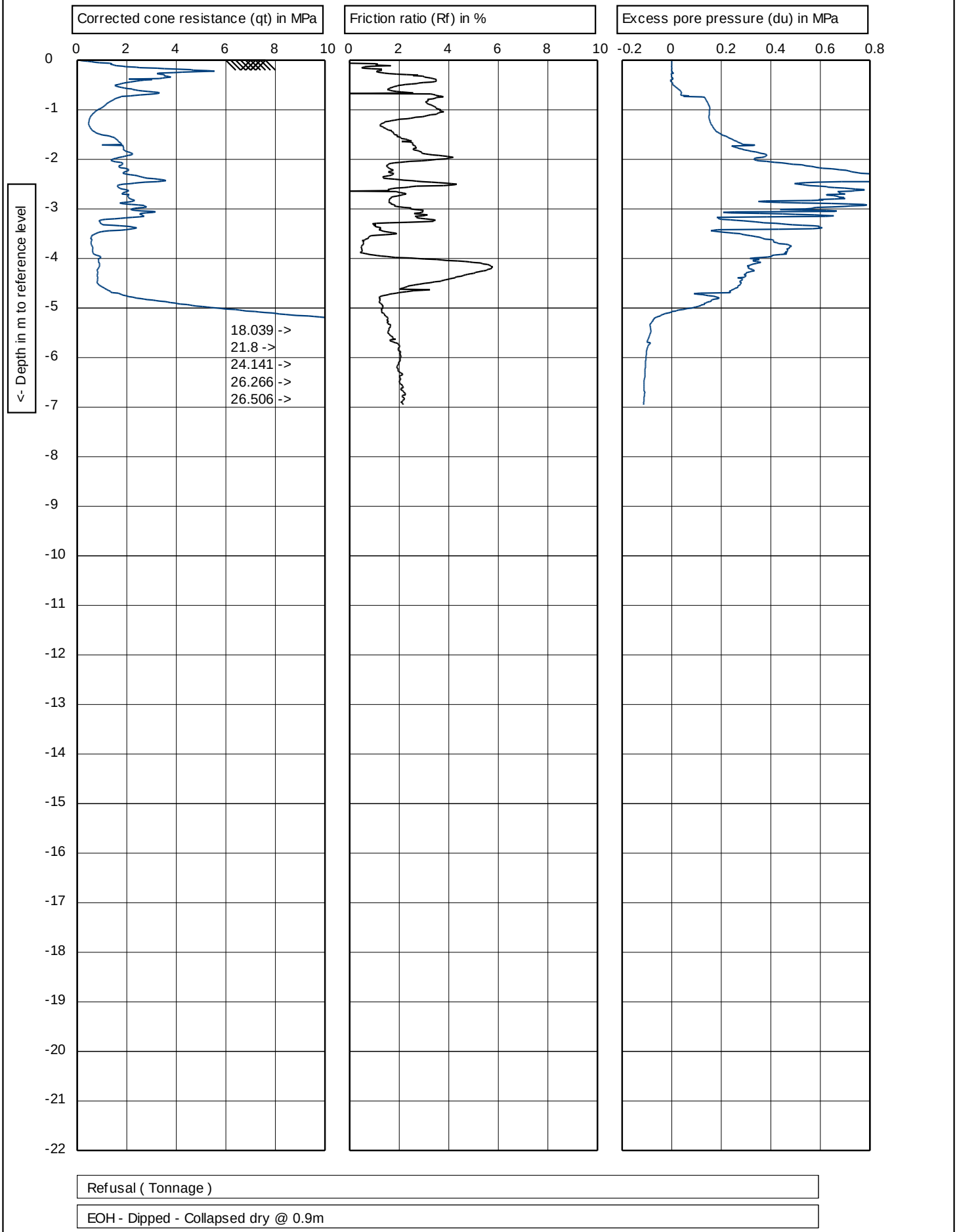
Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL | W.L.: **-0.9**

Project: **Waikato Expressway:Hamilton Sect.**
Location: **Kay Rd**
Position: **1798415, 5823254 NZTM**

| | |
|---|---|
| Predrill : | **0 m Predrilled** |
| Date: | **12/8/2014** |
| Cone no.: | **C10CFIIP.C11284** |
| Project no.: | **231695.00_027** |
| CPT no.: | **729** **1/6** |

1.40




OPUS

Graphs on this page are not IANZ accredited

1.40

r u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012

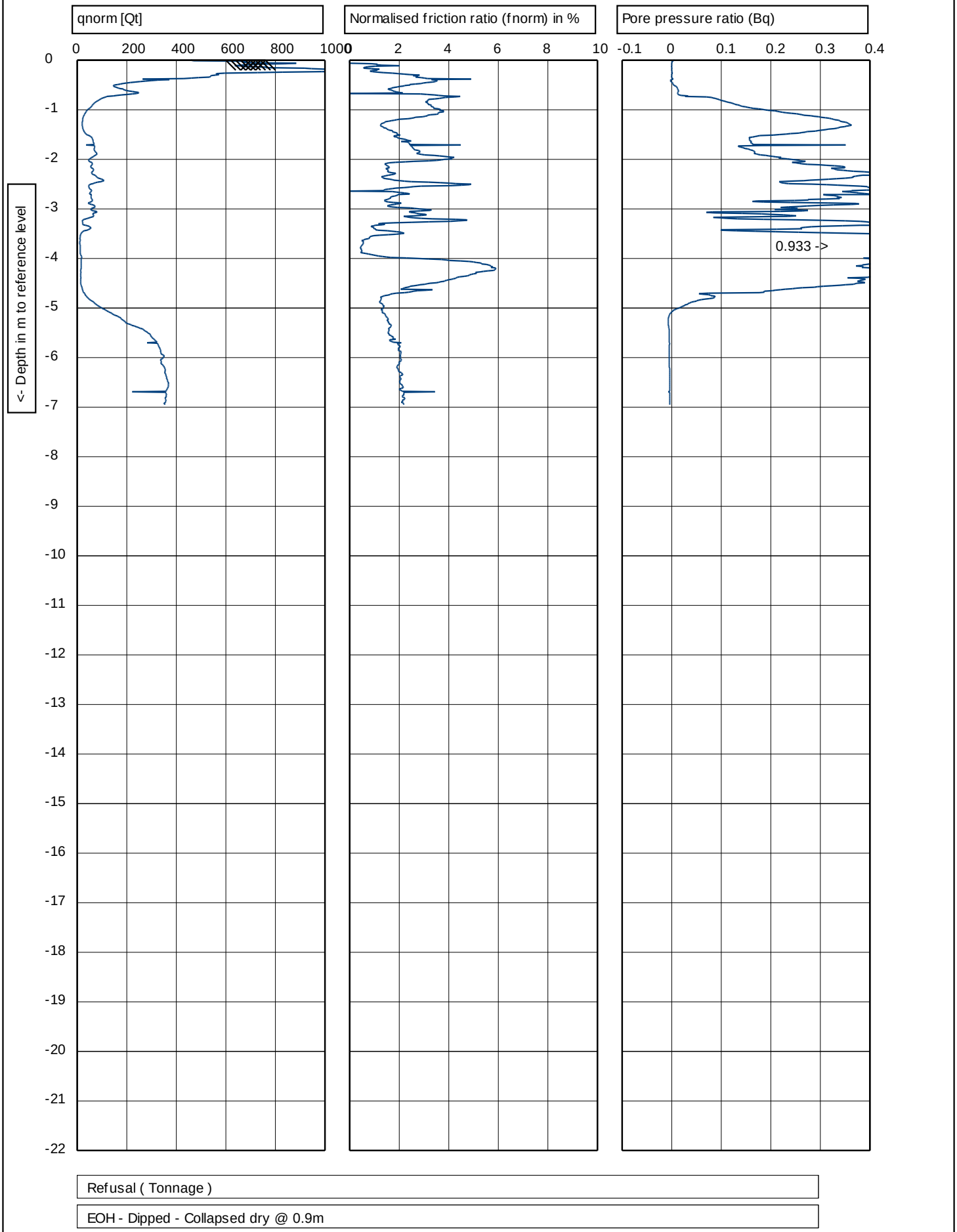
G.L. 0 MSL | W.L.: **-0.9**

Project: **Waikato Expressway:Hamilton Sect.**

Location: **Kay Rd**

Position: **1798415, 5823254 NZTM**

| | |
|---|---|
| Predrill : | **0 m Predrilled** |
| Date: | **12/8/2014** |
| Cone no.: | **C10CFIIP.C11284** |
| Project no.: | **231695.00_027** |
| CPT no.: | **729** **2/6** |




Refusal ( Tonnage )

EOH - Dipped - Collapsed dry @ 0.9m

OPUS

Graphs on this page are not IANZ accredited

1.40

r u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL | W.L.: **-0.9**

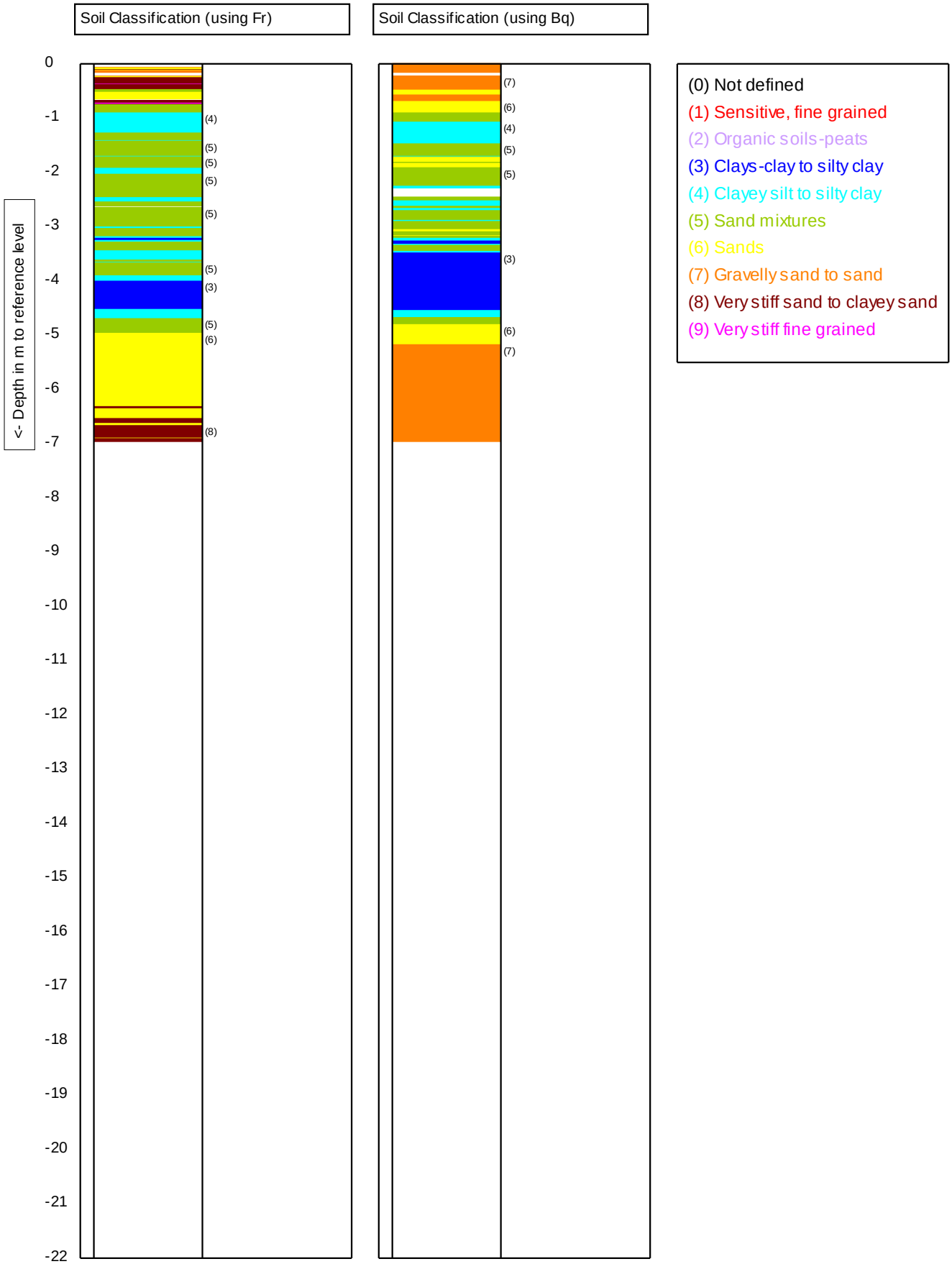
Project: **Waikato Expressway:Hamilton Sect.**

Location: **Kay Rd**

Position: **1798415, 5823254 NZTM**

| | |
|---|---|
| Predrill : | **0 m Predrilled** |
| Date: | **12/8/2014** |
| Cone no.: | **C10CFIIP.C11284** |
| Project no.: | **231695.00_027** |
| CPT no.: | **729** **3/6** |

NZGD ID: 73322



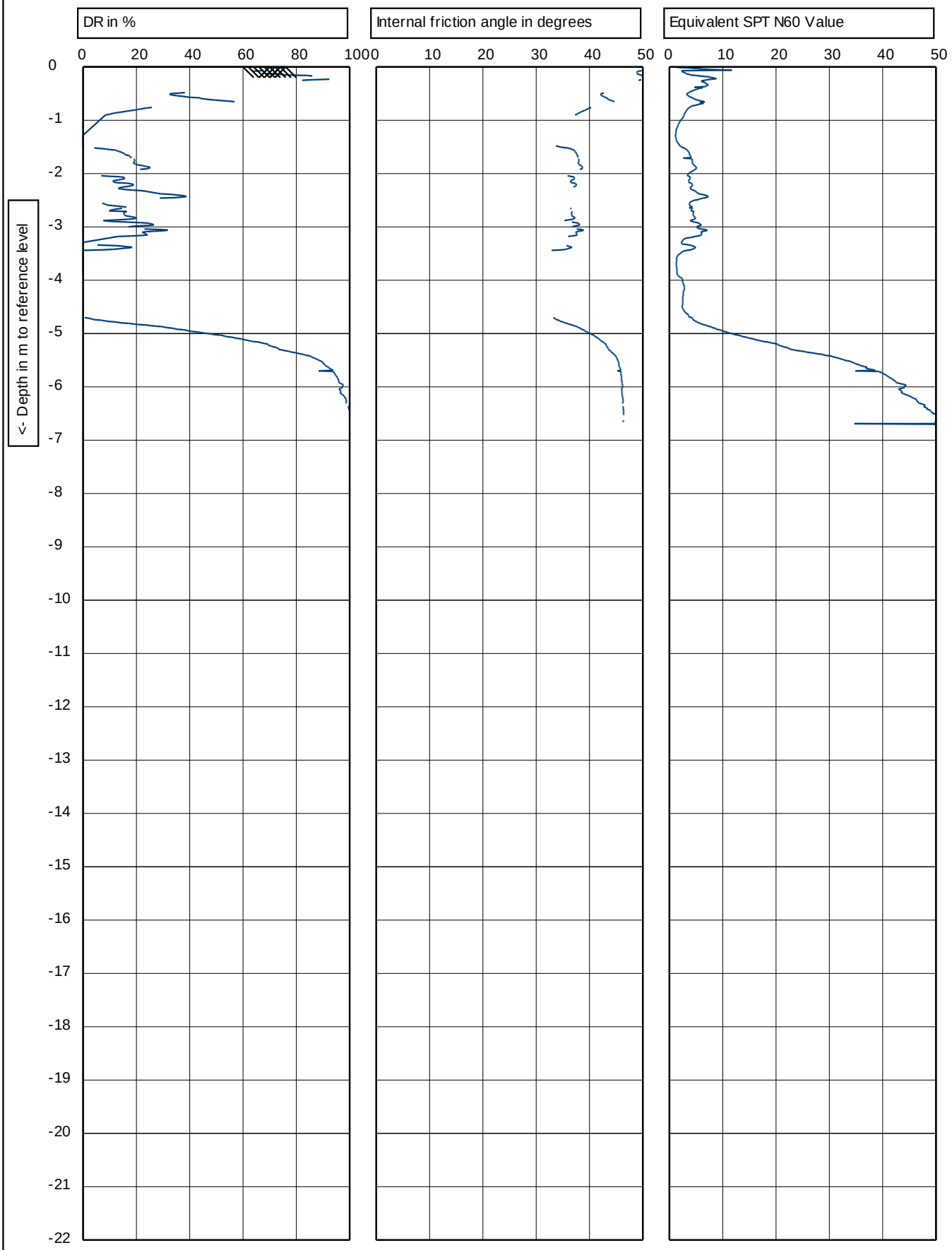

OPUS

Graphs on this page are not IANZ accredited

1.40

| | | | |
|---|---|---|---|
| r 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: | **12/8/2014** |
| Project: | **Waikato Expressway:Hamilton Sect.** | Cone no.: | **C10CFIIP.C11284** |
| Location: | **Kay Rd** | Project no.: | **231695.00_027** |
| Position: | **1798415, 5823254 NZTM** | CPT no.: | **729** **4/6** |

NZGD ID: 73322




Refusal ( Tonnage )

EOH - Dipped - Collapsed dry @ 0.9m

OPUS

Graphs on this page are not IANZ accredited

1.40

r u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL | W.L.: **-0.9**

Project: **Waikato Expressway:Hamilton Sect.**

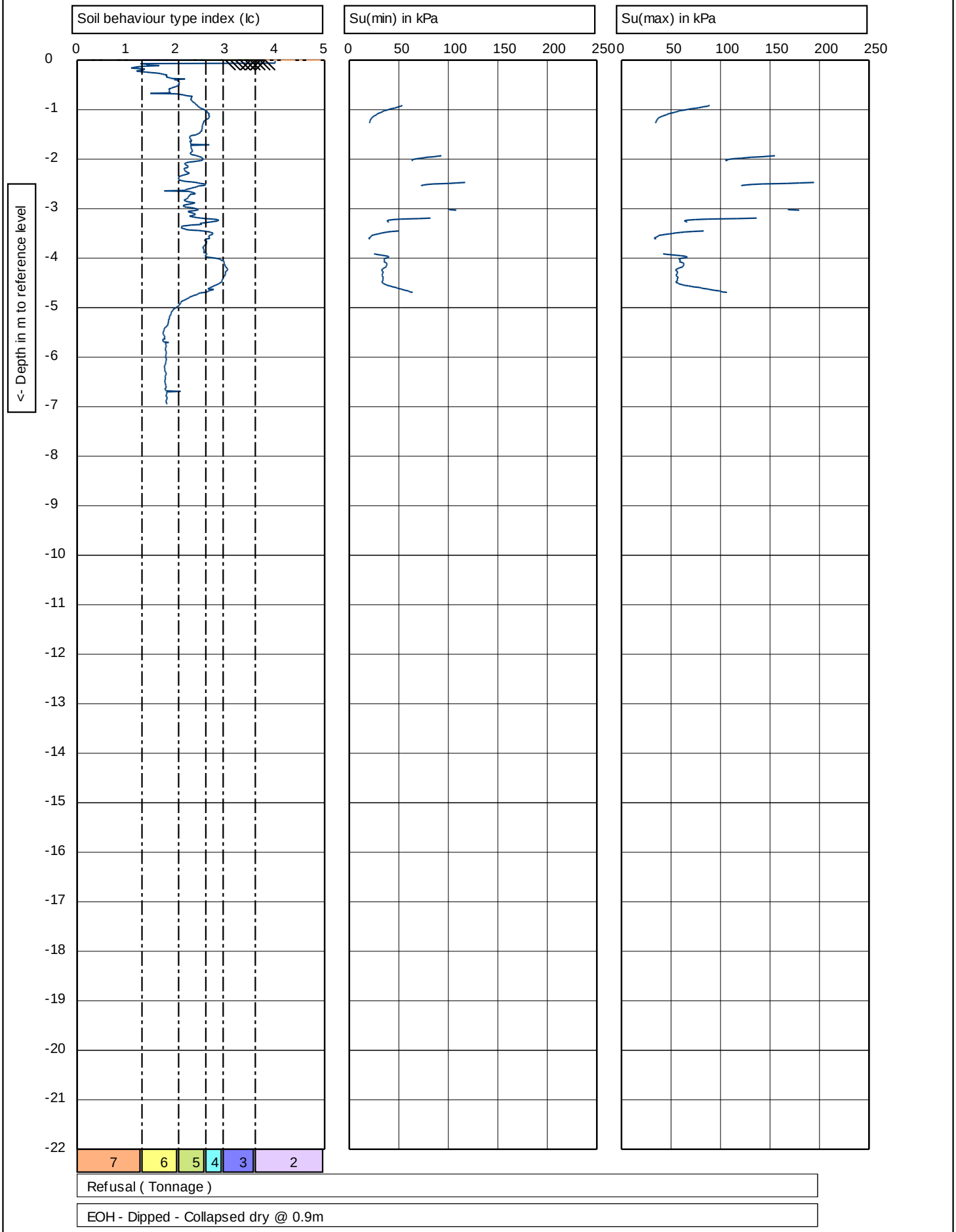
Location: **Kay Rd**

Position: **1798415, 5823254 NZTM**

| | |
|---|---|
| Predrill : | **0 m Predrilled** |
| Date: | **12/8/2014** |
| Cone no.: | **C10CFIIP.C11284** |
| Project no.: | **231695.00_027** |
| CPT no.: | **729** **5/6** |

NZGD ID: 73322

NZGD ID: 73322




OPUS

Graphs on this page are not IANZ accredited

1.40

r u2
150 cm²
10 cm²

Test according ASTM D5778-12 & ISO 22476-1:2012

G.L. 0 MSL | W.L.: **-0.9**

Project: **Waikato Expressway:Hamilton Sect.**

Location: **Kay Rd**

Position: **1798415, 5823254 NZTM**

| | |
|---|---|
| Predrill : | **0 m Predrilled** |
| Date: | **12/8/2014** |
| Cone no.: | **C10CFIIP.C11284** |
| Project no.: | **231695.00_027** |
| CPT no.: | **729** 6/6 |

