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SUBDIVISION SITE SUITABILITY ENGINEERING REPORT

18 STATION ROAD, KAWAKAWA

CEM & SJ BRADSHAW

C0506-S-01-R01
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REVISION 1

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TABLES

1 INTRODUCTION

This Site Suitability Engineering Report has been prepared by Geologix Consulting Engineers Ltd (Geologix) for CEM and SJ Bradshaw as our Client in accordance with our standard short form agreement and general terms and conditions of engagement.

The purpose of this report is to assist with Resource Consent application in relation to the proposed subdivision of an urban residential lot at 18 Station Road, Kawakawa, the 'site' to create one new residential lot. Specifically, this assessment addresses engineering elements of geotechnical assessment, natural hazards, wastewater, stormwater, internal roading and associated earthwork requirements to provide safe and stable building platforms with less than minor effects on the environment as a result of the proposed activities outlined in Section 1.1.

1.1 Proposal

It is understood that the Client proposes to subdivide the site into two lots as outlined in Table 1 below.

This understanding has been established from a proposed scheme plan by Thomson Survey[1] supplied to Geologix at the time of writing and discussions with the client. Amendments to the referenced scheme plan may require an update to the recommendations of this report which are based on conservative, typical urban residential development concepts.

Table 1: Summary of Proposed Scheme

Proposed Lot	Size	Purpose
1	0.1300 ha	New Residential Lot
2	0.1387 ha	Existing Residential

2 DESKTOP APPRAISAL

The site is accessed at its south-eastern corner boundary from the western end of Station Road. The site is legally described as Lot 1 DP 526023 and designated as a "Residential" zone. Topographically, the site is located on a ridge, with the Proposed Lot 2 situated on top of the ridge accessed via the south-facing slope. The Proposed Lot 1 is situated on the north-facing slope. The northern slope flattens toward the site's northern boundary, where a mapped flood hazard intersects the northern corner of the site.

Existing structures are present on-site within Proposed Lot 2 including two single-storey dwellings and a shed located on the southern half of the site as presented in the above-referenced Thomson Survey Scheme Plan.

The site setting is presented in Figure 1 below.

[1] *Thomson Survey Ltd, Proposed Subdivision of Lot 1 DP 526023, Ref No. 10624, dated 04/04/2024.*

Figure 1: Site Setting[2]

2.1 Existing Reticulated Networks

Available information for existing infrastructure is provided by Far North District Council (FNDC) Far North Maps GIS system. The GIS mapping indicates that the site is currently connected to reticulated wastewater and water supply.

The subdivision proposal within this report aims to utilise the existing water and wastewater infrastructure to support the servicing to the proposed developments, with stormwater being disposed of on site.

2.2 Geological Setting

Available geological mapping[3] indicates the site to be underlain by Neogene River Deposits. The unit typically consists of thin-bedded, carbonaceous sandstone and carbonaceous mudstone with intercalated conglomerate and lignite.

A stream is located approximately 120m northwest of the site. It should not be discounted that some weaker alluvial soils may be present.

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[2] Source: https://app.grip.co.nz/

[3] Edbrooke, S.E, 2001. Geology of the Auckland area. Institute of Geological & Nuclear Sciences 1:250 000 geological map 3.

3 SURFACE WATER FEATURES AND OVERLAND FLOWPATHS

During our site walkover and desktop appraisal of the available FNDC GIS data, Geologix have developed an understanding of surface water features and overland flow paths within the vicinity to the site.

3.1 Surface Water Features

According to available FNDC GIS data, there are no evident surface water features such as ponds or streams within the site boundaries.

There are no clearly defined overland flow paths evident within the site boundaries.

3.2 Sensitive Receptors

Based on available GIS data and information provided by the Planner (Thomson Survey), the Kawakawa Flood Plain comprises a wetland that is near to the northern boundary of proposed Lot 1. The proposal considers that the proximity of the proposed Lot 1 building footprint (impervious area) to the wetland is less than 30m, which is the setback specified in the FNDC ODP Rule 12.7.6.1.2(c). The achievable setback to the boundary (and wetland) is rather between 9 and 23m, the variance is due to the angle to the proposed footprint relative to the boundary.

The proposal does ensure that hydraulic neutrality is achieved for the site so as to avoid any effect from the proposed subdivision onto the wetland. This is explained further in Section 7.2.

3.3 Flood Hazard

Northland Regional Council Natural Hazard Maps indicates that the site has a river flood hazard of the 10%, 2% and 1% Annual Exceedance Probability (AEP) or 1-in-10/50/100 rain events, with the 1% AEP extent encroaching approximately 8 metres within the northern boundary (corner) and to an elevation of approximately 6.5m AMSL. This flood plain has no effect on the conceptual building envelope or infrastructure proposed for Lot 1 or 2.

This flood plain forms around the Kawakawa River which is located approximately 60m north of the site boundary.

Figure 2: 10yr, 50yr and 100yr Flood Level Graphic from Northland Regional Council

4 GROUND INVESTIGATION

A site-specific walkover survey and intrusive ground investigation was undertaken by Geologix on 7 June 2024. The ground investigation was scoped to confirm the findings of the above desktop observations where possible and to provide parameters for geotechnical assessment. The ground investigation comprised:

- One hand augered borehole designated BH01, was drilled within lot 1 with a target depth of 5.0 m below ground level (bgl). The hand auger refused at 2.1m bgl due to encountering a hard stratum.
- Dynamic Cone Penetration (DCP) testing was carried out from the base of BH01 until final refusal i.e. 20 blows per 100 mm penetration. Refusals were encountered at 4.8m bgl.
- No groundwater was encountered on the day of drilling.

4.1 Site Walkover Survey

A visual walkover survey of the property confirmed:

- The topographical understanding of the site developed from our desktop study, as outlined in Section 2, is in general accordance with that observed on site.

- Suitable building envelopes[5] can be formed on gently to moderately sloping land <20°.
- The easements to be used for services is located upslope of the area likely to be the location of future development.
- Currently, no horticulture activities were observed on the proposed subdivision.
- No overland flow paths are present in the southern part of the proposed lot 1 area. The northern vegetated part of the site has a flow path which is captured in the stream northwest of the site.
- The ground profile is generally smooth and there are no ground features that indicate instability.

4.2 Ground Conditions

Arisings recovered from the exploratory boreholes were logged by a suitably qualified geotechnical engineering professional in general accordance with New Zealand Geotechnical Society guidelines[6]. Engineering borehole logs are presented as Appendix B to this report and approximate borehole positions recorded on Drawing No. 200 within Appendix A. Strata identified during the ground investigation can be summarised as follows:

- **Topsoil encountered to 0.3 m bgl.** Described as organic silt, dark brown, very stiff, moist.
- **Neogene River Deposits to a depth of >4.8m bgl.** The alluvial residual soil encountered is silt with traces of clay becoming silt with traces of sand with depth, low plasticity and high permeability. Colour of the soil is brown to light brown. The soil below 0.8 m bgl has white and orange mottles and becomes clayey.

  In-situ field vane tests was taken at 0.3 m intervals to determine soil strength within this layer. The in-situ tests recorded vane shear strengths ranging from 154 kPa to Unable to Penetrate (UTP). Characteristic unit vane shear strength has been determined to be 180kPa at 95% confidence, indicative of very stiff soils.

  DCP testing indicates the soil is loose to medium dense from 2.1m to 3.2m then dense until 4.8m bgl where very dense material and refusal was encountered.

A summary of the above information is presented as Table 2 below.

Table 2: Summary of Ground Investigation

Hole ID	Proposed Lot	Hole Depth[1]	Topsoil Depth	Depth to Dense Soil	Very Dense Soil/Refusal Depth	Groundwater[2]
BH01	1	2.1 m	0.3 m	3.2 m	4.8 m	NE[3]

1. *All depths recorded in m bgl unless stated otherwise.*
2. *Groundwater measurements taken on day of drilling.*

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[5] *Measuring 14 m x 14 m according to FNDC District Plan Rule 13.7.2.2.*
[6] *New Zealand Geotechnical Society, Field Description of Soil and Rock, 2005.*

3. NE – Not Encountered.

5 GEOTECHNICAL ASSESSMENT

Geotechnical design parameters are presented in Table 3 below. They have been developed based on our ground investigation, the results of in-situ testing and experience with similar materials.

Table 3: Geotechnical Effective Stress Parameters

Geological Unit	Unit Weight, kN/m3	Effective Friction Angle, °	Effective Cohesion, kPa	Undrained shear strength, kPa
Neogene River Deposits	17	30	5	144*

** Adopting correction factor of 0.8 from the characteristic vane shear strength.*

5.1 Seismic Hazard

New Zealand Standard NZS1170.5:2004 Clause 2.1.4 specifies that to meet the requirements of the New Zealand Building Code, design of structures is to allow for two earthquake scenarios:

1. *Ultimate Limit State (ULS) shall provide for… "avoidance of collapse of the structural system…or loss of support to parts… damage to non-structural systems necessary for emergency building evacuation that renders them inoperable".*

2. *Serviceability Limit State (SLS) are to avoid damage to… "the structure and non-structural components that would prevent the structure from being used as originally intended without repair after the SLS earthquake…".*

The seismic hazard in terms of Peak Ground Acceleration (PGA) has been assessed based on the NZGS Module 1[7]. Table 4 presents the return periods for earthquakes with ULS and SLS 'unweighted' PGAs and design earthquake loads for the corresponding magnitude. The PGAs were determined using building Importance Level (IL) 2, defined by NZS1170.5:2004. Reference should be made to the structural designer's assessment for the final determination of building importance level.

Table 4: Summary of Seismic Hazard Parameters

Limit State	Effective Magnitude	Return Period (years)	Unweighted PGA
ULS	6.5	500	0.19 g
SLS	5.8	25	0.03 g

[7] *New Zealand Geotechnical Society, Earthquake Geotechnical Engineering Practice, Module 1, November 2021, Appendix A, Table A1.*

5.2 Site Stability

At the time of writing, no obvious indications of major deep-seated instability were identified at the site, and the risk of such deep-seated instability developing as a result of the development proposal is low.

In addition, no obvious indications of shallow instability including relic, or more recent evidence was noted during the Geologix ground investigation. The southern half of the property where the new dwelling is expected to be built is moderately sloping at an angle of approximately 20 °.

Within the scope of this ground investigation Geologix have undertaken a digitally modelled slope stability analysis through the critical section of the site topography as shown on drawing 200 in Appendix A. At this preliminary stage, this represents the area with the steepest slope.

The slope was analysed within propriety software Slide 2 Version 9.02, developed by RocScience Inc. The purpose of the stability assessment was to:

- Ensure development on the proposed site is feasible.
- Provide a working, accurate ground model in relation to site stability refined according to observed conditions and the results of this ground investigation.
- Inform the requirements of Consent, developed architectural design and further engineering works.

The stability analysis process was undertaken by calibrating the model to observed conditions by refining the ground investigation data to develop the effective stress parameters presented in Table 3 and applying them to the proposed condition.

Limit equilibrium stability analysis was adopted in the analysis to express the results as a Factor of Safety (FS). When FS = 1.0, the represented mechanism is in equilibrium with the disturbing, active forces equal to the resisting, stabilising forces. A lower FS indicates that instability could occur under the modelled scenario whereas a higher FS demonstrates a margin of safety in respect of stability. Minimum FS criteria have been developed for use in residential development by Auckland Council[9] which are widely adopted in the Far North region. Modelling three separate event scenarios the accepted minimum FS are summarised as follows:

- Minimum FS = 1.5 for static, normal groundwater conditions.
- Minimum FS = 1.3 for elevated groundwater conditions (storm events).