NZGD ID: 73322

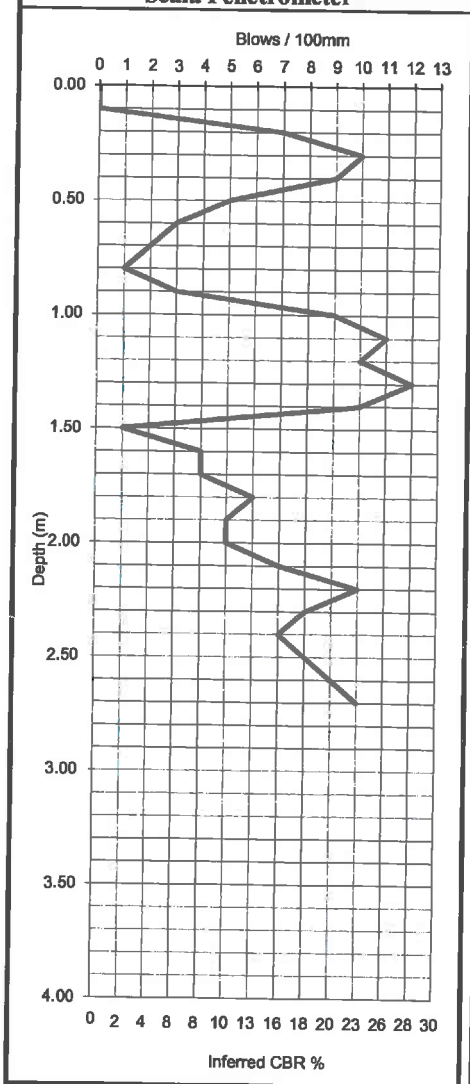
# TEST PIT / SCALA PENETROMETER TEST REPORT

OPUS

| | |
|---|---|
| Project : | **Waikato Expressway - Hamilton Section** |
| Location : | **Resolution Drive Extension** |
| Client : | **NZ Transport Agency** |
| Sampled by : | **E J West** |
| Test number : | **TP 728** |
| Shear vane number : | **DR 398** |
| Shear vane correction : | **Refer to Calibration Sheet** |
| Coordinates (NZTM) : | **N 5823311** |
| | **E 1798407** |
| Water level (m) : | **Not encountered** |

| | |
|---|---|
| **Project No :** | **2-31695.00** |
| **Lab Ref No :** | **15/802/002** |
| **Client Ref No :** | **TP 728** |

## Scala Penetrometer




## Test Results

| Depth (m) | Shear Strength (kPa) | Sample Details | Soil Description |
|---|---|---|---|
| 0.00 | | | AP65. Fresh angular silty SAND GRAVEL, dense, dry, non plastic. |
| 0.20 | Refusal | | Clayey SILT, orange brown, hard, moist, highly plastic. |
| 0.40 | 118/34 | | SILT, some Clay, orange brown / orange white / red, firm, moist, moderately plastic. |
| 0.80 | 118/38 | Bulk | SILT, some Clay, light yellowish brown, firm, moist, moderately plastic. |
| 1.60 | 17/3 | | Clayey SILT, light yellowish brown, soft, saturated, moderately plastic. |
| 1.80 | Refusal | Bulk | |
| 4.50 | | Bulk | Water weeping into hole. |
| 6.00 | | | *End of Pit.* |

**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 | Inferred CBR values are not IANZ accredited |

Date tested : 28/01/15
Date reported : 03/02/15



**IANZ Approved Signatory**

Designation : *Senior Civil Engineering Technician*
Date : 03/02/15

IANZ ACCREDITED LABORATORY

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



Opus International Consultants Ltd
Hamilton Laboratory
Quality Management Systems Certified to ISO 9001

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

Telephone +64 7 856 2870
Facsimile +64 7 856 2873
Website www.opus.co.nz

NZGD ID: 77263

OPUS

# Waikato Expressway – Hamilton Section

**Project No: 2-31695.00**
**Lab Ref No: 15/802/003**


***Pit Photo***

**Test Pit**

**TP 728**



NZGD ID: 77263

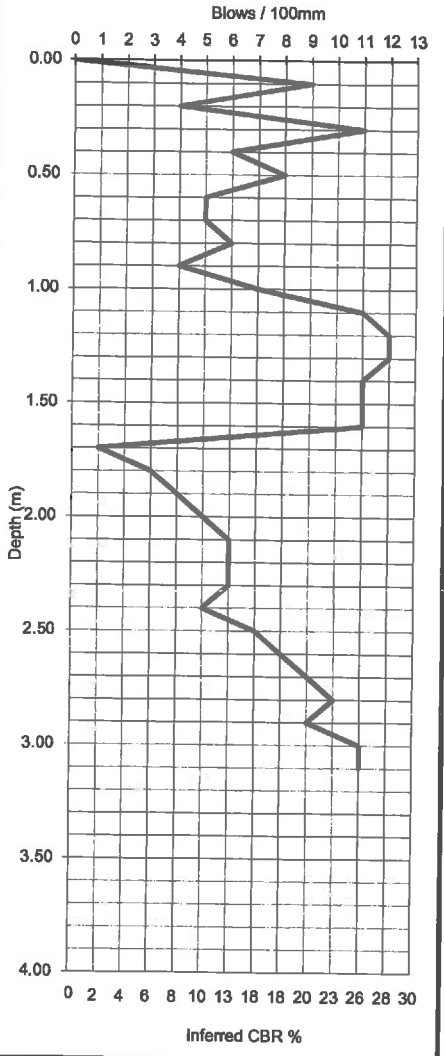
# TEST PIT / SCALA PENETROMETER TEST REPORT

OPUS

| | |
|---|---|
| Project : | **Waikato Expressway - Hamilton Section** |
| Location : | **Resolution Drive Extension** |
| Client : | **NZ Transport Agency** |
| Sampled by : | **E J West** |
| Test number : | **TP 729** |
| Shear vane number : | **DR 398** |
| Shear Vane correction : | **Refer to Calibration Sheet** |
| Coordinates (NZTM) : | **N 5823256** |
| | **E 1798417** |
| Water level (m): | **5.5** |

| | |
|---|---|
| **Project No :** | **2-31695.00** |
| **Lab Ref No :** | **15/802/002** |
| **Client Ref No :** | **TP 729** |

**Scala Penetrometer**




**Test Results**

| Depth (m) | Shear Strength (kPa) | Sample Details | Soil Description |
|---|---|---|---|
| 0.00 | | | AP65. Fresh angular silty sandy GRAVEL, dense, dry, non plastic. |
| 1.50 | Refusal | | Clayey SILT, orange brown / red / white mottled, firm, moist, highly plastic. Fill. |
| 3.50 | | | Fine to medium SAND, minor fine Gravel, yellowish brown, firm, moist, highly plastic. Fill. |
| 0.50 | 184/56 | | Clayey SILT, orange / brown, stiff, moist, highly plastic. Fill. |
| 0.70 | 151/22 | | SILT, trace Clay, orange / yellowish brown, soft, moist, slightly plastic. |
| 0.80 | 79/22 | | Clayey SILT, reddish grey, firm, moist, highly plastic. |
| 1.20 | 112/19 | Bulk | SILT, some Clay and medium Sand, light yellowish grey, firm, moist, highly plastic. |
| 3.10 | | Bulk | Silty medium SAND, minor Clay, yellowish white / orange mottled, medium dense, wet, non plastic. |
| 4.00 | | Bulk | Fine pumiceous SAND, yellowish white, medium dense, saturated, non plastic. |
| 5.10 | | Bulk | Fine pumiceous SAND, light brown, medium dense, saturated, non plastic. |
| 5.50 | | | *End of Pit. Water level.* |

**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 | Inferred CBR values are not IANZ accredited |

Date tested : 28/01/15
Date reported : 03/02/15



**IANZ Approved Signatory**

Designation : *Senior Civil Engineering Technician*
Date : 03/02/15

IANZ ACCREDITED LABORATORY

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



Opus International Consultants Ltd
Hamilton Laboratory
Quality Management Systems Certified to ISO 9001

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

Telephone +64 7 856 2870
Facsimile +64 7 856 2873
Website www.opus.co.nz

NZGD ID: 77264

OPUS

# Waikato Expressway – Hamilton Section

**Project No: 2-31695.00**
**Lab Ref No: 15/802/003**


***Pit Photo***

**Test Pit**

**TP 729**

Page 1 of 1

NZGD ID: 77264

AECOM

# LOG OF TEST PIT

INSPECTION PIT IDENTIFICATION: **TP04**

Client: Hamilton City Council
Project: Resolution Drive Borman to WEX
Project number: 60316742

Co-ordinates
Orientation -90° Elevation
Location Hamilton North
Feature 800m chainage from Borman Rd.

| Depth | GEOLOGICAL DESCRIPTION (Weathering, Colour, Fabric, Rock Name, Strength, Discontinuities, Lithological Features (bedding, foliation, mineralogy, cement, etc)) | Test Records | Sampling | Dynamic Cone Penetrometer (Blows per 100 mm) | SOIL PROPERTIES (Subordinate MAJOR minor; colour, structure, Strength; moisture condition; grading; bedding; plasticity; sensitivity; major fraction description; subordinate fraction description; minor fraction description etc) Depth Related Remarks / DEFECT DESCRIPTION (Joints, Bedding Seams, Shatter, Shear and Crush Zones, Foliation, Schistosity, Attitude, Spacing, Continuity, Roughness, Infilling, etc.) | Graphic Log | Instrumentation |
|---|---|---|---|---|---|---|---|
| 0.2 | FILL<br>0m: Fill. | | | | 0m: Silty GRAVEL; brown. Moist; gravel, coarse, angular. | | |
| 0.4 | 0.3m: Buried topsoil. | | | 4 | 0.3m: Organic SILT; black and orange. 'Hard'; moist; slightly plastic. | | |
| 0.6 | 0.5m: Reworked weathered volcanic ash. | | | 3<br>4 | 0.5m: Silty CLAY; light brown. 'Hard'; moist; slightly plastic. | | |
| 0.8 | | | | 6 | | | |
| 1.0 | | | | 6<br>6<br>7 | | | |
| 1.2 | | | | 8 | | | |
| 1.4 | | | | | | | |
| 1.6 | | | | | 1.5m: Sample taken.<br>TP04 terminated at 1.6m<br>Target Depth | | |
| 1.8 | | | | | | | |
| 2.0 | | | | | | | |
| 2.2 | | | | | | | |
| 2.4 | | | | | | | |
| 2.6 | | | | | | | |
| 2.8 | | | | | | | |

*For explanation of symbols and observations, see key sheet*

FLUID DEPTHS DURING DRILLING

| Date Time | Drilled Depth (m) | Casing Depth (m) | Fluid Depth (m) |
|---|---|---|---|

Hand Held Shear Vane

*Vane shear strength per NZGS guideline*

Length
Width
Stability Stable
Excavation Method
Orientation B

Remarks
No groundwater encountered.

Started 8/04/2014
Finished 8/04/2014
Date logged
Logged DK
Checked DMM



25/06/2014

NZGD ID: 77415

AECOM

# LOG OF TEST PIT

INSPECTION PIT IDENTIFICATION: **TP05**

Client: Hamilton City Council
Project: Resolution Drive Borman to WEX
Project number: 60316742

Co-ordinates
Orientation -90° Elevation
Location Hamilton North
Feature TP1

| Depth | GEOLOGICAL DESCRIPTION (Weathering, Colour, Fabric, Rock Name, Strength, Discontinuities, Lithological Features (bedding, foliation, mineralogy, cement, etc)) | Test Records | Sampling | Dynamic Cone Penetrometer (Blows per 100 mm) | SOIL PROPERTIES (Subordinate MAJOR minor; colour; structure, Strength; moisture condition; grading; bedding; plasticity; sensitivity; major fraction description; subordinate fraction description, minor fraction description etc) Depth Related Remarks / DEFECT DESCRIPTION (Joints, Bedding Seams, Shatter, Shear and Crush Zones, Foliation, Schistosity, Attitude, Spacing, Continuity, Roughness, Infilling, etc.) | Graphic Log | Instrumentation |
|---|---|---|---|---|---|---|---|
| 0.2 | FILL<br>0m: Fill. | | | | 0m: Silty GRAVEL; brown. Moist; gravel, coarse, angular. | | |
| 0.4 | 0.3m: Reworked weathered volcanic ash. | | | 7 | 0.3m: Silty CLAY; dark greyish brown. 'Stiff'; moist; highly plastic. | | |
| 0.6 | | | | 4 | | | |
| 0.8 | | | | 4 | 0.6m: Silty CLAY; orange. 'Firm to stiff'; moist; highly plastic. | | |
| 1.0 | | | | 4 | | | |
| 1.2 | | | | 4 | | | |
| 1.4 | | | | 7 | 1.3m: 'Firm'; saturated. | | |
| 1.6 | | | | 9 | | | |
| 1.8 | | | | 9 | TP05 terminated at 1.8m<br>Target Depth | | |
| 2.0 | | | | | | | |
| 2.2 | | | | | | | |
| 2.4 | | | | | | | |
| 2.6 | | | | | | | |
| 2.8 | | | | | | | |

*For explanation of symbols and observations, see key sheet*

FLUID DEPTHS DURING DRILLING

| Date Time | Drilled Depth (m) | Casing Depth (m) | Fluid Depth (m) |
|---|---|---|---|
| 08/04/2014 00:00 | 1.80 | - | 1.3 |

Hand Held Shear Vane

*Vane shear strength per NZGS guideline*

Length
Width
Stability Stable
Excavation Method
Orientation B

Remarks

Started 8/04/2014
Finished 8/04/2014
Date logged
Logged DK
Checked DMM

Page 1 of 1

25/06/2014

NZGD ID: 77416

AECOM

# LOG OF TEST PIT

INSPECTION PIT IDENTIFICATION **TP06**

Client Hamilton City Council
Project Resolution Drive Borman to WEX
Project number 60316742

Co-ordinates
Orientation -90° Elevation
Location Hamilton North
Feature 400m chainage from Ky Rd.

| Depth | GEOLOGICAL DESCRIPTION (Weathering, Colour, Fabric, Rock Name, Strength, Discontinuities, Lithological Features (bedding, foliation, mineralogy, cement, etc)) | Test Records | Sampling | Dynamic Cone Penetrometer (Blows per 100 mm) | SOIL PROPERTIES (Subordinate MAJOR minor; colour; structure. Strength; moisture condition; grading; bedding; plasticity; sensitivity; major fraction description; subordinate fraction description; minor fraction description etc) Depth Related Remarks / DEFECT DESCRIPTION (Joints, Bedding Seams, Shatter, Shear and Crush Zones, Foliation, Schistosity, Attitude, Spacing, Continuity, Roughness, Infilling, etc.) | Graphic Log | Instrumentation |
|---|---|---|---|---|---|---|---|
| 0.2 | FILL: 0m: Fill. | | | | 0m: Silty GRAVEL; brown. Moist; gravel, coarse, angular. | | |
| 0.4 | REWORKED ASH: 0.3m: Reworked weathered volcanic ash. | | | 15 | 0.3m: Silty CLAY; brownish orange. 'Very stiff'; moist; low plasticity. | | |
| 0.6 | | | | 8 | | | |
| 0.8 | | | | 6 | | | |
| 1.0 | | | | 6 | 0.8m: Clay, some silt; brwonish orange. 'Very stiff'; moist; high plasticity. | | |
| 1.2 | | | | 5 | | | |
| 1.4 | | | | 7 | | | |
| 1.6 | | | | 6 | TP06 terminated at 1.6m Target Depth | | |
| 1.8 | | | | 9 | | | |
| 2.0 | | | | | | | |
| 2.2 | | | | | | | |
| 2.4 | | | | | | | |
| 2.6 | | | | | | | |
| 2.8 | | | | | | | |

*For explanation of symbols and observations, see key sheet*

FLUID DEPTHS DURING DRILLING

| Date | Time | Drilled Depth (m) | Casing Depth (m) | Fluid Depth (m) |
|---|---|---|---|---|

Hand Held Shear Vane

*Vane shear strength per NZGS guideline*

Length
Width
Stability Stable
Excavation Method
Orientation B

Remarks
No groundwater encountered.

Started 8/04/2014
Finished 8/04/2014
Date logged
Logged DK
Checked DMM

Page 1 of 1

25/06/2014

NZGD ID: 77417

AECOM

# LOG OF TEST PIT

INSPECTION PIT IDENTIFICATION: **TP07**

Client: Hamilton City Council
Project: Resolution Drive Borman to WEX
Project number: 60316742

Co-ordinates
Orientation -90° Elevation
Location Hamilton North
Feature 600m chainage from Kay Rd.

| Depth | GEOLOGICAL DESCRIPTION (Weathering, Colour, Fabric, Rock Name, Strength, Discontinuities, Lithological Features (bedding, foliation, mineralogy, cement, etc)) | Test Records | Sampling | Dynamic Cone Penetrometer (Blows per 100 mm) | SOIL PROPERTIES (Subordinate MAJOR minor; colour; structure. Strength; moisture condition; grading, bedding; plasticity; sensitivity; major fraction description; subordinate fraction description; minor fraction description etc) Depth Related Remarks / DEFECT DESCRIPTION (Joints, Bedding Seams, Shatter, Shear and Crush Zones, Foliation, Schistosity, Attitude, Spacing, Continuity, Roughness, Infilling, etc.) | Graphic Log | Instrumentation |
|---|---|---|---|---|---|---|---|
| 0.2 | FILL: 0m: Fill. | | | | 0m: Silty GRAVEL; brown. Moist; gravel, coarse, angular. | | |
| 0.4 | | | | | | | |
| 0.6 | HINUERA FORMATION: 0.5m: Lacustrine mud, silt and sand with interbedded peat. | | | 7 | 0.5m: Silty CLAY; brown. 'Very stiff'; moist; slightly plastic. | | |
| 0.8 | | | | 6 | | | |
| 1.0 | | | | 5 | 0.8m: Organic SILT; dark brownish grey. Moist; slightly plastic; breaks apart easily. | | |
| 1.2 | | | | 7 | | | |
| 1.4 | | | | 7 | | | |
| 1.6 | | | | 8 | 1.2m: SILT; grey. 'Firm to stiff'; moist; slightly plastic. | | |
| 1.8 | | | | 9 | | | |
| 2.0 | | | | 7 | TP07 terminated at 1.5m Target Depth | | |
| 2.2 | | | | | | | |
| 2.4 | | | | | | | |
| 2.6 | | | | | | | |
| 2.8 | | | | | | | |

*For explanation of symbols and observations, see key sheet*

FLUID DEPTHS DURING DRILLING

| Date Time | Drilled Depth (m) | Casing Depth (m) | Fluid Depth (m) |
|---|---|---|---|

Hand Held Shear Vane

*Vane shear strength per NZGS guideline*

Length
Width
Stability Stable
Excavation Method
Orientation B

Remarks
No groundwater encountered.

Started 8/04/2014
Finished 8/04/2014
Date logged

Logged DK
Checked DMM

Page 1 of 1

25/06/2014

NZGD ID: 77418

AECOM

# LOG OF TEST PIT

INSPECTION PIT IDENTIFICATION **TP08**

Client Hamilton City Council
Project Resolution Drive Borman to WEX
Project number 60316742

Co-ordinates
Orientation -90° Elevation
Location Hamilton North
Feature 800m chainage from Kay Rd.

| Depth | GEOLOGICAL DESCRIPTION (Weathering, Colour, Fabric, Rock Name, Strength, Discontinuities, Lithological Features (bedding, foliation, mineralogy, cement, etc)) | Test Records | Sampling | Dynamic Cone Penetrometer (Blows per 100 mm) | SOIL PROPERTIES (Subordinate MAJOR minor; colour; structure, Strength; moisture condition; grading; bedding; plasticity; sensitivity; major fraction description; subordinate fraction description; minor fraction description etc) Depth Related Remarks / DEFECT DESCRIPTION (Joints, Bedding Seams, Shatter, Shear and Crush Zones, Foliation, Schistosity, Attitude, Spacing, Continuity, Roughness, Infilling, etc.) | Graphic Log | Instrumentation |
|---|---|---|---|---|---|---|---|
| 0.2 | FILL: 0m: Fill. | | | | 0m: Silty GRAVEL; brown. Moist; gravel, coarse, angular. | | |
| 0.4 | | | | | | | |
| 0.6 | HINUERA FORMATION: 0.5m: Lacustrine mud, silt and sand. | | | 2 | 0.5m: SILT, minor gravel; dark brown. 'Firm to stiff'; wet; high plasticity. | | |
| 0.8 | | | | 2 | | | |
| 1.0 | | | | 3 | 0.8m: Silty CLAY; light brown. 'Firm to stiff'; wet; high plasticity. | | |
| 1.2 | | | | 2 | | | |
| 1.4 | | | | 3 | | | |
| 1.6 | | | | 3 | | | |
| 1.8 | | | | 3 | 1.7m: Seepage into pit. | 1.8 ▽ | |
| 2.0 | | | | 3 | TP08 terminated at 1.8m Target Depth | | |
| 2.2 | | | | | | | |
| 2.4 | | | | | | | |
| 2.6 | | | | | | | |
| 2.8 | | | | | | | |

*For explanation of symbols and observations, see key sheet*

FLUID DEPTHS DURING DRILLING

| Date Time | Drilled Depth (m) | Casing Depth (m) | Fluid Depth (m) |
|---|---|---|---|
| 08/04/2014 00:00 | 1.80 | - | 1.7 |