[9] *Auckland Council, The Auckland Code of Practice for Land Development and Subdivision, Chapter 2: Earthworks and Geotechnical, May 2023.*

- Minimum FS = 1.0 for dynamic, seismic events.

5.2.1 *Stability Analysis Results*

Slope stability analysis results are presented in full as Appendix F and summarised below as Table 5.

Table 5: Summary of Stability Analysis Results

Profile	Scenario	Global Min.	Development Footprint (min FS)	Result
Existing Conditions	Static	2.125	>1.5	Pass
	Elevated GW	1.726	>1.3	
	Seismic	1.194	>1.0	
Proposed Conditions	Static	2.226	>1.5	Pass
	Elevated GW	1.834	>1.3	
	Seismic	1.255	>1.0	

Static, normal groundwater minimum FS = 1.5
Static, elevated groundwater minimum FS = 1.3
Dynamic, seismic conditions minimum FS = 1.0

5.2.2 *Stability Analysis Conclusions*

The developed slope stability model is considered to be a reasonable representation of the observed conditions on site. The dense to very dense layers encountered on site were conservatively ignored for the slope stability model. No detailed architectural plans or earthworks plan is available during the preparation of this report. Slope stability analyses may subject to be revised once earthworks extents are known.

From the current modelled slope stability analysis computation, FS are satisfactory and meet the minimum requirements for residential development according to the above parameters. Models are presented in full as Appendix D. It is concluded that development of the proposed building site does not accelerate and/ or worsen a natural hazard and specific geotechnical stability control is not required at this time. However, this should be further considered at the Building Consent stage once final development plans are available. The geotechnical review shall be undertaken by a Chartered Professional Geotechnical Engineer.

5.3 Soil Expansivity

Clay soil may undergo appreciable volume change in response to changes in moisture content and be classed as expansive. The reactivity and the typical range of movement that can be expected from potentially expansive soils underlying any given building site depends on the amount of clay present, the clay mineral type, and the proportion, depth, and distribution of clay throughout the soil profile. Clay soils typically have a high porosity and low permeability causing moisture changes to occur slowly and produce swelling upon wetting and shrinkage upon drying. Apart from seasonal moisture changes (wet winters and dry summers) other factors that can influence soil moisture content include:

- Influence of garden watering and site drainage.

- The presence of mature vegetation.
- Initial soil moisture conditions at the time of construction.

Prior to a quantitative analysis of the soil, the underlying Neogene River Deposits is conservatively expected to meet the requirements of a highly expansive or Class H soil type. In accordance with AS2870:2011[10] and New Zealand Building Code[11], Class H or Highly Expansive soils typically have a soil stability index (I_{SS}) range of 3.8 to 6.5% and a 500-year design characteristic surface movement return (y_s) of 78 mm.

It is recommended that a quantification of the soil expansivity are made by a geotechnical laboratory analysis at the Building Consent stage.

5.4 Liquefaction Potential

Liquefaction occurs when excess pore pressures are generated within loose, saturated, and generally cohesionless soils (typically sands and silty sands with <30 % fines content) during earthquake shaking. The resulting high pore pressures can cause the soils to undergo a partial to complete loss of strength. This can result in settlement and/ or horizontal movement (lateral spread) of the soil mass.

The Geologix ground investigation indicates the site to be predominantly underlain by silt and clayey silt with no groundwater and traces of sand. Based on the materials strength and consistency, and our experience with these materials, there is no liquefaction potential/ risk in a design level earthquake event.

5.5 Conceptual Foundations

5.5.1 Concept Shallow Foundation

The Neogene River Deposits have an average undrained shear strength exceeding 100 kPa, it is expected that shallow foundations such as timber pole foundations or standard raft/ strip footings can be adopted for the future dwelling, the latter on a fully supported earthworks platform. Such foundations may be designed by a professional structural engineer adopting an Ultimate Bearing Capacity of 300kPa for a highly expansive soil type and a geotechnical reduction factor of 0.5.

Where shallow standard raft and/ or strip footing foundations are proposed, it is recommended that any non-engineered fill, underlying soft spots (S_u <60 kPa) and any other unsuitable or deleterious materials (such as relic foundations, driveway hardstanding etc.) are sub-excavated and replaced with suitably selected and compacted materials such as GAP65 hard fill.

If piled foundations are proposed, it is recommended that all piled foundations are taken down to a minimum of 1.0 m bgl and designed by a professional structural engineer to take

[10] AS2870, Residential Slabs and Footings, 2011.
[11] New Zealand Building Code, Structure B1/AS1 (Amendment 19, November 2019), Clause 7.5.13.1.2.

into account a highly expansive soil type and the locally deepened within moderately steep sloping terrain.

If groundwater is encountered within the pile holes, tremie concrete pour methodology will most likely be required to displace groundwater and an allowance should be made for this by the Contractor.

If filling is required within proposed dwelling footprint, the retaining of placed materials may be required, which could comprise of concrete block walls. It is recommended that all retaining walls are designed by a suitably qualified professional engineer familiar with the findings of this report. Blockwork retaining walls can be designed for an ultimate bearing capacity of 300 kPa for a highly expansive soil class and a geotechnical reduction factor of 0.5.

5.6 Conceptual Earthworks and Methodology

It is recommended that all proposed excavations and fills at the site are retained by specifically engineered retaining walls subject to design at the Building Consent stage. Any permanent earthworks and batter slopes shall be subject to specific engineering assessment at Building Consent stage. Preliminary earthworks assessments please also refer to Section 9 of the report.

5.6.1 Temporary Works

To reduce the risk of temporary excavation instability, it is recommended that temporary unsupported excavations have a maximum vertical height of 1.0 m. Temporary unsupported excavations above this height shall be battered at 1V:1H or 45 °. It is expected that the above temporary works can be undertaken within the property boundaries.

Temporary excavations should not be left unsupported for a long period of time. Poles must be installed and backfilled against the excavated face immediately to ensure the slopes are not left unsupported.

Temporary batters should be covered with polythene sheets secured to the surface with pins or batons to prevent saturation. All works within proximity to excavations should be undertaken in accordance with Occupational Health and Safety regulations. In addition, it is recommended that all earthworks are conducted in periods of fine weather within the typical October to April earthwork season. Consent conditions commonly prescribe working restrictions.

5.6.2 Fills

Due to the moderately steep slope beneath the proposed preliminary building footprint, fill should be kept to a minimum. Earthwork fills will require support by fully engineered retaining walls.

It is recommended that proposed fills are subject to a specific engineering specification including compaction standards and construction monitoring at regular lift intervals (maximum 0.5 m).

In addition, any unsuitable and/ or deleterious materials such as organic pockets, nonengineered fill, relic foundations and/ or concrete hard standing and locally weaker spots (S_u <60 kPa) shall be cut to waste and not adopted for filling.

6 WASTEWATER ASSESSMENT

The scope of this wastewater assessment comprised an assessment of anticipated wastewater flows from proposed lots and the suitability of connecting to the existing reticulated network. Relevant design guideline documents adopted include:

- Watercare, Water and Wastewater Code of Practice for Land Development and Subdivision, Version 1.5, dated May 2015.
- FNDC Engineering Standards, Version 0.6, Date Issued: May 2023.

6.1 Existing On-site Wastewater Systems

According to the current site condition, there is no evidence of any existing on-site wastewater systems.

6.2 Existing Wastewater Reticulated Network

As described on the Far North Maps 3 Waters map and shown in Figure 3 below, there is an existing 100mm dia. uPVC public drain (ID: SS600001) running in a north-easterly direction towards a public manhole (ID: SP3050), before connecting to a 225mm dia. concrete drain (ID SL3293_3235).

Figure 3: FNDC 3Waters Maps GIS Image of Existing Services

6.3 Existing Wastewater Connection

Based on the site walkover and FNDC 3 Waters GIS, there is an existing wastewater connection in place that serves the site. This connection services the existing dwelling in proposed Lot 2 and will remain in place.

6.4 Proposed Wastewater Connection

It is proposed that the future dwelling in proposed Lot 1 connect to the existing 100mm dia. uPVC public drain (ID: SS600001) within the boundary of proposed Lot 1. A 100mm dia. uPVC connection is proposed to be installed to service the dwelling via gravitational flow.

When determining the finished floor level (FFL) of proposed dwelling, the depth of the existing wastewater pipeline should be confirmed to ensure there is sufficient fall in the connecting pipe. It is anticipated that the required building FFL will need to be > 11.75m in order to have sufficient fall to the proposed connection point, and with reasonable cover to the pipe. If a lower building floor level is adopted, then it is likely that a pumped sewerage system from the dwelling will be required. Proprietary systems for such situations are commonplace, and would need to be detailed further at the building consent stage.

The location and details of the proposed wastewater connection are shown on Drawing No. 100 within Appendix A.

6.5 Wastewater Generation Volume

The wastewater generation volume has been determined in accordance with FNDC Engineering Standards.

According to the FNDC Engineering Standards, Section 5.2.2.2, residential design flows have been taken as follows.

Table 6: Residential Wastewater Design Flows

Design Item	Criteria
Average dry weather flow	200 litres/ day/ person
Dry weather diurnal Peaking Factor	2.5
Wet weather diurnal Peaking Factor	5
Peak wet weather flow (PWWF)	1000 litres/ day/ person
No. of people per dwelling	4

The design criteria and potential wastewater flow is outlined by Table 6 above. This considers an existing wastewater network catchment above the point of analysis of **6** upstream households, increasing to **7** as a result of the application. Calculations are presented in full as Appendix D to this report and the results summarised below as Table 7.

Table 7: Summary of Wastewater Flow Calculations

Item	Calculated Wastewater Flow, l/s
Existing catchment, PWWF	0.23
Proposed catchment, PWWF	0.28
Increase PWWF from application	+0.05

6.6 Wastewater Network Capacity Assessment

Our analysis has established that the proposed application within the scope of this report provides only a minor, 0.05 litre/ second increase in discharge to the reticulated wastewater network.

No invert information is available on the FNDC 3 Waters GIS to undertake a capacity check of the existing public network, however, with only four residential lots (one additional proposed) connected to the 100mm pipe and the downstream pipe being a 225mm pipe, it is reasonably assumed that there is ample capacity in the existing network to service one additional dwelling.

7 STORMWATER ASSESSMENT

Considering the nature of urban subdivision and residential development, increased storm water runoff occurs as pervious surfaces such as lawns are converted to impervious features such as internal roading or future on-lot building and driveway.

7.1 Impervious Surfaces and Activity Status

A summary of the impervious areas of the proposed lots is provided as Table 8 below which has been developed from our observations and the provided Scheme Plan. For the proposed undeveloped lot, this has been taken as conceptual maximum probable development of typical urban residential scenario. Refer Section 7.2.

In our design concept for future development of proposed Lot 1, we have considered a typical urban residential roof of 200 m^2 and associated driveways/ car parking area of 100 m^2, resulting in a total impervious area of 300 m^2. This represents a 23.08 % total impervious area of the gross Lot 1 site and is therefore considered as **Permitted Activity**, according to FNDC Operative District Plan Rule 7.6.5.1.6.

Within proposed Lot 2 with an impervious area of 430 m^2, existing parking area/ driveway and buildings, it is calculated that the total impervious area under post-development conditions will remain the same given the RoW access to Lot 1 is in currently in impervious condition. Thereby this activity remains and also falls under the category of **Permitted Activity**, according to FNDC Operative District Plan Rule 7.6.5.1.6.