Hand Held Shear Vane

*Vane shear strength per NZGS guideline*

Length
Width
Stability Stable

Excavation Method
Orientation B

Remarks

Started 8/04/2014
Finished 8/04/2014
Date logged

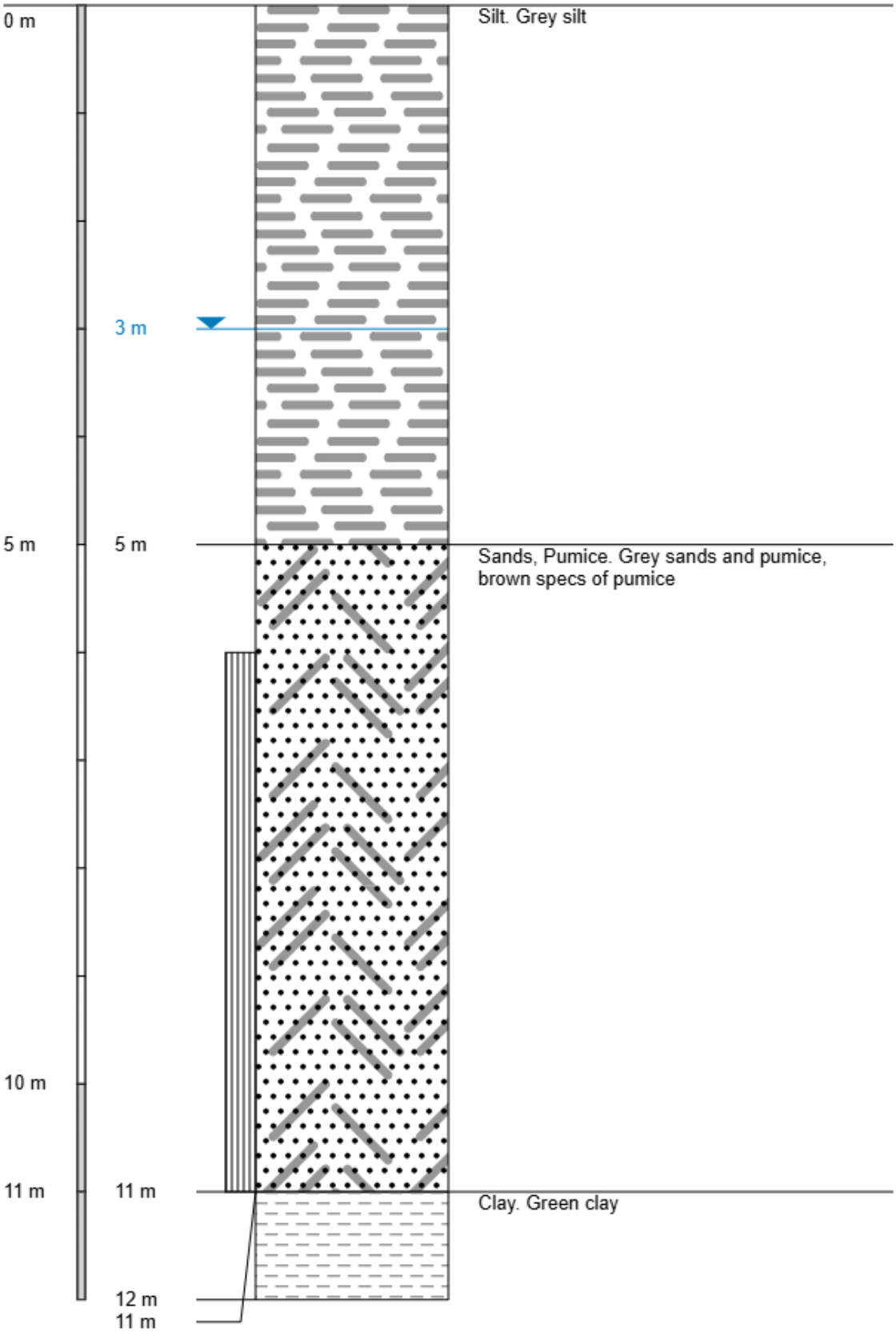
Logged DK
Checked DMM

Page 1 of 1

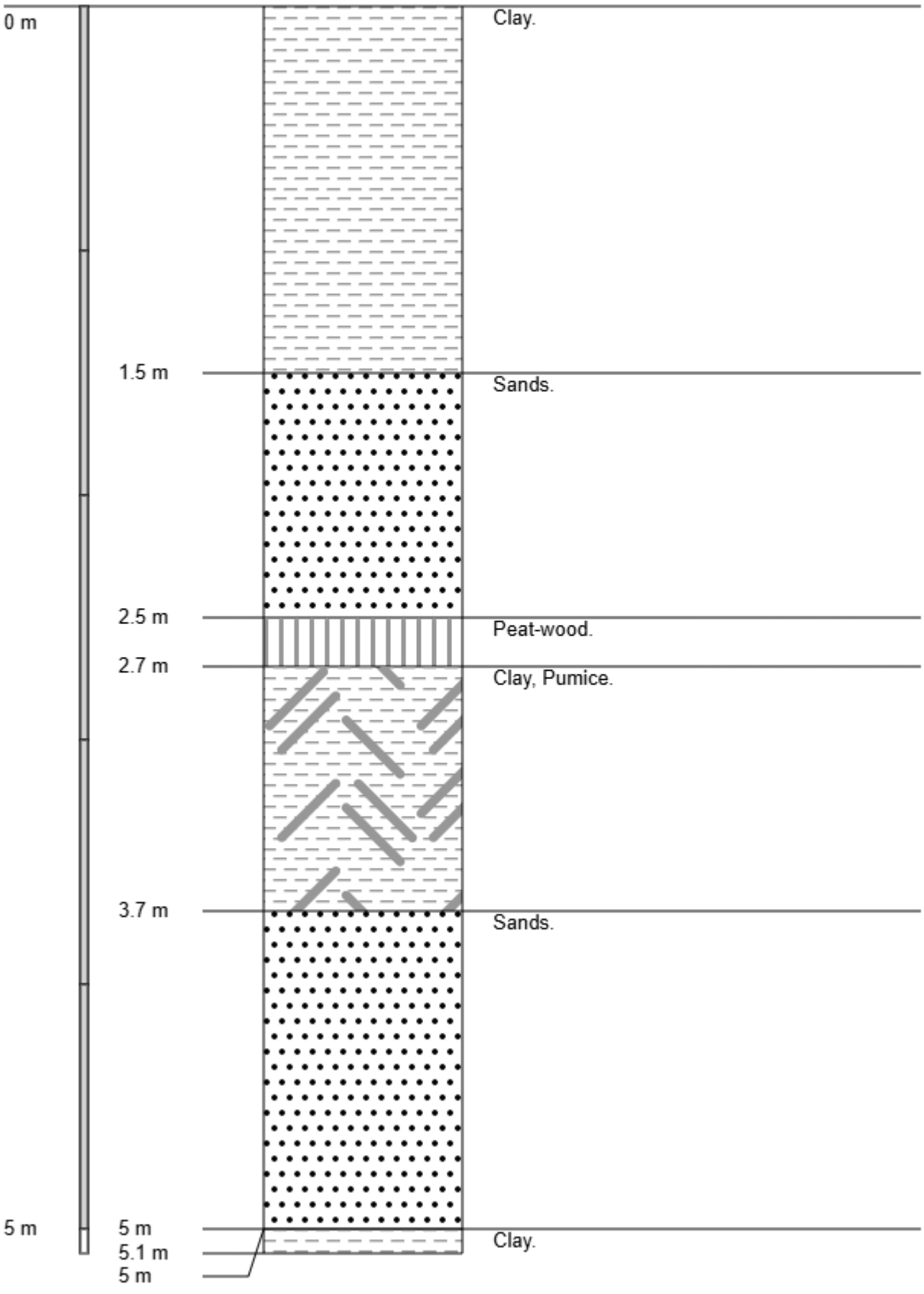
25/06/2014

NZGD ID: 77419

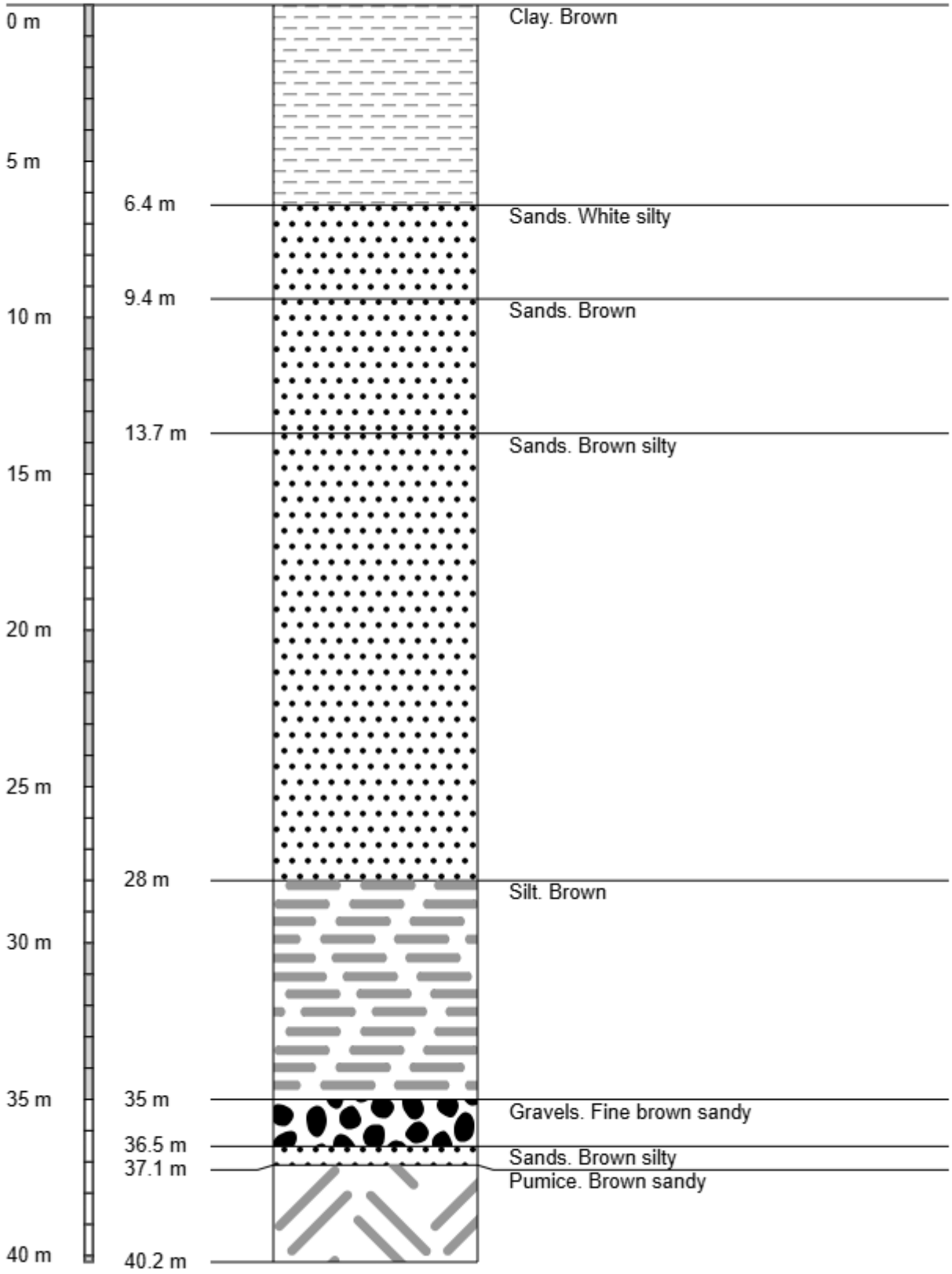
**Council well number** : 72_10734
**Well name** : Bore 72 - Station 10734
**Drilling company** : Barham United Welldrillers Limited
**Drilling date** : 27/07/2020
**Drilling method** : -
**Locality** : -
**Total depth drilled** : 11m
**NZTM** : 1797183 : 5824212



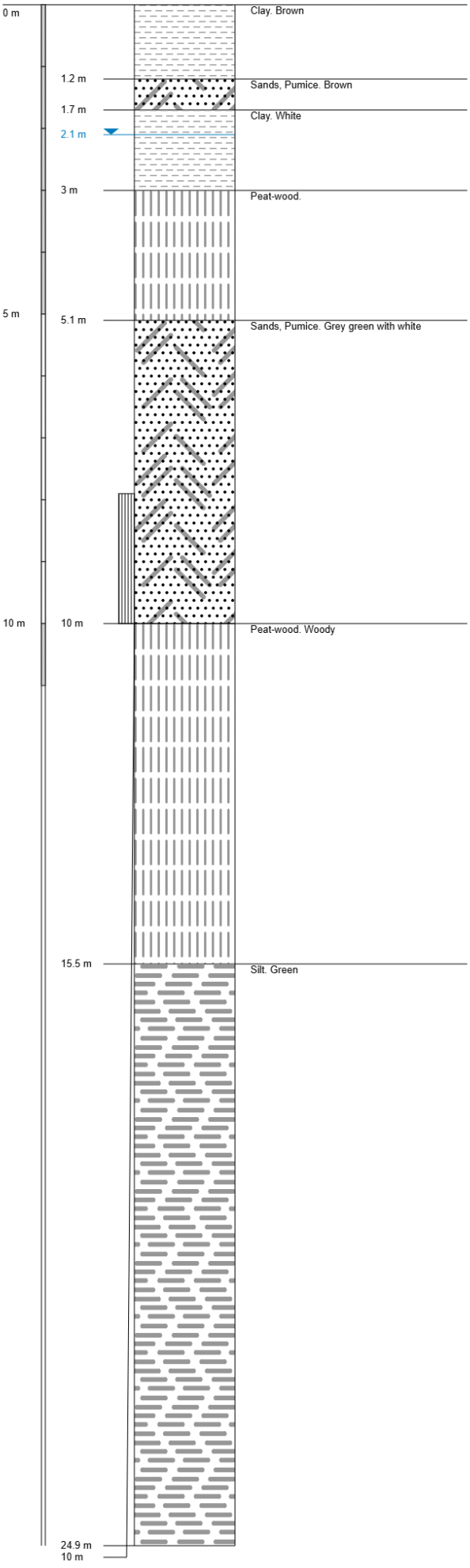
**Council well number** : 69_775
**Well name** : Bore 69 - Station 775
**Drilling company** : King Drilling Company Limited
**Drilling date** : 19/10/1988
**Drilling method** : -
**Locality** : -
**Total depth drilled** : 5m
**NZTM** : 1797343 : 5823368



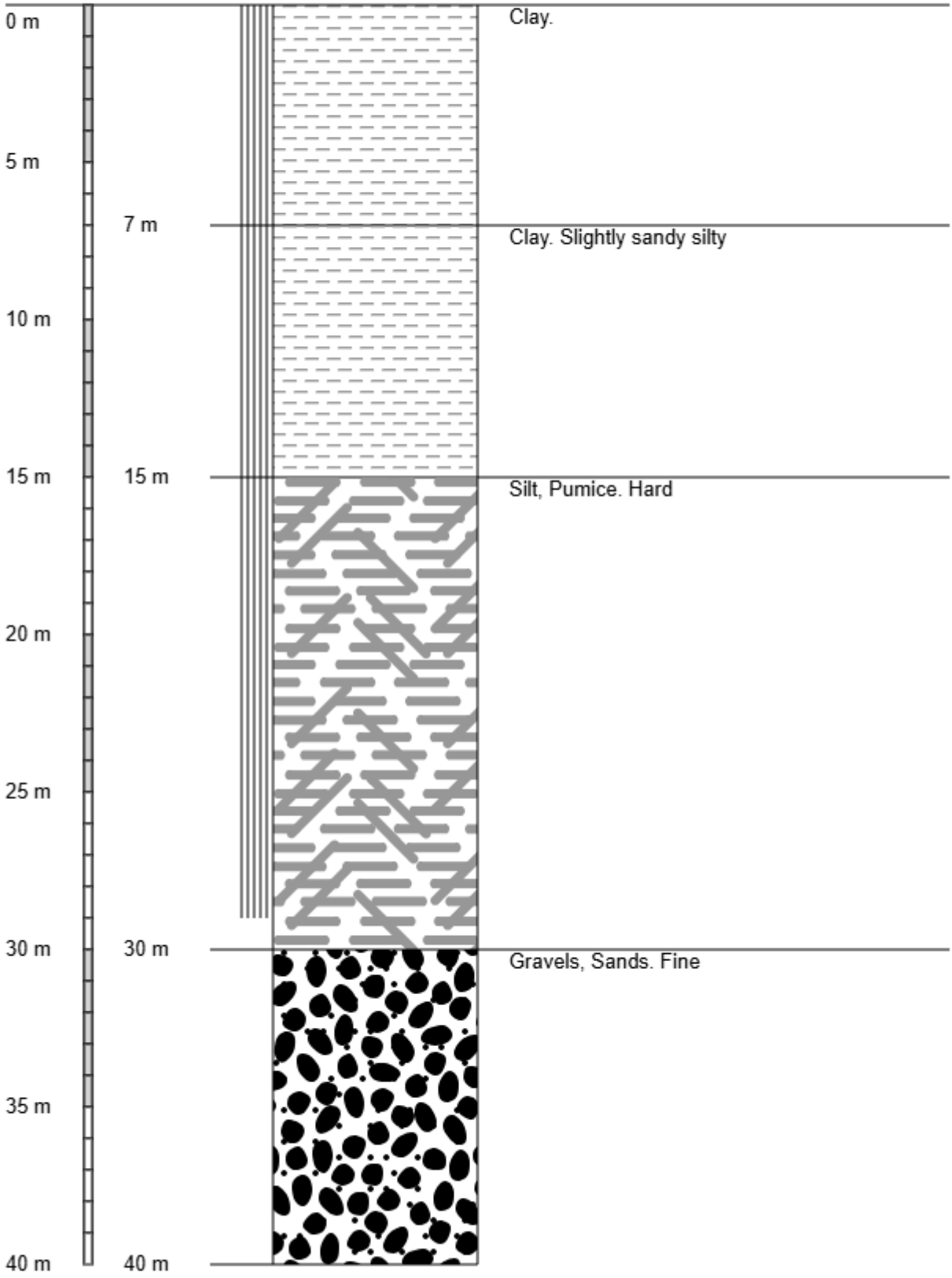
**Council well number** : 69_1282
**Well name** : Bore 69 - Station 1282
**Drilling company** : Benton & Son Limited
**Drilling date** : 18/03/1991
**Drilling method** : -
**Locality** : -
**Total depth drilled** : 40.2m
**NZTM** : 1798242 : 5823969



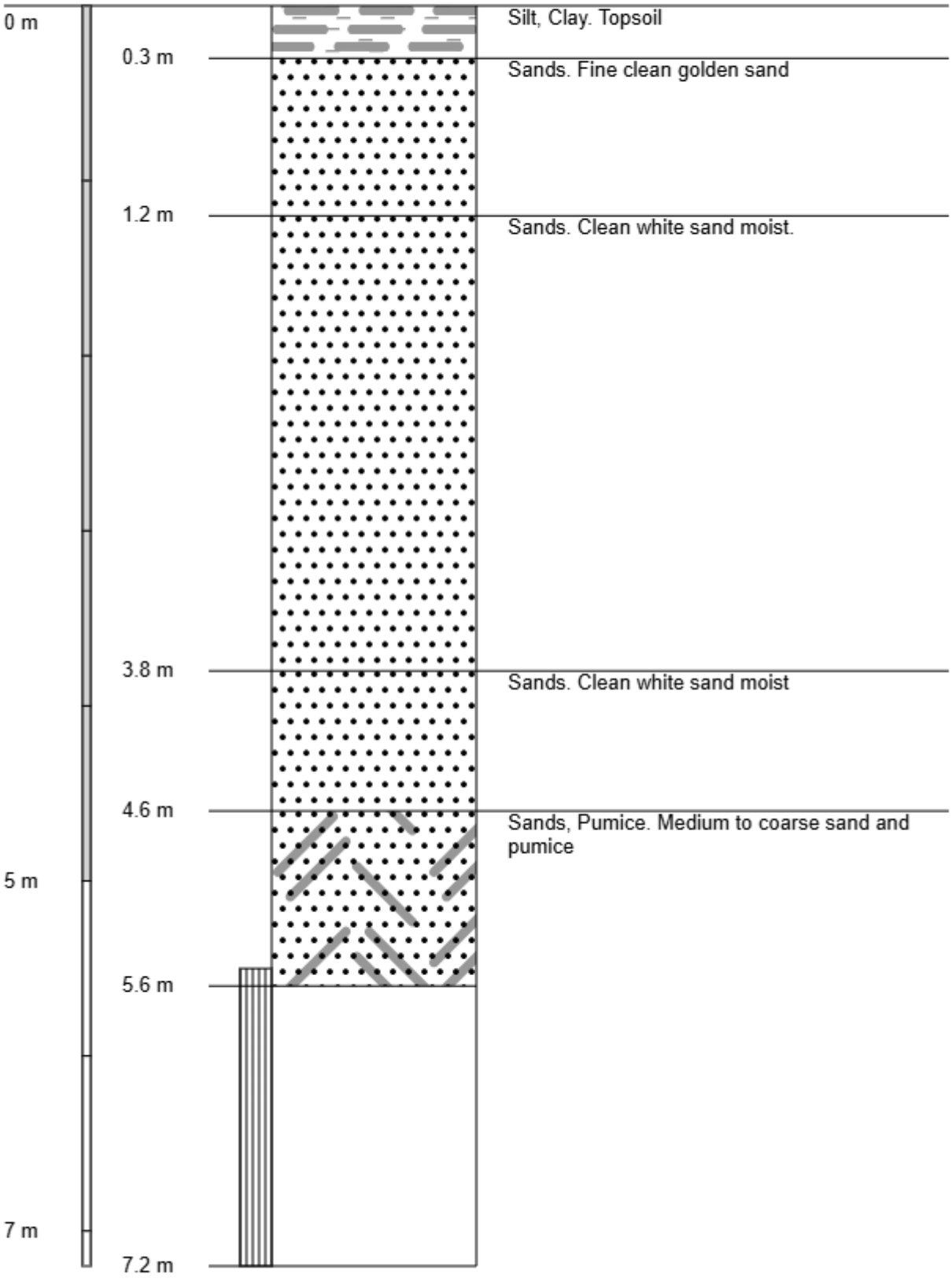
**Council well number** : 69_1588
**Well name** : Bore 69 - Station 1588
**Drilling company** : Benton & Son Limited
**Drilling date** : 17/11/1992
**Drilling method** : -
**Locality** : -
**Total depth drilled** : 10m
**NZTM** : 1797741 : 5824169