Furthermore, the subdivision stormwater proposal has been assessed in accordance with the Operative FNDC Plan Section 13.10.4 on the basis that the overall subdivision is determined to be a **Discretionary Activity.**

Table 8: Summary of Impervious Surfaces

Surface	Proposed Lot 1		Proposed Lot 2	
Existing Condition			**(2,687 m^2)**	
Roof	0 m^2	0 %	182 m^2	6.81 %
Driveway	0 m^2	0 %	248 m^2	9.23 %
Total impervious	0 m^2	0 %	430 m^2	16.00 %
Proposed Condition	**(1,300 m^2)**		**(1,387 m^2)**	
Roof	200 m^2 (Concept)	15.38 %	182 m^2	13.12 %
Driveway	100 m^2 (Concept)	7.69 %	165.5 m^2	11.93 %
RoW (Lot 1)	0 m^2	0 %	82.5 m^2	5.95 %
Total impervious	300 m^2	23.08 %	430 m^2	31.00 %
Activity Status	**Permitted**		**Permitted**	

7.2 Stormwater Management Concept

The stormwater management concept considered in this report has been prepared to meet the requirements of the local and regional consent authorities considering the design storm event as follows:

- **Probable Future Development (Proposed Lot 1).** The proposed application includes subdivision development only and not lot specific residential development. A conceptual future on-lot development has been developed as presented in Table 9.
- **Existing On-site Development (Proposed Lot 2).** There is no proposed increase in impervious area to this lot. As indicated in Table 8, existing impervious areas remain

within the permitted activity threshold. Drainage will be managed as per the status quo which is effective.

- **Subdivision Development.** Access to the new proposed Lot 1 will be via the existing metal driveway within the proposed Lot 2 area and within associated easement A. The proposed conceptual driveway will not create additional impervious area; therefore, no attenuation of the driveway is required. Stormwater runoff from the RoW surface will be managed as per the existing scenario, discharged into an existing swale drain sited on the southern boundary edge. From there, stormwater is conveyed through an existing 350 mm HDPE culvert pipe beneath Station Road.

7.3 Design Storm Event

Relevant design rainfall intensity and depths have been ascertained for the site location from the NIWA HIRDS meteorological model[13]. The NIWA HIRDS rainfall data is presented in full within Appendix D. Provision for climate change has been adopted by means of applying a factor of 20 % to rainfall intensities used in the post-development condition only, in accordance with FNDC Engineering Standards 2023.

Noting the risk of downstream flooding within the receiving Kawakawa River, and the presence of the wetland, this assessment has been modelled to provide stormwater attenuation up to and including 80 % of the pre-development condition for the 1 % AEP storm events which is recommended for the site including any future activities to comply with FNDC Engineering Standard Table 4-1.

This provides additional conservatism over the 10 % AEP pre-development requirement to comply with NRP Rule C6.4.2(2) and also with the Operative District Plan 13.7.3.4 (a). Attenuation modelling under this scenario avoids exacerbating downstream flooding and provides for sufficient flood control as presented in the FNDC Engineering Standards.

Furthermore, the attention provide ensures overall neutrality of post-development peak flows from the site, so as negate effects on the wetland that lies beyond the northern boundary.

FNDC Engineering Standard Table 4-1 also stipulates that flow attenuation controls reduce the post-development peak discharge to 80 % of the pre-development condition for the 50 % and 20 % AEP storm event. To be compliant with the above rules, the attenuation modelling within this report has been undertaken for all of the above storm events. The results are summarised in Table 9 and provided in full in Appendix C.

Outlet dispersion devices have been designed to manage the 20 % AEP event to reduce scour and erosion at discharge locations. These are detailed further in Section 7.4.1 of this report.

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[13] *NIWA High Intensity Rainfall Data System, https://hirds.niwa.co.nz.*

7.4 Concept Stormwater Attenuation

Based on the design storm events indicated above and the corresponding modelling results Appendix C, an attenuation concept to suit the maximum storage requirement has been provided. In this case the concept limits the post-development peak discharge to 80 % of the pre-development condition for the 1 % AEP storm event. This is achievable by installing specifically sized low-flow orifices into the roof runoff tanks which comprise a detention volume and a retention volume. A typical schematic retention/ detention tank arrangement detail is presented as Drawing No. 401 within Appendix A.

The concept design presented in this report for the purposes of providing the above attenuation requirements should be subject to verification and an updated design at Building Consent stage once final development plans are available. This is typically applied as a consent notice to the applicable titles. We note that the detailed design will be required to provide appropriate orifices to ensure the 50 % and 20 % AEP events.

The rational method has been adopted by Geologix with run-off coefficients as published by FNDC Engineering Standards[14] to provide a suitable attenuation design to limit post-development peak flows to 80 % of pre-development conditions.

Table 9: Summary of Probable Future Development Concept

Item	Pre-development Impervious Area	Post-development Impervious Area	Proposed Concept Attenuation Method
Proposed Lot 1 Future Concept Development			
Potential Buildings	0 m^2	200 m^2	Detention within roof water tank.
Potential Driveway	0 m^2	100 m^2	Off-set detention in roof water tanks.
Total	**0 m^2**	**300 m^2**	
Proposed Lot 2			
Existing Buildings	182 m^2	182 m^2	Not Required, impervious area < permitted activity.
Existing Driveway	248 m^2	165.5 m^2	Not Required, impervious area < permitted activity.
RoW for Lot 1	0 m^2	82.5 m^2	Not Required, impervious area < permitted activity.
Total	**430 m^2**	**430 m^2**	

Calculations to support the concept design are presented as Appendix C to this report. A summary of the concept on-lot stormwater attenuation design is presented in Table 10. As mentioned above, it is recommended that this concept design is refined at the Building Consent stage once final development plans are available.

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[14] *FNDC Engineering Standards 2021, Version 0.6, Issued May 2023.*

Table 10: Probable Future Development Attenuation Concept

Design Parameter	Flow Attenuation: 50 % AEP (80% of pre dev)	Flow Attenuation: 20 % AEP (80% of pre dev)	Flood Control: 10 % AEP	Flood Control: 1 % AEP (80% of pre dev)
Proposed Lot 1				
Regulatory Compliance	FNDC Engineering Standards Table 4-1	FNDC Engineering Standards Table 4-1	NRC Proposed Regional Plan Rule C6.4.2(2)	FNDC Engineering Standards Table 4-1
Pre-development peak flow	2.89 l/s	3.75 l/s	4.40 l/s	6.52 l/s
80 % pre-development peak flow	2.31 l/s	3.00 l/s	NA	5.22 l/s
Post-development peak flow	6.56 l/s	8.50 l/s	9.97 l/s	14.78 l/s
Total Storage Volume Required	6,762 litres	8,840 litres	5,295 litres	16,197 litres
Concept Summary:	- Attenuation storage calculation accounts for offset flow from driveway (not indicated explicitly in summary above. Refer Appendix C for calcs in full) - Attenuation to 80 % of pre-development condition for 1 % AEP storm represents maximum storage requirement and is adopted for the concept design tank storage. - 1 x 25,000 litre tank is sufficient for attenuation (16,197l) + domestic water storage (balance) - 1 % AEP attenuation in isolation requires a 21 mm orifice 1.54 m below overflow. However regulatory requirements are to consider an additional orifice/s to control the 50 %, 20 % and 1 % AEP events specifically. We note this may vary the concept orifice indicated above. This should be provided with detailed design for building consent approval.			

7.4.1 *On-Lot Discharge Dispersion*

The direct discharge of rainwater tank overflow in a concentrated manner can cause scour and erosion in addition to saturation of shallow soils. It is recommended that overflow from rainwater detention tanks is conveyed in sealed pipes to a designated discharge point with suitable dispersion devices downslope of proposed building footprints. A concept design accommodating this is presented within Appendix A on Drawing Nos. 401 and 402.

It is recommended that the conceptually sized dispersion devices are subject to specific assessment at the Building Consent stage to limit scour and erosion from tank overflows.

Typical urban/ rural residential developments construct either above or below ground discharge dispersion pipes. Feeding pipes can be either buried or pinned to the surface as desired. It is recommended that all pipes are designed to accommodate the design storm event peak flows from the attenuation tank and including minimum 100 mm dia. PVC piping. A concept dispersion pipe or trench length is presented in Table 11. Calculations to derive this are presented within Appendix C, based on the NIWA HIRDS Depth-Duration data and TR2013/018 document. Typical details of these options are presented within Appendix A as drawing No. 402.

Table 11: Summary of Concept Dispersion Devices

Concept Impervious Area to Tank	Tank Outlet Velocity (at spreader orifices)	Tank outlet pipe diameter	Spreader pipe diameter	Dispersion Pipe/ Trench Length	Spreader orifice size	Concept
Proposed Lot 1						
300 m2	0.87 m/s	0.1 m	0.20 m	7.6 m	20 mm	Above ground dispersion device or in-ground dispersion trench.

7.5 Stormwater Quality

The proposed application is for a rural residential subdivision and future development. The key contaminant risks in this setting include:

- Sediments and minor contaminants washed from impervious surfaces.
- Leaf matter, grass, and other organic debris.

Stormwater treatment requirements are minor to maintain good quality stormwater discharge. Stormwater quality will be provided by:

- Leaf guards on roof guttering/ first flush devices on roof guttering and downpipes.
- Rainwater tank for potable use onsite only to be filled by roof runoff.
- Room for sedimentation (minimum 150 mm recommended as per Auckland Council GD01) within the base of the stormwater attenuation roof runoff tanks as dead storage volume.
- Stormwater discharges directed towards roading swale drains where possible.
- Grassed swale drains from rainwater inception (road surfaces) to discharge points.

The risk of other contaminants being discharged out of the site boundaries (hydrocarbons, metals etc.) as a result of the proposed activities once stormwater has been processed through the above measures that will affect the downstream water quality is considered low.

8 POTABLE WATER & FIRE FIGHTING

8.1 Potable Water Reticulation

The site is located within a well-established public water supply area and is currently located adjacent to a public 65 mm MDPE water supply pipeline outside the eastern boundary. The existing water connection will be reused for serving proposed lot 2 and a new water meter will be installed at the at the roadside boundary of lot 2 within Station Road berm area to service lot 1.

8.2 Fire Fighting

There is one fire hydrant within Station Road southeast of the site approximately 120 m and a second hydrant located 270 m northeast from site on State Highway 1. These are indicated as Figure 4 below.

The fire-fighting requirements for the proposed development are determined to be FW2 in accordance with the SNZ PAS 4509:2008, New Zealand Fire Service Firefighting Water Supplies Code of Practice. The standard requires a minimum of two fire hydrants – one within 135 m, and the second within 270m to the entrance of the furthest property.

According to above assumption, the proposed developments comply with the SNZ PAS 4509:2008, New Zealand Fire Service Firefighting Water Supply Code of Practice.

Figure 4: Fire Hydrant Mapping

8.3 Considerations for Consenting of Water Works

The proposed water infrastructure associated to the establishment of the subdivision includes a new water meter and connection to the pressure main in the road reserve, as well as a new private water pipeline to service Lot 1 via Easement A. These works will require a building consent application prior to construction, as well as a connection request to FNDC for a new water meter.

9 EARTHWORKS

As part of the subdivision application, earthworks are required as follows:

- **Potential modification of top portion (3 – 5m) of accessway within Easement A.** Cut/ fill earthworks may be required to create a suitable transition to Lot 1 within the bounds of easement A subject to future Lot 1 driveway construction (and Building Consent design). It is suggested that such minor earthworks would be appropriate to be completed with the Lot 1 driveway construction, rather than at subdivision formation.