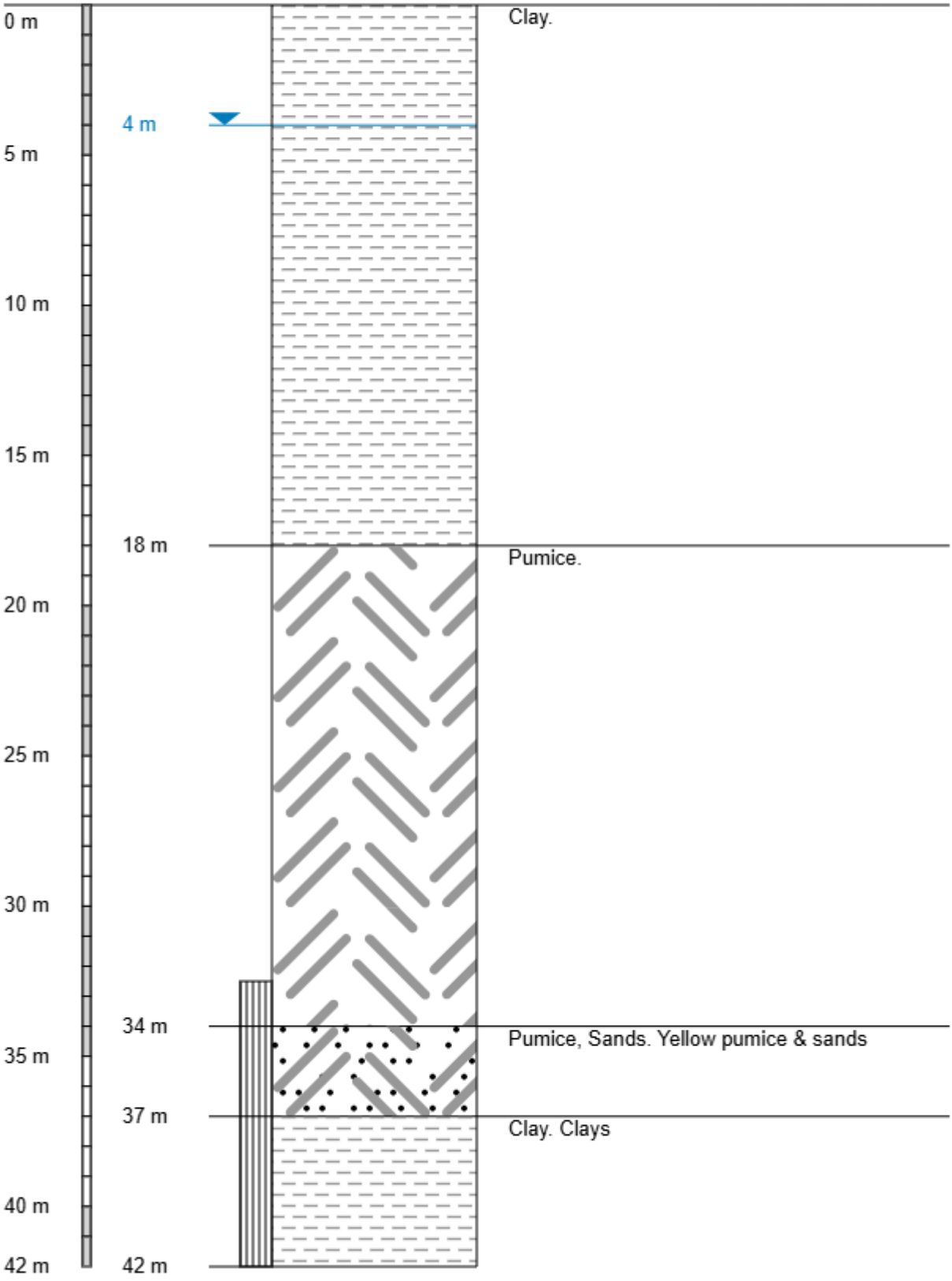
**Council well number** : 69_1611
**Well name** : Bore 69 - Station 1611
**Drilling company** : Benton & Son Limited
**Drilling date** : 24/01/1988
**Drilling method** : -
**Locality** : -
**Total depth drilled** : 40m
**NZTM** : 1798142 : 5823969



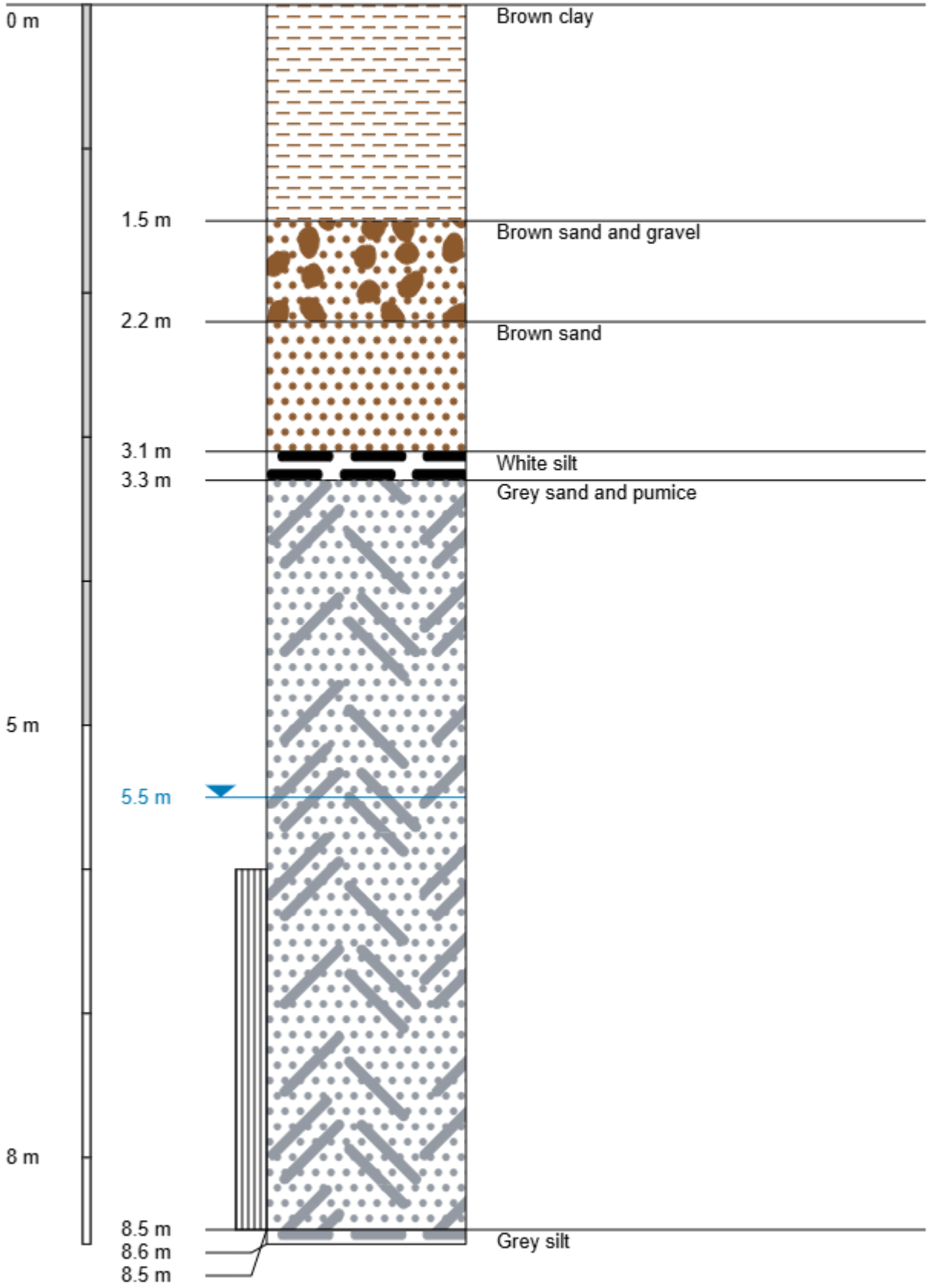
**Council well number** : 72_661
**Well name** : Bore 72 - Station 661
**Drilling company** : Drill 4 U
**Drilling date** : 01/07/2001
**Drilling method** : -
**Locality** : -
**Total depth drilled** : 7.2m
**NZTM** : 1797041 : 5824168



**Council well number** : 72_5001
**Well name** : Bore 72 - Station 5001
**Drilling company** : Barham United Welldrillers Limited
**Drilling date** : 11/02/2010
**Drilling method** : -
**Locality** : -
**Total depth drilled** : 42m
**NZTM** : 1798172 : 5823946



**Council well number** : 72_12208
**Well name** : Bore 72 - Station 12208
**Drilling company** : Benton & Son Limited
**Drilling date** : 14/07/2021
**Drilling method** : Rotary
**Locality** : Horsham Downs
**Total depth drilled** : 8.5m
**NZTM** : 1796918 : 5823693



CMW Geosciences
Great People | Practical Solutions

# APPENDIX B
## Laboratory Testing

# PLASTICITY INDEX FOR SOILS TEST REPORT

OPUS

Project : **Waikato Expressway Hamilton Section**
Location : **See Below**
Client : **NZ Transport Agency**
Contractor : **Opus Hamilton**
Sampled by : **Opus Hamilton**
Date received : **January 2015**
Sampling method : **See Below**
Sample condition : **As received**

**Project No :** 2-31695.00
**Lab Ref No :** 15/803/006a
**Client Ref No :**

## Test Results

| General Location: | Lake Rd off ramp | Osborne Road Cut | | Resolution Drive Ext. | Ruakura Rd Relocation |
|---|---|---|---|---|---|
| Sampling method: | Bulk Sample | Bulk Sample | Bulk Sample | Bulk Sample | Bulk Sample |
| Soil Fraction Tested: | Whole Soil | -425um | -425um | -425um | -425um |
| Sample Location : | TP711 | TP715 | TP715 | TP728 | TP742 |
| Depth (m) : | 1.8 - 2.7 | 3.1 - 4.1 | 4.1 - 6.0 | 1.6 - 4.5 | 0.2 - 0.7 |
| Liquid Limit : | 63 | 50 | 53 | 49 | 54 |
| Plastic Limit : | 40 | 34 | 34 | 34 | 29 |
| Plasticity Index : | 23 | 16 | 19 | 15 | 25 |
| Natural Water Content (%): | 59.0 | 51.3 | 35.7 | 75.7 | 24.4 |

Sample Description (as logged): **TP711 1.8-2.7m :** SILT, trace clay.
**TP715 3.1-4.1m :** SILT, minor clay.
**TP715 4.1-6.0m :** H/W medium to coarse SAND.
**TP728 1.6-4.5m :** Clayey SILT.
**TP742 0.2-0.7m :** SILT, trace clay.

| Test Methods | | Notes |
|---|---|---|
| Water Content | NZS 4402 : 1986, Test 2.1 | Soil Fraction Tested as shown |
| Liquid Limit | NZS 4402 : 1986, Test 2.2 | 1. Unable to form groove and/or sample slipping in bowl. |
| Plastic Limit | NZS 4402 : 1986, Test 2.3 | 2. Unable to roll to specified dimensions.(Sandy sample) |
| Plasticity Index | NZS 4402 : 1986, Test 2.4 | 3. **N.P.** denotes **Non Plastic** |
| | | 4. Where applicable the sample was rubbed through the 425um sieve. |

Date tested : 16-20/03/15
Date reported : 23/03/15

**IANZ Approved Signatory**

Designation : *Senior Civil Engineering Technician*
Date : 23/03/15

**Testing is covered by IANZ Accreditation**
**This report may only be reproduced in full**

IANZ ACCREDITED LABORATORY

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation



**Opus International Consultants Limited**
Hamilton Laboratory
Quality Management Systems Certified to ISO 9001

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

t: +64 7 856 2870
f: +64 7 856 2873
w: www.opus.co.nz

NZGD ID: 77263

# PARTICLE SIZE ANALYSIS (WET SIEVE METHOD) TEST REPORT

OPUS

Project : **Waikato Expressway**
Location : **Hamilton Section**
Client : **OPUS Hamilton**

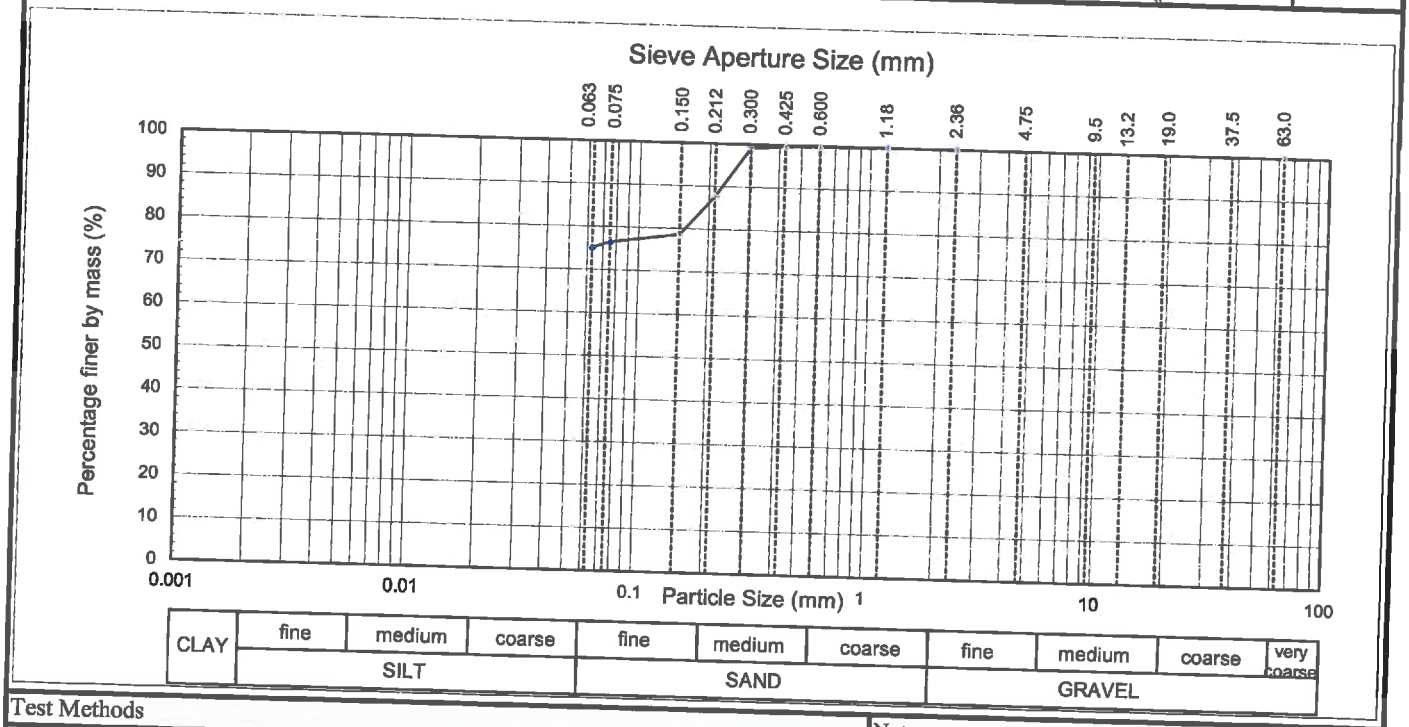
BH/TP/Sample ID: **TP728**
Sampled by : **Opus Hamilton**
Date received : **5/03/15**
Sampling method : **Bulk**
Sample condition : **As Received**
Sample description : **Sandy CLAY/SILT**
Solid Particle Density (t/m$^3$): **NA**
Water Content (as received): **76.0 %**

Depth: 1.6 metres
Date: 2015

**Project No:** 2-31695.00
**Lab Ref No:** 15/803/006
**Client Ref:**

| Sieve Analysis | | | | | | Hydrometer Analysis | | | |
|---|---|---|---|---|---|---|---|---|---|
| Sieve Size (mm) | Passing (%) | Sieve Size (mm) | Passing (%) | Sieve Size (mm) | Passing (%) | Particle Size (mm) | Passing (%) | Particle Size (mm) | Passing (%) |
| 63.0 | -- | 4.75 | -- | 0.300 | 99 | -- | -- | -- | -- |
| 37.5 | -- | 2.36 | 100 | 0.212 | 88 | -- | -- | -- | -- |
| 19.0 | -- | 1.18 | 100 | 0.150 | 79 | -- | -- | -- | -- |
| 13.2 | -- | 0.600 | 100 | 0.075 | 76 | -- | -- | -- | -- |
| 9.5 | -- | 0.425 | 100 | 0.063 | 75 | -- | -- | -- | -- |
| | | | | | | -- | -- | -- | -- |
| | | | | | | -- | -- | | |

**Note:** "--" denotes sieve not used and/or hydrometer analysis not tested




| Test Methods | Notes |
|---|---|
| Particle Size Analysis: NZS 4402:1986: Test 2.8.1 (Wet Sieve Method) | Fraction Passing finest sieve is by difference |
| Water Content: NZS 4402: 1986 Test 2.1 | |

Date Tested: 28/04/15
Date Reported: 30/04/15

**Sampling is not covered by IANZ Accreditation**

**This report may only be reproduced in full**

IANZ ACCREDITED LABORATORY
All tests reported herein have been performed in accordance with the laboratory's scope of accreditation

**IANZ Approved Signatory**
Designation : Senior Civil Engineering Technician
Date : 30/04/15

csf 2100 (12/06/13)

**Opus International Consultants Limited**
Hamilton Laboratory
Quality Management Systems Certified to ISO 9001

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

t: +64 7 856 2870
f: +64 7 856 2873
w: www.opus.co.nz



NZGD ID: 77263

# TEST REPORT

OPUS

| | |
|---|---|
| Project : | **Waikato Expressway- Hamilton Section** |
| Location : | **Hamilton** |
| Client : | **NZ Transport Agency** |
| Contractor : | **N/A** |
| Sampled by : | **Opus** |
| Date sampled : | **Various** |
| Sampling method : | **Testpit** |
| Sample condition : | **As received** |

| | |
|---|---|
| **Project No :** | **2-31695.00** |
| **Lab Ref No :** | **15/803/006a** |
| **Client Ref No :** | **5G3HL** |

## Test Results

| Sample Location | Depth (m) | Water Content (%) |
|---|---|---|
| TP742 | 0.2-0.7 | 23.9 |
| TP711 | 1.8-2.7 | 61.1 |
| TP715 | 4.1-6.0 | 36.3 |
| TP715 | 3.1-4.1 | 51.1 |
| TP752 | 0.4-1.4 | 43.3 |
| TP777 | 2.6-5.0 | 24.7 |
| TP728 | 1.8 | 76.3 |

| Test Methods | | Notes |
|---|---|---|
| Water Content | NZS 4402 : 1986 Test 2.1 | |

Date tested : 9-13/03/15
Date reported : 16/03/15

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

**IANZ Approved Signatory**

Designation : *Senior Civil Engineering Technician*
Date : 16/03/15

IANZ ACCREDITED LABORATORY

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation



Opus International Consultants Ltd
Hamilton Laboratory
Quality Management Systems Certified to ISO 9001

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

Telephone +64 7 856 2870
Facsimile +64 7 856 2873
Website www.opus.co.nz

NZGD ID: 77263

# DRY DENSITY / WATER CONTENT RELATIONSHIP
## STANDARD COMPACTION

OPUS

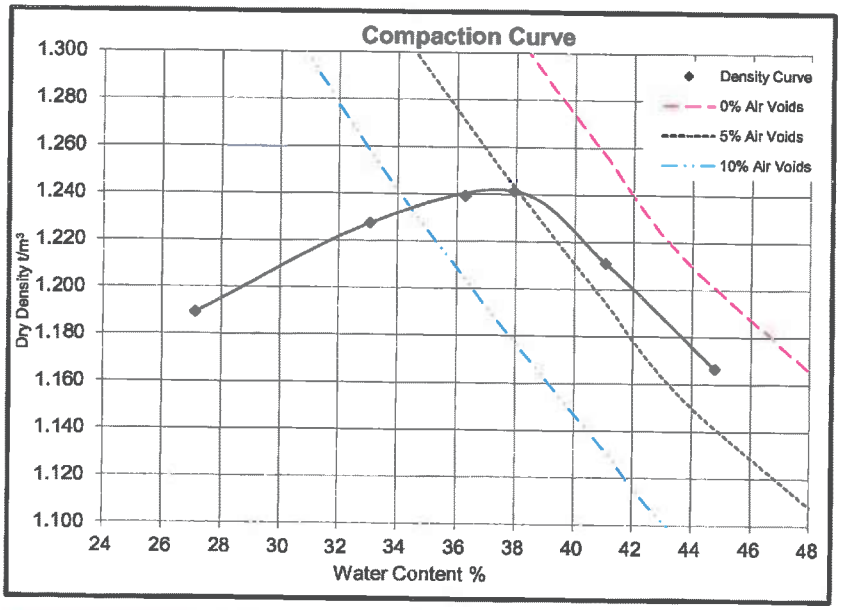
| | |
|---|---|
| Project : | **Waikato Expressway- Hamilton Section** |
| Location : | **Hamilton** |
| Client : | **NZ Transport Agency** |
| Contractor : | **N/A** |
| Sampled by : | **J West (Opus)** |
| Date sampled : | **28/01/15** |
| Sampling method : | **Testpit** |
| Sample description : | **SILT, some fine to medium sand; light brown.** |
| Sample condition : | **As received** |
| Solid density : | **2.60 t/m³ (Assumed)** |
| Source: | **TP728, 1.8m** |

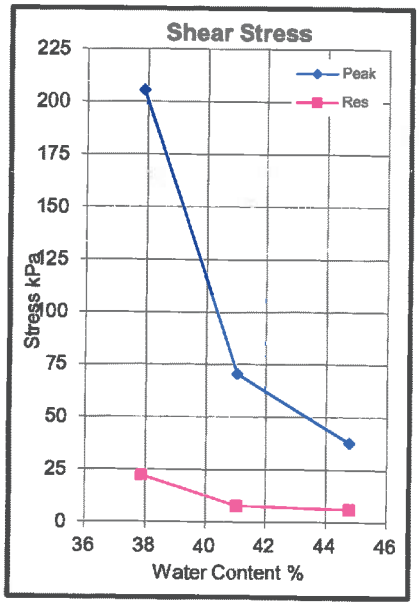
| | |
|---|---|
| **Project No :** | **2-31695.00** |
| **Lab Ref No :** | **15/803/006** |
| **Client Ref No :** | **TP728, 1.8m** |