- **There is no other earthworks to be undertaken for subdivision formation**

Table 12: Summary of Proposed Earthworks Volumes

Activity	Proposed Volume	Net	Max. Height
Modify RoW Accessway			
Cut	10.0 m^3		0.4 m
Fill (imported layer works)	5.0 m^3		0.4 m
Sub-total	15.0 m^3	5.0 m^3	

According to the above Table 12, proposed earthwork volumes are well within the 200 m^3 Permitted Activity volume limit outlined by FNDC District Plan Rule 12.3.6.1.3(a) and the maximum cut and fill height is <3 m to comply with 12.3.6.1.3(b).

Rule C.8.3.1, Table 15 of the Proposed Regional Plan outlines a Permitted Activity as 5,000 m^2 of exposed earth at any time for 'other areas'. Proposed earthwork areas to form the subdivision, comply with the Permitted Activity standard for other areas. A full assessment according to the criteria is presented within Appendix E.

9.1 General Recommendations

Bulk fill with site-won earth can be moderately sensitive to disturbance when exposed to rain or runoff which may cause saturation or vehicle movements and trafficking during earthworks. Accordingly, care should be taken during construction, including probable future developments to minimise degradation of any earth fill due to construction traffic and to minimise machinery on site.

Any areas of proposed bulk fill which are required to meet specific subgrade requirements within should be subject to a specific earthwork specification prepared by a professional Engineer such as Geologix.

Temporary batters should be covered with polythene sheets secured to the surface with pins or batons to prevent saturation. All works within close proximity to excavations should be undertaken in accordance with Occupational Safety and Health regulations.

All earthworks should be carried out in periods of fine weather within the typical October to April earthwork season. Consent conditions commonly prescribe working restrictions.

It is expected that there will be retaining walls, with a maximum height of 1.0 m to the north and 0.6 m to the south, to support the proposed accessway in terms of geotechnical aspects. It is proposed that a qualified geotechnical engineer undertake the detailed retaining wall design during the building consent stage, taking into account geotechnical stability control requirements.

9.2 Erosion and Sediment Control

Erosion and sediment control measures are required to control sediment runoff from areas of proposed earthworks within the scope of this application. Erosion and sediment control measures to form the subdivision are summarised as follows:

- Silt fences around the downslope face of any trenching for proposed pipework that is open or not suitably stabilised within a single day's work.
- Stabilised entrance to be put in place at proposed Lot 1 site entrance.

10 NATURAL HAZARD ASSESSMENT

To satisfy the Resource Management Act, 1991 the proposed subdivision must plan for and manage the risk from natural hazards to reduce the potential adverse effects to less than minor. Regulatory assessment of natural hazards at the site location are managed under the jurisdiction of the FNDC District Plan[15], Northland Regional Council (NRC) Proposed Regional Plan for Northland[16] and Regional Water and Soil Plan for Northland. Following our ground investigation and considering the measures presented in this report, a summary of the proposed activities against defined natural hazards is presented as Table 13.

Table 13: Summary of Natural Hazards

Natural Hazard	Applicability	Mitigation & Effect on Environment
Erosion	Yes	Erosion potential at stormwater outlet and earthworks areas. Mitigation provided by means of suitable outlet device and ESC controls. Resultant effects are less than minor.
Overland flow paths, flooding, inundation	Yes	There is indication of flooding hazard within site boundaries albeit at the lower reaches of the site. Proposed development is >15m setback from the 1%AEP flood plain. Mitigation against effects of the development to the floodplain (to downstream properties) provided to suit FNDC standards. Resultant effects are less than minor.
Landslip	NA	No anticipated effects, less than minor.
Rockfall	NA	No anticipated effects, less than minor.
Alluvion	NA	No anticipated effects, less than minor.
Avulsion	NA	No anticipated effects, less than minor.
Unconsolidated fill	NA	No anticipated effects, less than minor.
Soil contamination	NA	No anticipated effects, less than minor.
Subsidence	NA	No anticipated effects, less than minor.
Fire hazard	NA	No anticipated effects, less than minor.
Sea level rise	NA	No anticipated effects, less than minor.

NA – Not Applicable.

[15] *Operative District Plan Rule 13.7.3.2.*
[16] *Proposed Regional Plan for Northland June 2023 – Appeals Version, Chapter D.6.*

11 ACCESS AND INTERNAL ROADING

It should be noted that we are not traffic engineers, and no specific Traffic Impact Assessment is included within the scope of these works.

11.1 Vehicle Crossings

An existing vehicle crossing will provide access to proposed Lot 1 and 2 from Station Road. The existing consented vehicle crossing will remain and function in its current condition as it is deemed to be in reasonable accordance with the FNDC standards in terms of dimensions and surfacing.

11.2 Right of Ways (RoW)

Currently formed driveway within Lot 2 will provide internal access to the proposed Lot 1 via a Right of Way (Easement A). In its existing form, it meets the 3 m minimum width carriageway requirement in accordance with the standards specified in Appendix 3B-1 of the Operative District Plan and in accordance with Drawing Sheet No. 7 of the FNDC Engineering Standards, as summarised in Table 14.

RoW gradient is approximately 10 %. However, a reduction of the breakover angle to create a suitable transition onto Lot 1, may be required depending on the Lot 1 accessway design. It is recommended that this relatively minor works be incorporated with and constructed at building consent stage for Lot 1 development.

Table 14 Summary of Proposed RoW specification

Location	Servicing Lot	Standard	Future H.E	Min. Legal Width	Min. Carriageway Width
Right of Way (Easement A)	1 & 2	Category A	2	-	3.0 m.

12 LIMITATIONS

This report has been prepared for CEM & SJ Bradshaw. It may be relied upon by our Client and their appointed Consultants, Contractors and for the purpose of Consent as outlined by the specific objectives in this report. This report and associated recommendations, conclusions or intellectual property is not to be relied upon by any other party for any purpose unless agreed in writing by Geologix Consulting Engineers Ltd and our Client. In any case the reliance by any other party for any other purpose shall be at such parties' sole risk and no reliability is provided by Geologix Consulting Engineers Ltd.

The opinions and recommendations of this report are based on plans, specifications and reports provided to us at the time of writing, as referenced. Any changes, additions or amendments to the project scope and referenced documents may require an amendment to this report and Geologix Consulting Engineers should be consulted. Geologix Consulting Engineers Ltd reserve the right to review this report and accompanying plans.

The recommendations and opinions in this report are based on arisings extracted from exploratory boreholes at discrete locations and any available existing borehole records. The nature and continuity of subsurface conditions, interpretation of ground condition and models away from these specific ground investigation locations are inferred. It must be appreciated that the actual conditions may vary from the assumed ground model. Differences from the encountered ground conditions during subdivision construction may require an amendment to the recommendations of this report.

APPENDIX A

Drawings

GENERAL NOTES

1. DRAWING REPRODUCED FROM THOMSON SURVEY LTD REF.10624, DATED APRIL 2024.
2. TOPOGRAPHIC SURVEY DATA IS CAPTURED FROM LINZ.
3. HORIZONTAL CO ORDINATE SYSTEM = NZGD2000.
4. VERTICAL DATUM = NZVD2016.
4. MAJOR INTERVALS 5.0 m.
5. MINOR INTERVALS 1.0 m.
6. FOR INDICATION ONLY, NOT FOR CONSTRUCTION.
7. DO NOT SCALE FROM THIS DRAWING.

- BH01 — GEOLOGIX HAND AUGER LOCATION - JUNE 2024
- PROPOSED BUILDING SHAPE FACTOR
- EXISTING IMPERVIOUS DRIVEWAY
- PROPOSED LOT BOUNDARY
- PROPOSED EASEMENT BOUNDARY
- SW — EXISTING STORMWATER PIPE
- UNLINED OPEN CHANNEL
- SS — PROPOSED WASTEWATER PIPE
- SS — EXISTING WASTEWATER PIPE
- EXISTING WATER SUPPLY PIPE
- PROPOSED WATER SUPPLY PIPE
- H — FIRE HYDRANT
- WATER METER
- EXISTING STORMWATER/ WASTEWATER MANHOLE
- CONCEPT 25,000 LITRE WATER TANK ATTENUATING TO DISPERSION DEVICE TO CONTROL 300 m² AREA
- DIRECTION OF WATER FLOW

Meters 5 0 5 10
1:500

Revision	Issue	Date
1	CONSENT	03/10/2024

geologix consulting engineers
AUCKLAND | NORTHLAND

Project Name and Address
18 STATION ROAD
KAWAKAWA
LOT 1 DP 526023

Project	Drawn By
C0506	SD

Client
CEM & SJ BRADSHAW

Sheet Title
ENGINEERING PLAN

Sheet
100

FILE PATH: Z:\Projects\C0500-C0599\C0506 - 18 Station Road, Kawakawa\07 - Technical & Drawings\Drawings\C0506-S-01-R01.dwg\C0506-S-01-R01.dwg

PLOTTED: 03/04/2022

GENERAL NOTES

1. DRAWING REPRODUCED FROM THOMSON SURVEY LTD REF.10624, DATED APRIL 2024.
2. TOPOGRAPHIC SURVEY DATA IS CAPTURED FROM LINZ.
3. HORIZONTAL CO ORDINATE SYSTEM = NZGD2000.
4. VERTICAL DATUM = NZVD2016.
4. MAJOR INTERVALS 5.0 m.
5. MINOR INTERVALS 1.0 m.
6. FOR INDICATION ONLY, NOT FOR CONSTRUCTION.
7. DO NOT SCALE FROM THIS DRAWING.