**Test Results**

| | | | | | |
|---|---|---|---|---|---|
| Maximum dry density | 1.24 | t/m³ | Natural water content | 76.3 | % |
| Optimum water content | 37 | % | Fraction tested | Passing 19mm | |

| Sample ID | | -850 | -750 | -700 | -650 | -600 | -550 | Nat |
|---|---|---|---|---|---|---|---|---|
| Bulk density | t/m³ | 1.512 | 1.633 | 1.689 | 1.712 | 1.708 | 1.689 | - |
| Water content | % | 27.1 | 33.1 | 36.3 | 37.9 | 41.1 | 44.8 | 76.3 |
| Dry density | t/m³ | 1.189 | 1.227 | 1.239 | 1.241 | 1.211 | 1.166 | - |
| Sample condition | | Hard Dry-moist | Hard Moist | Hard Moist-wet | V. Stiff Wet | Stiff Wet | Firm Wet | |
| Peak stress | kPa | Refusal | Refusal | >207 | 205 | 71 | 38 | - |
| Remoulded stress | kPa | - | - | - | 22 | 8 | 6 | - |




| Test Methods | Notes |
|---|---|
| Compaction NZS 4402 : 1986 Test 4.1.1 (Standard) | |
| Shear Strength using a Hand Held Shear Vane, NZ Geotechnical Soc Inc 8/2001 | |

Date tested : 18/03/15
Date reported : 23/03/15

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

**IANZ Approved Signatory**

Designation : *Senior Civil Engineering Technician*
Date : 23/03/15

IANZ ACCREDITED LABORATORY

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation



Opus International Consultants Ltd
Hamilton Laboratory
Quality Management Systems Certified to ISO 9001

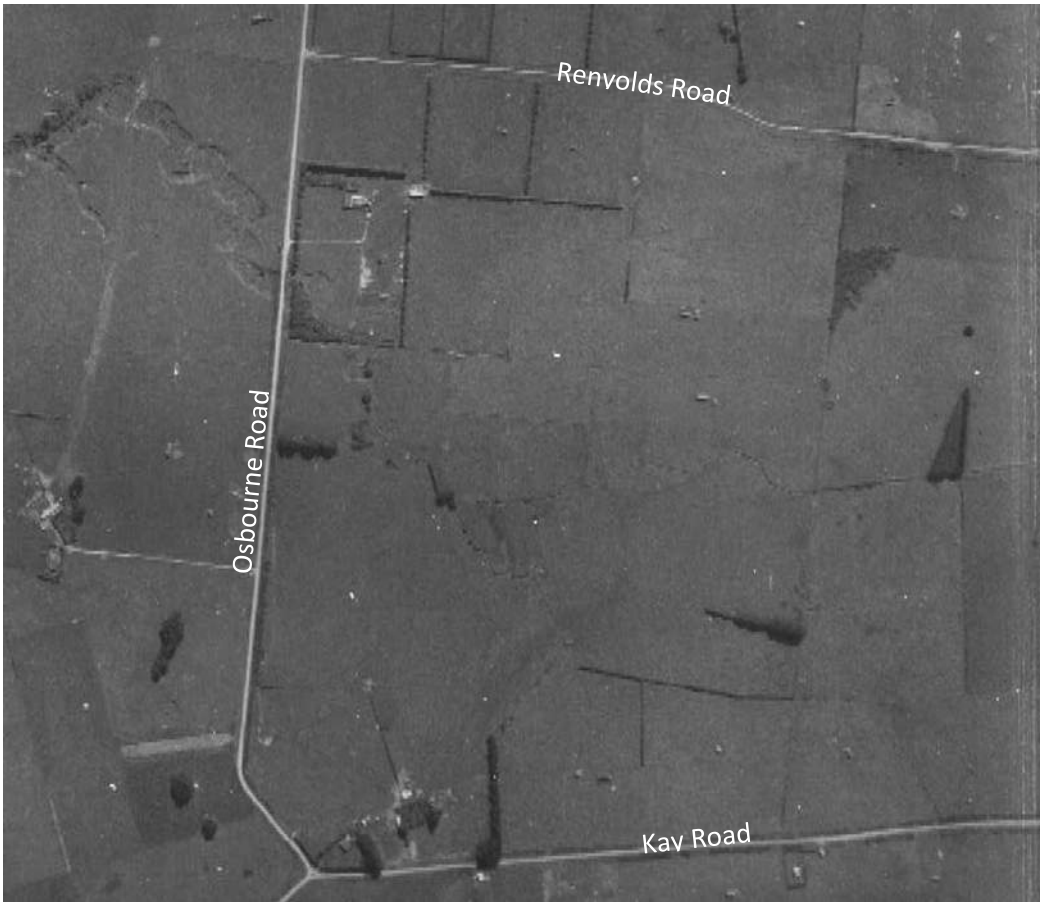
Fox Street
Private Bag 3057, Waikato Mail Centre,
Hamilton 3240, New Zealand

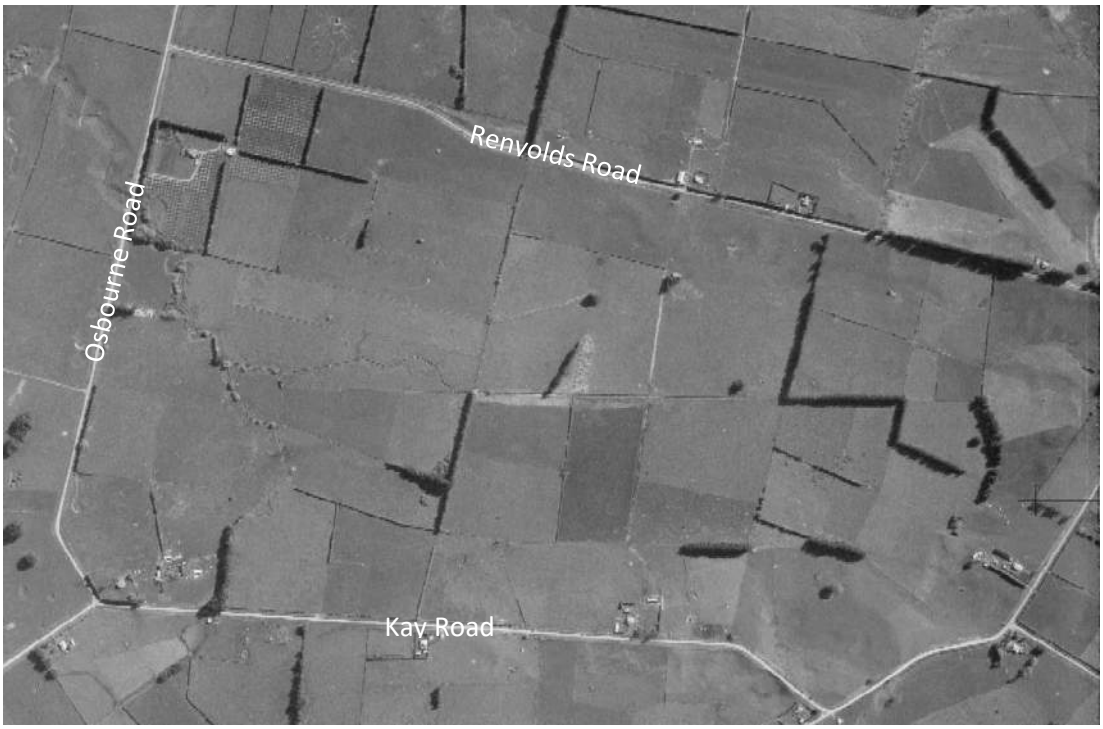
Telephone +64 7 856 2870
Facsimile +64 7 856 2873
Website www.opus.co.nz

NZGD ID: 77263

CMW Geosciences
Great People | Practical Solutions

# APPENDIX C
## Histoical Photographs

| Date and source | Key Features |
|---|---|
| 1941<br>Retrolens |  <br>• No photographs available for the eastern part of site.<br>• Gully present under Osbourne Road into the proposed site.<br>• Area appears to be used for agricultural purposes (pasture). |

| | |
|---|---|
| 1952<br>Retrolens |  <br>• Orchard present in the west in the corner of Osbourne and Reynolds Road. |
| 1979<br>Retrolens |  <br>• Construction of a road along the eastern boundary has begun.<br>• Orchard has expanded into nearby paddocks.<br>• Hedgerows within the farm have been removed. |

| | |
|---|---|
| 1991 Retrolens |  <br>• Orchard has expanded further, and hedgerows have been planted. |
| 2022 Google Earth |  <br>• Potential uncontrolled fill located behind 40B Reynolds Road (Circled in red). |

CMW Geosciences
Great People | Practical Solutions

# APPENDIX D
## WRC Hazard Maps

# Waikato Regional Hazards Portal

Visit our regional hazards and emergency management page

Overview | River flooding | Flood management | Waikato District defended areas | Coastal hazards | Coastal inundation | Earthquakes and landslides | Volcanoes and geothermal | Karapiro dam break | Emergency Management

## River Flooding

Floods are New Zealand's number one hazard in terms of frequency, losses, and declared Civil Defence emergencies. River floods occur due to heavy rain that causes rivers to overflow their banks. Other types of flooding include ponding, contributed to by poorly drained soils and/or high water tables, and urban flooding caused by street drains becoming blocked or overcome.

The Waikato region has 20 large rivers and about 1400 small river systems. Many of the region's river systems are prone to flooding and flooding is frequent because of steep terrain, low lying flood plains and areas of high rainfall.

To see a map with local scale flood depth data (instead of hazard) for the same scenario, click here (and zoom in).

For more information, click here.

For flood warnings and updates for the Waikato, visit Flood Room Live.

For what to do in the event of a flood, click here.

Waitakaruru flooding, 2017

***Key terms:***

**AEP** = annual exceedance probability, or the chance of an event happening in any one year.

# Waikato Regional Hazards Portal

Visit our regional hazards and emergency management page

Overview | River flooding | Flood management | Waikato District defended areas | Coastal hazards | Coastal inundation | Earthquakes and landslides | Volcanoes and geothermal | Karapiro dam break | Emergency Management

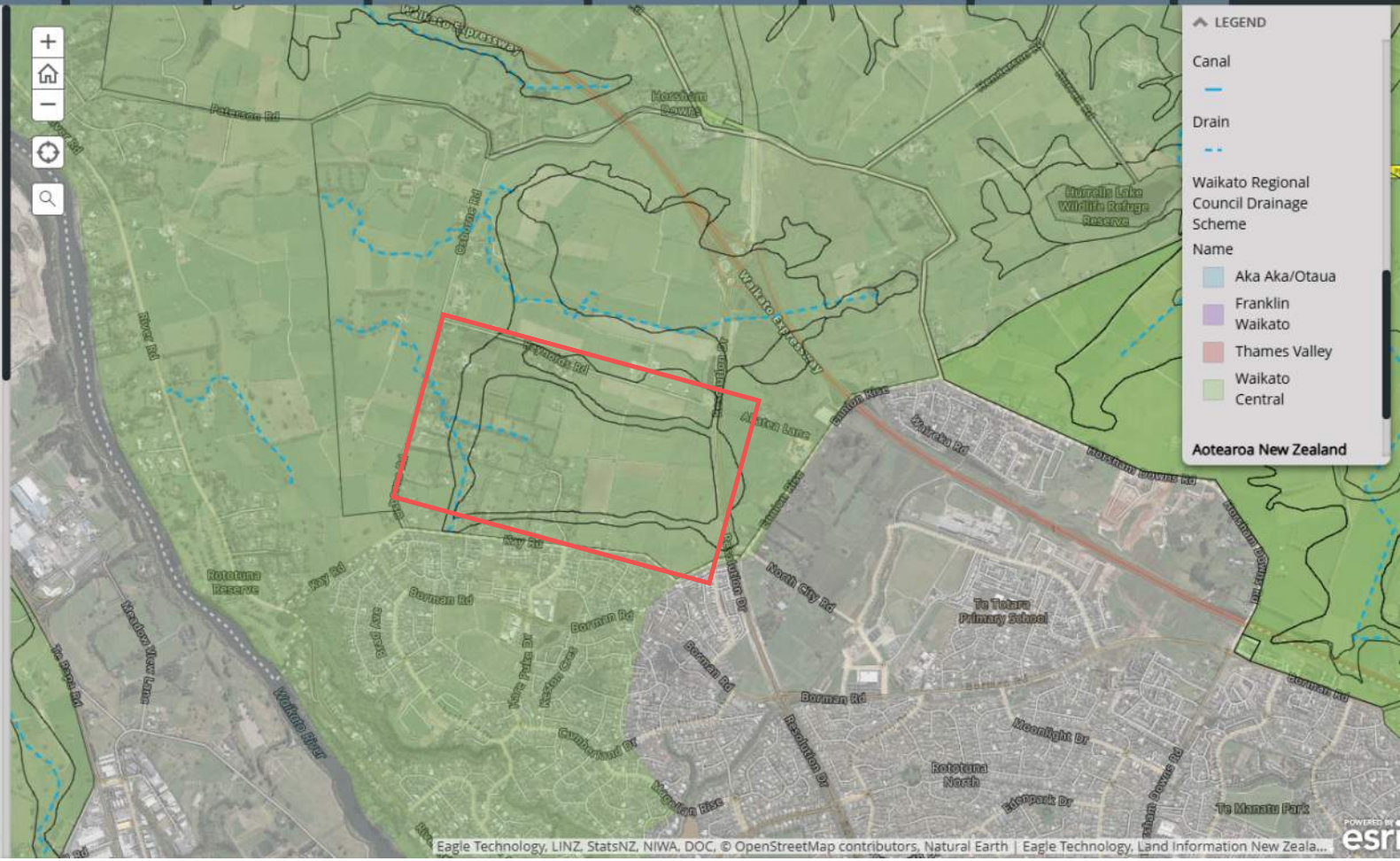
## Flood Management

Waikato Regional Council owns and maintains many flood protection schemes. These schemes significantly reduce the risk of river flooding to many low lying areas, through measures such as stopbanks, floodgates and channel maintenance. Each stopbank is designed to provide a certain level of protection - this may be to the 1% AEP event, or it may only be to the 10% AEP event. When a flood event occurs that is greater than the design level, the river may overtop the stopbank and cause flooding. In addition, there is always a small chance that a stopbank will fail (breach). The level of risk that remains for defended properties is known as "residual risk".

Stopbank

## Land Drainage

Waikato Regional Council also own and maintain land drainage schemes. The level of service for the open drains and culverts of these schemes is generally to drain water from a 10% AEP rainfall event within 3 days. This is intended to remove ponding from rural areas prior to pasture damage occurring, rather than to prevent inundation. Different Drainage Differentials receive different levels of



# Waikato Regional Hazards Portal

Visit our regional hazards and emergency management page

Overview | River flooding | Flood management | Waikato District defended areas | Coastal hazards | Coastal inundation | Earthquakes and landslides | Volcanoes and geothermal | Karapiro dam break | Emergency Management

## Earthquakes

New Zealand lies on the boundary of the Pacific and Australian tectonic plates. These plates are colliding with huge force, causing one to slowly grind over, under or alongside the other. This results in many faults (cracks extending deep within the earth), including in the Waikato. An earthquake occurs when stress builds up on these faults and is then released suddenly, causing the earth to vibrate as energy radiates away from the fault.

There are thousands of earthquakes in New Zealand every year, however many are not felt. Earthquakes can result in secondary hazards such as ground shaking, liquefaction (see below), land instability and tsunami (tsunami are caused by offshore faults).

To view ground shaking susceptibility data for the Waikato Region in this map, click here.

For more information, click here.

For what to do in an earthquake, click here.

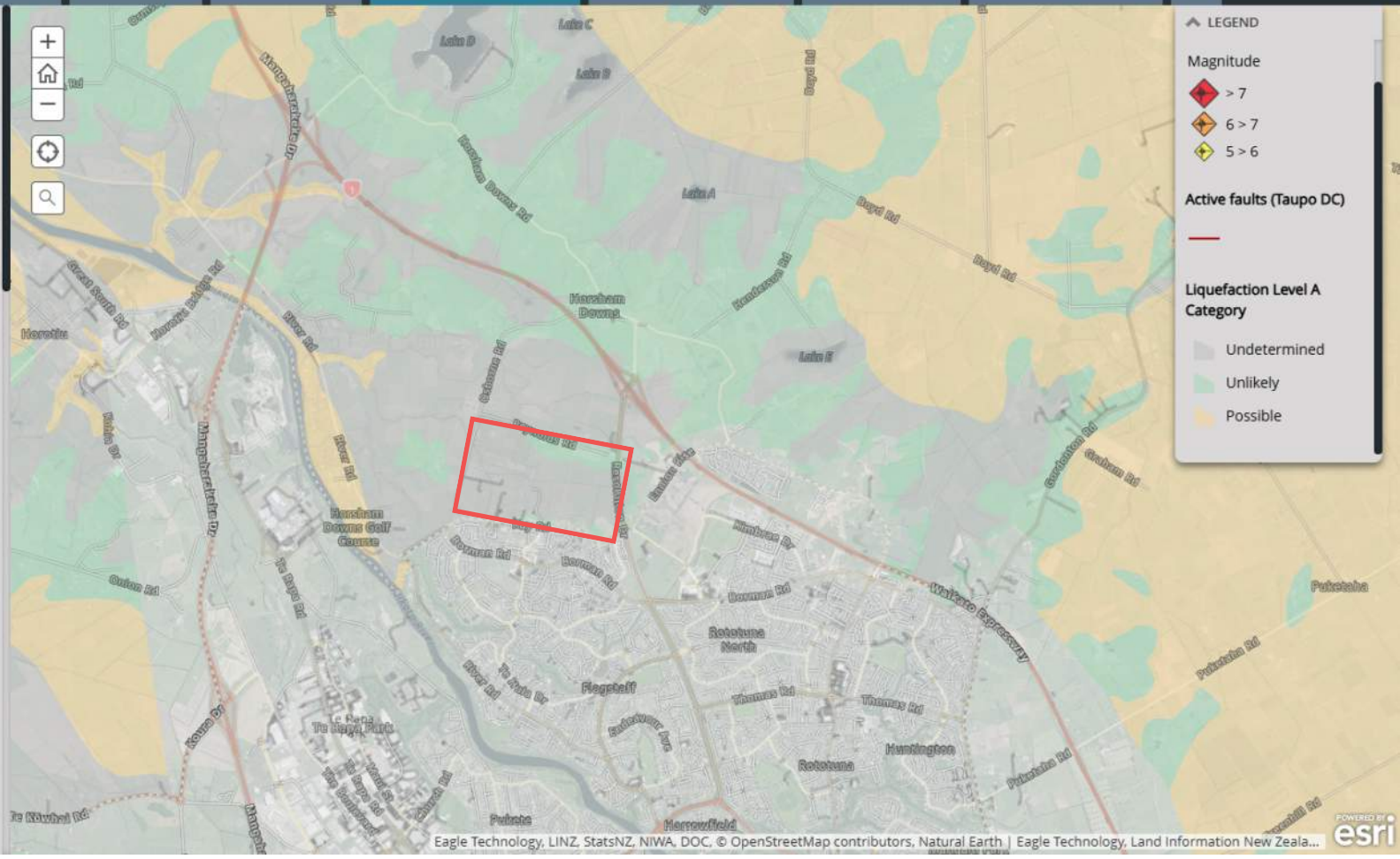
For information on recent earthquakes, visit GeoNet

Damage caused by a fault trace during 1987 Edgecumbe earthquake (GNS Science)

## Liquefaction Vulnerability Assessment - Level A Desktop Study

Liquefaction is a natural process where earthquake shaking increases the water pressure in the ground in some types of soil, resulting in temporary loss of soil strength. It can cause significant damage and disruption, as was seen in the Christchurch earthquakes.

The November 2019 Building Code Update has revised B1/AS1 to ensure new buildings are built safe and strong enough to withstand liquefaction effects. To help district councils within the Waikato region, we have done a liquefaction hazard assessment to provide Level A liquefaction mapping for the whole region.



# Waikato Regional Hazards Portal

Visit our regional hazards and emergency management page

Waikato Regional Council

Overview | River flooding | Flood management | Waikato District defended areas | Coastal hazards | Coastal inundation | Earthquakes and landslides | Volcanoes and geothermal | Karapiro dam break | Emergency Management

## Volcanoes

The Waikato region is exposed to volcanic risk from many volcanic centres, both within and outside of the region. These volcanic centres vary in type, risk, and activity (e.g. dormant, unrest, eruption). There are three main types of volcano:

1. Cone volcanoes (e.g. Mt Ruapehu);
2. Caldera volcanoes (e.g. Lake Taupo); and
3. Volcanic fields (e.g. Auckland area).

The different types can produce a wide variety of volcanic hazards including ashfall, pyroclastic flows, bombs and blocks (flying rocks), lahars and lava flows. These hazards are more or less likely to occur in an eruption, depending on the volcano type.

The volcanic hazard most likely to impact the Waikato region is volcanic ash, which is carried by the wind, and can adversely affect agriculture, infrastructure, air transport, human health, etc. Lake Taupo poses the biggest volcanic threat to our region; however, the probability of a large eruption is extremely low.

For more information, click here.

For what to do in a volcanic eruption, click here.