BH01 — GEOLOGIX HAND AUGER & DYNAMIC CONE PENETROMETER - JUNE 2024

PROPOSED BUILDING SHAPE FACTOR

EXISTING BUILDINGS

PROPOSED LOT BOUNDARY

PROPOSED EASEMENT BOUNDARY

Meters: 2.5 0 2.5 5
1:250

Revision	Issue	Date
1	CONSENT	03/10/2024

geologix consulting engineers
AUCKLAND | NORTHLAND

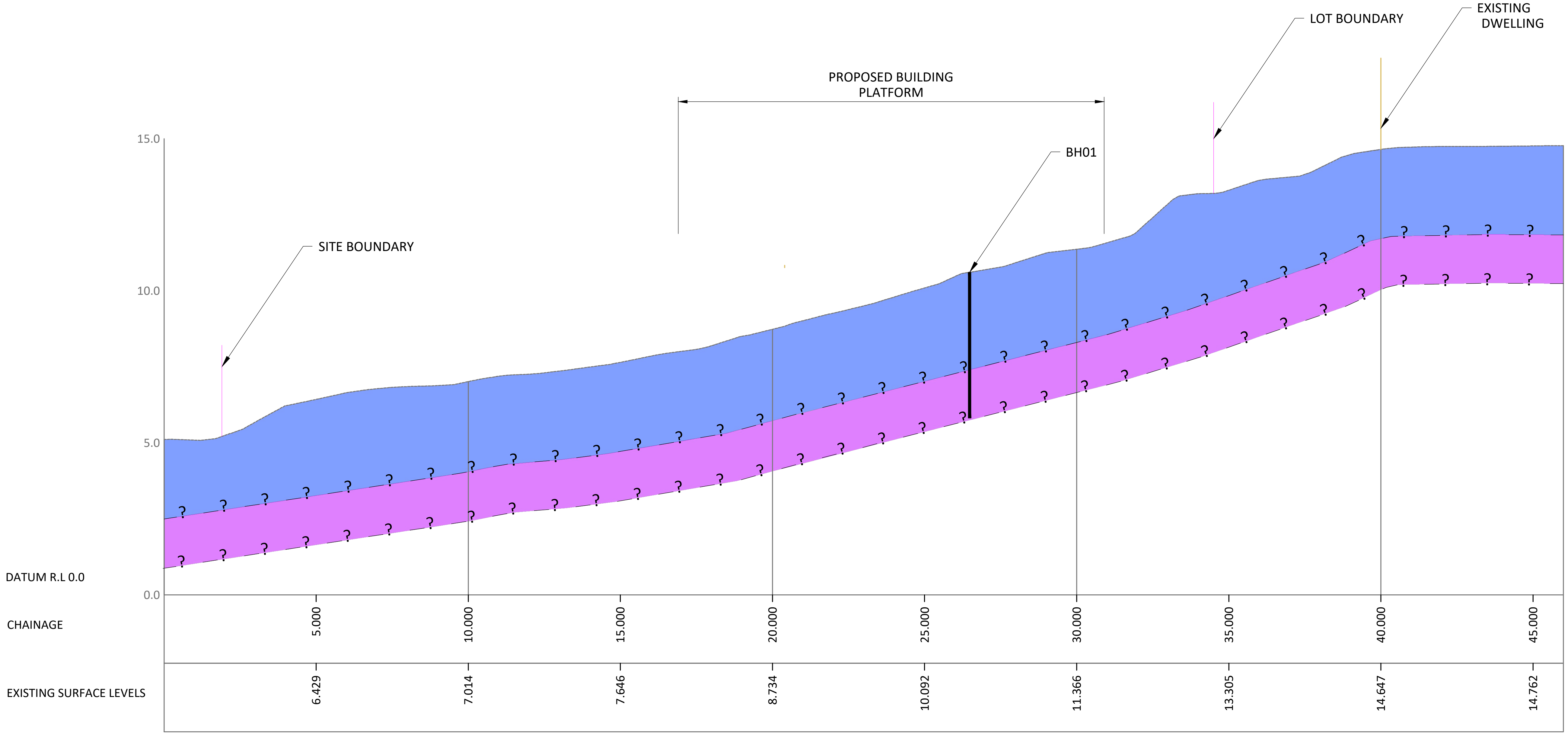
Project Name and Address
18 STATION ROAD
KAWAKAWA
LOT 1 DP 526023

Project	Drawn By
C0506	SD

Client
CEM & SJ BRADSHAW

Sheet Title
GEOTECHNICAL PLAN

Sheet
200



GEOTECHNICAL CROSS SECTION - A
SCALE - HORIZ 1:150.0, VERT. 1:150.0

GENERAL NOTES

1. DRAWING REPRODUCED FROM THOMSON SURVEY LTD REF.10624, DATED APRIL 2024.
2. TOPOGRAPHIC SURVEY DATA IS CAPTURED FROM LINZ.
3. HORIZONTAL CO ORDINATE SYSTEM = NZGD2000.
4. VERTICAL DATUM = NZVD2016.
5. FOR INDICATION ONLY, NOT FOR CONSTRUCTION.
6. DO NOT SCALE FROM THIS DRAWING.

VERY STIFF NEOGENE RIVER DEPOSITS

DENSE TO VERY DENSE NEOGENE RIVER DEPOSITS

? STRATA BOUNDARY

Meters 1.5 0 1.5 3
1:150

Revision	Issue	Date
1	CONSENT	18/10/2024

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AUCKLAND | NORTHLAND

Project Name and Address
18 STATION ROAD
KAWAKAWA
LOT 1 DP 526023

Project	Drawn By
C0506	SD

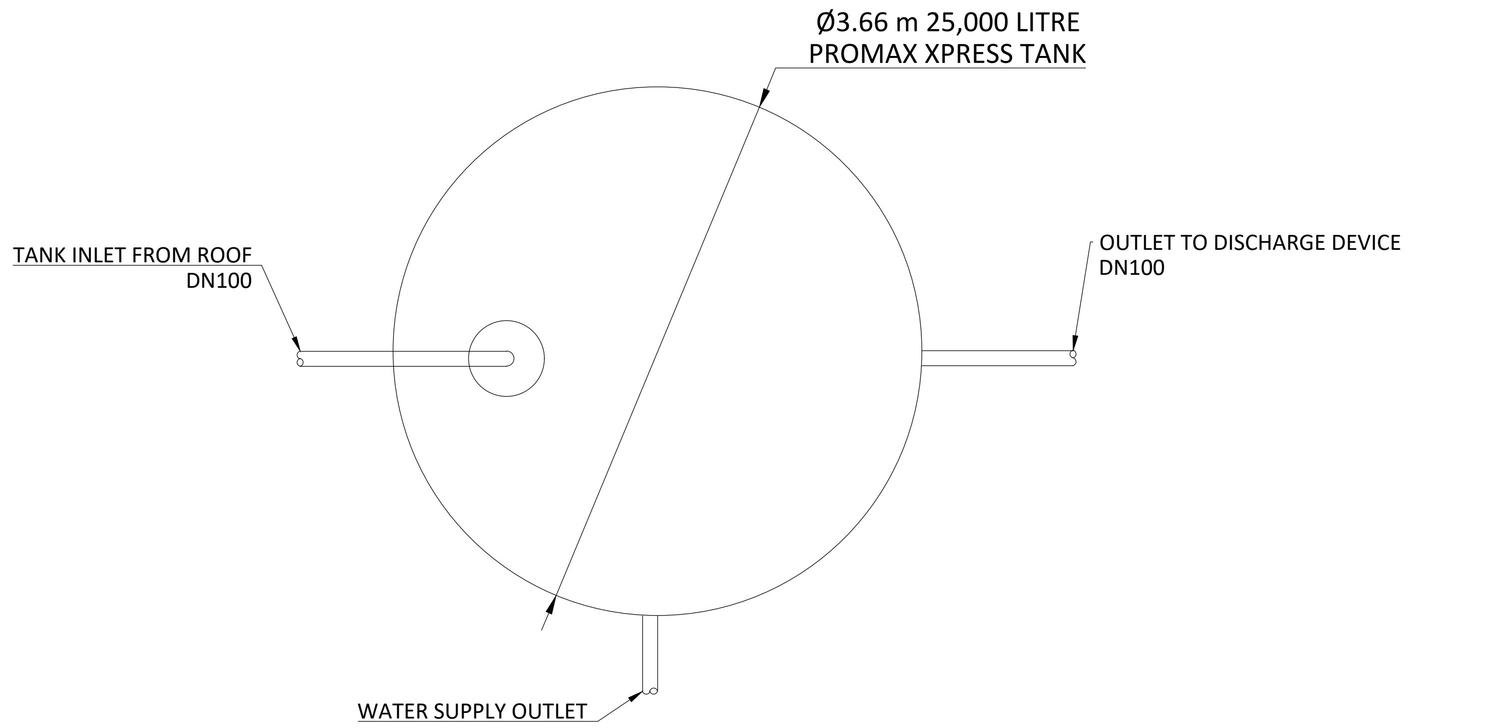
Client
CEM & SJ BRADSHAW

Sheet Title
GEOTECHNICAL CROSS SECTION - A

Sheet
201

PROPOSED TANK PLAN VIEW

1:50, A3



PROPOSED TANK SIDE VIEW

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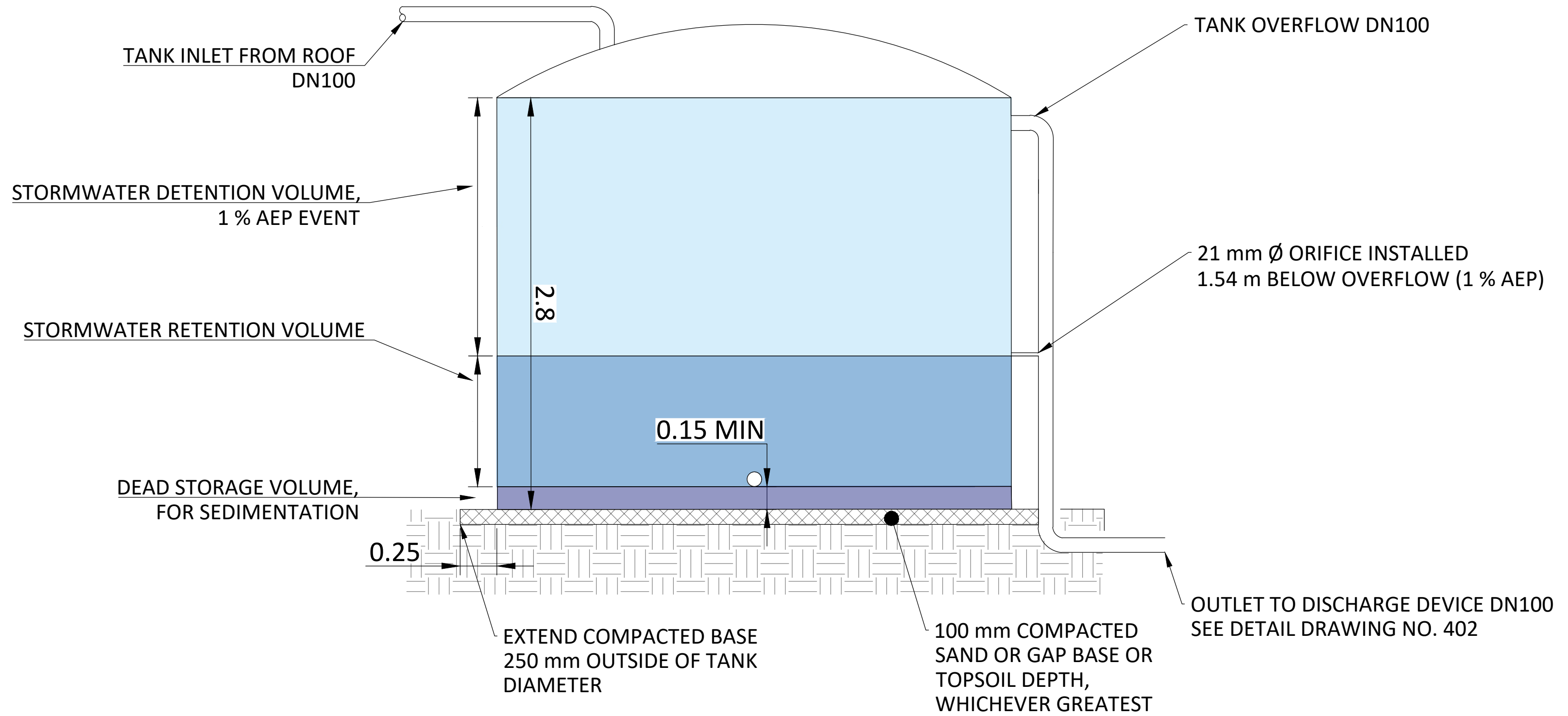


GENERAL NOTES

1. TANK, PIPING AND FITTINGS TO BE INSTALLED AS PER MANUFACTURERS RECOMMENDATIONS AND IN ACCORDANCE WITH NZBC E1, UNLESS SPECIFICALLY STATED OTHERWISE.
2. ALL WORK TO BE UNDERTAKEN IN ACCORDANCE WITH NEW ZEALAND BUILDING CODE E1 ACCEPTABLE SOLUTIONS, RELEVANT STANDARDS AND GUIDELINES.
3. DO NOT SCALE FROM THIS DRAWING.
4. CONTRACTOR IS TO ORGANISE ALL SET OUT, INSPECTIONS AND MONITORING AS REQUIRED TO MEET CONSENT CONDITIONS.

1	CONSENT	18/07/2024
Revision	Issue	Date

geologix consulting engineers

AUCKLAND | NORTHLAND

Project Name and Address
18 STATION ROAD
KAWAKAWA
LOT 1 DP 526023

Project	Drawn By
C0506	SD

Client
CEM & SJ BRADSHAW

Sheet Title
TYPICAL TANK DETAIL

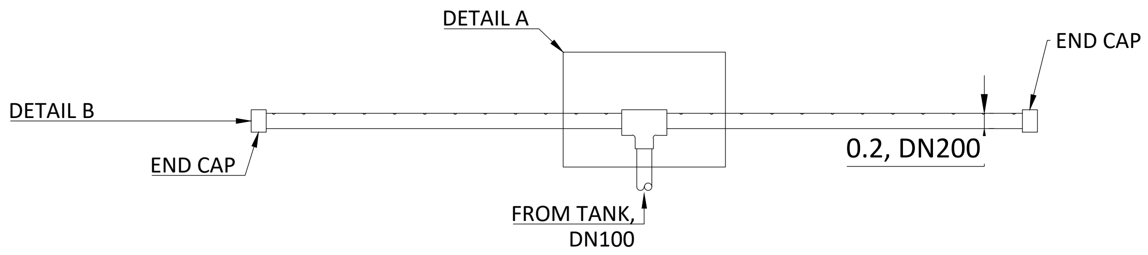
Sheet
401

FILE PATH: Z:\Projects\C0500-C0599\C0506 - 18 Station Road, Kawakawa\07 - Technical & Drawings\Drawings\C0506-SW-DETAILS.dwg\C0506-SW-DETAILS.dwg

PLOTTED: 03/05/2022

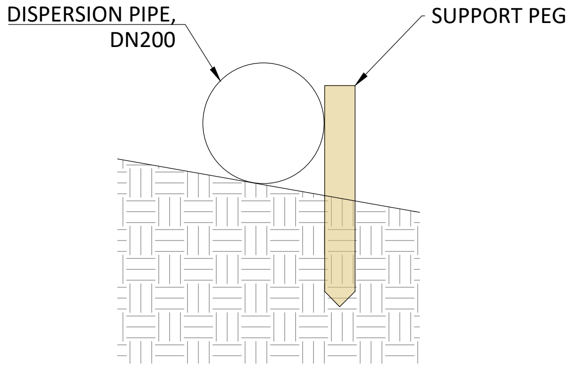
OPTION 1: DISPERSION VIA ABOVE GROUND PIPE

NOT TO SCALE



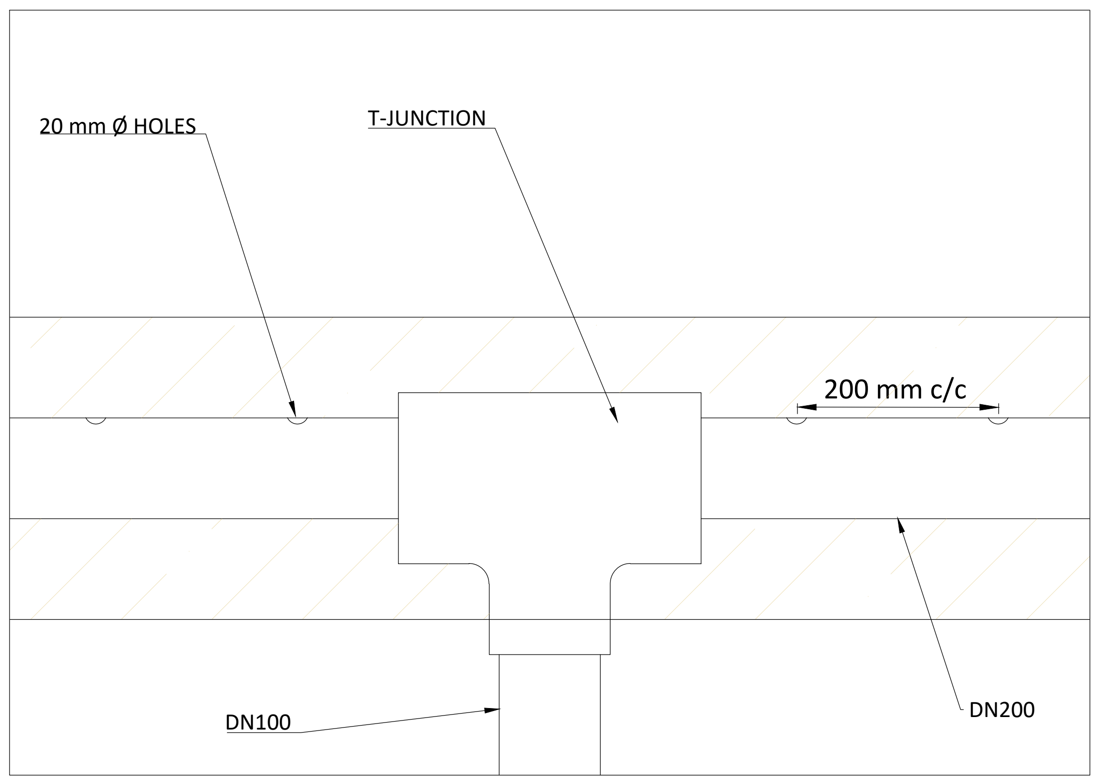
DETAIL B - SIDE VIEW

NOT TO SCALE



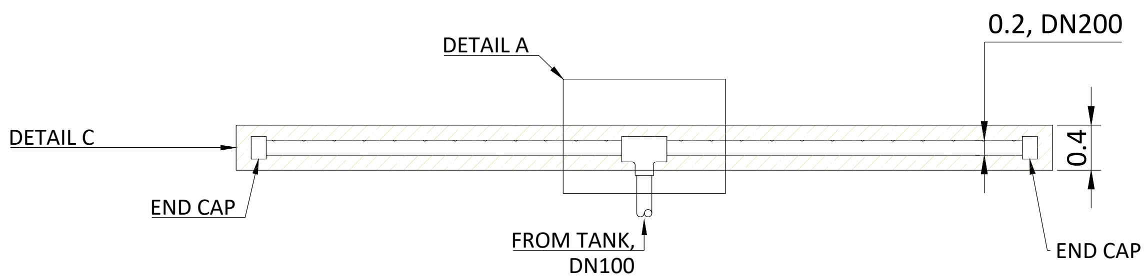
DETAIL A - T JUNCTION AND PERFORATIONS

NOT TO SCALE



OPTION 2: DISPERSION VIA BELOW GROUND TRENCH

NOT TO SCALE



DETAIL C - SIDE VIEW

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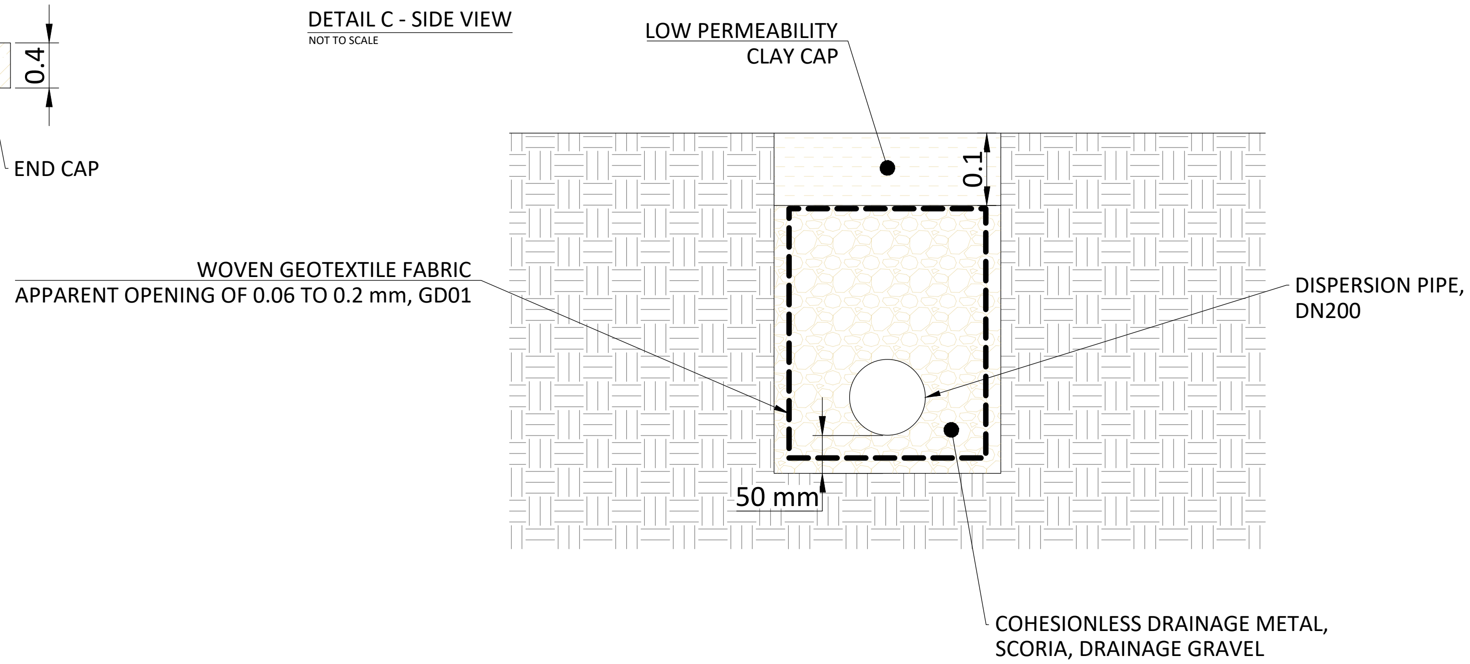

GENERAL NOTES

1. ALL WORK TO BE UNDERTAKEN IN ACCORDANCE WITH NEW ZEALAND BUILDING CODE E1 ACCEPTABLE SOLUTIONS, RELEVANT STANDARDS AND GUIDELINES INCLUDING AUCKLAND COUNCIL GD01, WHERE APPLICABLE.
2. DO NOT SCALE FROM THIS DRAWING.
3. CONTRACTOR IS TO ORGANISE ALL SET OUT, INSPECTIONS AND MONITORING AS REQUIRED TO MEET CONSENT CONDITIONS.