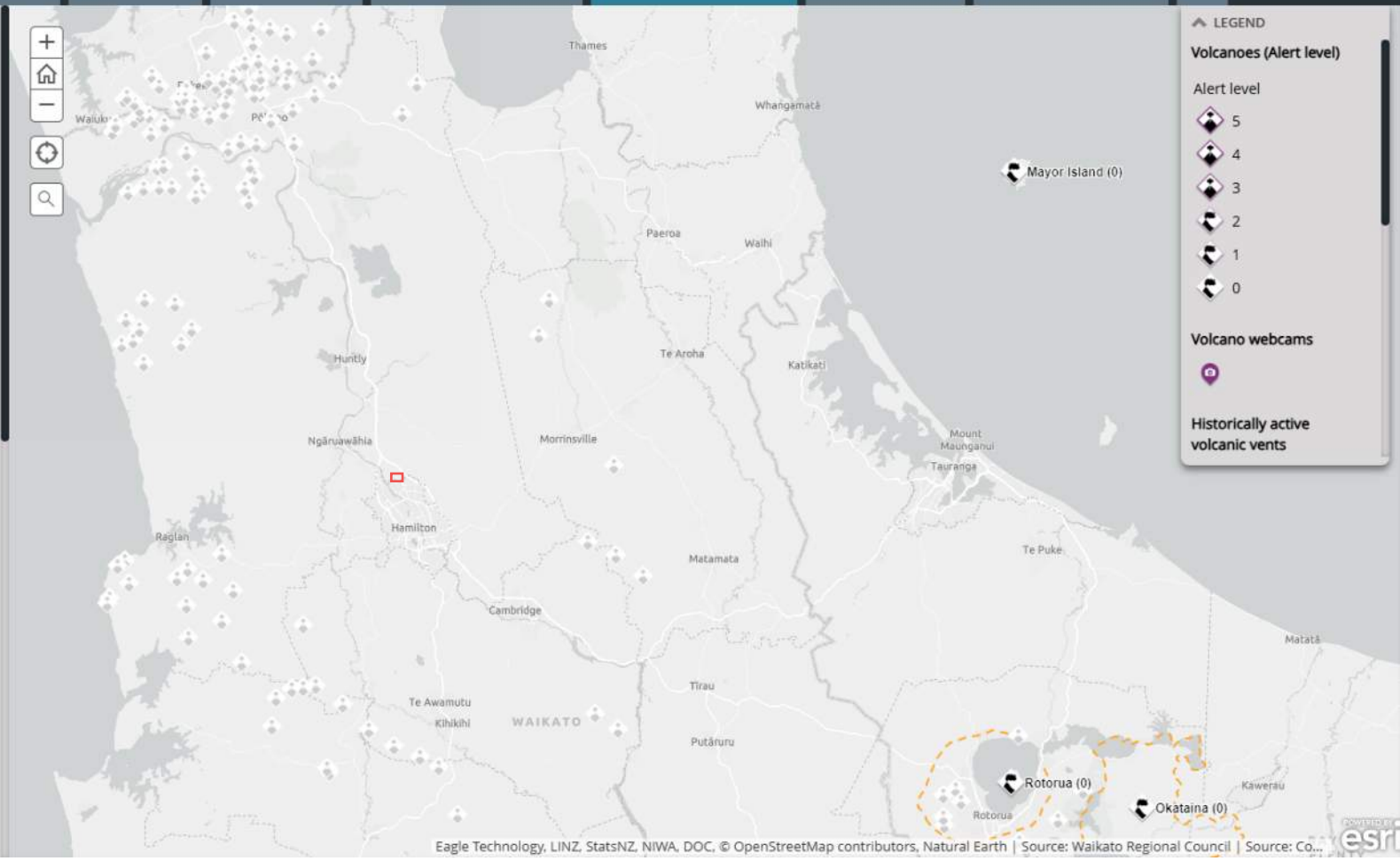
For more detailed information on volcano status, visit GeoNet.

Mt Ruapehu erupts, 1995

## Geothermal

The Waikato region contains about 70% of New Zealand's geothermal resource. Geothermal areas contain natural hazards such as hot springs, boiling mud pools and unstable ground, and can produce hydrothermal eruptions. Geothermal areas are valuable as tourist attractions, energy sources and unique habitats.

Geothermal systems are places where the earth is hotter than surrounding areas, due to hot rock or magma near the earth's surface. Most of New Zealand's geothermal systems are hydrothermal systems, which means ground water from the surrounding area is heated by




**Hamilton**

Level 1 | Block C
401 Grey Street
Hamilton 3216
New Zealand

Ph: +64 7 2820 039

www.cmwgeosciences.com

# APPENDIX C - Wastewater Treatment Plant Case Study

RAATH AND ASSOCIATES

source to consumption

# WASTEWATER SOLUTIONS

## AS PURE AS NEW ZEALAND

**DESIGN**

**REMEDIATION**

**WASTEWATER TREATMENT**

# WATER ENGINEERING DESIGNS

We do designs for pumpstations in potable water and wastewater as well as full reticulation systems. The latest project I have completed was for the Waipapa Sports Facility in Waipapa Northland. We were responsible for the complete design and operational philosophy.

We designed headworks and reticulation for 26 L/s headworks coupled to a 1 to 16 l/s irrigation pump set and reticulation system. We designed a 12.5 L/s 110 kPa fire reticulation system including water storage. We also designed an 8 L/s Purification with Temple Water and the reticulation system for the complete sports facility.

Figure 1 Below are some photos of the construction. The pumps are in operation and irrigation of the sports fields have been in operation for the last week without any hick ups. We will do official commissioning and hand over early in April.


**Figure 1**
*Installations at Waipapa*

# BIOLOGICAL REMEDIATION OF WWTW PONDS AND LANDFILLS

One of our innovative solutions we have is the agency we have for BluePlanet Labs based in America. We are Also distributors of Moleaer Nanobubblers which is perfect for preventing algae blooms in Golf Estate ponds etc.

This is a microbial solution that does natural sludge reduction over a period of six months. We are busy with a trial at Whiritoa located in Hauraki District council and the results are extraordinary. We still have two months left but have managed to get better than anticipated results from the first three months.

We started implementing the first trial on 14 September 2023.

Figure 2 indicates the visible change in the condition of the facultative pond in the first two months of application.


**Figure 2**
*Facultative-Primary Pond*


**Figure 3**
*Maturation-Secondary Pond*

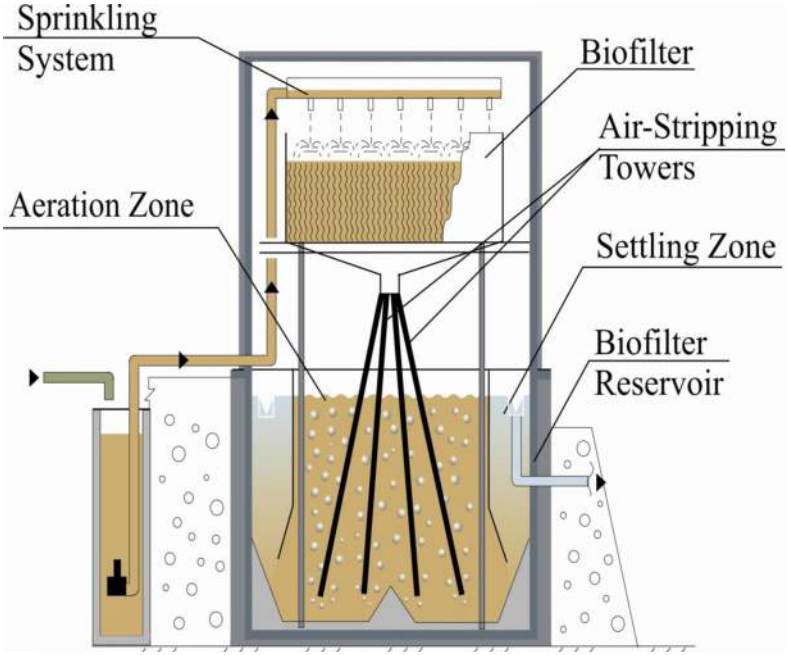
Figure 3 indicates the visible change in the condition of the maturation pond in the first two months of application.

Figure 4 indicates the visible change in the sludge volume of the facultative pond in the first two months of application. The method was using a tube taking a grab sample at exactly the same spot tin the pond at times indicated on the figure.


**Figure 4**
*Sludge reduction*

# HOW DOES IT WORK?

- Waste water is mixed with activated sludge in mixing the chamber
- Sludge mixture is pumped to the biofilter sprinkling system by the circulation pump
- Falling drops are broken upon the disks and sprinkled across the biofilter feed
- Liquid exiting the biofilter feed is collected in collection tray
- Sludge mixture is conveyed by air-stripping towers to the aeration zone of the aeration tank
- Natural aeration with shock treatment and bubble flow in aeration zone
- Sludge from settling zone is pumped back to the mixing chamber completing the cycle
- Pure water is collected in the collection trays in the settling zones and gravitates to anoxic zone for denitrification



# WASTE WATER TREATMENT TECHNOLOGY

I have attached an overview of our patented system. Very important to note is that it can be retrofitted.

Figure 7 is a photo of a 12.5 KL/day plant we constructed. The process remains the same for plants from 12 500 L/day up to 120 000 L/day. The blocks expand and increase parabolically as treatment capacity increases.

Please note that we possess the capability to design, Construct, Commision train and maintain/operate all of our technologies. We work with strategic partners where needed.

**Figure 7**
*KL/day treatment plant*


**www.allraath.com**

**Mobile:** s 9(2)(a)
**Email:** s 9(2)(a)

RAATH AND ASSOCIATES

source to consumption

# WASTEWATER SOLUTIONS

## AS PURE AS NEW ZEALAND

**DESIGN**

**REMEDIATION**

**WASTEWATER TREATMENT**

# WATER ENGINEERING DESIGNS

We do designs for pumpstations in potable water and wastewater as well as full reticulation systems. The latest project I have completed was for the Waipapa Sports Facility in Waipapa Northland. We were responsible for the complete design and operational philosophy.

We designed headworks and reticulation for 26 L/s headworks coupled to a 1 to 16 l/s irrigation pump set and reticulation system. We designed a 12.5 L/s 110 kPa fire reticulation system including water storage. We also designed an 8 L/s Purification with Temple Water and the reticulation system for the complete sports facility.

Figure 1 Below are some photos of the construction. The pumps are in operation and irrigation of the sports fields have been in operation for the last week without any hick ups. We will do official commissioning and hand over early in April.


**Figure 1**
*Installations at Waipapa*

# BIOLOGICAL REMEDIATION OF WWTW PONDS AND LANDFILLS

One of our innovative solutions we have is the agency we have for BluePlanet Labs based in America. We are Also distributors of Moleaer Nanobubblers which is perfect for preventing algae blooms in Golf Estate ponds etc.

This is a microbial solution that does natural sludge reduction over a period of six months. We are busy with a trial at Whiritoa located in Hauraki District council and the results are extraordinary. We still have two months left but have managed to get better than anticipated results from the first three months.

We started implementing the first trial on 14 September 2023.

Figure 2 indicates the visible change in the condition of the facultative pond in the first two months of application.


**Figure 2**
*Facultative-Primary Pond*


**Figure 3**
*Maturation-Secondary Pond*

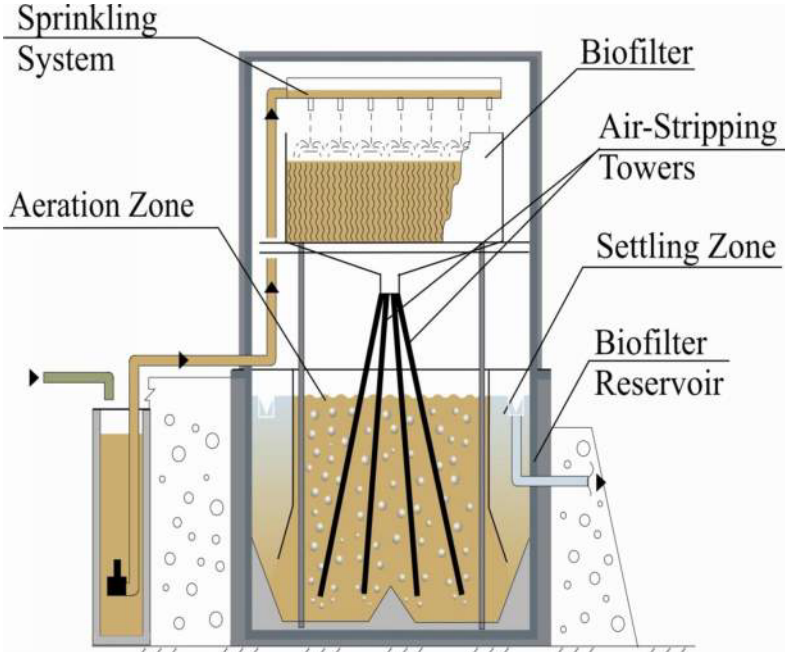
Figure 3 indicates the visible change in the condition of the maturation pond in the first two months of application.

Figure 4 indicates the visible change in the sludge volume of the facultative pond in the first two months of application. The method was using a tube taking a grab sample at exactly the same spot tin the pond at times indicated on the figure.


**Figure 4**
*Sludge reduction*

# HOW DOES IT WORK?

- Waste water is mixed with activated sludge in mixing the chamber
- Sludge mixture is pumped to the biofilter sprinkling system by the circulation pump
- Falling drops are broken upon the disks and sprinkled across the biofilter feed
- Liquid exiting the biofilter feed is collected in collection tray
- Sludge mixture is conveyed by air-stripping towers to the aeration zone of the aeration tank
- Natural aeration with shock treatment and bubble flow in aeration zone
- Sludge from settling zone is pumped back to the mixing chamber completing the cycle
- Pure water is collected in the collection trays in the settling zones and gravitates to anoxic zone for denitrification



# WASTE WATER TREATMENT TECHNOLOGY

I have attached an overview of our patented system. Very important to note is that it can be retrofitted.

Figure 7 is a photo of a 12.5 KL/day plant we constructed. The process remains the same for plants from 12 500 L/day up to 120 000 L/day. The blocks expand and increase parabolically as treatment capacity increases.

Please note that we possess the capability to design, Construct, Commision train and maintain/operate all of our technologies. We work with strategic partners where needed.

**Figure 7**
*KL/day treatment plant*


**www.allraath.com**

**Mobile:** s 9(2)(a)
**Email:** s 9(2)(a)

# APPENDIX D Engineering Calculations.

| | Maven Associates | | Job Number 407001 | Sheet 1 | Rev: A |
|---|---|---|---|---|---|
| Job Title<br>Calc Title | HT-1<br>Catchment Areas | | Author<br>NAK | Date<br>Jul-25 | Checked |

| | | | Run off Volumes | | | | |
|---|---|---|---|---|---|---|---|
| | | | WQV | | | | |
| **Pond** | **Catchment Area (m2)** | **Ha** | 1/3 of 2yr | (yr) | 2 | 10 | 100 |
| A | 164526 | 16.45 | 665 | m3 | 5789 | 12925 | 18910 |
| B | 127342 | 12.73 | 605 | m3 | 5270 | 11766 | 17214 |
| C | 149765 | 14.98 | 535 | m3 | 4657 | 10398 | 15213 |
| D | 132360 | 13.24 | 531 | m3 | 4618 | 10311 | 15086 |
| E | 131252 | 13.13 | 531 | m3 | 4618 | 10311 | 15086 |
| Whole site | 728500.5701 | 72.85 | 2945 | m3 | 25634 | 57232 | 83732 |

**Pond size Based on 4%**

| Catchment | Catchment Area ($m^2$) | Wetland required Area (m2) | Wetland actual Area (m2) | Area % |
|---|---|---|---|---|
| A | 164526.00 | 6581 | 2737 | 1.7 |
| B | 127342.00 | 5094 | 3356 | 2.6 |
| C | 149765.00 | 5991 | 6941 | 4.6 |
| D | 132360.00 | 5294 | 6462 | 4.9 |
| E | 131252.00 | 5250 | 6462 | 4.9 |
| Whole site | 728500.57 | 29140 | 6462 | 0.9 |

| Maven Associates Ltd. | | Job Number 407001 | Sheet 1 | Rev A |
|---|---|---|---|---|
| Job Title<br>Calc Title | HT1<br>Pre-development | Author NDL | Date 20/08/2025 | Checked DJM |

**1. Runoff Curve Number (CN) and initial Abstraction (Ia)**

| Soil name and classification | Cover description (cover type, treatment, and hydrologic condition) | Curve Number CN* | Area (ha) 10000m2=1ha | Product of CN x area |
|---|---|---|---|---|
| | | | | |
| B | Open Space (Sandy Loam or Silty Loam) | 61 | 85.00 | 5185.00 |
| | | | | |
| | | | | |
| | | | | |
| * from Appendix B | | Totals = | 85.00 | 5185.00 |

WQV

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{5185.00}{85.00} =$ 61.0

Ia (weighted) = $\frac{5 \times \text{pervious area}}{\text{total area}} = \frac{5 \times 85.00}{85.00}$ 5.0 mm

**2. Time of Concentration**

Channelisation factor C = 1 (From Table 4.2) natural channels

Catchment length L = 1.44 km (along drainage path)

Catchment Slope Sc= 0.01 m/m (by equal area method)

Runoff factor, $\frac{CN}{200 - CN} = \frac{61.0}{200-61.0} =$ 0.44

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0 1 1.27 1.57 3.98 = 1.115 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.747 hrs

OK
use
0.75 hrs
44.8332337

**Worksheet 1: Runoff Parameters and Time of Concentration**

| Cover description | | Curve numbers for hydrologic soil group | | | |
|---|---|---|---|---|---|
| Cover type and hydrologic condition | Average percent impervious area [2] | A | B | C | D |
| ***Fully developed urban areas (vegetation established)*** | | | | | |
| Open space (lawns, parks, golf courses, cemeteries, etc.) [3]: | | | | | |
| Poor condition (grass cover < 50%) | | 68 | 79 | 86 | 89 |
| Fair condition (grass cover 50% to 75%) | | 49 | 69 | 79 | 84 |
| Good condition (grass cover > 75%) | | 39 | 61 | 74 | 80 |
| Impervious areas: | | | | | |
| Paved parking lots, roofs, driveways, etc. (excluding right-of-way) | | 98 | 98 | 98 | 98 |
| Streets and roads: | | | | | |
| Paved; curbs and storm sewers (excluding right-of-way) | | 98 | 98 | 98 | 98 |
| Paved; open ditches (including right-of-way) | | 83 | 89 | 92 | 93 |
| Gravel (including right-of-way) | | 76 | 85 | 89 | 91 |
| Dirt (including right-of-way) | | 72 | 82 | 87 | 89 |
| Western desert urban areas: | | | | | |
| Natural desert landscaping (pervious areas only) [4] | | 63 | 77 | 85 | 88 |
| Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders) | | 96 | 96 | 96 | 96 |
| Urban districts: | | | | | |
| Commercial and business | 85 | 89 | 92 | 94 | 95 |
| Industrial | 72 | 81 | 88 | 91 | 93 |
| Residential districts by average lot size: | | | | | |
| 1/8 acre or less (town houses) | 65 | 77 | 85 | 90 | 92 |
| 1/4 acre | 38 | 61 | 75 | 83 | 87 |
| 1/3 acre | 30 | 57 | 72 | 81 | 86 |
| 1/2 acre | 25 | 54 | 70 | 80 | 85 |
| 1 acre | 20 | 51 | 68 | 79 | 84 |
| 2 acres | 12 | 46 | 65 | 77 | 82 |
| ***Developing urban areas*** | | | | | |
| Newly graded areas (pervious areas only, no vegetation) [5] | | 77 | 86 | 91 | 94 |
| Idle lands (CN's are determined using cover types similar to those in table 2-2c). | | | | | |

| Cover description | | | | | |
|---|---|---|---|---|---|
| Cover type and hydrologic condition | Hydrologic condition | A | B | C | D |
| Fully developed urban areas (vegetation established) | | | | | |
| Open space (lawns, parks, reserves, etc.) | | | | | |
| Condition (grass cover < 50%) | Poor | 68 | 79 | 86 | 89 |
| Fair condition ( grass cover 50%-75%) | Fair | 49 | 69 | 79 | 84 |
| Good condition (grass cover >75%) | Good | 39 | 61 | 74 | 80 |
| Impervious areas | | | | | |
| Paved parking lots, roofs, driveways, etc. | | 98 | 98 | 98 | 98 |
| Streets and roads* | | | | | |
| Paved; kerbing and catchpits (excluding right-of-way) | | 98 | 98 | 98 | 98 |
| Paved; open ditches (including right-of-way) | | 83 | 89 | 92 | 93 |
| Gravel (including right-of-way) | | 76 | 85 | 89 | 91 |
| Dirt (including right-of-way) | | 72 | 82 | 87 | 89 |
| Pasture, grassland, or range – continuous forage for grazing | Poor | 68 | 79 | 86 | 89 |
| | Fair | 49 | 69 | 79 | 84 |
| | Good | 39 | 61 | 74 | 80 |
| Straight row crops | Poor | 72 | 81 | 88 | 91 |
| | Good | 67 | 78 | 85 | 89+ |
| Bush – bush-weed-grass mixture with bush being the major element | Poor | 48 | 67 | 77 | 83 |
| | Fair | 35 | 56 | 70 | 77 |
| | Good | 30 | 48 | 65 | 73 |
| Bush – grass combination (orchard or tree farm) | Poor | 57 | 73 | 82 | 86 |
| | Fair | 43 | 65 | 76 | 82 |
| | Good | 32 | 58 | 72 | 79 |
| Bush** | Poor | 45 | 66 | 77 | 83 |
| | Fair | 36 | 60 | 73 | 79 |
| | Good | 30 | 55 | 70 | 77 |
| Farmsteads – buildings, lanes, driveways, and surrounding lots | | 59 | 74 | 82 | 86 |

| Maven Associates Ltd. | | Job Number 407001 | Sheet 2 | Rev A |
|---|---|---|---|---|
| Job Title<br>Calc Title | HT1<br>Pre-development | Author<br>NDL | Date<br>20/08/2025 | Checked<br>DJM |