Revision	Issue	Date
1	CONSENT	18/07/2024

geologix consulting engineers

AUCKLAND | NORTHLAND

Project Name and Address
18 STATION ROAD
KAWAKAWA
LOT 1 DP 526023

Project	Drawn By
C0506	SD

Client
CEM &SJ BRADSHAW

Sheet Title
TYPICAL DISPERSION PIPE DETAIL

Sheet
402

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PLOTTED: 03/05/2022

APPENDIX B

Engineering Borehole Logs

INVESTIGATION LOG

geologix consulting engineers

HOLE NO.: BH01

CLIENT: CEM & SJ Bradshaw
PROJECT: 18 Station Road
JOB NO.: C0506

SITE LOCATION: 18 Station Road, Kawakawa
START DATE: 07/06/2024
CO-ORDINATES:
ELEVATION: Ground
END DATE: 07/06/2024
CONTRACTOR: Internal
RIG: 50mm auger
DRILLER: TW
LOGGED BY: TW

MATERIAL DESCRIPTION

(See Classification & Symbology sheet for details)

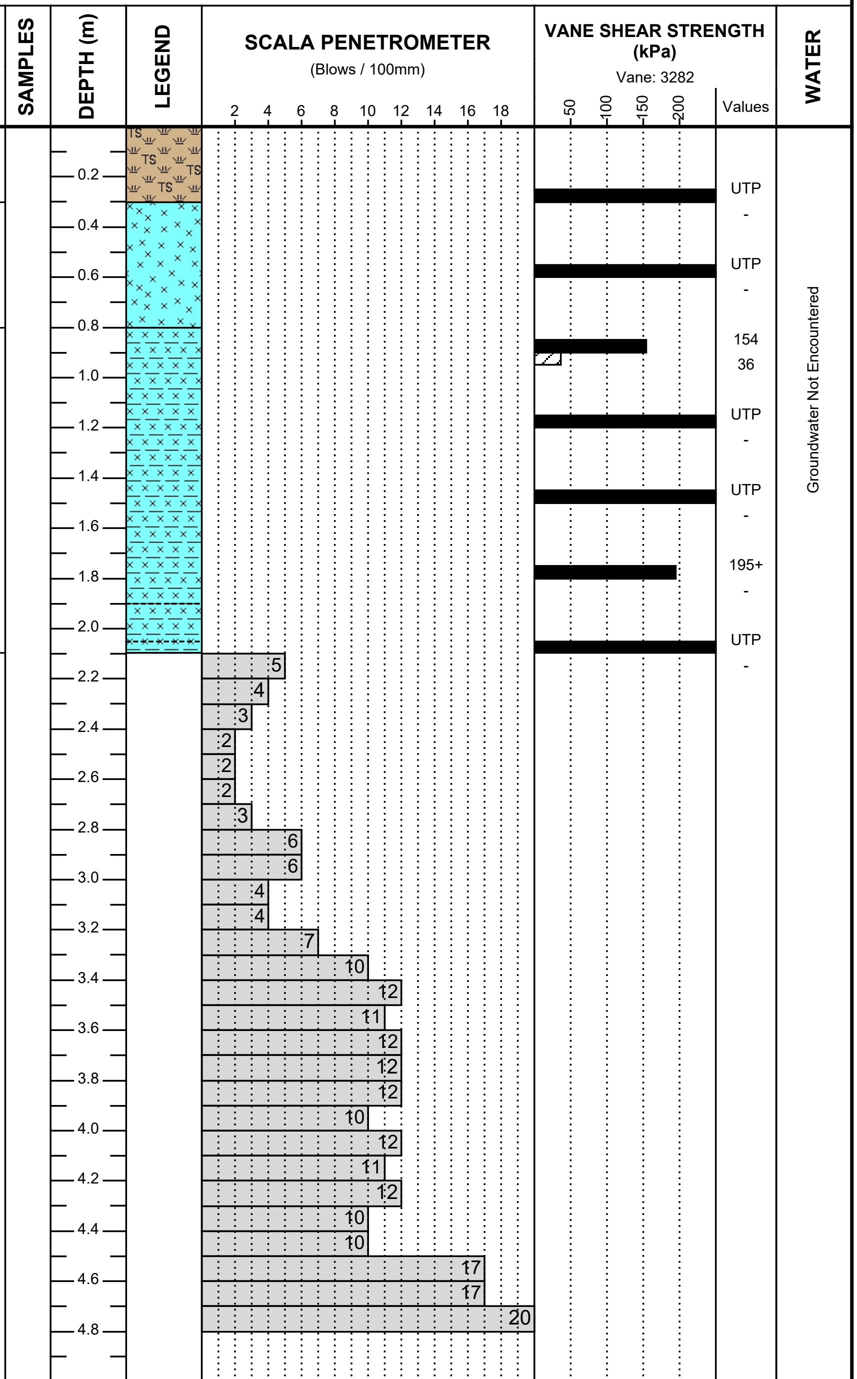
TOPSOIL comprising of organic silt; dark brown; moist; low plasticity.

SILT, with some clay, with trace sand; brown.
Hard; moist; low plasticity; sand, fine; [Neogene River Deposite].

Clayey SILT, with trace sand; light brown with white and orange mottles.
Very stiff to hard; moist; low plasticity; sand, fine; [Neogene River Deposits].

1.9m - 2.1m: Trace dark orange inclusions.

End Of Hole: 2.10m



PHOTO(S)

REMARKS

1. Hand auger refused at 2.1 m bgl due to hard strata encountered.
2. Groundwater not encountered during drilling.

WATER

- Standing Water Level
- Out flow
- In flow

INVESTIGATION TYPE

- [x] Hand Auger
- [ ] Test Pit

Generated with CORE-GS by Geroc - Hand Auger - scala & vane bars - 11/06/2024 12:09:26 pm

APPENDIX C

Stormwater Attenuation Design

Project Ref:	C0506		STORMWATER ATTENUATION TANK DESIGN
Project Address:	18 STATION ROAD, KAWAKAWA		
Design Case:	CONCEPT FUTURE DEVELOPMENT		50 % AEP STORM EVENT, 80 % OF PRE DEVELOPMENT
Date:	4 October 2024	REV 1	

geologix consulting engineers

ATTENUATION DESIGN PROVIDED IN ACCORDANCE WITH NEW ZEALAND BUILDING CODE E1 FOR THE RATIONALE METHOD ACCOUNTING FOR THE EFFECTS OF CLIMATE CHANGE (20% FACTOR AS PER FNDC ENGINEERING STANDARDS).
PRE-DEVELOPMENT RUNOFF IS FACTORED BY 80% TO SUIT FNDC STANDARDS
RUNOFF COEFFIENTS DETERMINED FROM FNDC ENGINEERING STANDARDS 2023 TABLE 4-3.

PRE DEVELOPMENT CATCHMENT PARAMETERS				**POST DEVELOPMENT CATCHMENT PARAMETERS**			
ITEM	AREA, A, m2	COEFFICIENT, C	DESCRIPTION	ITEM	AREA, A, m2	COEFFICIENT, C	DESCRIPTION
IMPERVIOUS A				TO TANK	200	0.96	ROOF
IMPERVIOUS B	0	0		OFFSET	100	0.80	DRIVEWAY - METAL
IMPERVIOUS C	0	0		PERVIOUS	0	0	
EX. PERVIOUS	300	0.48	GRASS & BUSH	EX. CONSENTED	0	0	
TOTAL	**300**	TYPE C		**TOTAL**	**300**	TYPE C	

RAINFALL INTENSITY, 50% AEP, 10MIN DURATION			
50 % AEP RAINFALL INTENSITY, 10 MIN, I, mm/hr	72.3	mm/hr	* CLIMATE CHANGE FACTOR OF 20% APPLIED IN ACCORDANCE WITH FNDC ENGINEERING STANDARDS 4.3.9.1. NIWA HISTORIC RAINFALL INTENSITY DATA, 10MIN, IS MULTIPLIED BY CLIMATE CHANGE FACTOR.
CLIMATE CHANGE FACTOR, 2.1 DEG, 10 MIN*	20	%	
50 % AEP RAINFALL INTENSITY, 10 MIN WITH CC	86.76	mm/hr	

PRE AND POST-DEVELOPMENT RUNOFF, 50%AEP WITH CC, VARIOUS DURATIONS

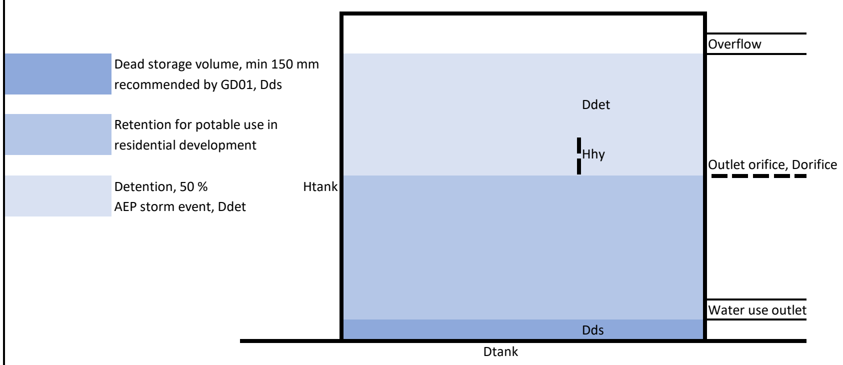
DURATION, min	INTENSITY, mm/hr	CC FACTOR	INTENSITY WITH CC, mm/hr	POST DEV RUNOFF, Qpost, l/s	PRE DEV RUNOFF, Qpre, l/s	80% of PRE DEV RUNOFF, Qpre(80%), l/s	COMMENTS
10	72.30	1.2	86.76	6.56	2.89	2.31	*Critical duration (time of concentration) for the catchments is 10min*
20	52.10	1.2	62.52	4.72	2.50	2.00	
30	42.80	1.2	51.36	3.88	2.05	1.64	
60	30.10	1.2	36.12	2.73	1.44	1.16	
120	20.70	1.2	24.84	1.88	0.99	0.79	*Pre-dev calculated on Intensity without CC factor*
360	10.90	1.2	13.08	0.99	0.52	0.42	
720	6.98	1.2	8.38	0.63	0.34	0.27	
1440	4.31	1.2	5.17	0.39	0.21	0.17	
2880	2.57	1.2	3.08	0.23	0.12	0.10	
4320	1.86	1.2	2.23	0.17	0.09	0.07	

ATTENUATION ANALYSIS, VARIOUS DURATIONS

DURATION, min	OFFSET FLOW, Qoff, l/s	TANK INFLOW , Qin, l/s	ALLOWABLE TANK OUTFLOW, Qpre(80%) - Qoff, l/s	SELECTED TANK OUTFLOW, Qout, l/s	DIFFERENCE (Qin - Qout), l/s	Required Storage, litres	
10	1.93	4.63	0.39	0.39	4.24	2545	*select largest required storage , regardless of duration, to avoid overflow*
20	1.39	3.33	0.61	0.39	2.95	3539	
30	1.14	2.74	0.50	0.39	2.35	4236	
60	0.80	1.93	0.35	0.39	1.54	5547	
120	0.55	1.32	0.24	0.39	0.94	6762	
360	0.29	0.70	0.13	0.39	0.31	6739	
720	0.19	0.45	0.08	0.39	0.06	2640	
1440	0.11	0.28	0.05	0.39	No Att. Req.	0	
2880	0.07	0.16	0.03	0.39	No Att. Req.	0	
4320	0.05	0.12	0.02	0.39	No Att. Req.	0	

ATTENUATION TANK DESIGN OUTPUT

Concept sizing for 25,000 litre tank



SPECIFICATION

TOTAL STORAGE REQUIRED	6.762	m3	Select largest storage as per analysis
TANK HEIGHT, Htank	2.6	m	Concept sizing for 25,000 litre tank
TANK DIAMETER, Dtank	3.66	m	No. of Tanks 1
TANK AREA, Atank	10.52	m2	Area of ONE tank
TANK MAX STORAGE VOLUME, Vtank	27354	litres	
REQUIRED STORAGE HEIGHT, Ddet	0.64	m	Below overflow
DEAD STORAGE VOLUME, Dds	0.15	m	GD01 recommended minimum
TOTAL WATER DEPTH REQUIRED	0.79	m	
SELECTED TANK OUTFLOW, Qout, l/s	0.00039	m3/s	Selected tank outflow
AVERAGE HYDRAULIC HEAD, Hhy	0.32	m	
AREA OF ORIFICE, Aorifice	2.48E-04	m2	
ORIFICE DIAMETER, Dorifice	18	mm	
VELOCITY AT ORIFICE	3.55	m/s	At max. head level

Project Ref:	C0506	**STORMWATER ATTENUATION TANK DESIGN**	geologix consulting engineers
Project Address:	18 STATION ROAD, KAWAKAWA		
Design Case:	CONCEPT FUTURE DEVELOPMENT	**20 % AEP STORM EVENT, TO PERMITTED ACTIVITY THRESHOLD**	
Date:	4 October 2024 REV 1		

ATTENUATION DESIGN PROVIDED IN ACCORDANCE WITH NEW ZEALAND BUILDING CODE E1 FOR THE RATIONALE METHOD ACCOUNTING FOR THE EFFECTS OF CLIMATE CHANGE (20% FACTOR AS PER FNDC ENGINEERING STANDARDS).
PRE-DEVELOPMENT RUNOFF IS FACTORED BY 80% TO SUIT FNDC STANDARDS
RUNOFF COEFFIENTS DETERMINED FROM FNDC ENGINEERING STANDARDS 2023 TABLE 4-3.