1. Data

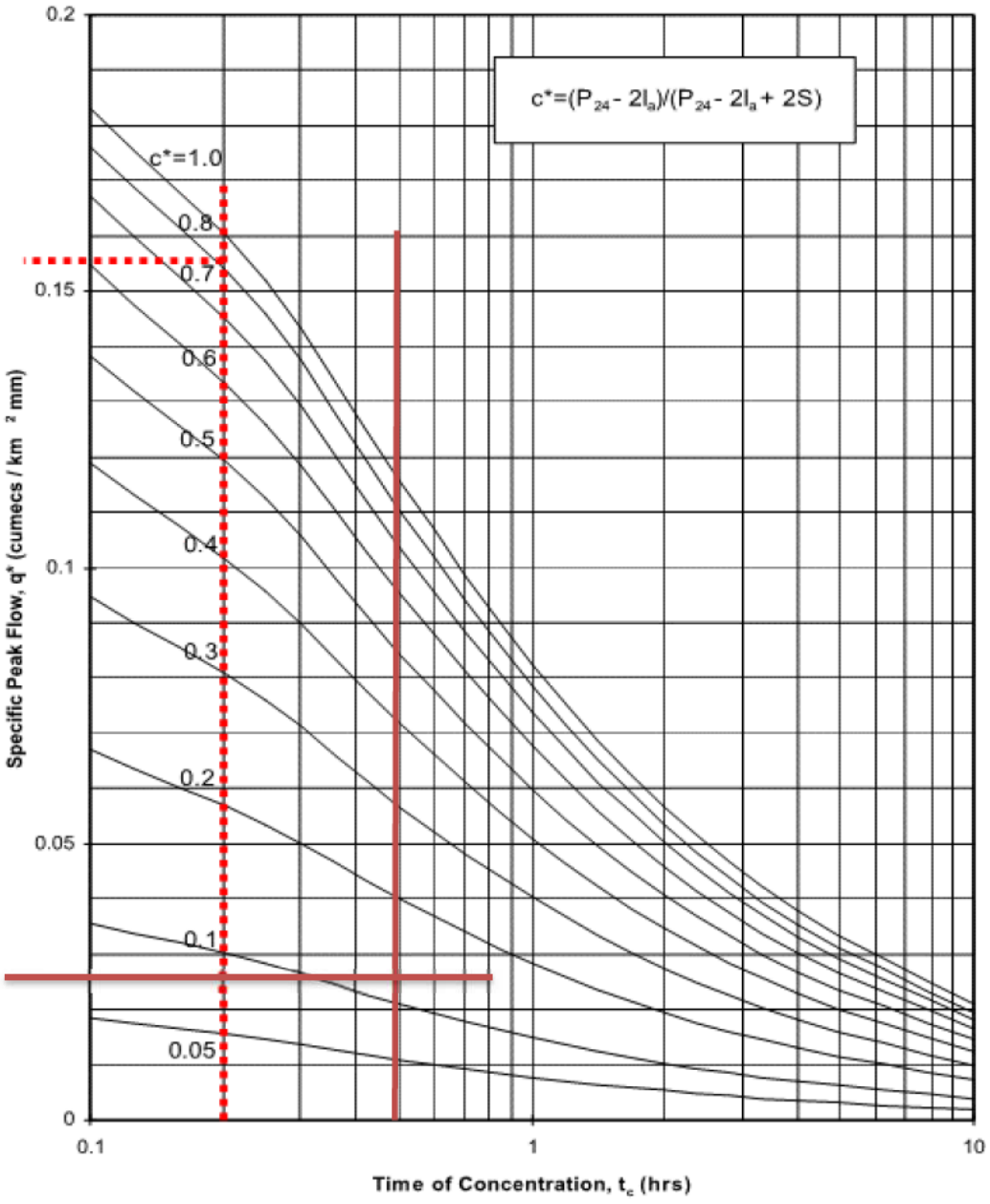
| | | | |
|---|---|---|---|
| Catchment Area | A= | 0.85000 | km2( 100ha =1km2) |
| Runoff curve number | CN= | 61.0 | (from worksheet 1) |
| Initial abstraction | Ia= | 5.0 | mm (from worksheet 1) |
| Time of concentration | tc= | 0.75 | hrs (from worksheet 1) |

2. Calculate storage, S =(1000/CN - 10)25.4 = 162 mm

| | | |
|---|---|---|
| 3. Average recurrence interval, ARI | 2 | (yr) |
| 4. 24 hour rainfall depth, P24 | 62.5 | (mm) |
| 5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S | 0.139 | |
| 6. Specific peak flow rate q* | 0.025 | |
| 7. Peak flow rate, $q_p=q^*A^*P_{24}$ | **1.328** | (m3/s) |
| 8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$ | 15.0 | |
| 9. Runoff volume, $V_{24} = 1000xQ_{24}A$ | 12780.34 | (m3) |

NO CLIMATE CHANGE

**Worksheet 2: Graphical Peak Flow Rate**


c*=(P24 - 2Ia)/(P24 - 2Ia + 2S)
c*=1.0
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.05
0.2
0.15
0.1
0.05
0
0.1
1
10
Specific Peak Flow, q* (cumecs / km ² mm)
Time of Concentration, tc (hrs)

| Maven Associates Ltd. | | Job Number 407001 | Sheet 3 | Rev A |
|---|---|---|---|---|
| Job Title<br>Calc Title | HT1<br>Pre-development | Author<br>NDL | Date<br>20/08/2025 | Checked<br>DJM |

1. Data

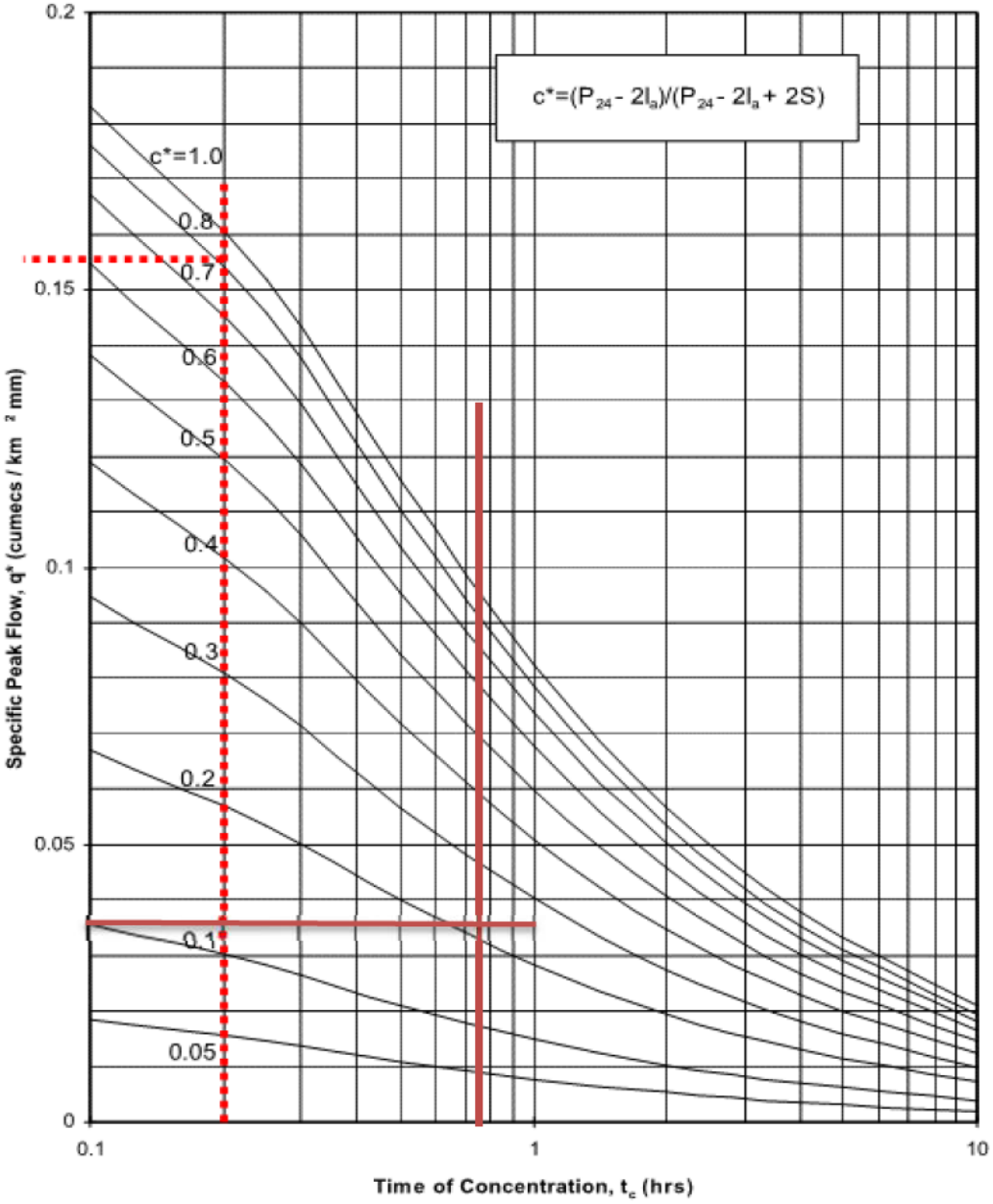
| | | | |
|---|---|---|---|
| Catchment Area | A= | 0.85000 | km2( 100ha =1km2) |
| Runoff curve number | CN= | 61.0 | (from worksheet 1) |
| Initial abstraction | Ia= | 5.0 | mm (from worksheet 1) |
| Time of concentration | tc= | 0.75 | hrs (from worksheet 1) |

2. Calculate storage, S =(1000/CN - 10)25.4 = 162 mm

| | | |
|---|---|---|
| 3. Average recurrence interval, ARI | 10 | (yr) |
| 4. 24 hour rainfall depth, P24 | 95.3 | (mm) |
| 5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S | 0.208 | |
| 6. Specific peak flow rate q* | 0.036 | |
| 7. Peak flow rate, $q_p=q^*A^*P_{24}$ | **2.916** | (m3/s) |
| 8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$ | 32.3 | |
| 9. Runoff volume, $V_{24} = 1000xQ_{24}A$ | 27428.40 | (m3) |

NO CLIMATE CHANGE

**Worksheet 2: Graphical Peak Flow Rate**


c*=(P24 - 2Ia)/(P24 - 2Ia + 2S)
c*=1.0
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.05
0.2
0.15
0.1
0.05
0
0.1
1
10
Specific Peak Flow, q* (cumecs / km ² mm)
Time of Concentration, tc (hrs)

| Maven Associates Ltd. | | Job Number 407001 | Sheet 4 | Rev A |
|---|---|---|---|---|
| Job Title<br>Calc Title | HT1<br>Pre-development | Author<br>NDL | Date<br>20/08/2025 | Checked<br>DJM |

1. Data

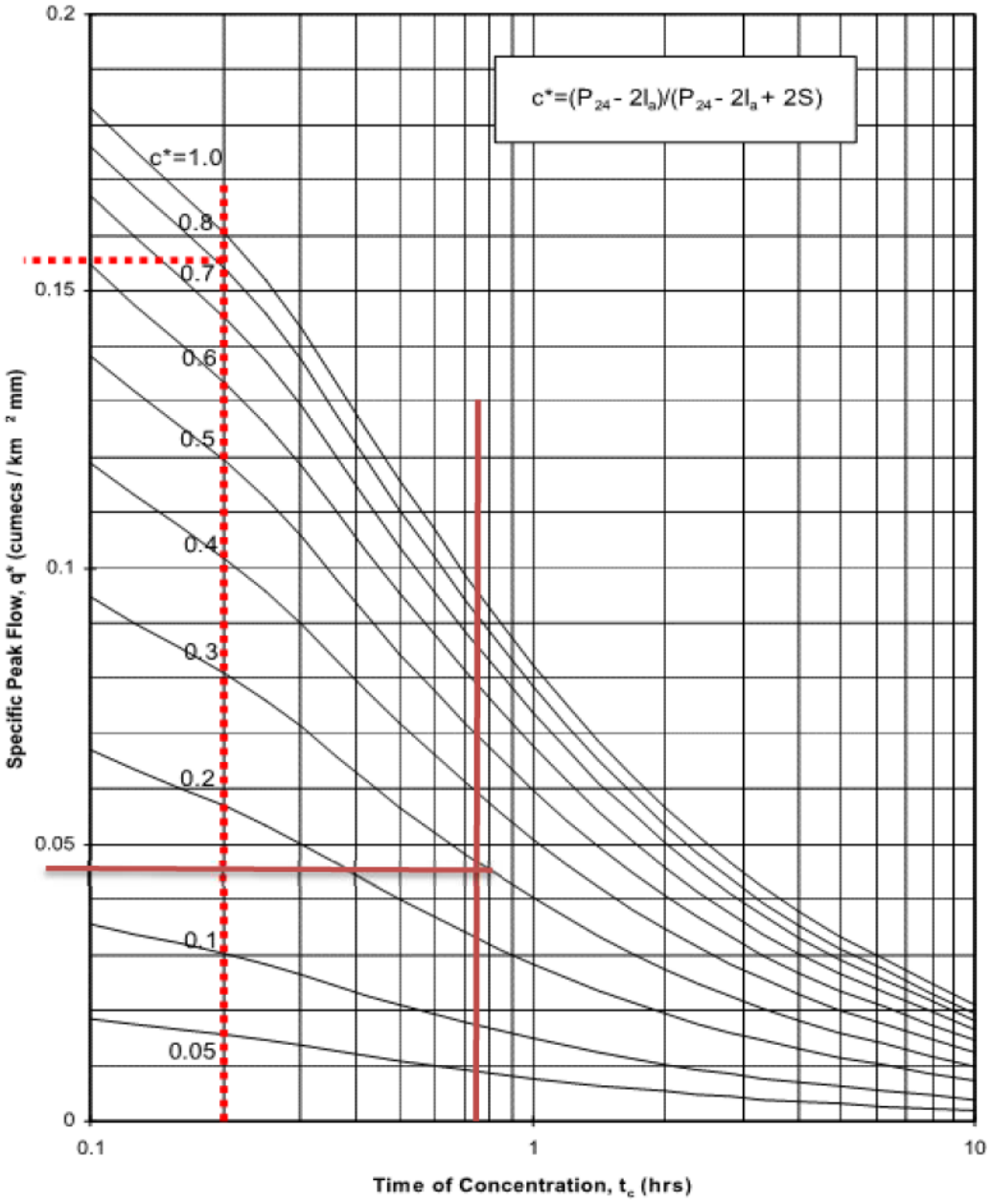
| | | | |
|---|---|---|---|
| Catchment Area | A= | 0.85000 | km2( 100ha =1km2) |
| Runoff curve number | CN= | 61.0 | (from worksheet 1) |
| Initial abstraction | Ia= | 5.0 | mm (from worksheet 1) |
| Time of concentration | tc= | 0.75 | hrs (from worksheet 1) |

2. Calculate storage, S =(1000/CN - 10)25.4 = 162 mm

| | | |
|---|---|---|
| 3. Average recurrence interval, ARI | 100 | (yr) |
| 4. 24 hour rainfall depth, P24 | 148 | (mm) |
| 5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S | 0.298 | |
| 6. Specific peak flow rate q* | 0.045 | |
| 7. Peak flow rate, $q_p=q^*A^*P_{24}$ | **5.661** | (m3/s) |
| 8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$ | 67.0 | |
| 9. Runoff volume, $V_{24} = 1000xQ_{24}A$ | 56915.60 | (m3) |

NO CLIMATE CHANGE

**Worksheet 2: Graphical Peak Flow Rate**


c*=(P24 - 2Ia)/(P24 - 2Ia + 2S)
c*=1.0
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.05
0.2
0.15
0.1
0.05
0
0.1
1
10
Specific Peak Flow, q* (cumecs / km ² mm)
Time of Concentration, tc (hrs)

| Maven Associates Ltd. | | Job Number 407001 | Sheet 5 | Rev A |
|---|---|---|---|---|
| Job Title<br>Calc Title | HT1<br>Post-development | Author<br>NDL | Date<br>20/08/2025 | Checked<br>DJM |

**1. Runoff Curve Number (CN) and initial Abstraction (Ia)**

| Soil name and classification | Cover description (cover type, treatment, and hydrologic condition) | Curve Number CN* | Area (ha) 10000m2=1ha | Product of CN x area |
|---|---|---|---|---|
| C | Road | 98 | 7.00 | 686.0 |
| C | Residential District (30% PERVIOUS) | 74 | 18.9 | 1398.6 |
| C | Residential District (70% IMPERVIOUS) | 90 | 44.10 | 3969.0 |
| B | FIELD | 61 | 15.000 | |
| * from Appendix B | | Totals = | 85.00 | 6053.6 |

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{6053.60}{85.000} = 71.2$

Ia (weighted) = $\frac{5 \times \text{pervious area}}{\text{total area}} = \frac{5 \times 18.90}{85.00} = 1.1$ mm

**2. Time of Concentration**

Channelisation factor C = 1 (From Table 4.2) piped

Catchment length L = 1.44 km (along drainage path)

Catchment Slope Sc= 0.01 m/m (by equal area method)

Runoff factor, $\frac{CN}{200 - CN} = \frac{71.2}{200-71.2} = 0.55$

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.1 1 1.27 1.39 3.98 = 0.982 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.658 hrs

OK
use
0.658 hrs

**Worksheet 1: Runoff Parameters and Time of Concentration**

| Cover description | | Curve numbers for hydrologic soil group | | | |
|---|---|---|---|---|---|
| Cover type and hydrologic condition | Average percent impervious area [2] | A | B | C | D |
| ***Fully developed urban areas (vegetation established)*** | | | | | |
| Open space (lawns, parks, golf courses, cemeteries, etc.) [3]: | | | | | |
| Poor condition (grass cover < 50%) | | 68 | 79 | 86 | 89 |
| Fair condition (grass cover 50% to 75%) | | 49 | 69 | 79 | 84 |
| Good condition (grass cover > 75%) | | 39 | 61 | 74 | 80 |
| Impervious areas: | | | | | |
| Paved parking lots, roofs, driveways, etc. (excluding right-of-way) | | 98 | 98 | 98 | 98 |
| Streets and roads: | | | | | |
| Paved; curbs and storm sewers (excluding right-of-way) | | 98 | 98 | 98 | 98 |
| Paved; open ditches (including right-of-way) | | 83 | 89 | 92 | 93 |
| Gravel (including right-of-way) | | 76 | 85 | 89 | 91 |
| Dirt (including right-of-way) | | 72 | 82 | 87 | 89 |
| Western desert urban areas: | | | | | |
| Natural desert landscaping (pervious areas only) [4] | | 63 | 77 | 85 | 88 |
| Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders) | | 96 | 96 | 96 | 96 |
| Urban districts: | | | | | |
| Commercial and business | 85 | 89 | 92 | 94 | 95 |
| Industrial | 72 | 81 | 88 | 91 | 93 |
| Residential districts by average lot size: | | | | | |
| 1/8 acre or less (town houses) | 65 | 77 | 85 | 90 | 92 |
| 1/4 acre | 38 | 61 | 75 | 83 | 87 |
| 1/3 acre | 30 | 57 | 72 | 81 | 86 |
| 1/2 acre | 25 | 54 | 70 | 80 | 85 |
| 1 acre | 20 | 51 | 68 | 79 | 84 |
| 2 acres | 12 | 46 | 65 | 77 | 82 |
| ***Developing urban areas*** | | | | | |
| Newly graded areas (pervious areas only, no vegetation) [5] | | 77 | 86 | 91 | 94 |
| Idle lands (CN's are determined using cover types similar to those in table 2-2c). | | | | | |

| Maven Associates Ltd | Job Number 407001 | Sheet 6 | Rev A |
|---|---|---|---|
| Job Title HT1<br>Calc Title Post-development SW Demand | Author NDL | Date 20/08/2025 | Checked DJM |

1. Data

| | | | | |
|---|---|---|---|---|
| Catchment Area | A= | 0.850 | km2( 100ha =1km2) | |
| Runoff curve number | CN= | 71.2 | (from worksheet 1) | |
| Initial abstraction | Ia= | 1.1 | mm (from worksheet 1) | |
| Time of concentration | tc= | 0.658 | hrs (from worksheet 1) | |

2. Calculate storage, S =(1000/CN - 10)25.4 = 103 mm

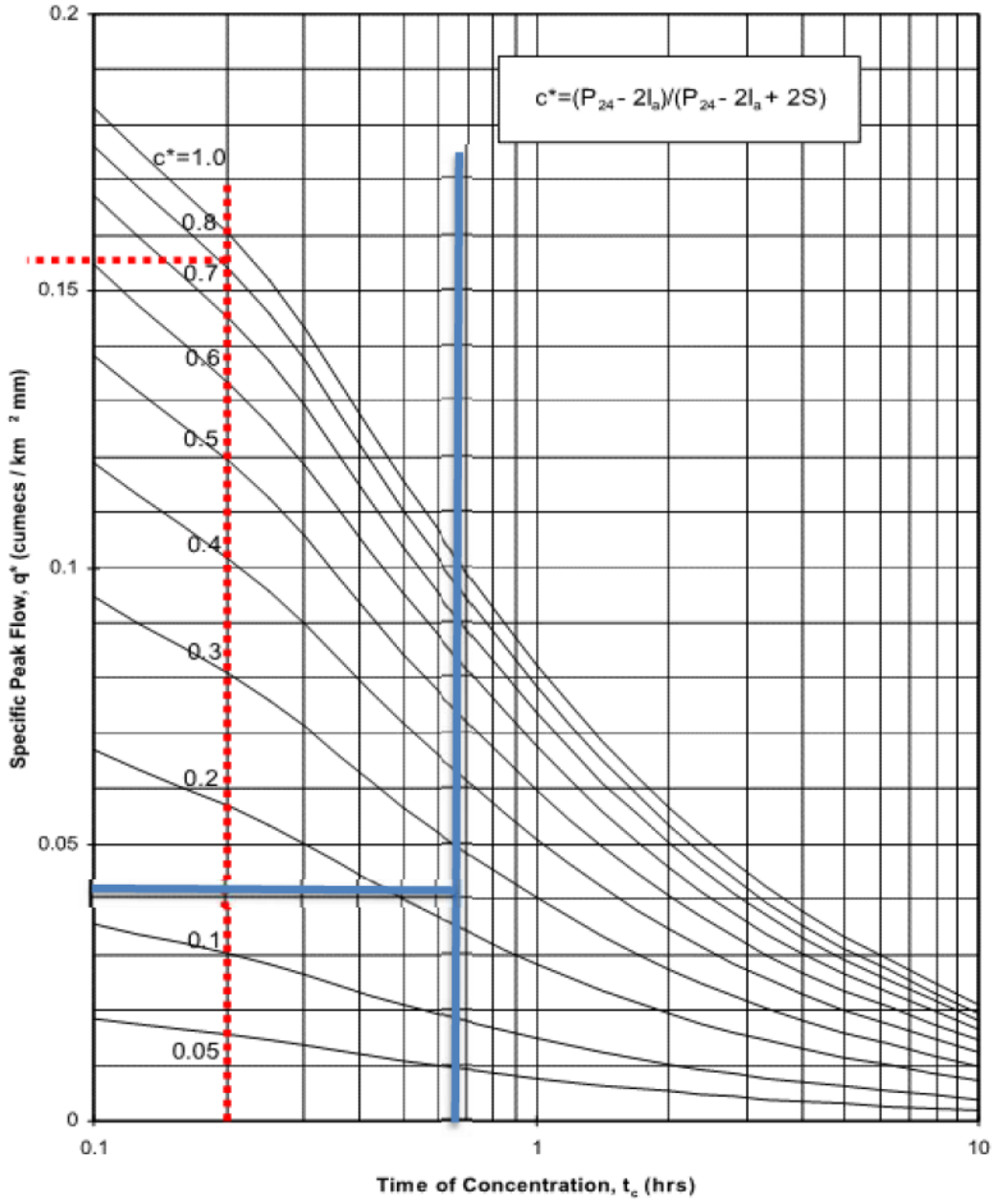
| | | | |
|---|---|---|---|
| 3. | Average recurrence interval, ARI | 2 | (yr) |
| 4. | 24 hour rainfall depth, P24 | 66.3 | (mm) |
| 5. | Compute c* = P24 - 2Ia/P24 - 2Ia+2S | 0.238 | |
| 6. | Specific peak flow rate q* | 0.041 | |
| 7. | Peak flow rate, $q_p=q^*A^*P_{24}$ | **2.311** | |
| 8. | Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$ | 25.3 | |
| 9. | Runoff volume, $V_{24} = 1000xQ_{24}A$ | 21521.55 | (m3) |

***HEC-HMS Check***

| | |
|---|---|
| | Pre-Dev |

| | | |
|---|---|---|
| Pre development run off volume | **12780.34** | (m3) |
| Post development run off volume | **21521.55** | (m3) |
| Pre development flow rate | **1.33** | (m3/s) |
| Post development flow rate | **2.31** | (m3/s) |

**Worksheet 2: Graphical Peak Flow Rate**


c*=(P24 - 2Ia)/(P24 - 2Ia + 2S)
c*=1.0
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.05
0.2
0.15
0.1
0.05
0
0.1
1
10
Specific Peak Flow, q* (cumecs / km ² mm)
Time of Concentration, tc (hrs)

| Maven Associates Ltd | Job Number 407001 | Sheet 7 | Rev A |
|---|---|---|---|
| Job Title HT1<br>Calc Title Post-development SW Demand | Author NDL | Date 20/08/2025 | Checked DJM |

1. Data

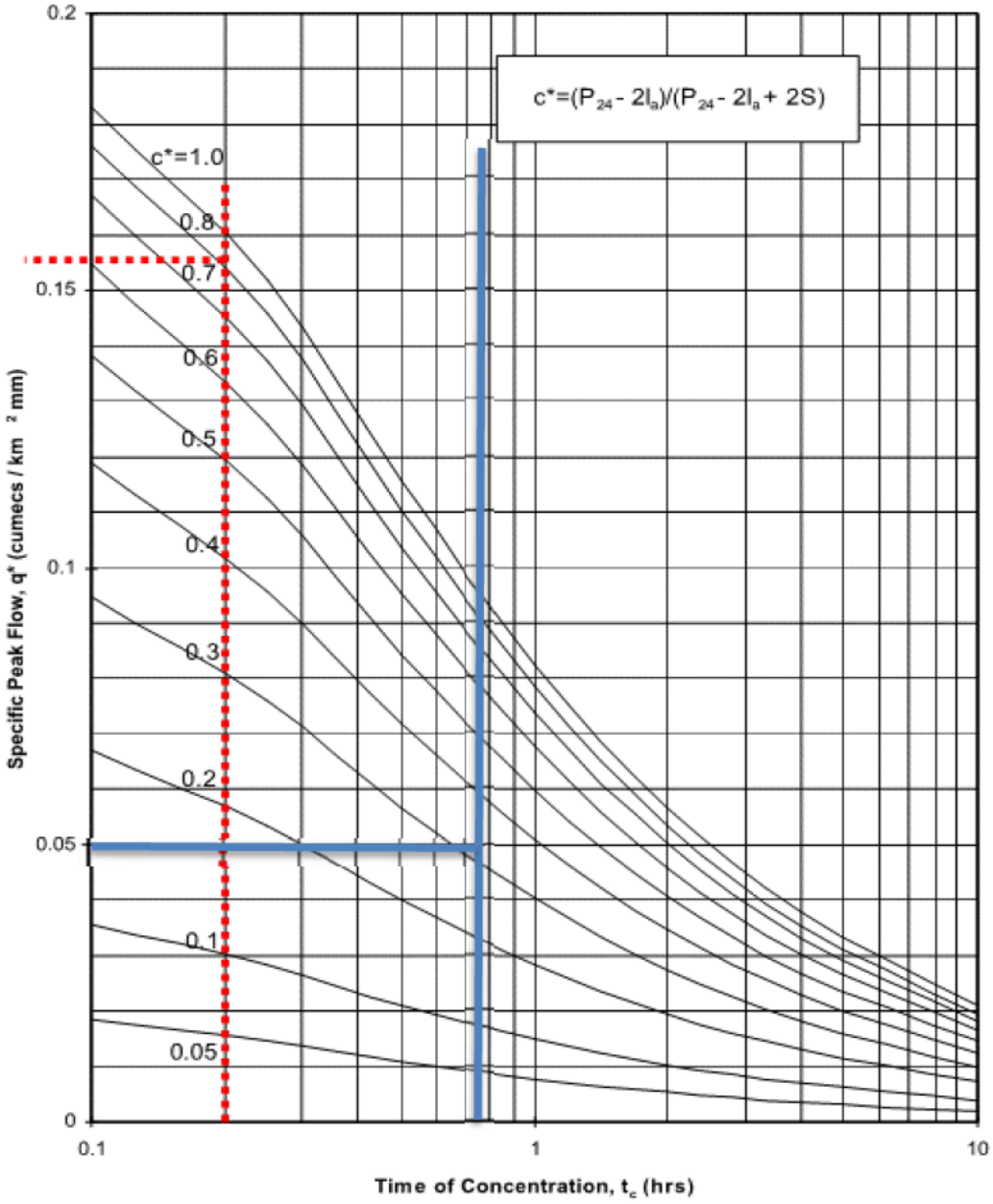
| | | | | |
|---|---|---|---|---|
| Catchment Area | A= | 0.850 | km2( 100ha =1km2) | |
| Runoff curve number | CN= | 71.2 | (from worksheet 1) | |
| Initial abstraction | Ia= | 1.1 | mm (from worksheet 1) | |
| Time of concentration | tc= | 0.658 | hrs (from worksheet 1) | |

2. Calculate storage, S =(1000/CN - 10)25.4 = 103 mm

| | | | | |
|---|---|---|---|---|
| 3. | Average recurrence interval, ARI | 10 | (yr) | |
| 4. | 24 hour rainfall depth, P24 | 102 | (mm) | |
| 5. | Compute c* = P24 - 2Ia/P24 - 2Ia+2S | 0.327 | | |
| 6. | Specific peak flow rate q* | 0.050 | | ***HEC-HMS Check*** |
| 7. | Peak flow rate, $q_p=q^*A^*P_{24}$ | **4.335** | | Pre-Dev |
| 8. | Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$ | 50.0 | | |
| 9. | Runoff volume, $V_{24} = 1000xQ_{24}A$ | 42506.93 | (m3) | |

| | | |
|---|---|---|
| Pre development run off volume | **27428.40** | (m3) |
| Post development run off volume | **42506.93** | (m3) |
| Pre development flow rate | **2.92** | (m3/s) |
| Post development flow rate | **4.34** | (m3/s) |

**Worksheet 2: Graphical Peak Flow Rate**


c*=(P24 - 2Ia)/(P24 - 2Ia + 2S)
c*=1.0
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.05
0.2
0.15
0.1
0.05
0
0.1
1
10
Specific Peak Flow, q* (cumecs / km ² mm)
Time of Concentration, tc (hrs)

| Maven Associates Ltd | Job Number 407001 | Sheet 8 | Rev A |
|---|---|---|---|
| Job Title HT1<br>Calc Title Post-development SW Demand | Author NDL | Date 20/08/2025 | Checked DJM |

1. Data

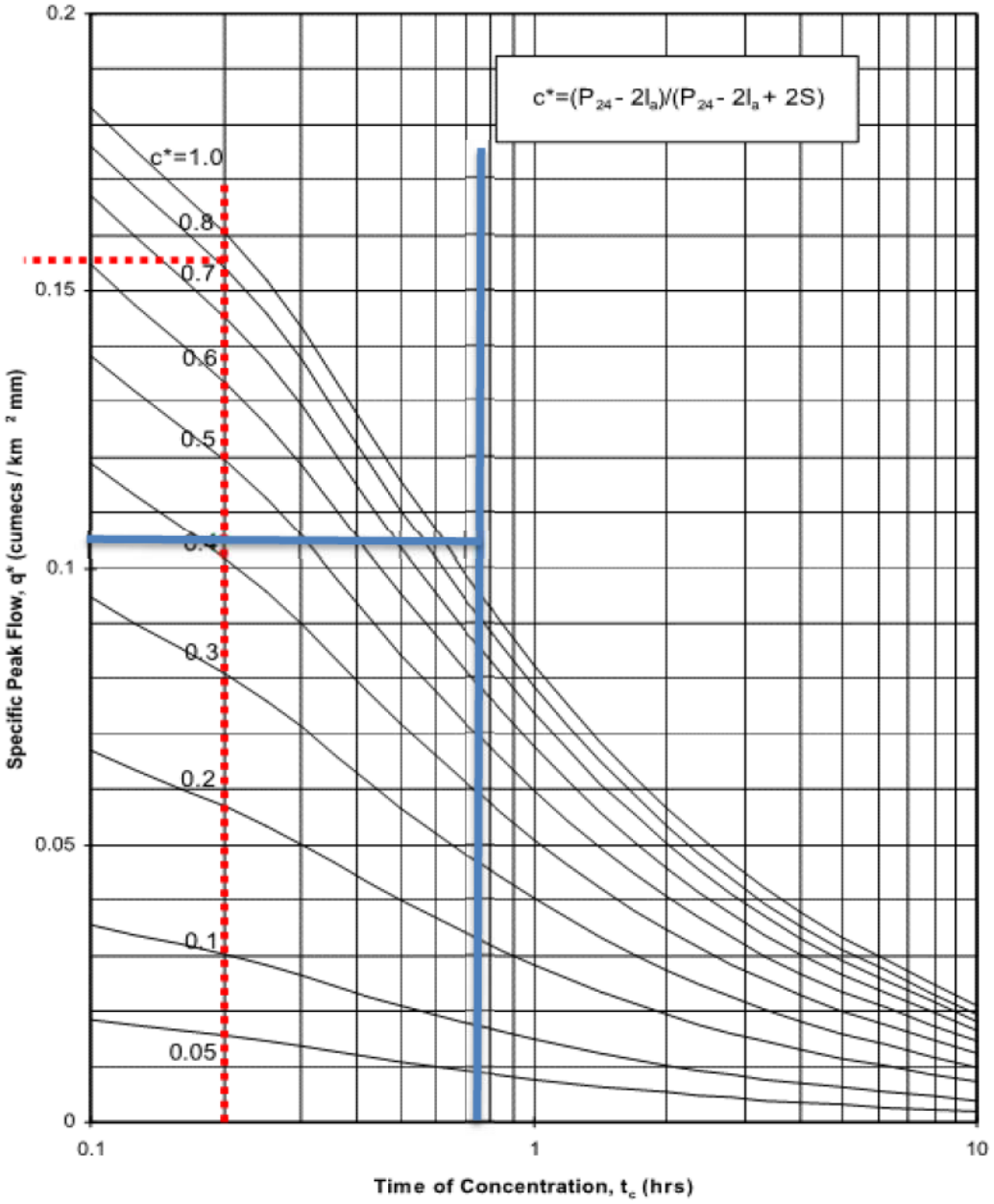
| | | | | |
|---|---|---|---|---|
| Catchment Area | A= | 0.850 | km2( 100ha =1km2) | |
| Runoff curve number | CN= | 71.2 | (from worksheet 1) | |
| Initial abstraction | Ia= | 1.1 | mm (from worksheet 1) | |
| Time of concentration | tc= | 0.658 | hrs (from worksheet 1) | |

2. Calculate storage, S =(1000/CN - 10)25.4 = 103 mm

| | | | | |
|---|---|---|---|---|
| 3. | Average recurrence interval, ARI | 100 | (yr) | |
| 4. | 24 hour rainfall depth, P24 | 158 | (mm) | |
| 5. | Compute c* = P24 - 2Ia/P24 - 2Ia+2S | 0.431 | | |
| 6. | Specific peak flow rate q* | 0.105 | | *HEC-HMS Check* |
| 7. | Peak flow rate, $q_p=q^*A^*P_{24}$ | **14.102** | | **4.529** 80% Pre |
| 8. | Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$ | 94.8 | | |
| 9. | Runoff volume, $V_{24} = 1000xQ_{24}A$ | 80612.59 | (m3) | |

| | | |
|---|---|---|
| Pre development run off volume | **56915.60** | (m3) |
| Post development run off volume | **80612.59** | (m3) |
| Pre development flow rate | **5.66** | (m3/s) |
| Post development flow rate | **14.10** | (m3/s) |
| 100yr - 10yr post development | **38105.66** | (m3) |

**Worksheet 2: Graphical Peak Flow Rate**


c*=(P24 - 2Ia)/(P24 - 2Ia + 2S)
c*=1.0
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.05
0.2
0.15
0.1
0.05
0
0.1
1
10
Specific Peak Flow, q* (cumecs / km ² mm)
Time of Concentration, tc (hrs)

Rainfall depths (mm) :: Historical Data

| ARI | AEP | 10m | 20m | 30m | 1h | 2h | 6h | 12h |
|---|---|---|---|---|---|---|---|---|
| 1.58 | 0.633 | 8.94 | 12.3 | 14.6 | 19.5 | 25.4 | 37.4 | 46.7 |
| 2 | 0.5 | 9.82 | 13.4 | 16 | 21.3 | 27.9 | 41 | 51.1 |
| 5 | 0.2 | 12.9 | 17.6 | 21 | 27.9 | 36.4 | 53.4 | 66.4 |
| 10 | 0.1 | 15.2 | 20.8 | 24.8 | 32.9 | 42.9 | 62.8 | 78.1 |
| 20 | 0.05 | 17.7 | 24.2 | 28.8 | 38.2 | 49.7 | 72.7 | 90.3 |
| 30 | 0.033 | 19.2 | 26.2 | 31.2 | 41.4 | 53.9 | 78.8 | 97.8 |
| 40 | 0.025 | 20.4 | 27.8 | 33 | 43.7 | 56.9 | 83.2 | 103 |
| 50 | 0.02 | 21.2 | 29 | 34.4 | 45.6 | 59.3 | 86.7 | 108 |
| 60 | 0.017 | 22 | 30 | 35.6 | 47.2 | 61.3 | 89.6 | 111 |
| 80 | 0.013 | 23.2 | 31.6 | 37.5 | 49.7 | 64.5 | 94.2 | 117 |
| 100 | 0.01 | 24.1 | 32.8 | 39 | 51.6 | 67.1 | 97.9 | 121 |
| 250 | 0.004 | 28 | 38.2 | 45.3 | 59.9 | 77.8 | 113 | 140 |

Rainfall depths (mm) :: RCP8.5 for the period 2031-2050

| ARI | AEP | 10m | 20m | 30m | 1h | 2h | 6h | 12h |
|---|---|---|---|---|---|---|---|---|
| 1.58 | 0.633 | 9.84 | 13.5 | 16.1 | 21.4 | 27.8 | 40.4 | 49.8 |
| 2 | 0.5 | 10.8 | 14.8 | 17.7 | 23.5 | 30.6 | 44.4 | 54.8 |
| 5 | 0.2 | 14.3 | 19.5 | 23.3 | 30.9 | 40.2 | 58.2 | 71.6 |
| 10 | 0.1 | 16.9 | 23.1 | 27.5 | 36.5 | 47.5 | 68.6 | 84.4 |
| 20 | 0.05 | 19.7 | 26.9 | 32 | 42.5 | 55.1 | 79.6 | 97.8 |
| 30 | 0.033 | 21.4 | 29.2 | 34.8 | 46.1 | 59.8 | 86.3 | 106 |
| 40 | 0.025 | 22.7 | 30.9 | 36.8 | 48.7 | 63.2 | 91.2 | 112 |
| 50 | 0.02 | 23.7 | 32.3 | 38.4 | 50.8 | 65.9 | 95 | 117 |
| 60 | 0.017 | 24.5 | 33.4 | 39.7 | 52.6 | 68.1 | 98.2 | 121 |
| 80 | 0.013 | 25.8 | 35.2 | 41.8 | 55.4 | 71.7 | 103 | 127 |
| 100 | 0.01 | 26.9 | 36.6 | 43.5 | 57.6 | 74.5 | 107 | 132 |
| 250 | 0.004 | 31.3 | 42.6 | 50.6 | 66.9 | 86.5 | 124 | 152 |

Rainfall depths (mm) :: RCP8.5 for the period 2081-2100

| 24h | 48h | 72h | 96h | 120h |
|---|---|---|---|---|
| 57.1 | 68.6 | 75.8 | 81 | 85 |
| 62.5 | 75.1 | 82.8 | 88.5 | 93 |
| 81.2 | 97.3 | 107 | 115 | 120 |
| 95.3 | 114 | 126 | 134 | 141 |
| 110 | 132 | 145 | 155 | 163 |
| 119 | 143 | 157 | 167 | 176 |
| 126 | 150 | 166 | 177 | 185 |
| 131 | 157 | 172 | 184 | 193 |
| 135 | 162 | 178 | 190 | 199 |
| 142 | 170 | 187 | 199 | 209 |
| 148 | 176 | 194 | 207 | 217 |
| 170 | 203 | 224 | 238 | 250 |

| 24h | 48h | 72h | 96h | 120h |
|---|---|---|---|---|
| 60.5 | 72 | 79 | 84.2 | 88.3 |
| 66.3 | 78.9 | 86.7 | 92.3 | 96.7 |
| 86.6 | 103 | 113 | 120 | 126 |
| 102 | 121 | 133 | 141 | 148 |
| 118 | 140 | 153 | 163 | 171 |
| 128 | 151 | 166 | 176 | 184 |
| 135 | 160 | 175 | 186 | 195 |
| 140 | 166 | 182 | 194 | 203 |
| 145 | 172 | 188 | 200 | 209 |
| 152 | 181 | 198 | 210 | 220 |
| 158 | 188 | 205 | 218 | 228 |
| 183 | 216 | 237 | 251 | 263 |

## WW Calculations - Pre Development Catchment Area (Site)

| | | | |
|---|---|---|---|
| **Project:** | Orchard Grove | Job Number: | 407001 |
| **Client:** | Gordan Litt Farm | | |
| **Calculation by:** | N.D.L | Date: | 26/08/2025 |
| **Checked by:** | D.J.M | | |

| ***Design flow as per 5.2.4.7 Design criteria*** | | | |
|---|---|---|---|
| **Proposed development area:** | | ***Residential Total*** | **71.48** |
| | | ***Commercial Total*** | **0.44** |
| | | ***Project area total*** | **71.92** |
| ***Designed Dwellings total (If known)*** | | | ***815*** |
| **Zones** | **Area (Ha)** | **Population Equivalent (persons per Ha)** | **Sub Total** |
| Residential - General | 28.25 | 70 | 1978 |
| Residential - Medium Density | 8.88 | 120 | 1066 |
| Residential - High Density | 2.47 | 150 | 371 |
| Central City Zone | 0 | 300 | 0 |
| Residential - Large Lot | 0.26 | 45 | 12 |
| Future Urban Zones | | 70 | 0 |
| All Business , Community Facility's, Industrial Zones | 0.44 | 45 | 20 |
| Primary Schools | 0 | 45 | 0 |
| Secondary Schools | 0 | 150 | 0 |
| | **Beds** | **Population Per Bed** | |
| Hospitals | 0 | 3.5 | 0 |
| Motels | 0 | 0.6 | 0 |
| ***Residential Total*** | ***39.86*** | | ***3425.30*** |
| ***Commercial Total*** | ***0.44*** | | ***19.80*** |
| | | ***Total Population*** | ***3445.10*** |

| **Peaking Factor: Refer RITS 5.2.4.6 Table 90** | | |
|---|---|---|
| ***Residential*** | 3425 | 2.6 |
| ***Commercial*** | 20 | 8.5 |

| **PARAMETERS** | | | |
|---|---|---|---|
| Water consumption | 200 | Litres Per person per day | 689020.00 |
| Infiltration allowance | 2250 | Litres Per Hectare per day | 90675.00 |
| Surface water ingress | 16500 | Litres Per Hectare per day | 664950.00 |

| ***Catchment Results*** | | | |
|---|---|---|---|
| Average dry wether flow: (200 liters per day. per person) + (Infiltration allowance X Catchment area) | | | |
| ADF | ***$M^3$ PER Day*** | | ***779.695*** |
| Peak daily flow: ( (Peaking factor X (200 liters per day. per person)) + (Infiltration allowance X Catchment area))/ 86400 | | | |
| PDF | ***LITERS PER SECOND*** | | ***1.155*** |
| Peaking wet weather flow (PWWF or Exceptional PDWF): ( (Peaking factor X (200 liters per day. per person)) + (Infiltration allowance X Catchment area +Surface water Ingress))/ 86400 | | | |
| PWWF | ***LITERS PER SECOND*** | | ***8.851*** |