PRE DEVELOPMENT CATCHMENT PARAMETERS				**POST DEVELOPMENT CATCHMENT PARAMETERS**			
ITEM	AREA, A, m2	COEFFICIENT, C	DESCRIPTION	ITEM	AREA, A, m2	COEFFICIENT, C	DESCRIPTION
IMPERVIOUS A	0	0		TO TANK	200	0.96	ROOF
IMPERVIOUS B	0	0		OFFSET	100	0.8	DRIVEWAY - METAL
IMPERVIOUS C	0	0	GRASS & BUSH	PERVIOUS	0	0	
EX. PERVIOUS	300	0.48		EX. CONSENTED	0	0	
				0	0	0	
TOTAL	**300**	TYPE C		**TOTAL**	**300**	TYPE C	

RAINFALL INTENSITY, 20% AEP, 10MIN DURATION			
20 % AEP RAINFALL INTENSITY, 10 MIN, I, mm/hr	93.8	mm/hr	* CLIMATE CHANGE FACTOR OF 20% APPLIED IN ACCORDANCE WITH FNDC ENGINEERING STANDARDS 4.3.9.1. NIWA HISTORIC RAINFALL INTENSITY DATA, 10MIN, IS MULTIPLIED BY CLIMATE CHANGE FACTOR.
CLIMATE CHANGE FACTOR, 2.1 DEG, 10 MIN*	20	%	
20 % AEP RAINFALL INTENSITY, 10 MIN WITH CC	112.6	mm/hr	

PRE AND POST-DEVELOPMENT RUNOFF, 20%AEP WITH CC, VARIOUS DURATIONS

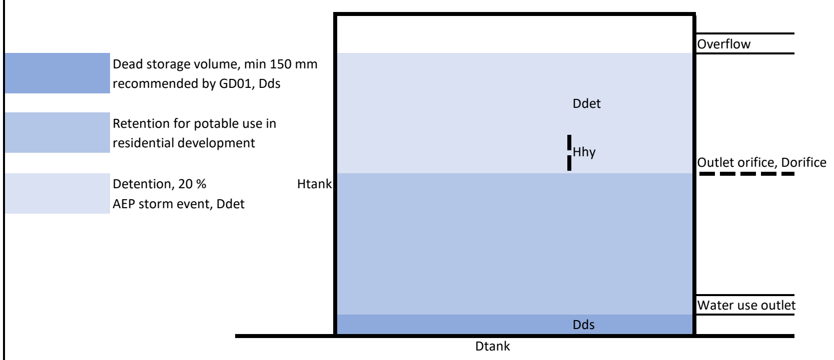
DURATION, min	INTENSITY, mm/hr	CC FACTOR	INTENSITY WITH CC, mm/hr	POST DEV RUNOFF, Qpost, l/s	PRE DEV RUNOFF, Qpre, l/s	80% of PRE DEV RUNOFF, Qpre(80%), l/s	COMMENTS
10	93.80	1.2	112.56	8.50	3.75	3.00	*Critical duration (time of concentration) for the catchments is 10min*
20	67.70	1.2	81.24	6.14	3.25	2.60	
30	55.60	1.2	66.72	5.04	2.67	2.14	
60	39.20	1.2	47.04	3.55	1.88	1.51	
120	27.00	1.2	32.40	2.45	1.30	1.04	
360	14.20	1.2	17.04	1.29	0.68	0.55	
720	9.14	1.2	10.97	0.83	0.44	0.35	
1440	5.67	1.2	6.80	0.51	0.27	0.22	
2880	3.38	1.2	4.06	0.31	0.16	0.13	
4320	2.44	1.2	2.93	0.22	0.12	0.09	

ATTENUATION ANALYSIS, VARIOUS DURATIONS

DURATION, min	OFFSET FLOW, Qoff, l/s	TANK INFLOW , Qin, l/s	ALLOWABLE TANK OUTFLOW, Qpre(80%) - Qoff, l/s	SELECTED TANK OUTFLOW, Qout, l/s	DIFFERENCE (Qin - Qout), l/s	Required Storage, litres	
10	2.50	6.00	0.50	0.50	5.50	3302	*select largest required storage , regardless of duration, to avoid overflow*
20	1.81	4.33	1.44	0.50	3.83	4599	
30	1.48	3.56	1.19	0.50	3.06	5505	
60	1.05	2.51	0.84	0.50	2.01	7231	
120	0.72	1.73	0.58	0.50	1.23	8840	
360	0.38	0.91	0.30	0.50	0.41	8824	
720	0.24	0.58	0.19	0.50	0.08	3659	
1440	0.15	0.36	0.12	0.50	No Att. Req.	0	
2880	0.09	0.22	0.07	0.50	No Att. Req.	0	
4320	0.07	0.16	0.05	0.50	No Att. Req.	0	

ATTENUATION TANK DESIGN OUTPUT

Concept sizing for 25,000 litre tank



SPECIFICATION

TOTAL STORAGE REQUIRED	8.840	m3	Select largest storage as per analysis	
TANK HEIGHT, Htank	2.6	m	Concept sizing for 25,000 litre tank	
TANK DIAMETER, Dtank	3.66	m	No. of Tanks	1
TANK AREA, Atank	10.52	m2	Area of ONE tank	
TANK MAX STORAGE VOLUME, Vtank	27354	litres		
REQUIRED STORAGE HEIGHT, Ddet	0.84	m	Below overflow	
DEAD STORAGE VOLUME, Dds	0.15	m	GD01 recommended minimum	
TOTAL WATER DEPTH REQUIRED	0.99	m		
SELECTED TANK OUTFLOW, Qout, l/s	0.00050	m3/s	Selected tank outflow	
AVERAGE HYDRAULIC HEAD, Hhy	0.42	m		
AREA OF ORIFICE, Aorifice	2.81E-04	m2		
ORIFICE DIAMETER, Dorifice	19	mm		
VELOCITY AT ORIFICE	4.06	m/s	At max. head level	

Project Ref:	C0506	**STORMWATER ATTENUATION TANK DESIGN**	geologix consulting engineers
Project Address:	18 STATION ROAD, KAWAKAWA		
Design Case:	CONCEPT FUTURE DEVELOPMENT	**10 % AEP STORM EVENT, TO PRE-DEVELOPMENT FLOW**	
Date:	4 October 2024 REV 1		

ATTENUATION DESIGN PROVIDED IN ACCORDANCE WITH NEW ZEALAND BUILDING CODE E1 FOR THE RATIONALE METHOD ACCOUNTING FOR THE EFFECTS OF CLIMATE CHANGE (20% FACTOR AS PER FNDC ENGINEERING STANDARDS).
THE 10% AEP SCENARIO IS PROVIDED TO SATISFY FNDC DISTRICT PLAN RULE 13.7.3.4. PRE-DEVELOPMENT RUNOFF REMAINS UNFACTORED IN THIS SCENARIO.
RUNOFF COEFFIENTS DETERMINED FROM FNDC ENGINEERING STANDARDS 2023 TABLE 4-3.

PRE DEVELOPMENT CATCHMENT PARAMETERS				**POST DEVELOPMENT CATCHMENT PARAMETERS**			
ITEM	AREA, A, m2	COEFFICIENT, C	DESCRIPTION	ITEM	AREA, A, m2	COEFFICIENT, C	DESCRIPTION
IMPERVIOUS A	0	0		TO TANK	200	0.96	ROOF
IMPERVIOUS B	0	0		OFFSET	100	0.8	DRIVEWAY - METAL
IMPERVIOUS C	0	0		PERVIOUS	0	0	
EX. PERVIOUS	300	0.48	GRASS & BUSH	EX. CONSENTED	0	0	
0	0	0		0	0	0	
TOTAL	**300**	TYPE C		**TOTAL**	**300**	TYPE C	

RAINFALL INTENSITY, 10% AEP, 10MIN DURATION

10 % AEP RAINFALL INTENSITY, 10 MIN, I, mm/hr	110.0	mm/hr	* CLIMATE CHANGE FACTOR OF 20% APPLIED IN ACCORDANCE WITH FNDC ENGINEERING STANDARDS 4.3.9.1. NIWA HISTORIC RAINFALL INTENSITY DATA, 10MIN, IS MULTIPLIED BY CLIMATE CHANGE FACTOR.
CLIMATE CHANGE FACTOR, 2.1 DEG, 10 MIN*	20	%	
10 % AEP RAINFALL INTENSITY, 10 MIN WITH CC	132.0	mm/hr	

PRE AND POST-DEVELOPMENT RUNOFF, 10%AEP WITH CC, VARIOUS DURATIONS

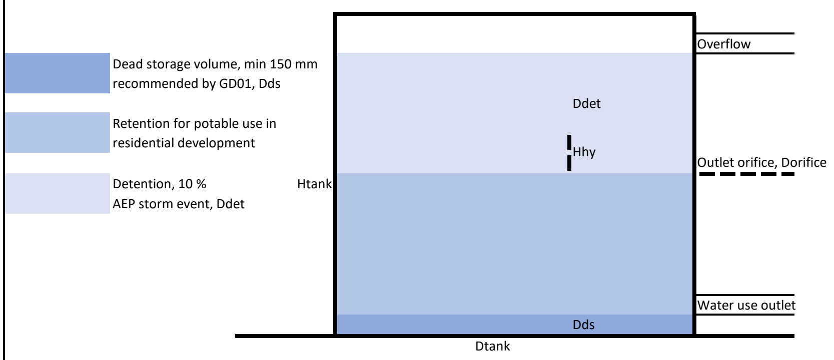
DURATION, min	INTENSITY, mm/hr	CC FACTOR	INTENSITY WITH CC, mm/hr	POST DEV RUNOFF, Qpost, l/s	PRE DEV RUNOFF, Qpre, l/s		COMMENTS
10	110.00	1.2	132.00	9.97	4.40		*Critical duration (time of concentration) for the catchments is 10min*
20	79.20	1.2	95.04	7.18	3.80		
30	65.10	1.2	78.12	5.90	3.12		
60	45.90	1.2	55.08	4.16	2.20		
120	31.70	1.2	38.04	2.87	1.52		
360	16.70	1.2	20.04	1.51	0.80		
720	10.80	1.2	12.96	0.98	0.52		
1440	6.67	1.2	8.00	0.60	0.32		
2880	3.98	1.2	4.78	0.36	0.19		
4320	2.88	1.2	3.46	0.26	0.14		

ATTENUATION ANALYSIS, VARIOUS DURATIONS

DURATION, min	OFFSET FLOW, Qoff, l/s	TANK INFLOW , Qin, l/s	ALLOWABLE TANK OUTFLOW, Qpre - Qoff, l/s	SELECTED TANK OUTFLOW, Qout, l/s	DIFFERENCE (Qin - Qout), l/s	Required Storage, litres	
10	2.93	7.04	1.47	1.47	5.57	3344	*select largest required storage , regardless of duration, to avoid overflow*
20	2.11	5.07	1.69	1.47	3.60	4323	
30	1.74	4.17	1.39	1.47	2.70	4860	
60	1.22	2.94	0.98	1.47	1.47	5295	
120	0.85	2.03	0.68	1.47	0.56	4047	
360	0.45	1.07	0.36	1.47	No Att. Req.	0	
720	0.29	0.69	0.23	1.47	No Att. Req.	0	
1440	0.18	0.43	0.14	1.47	No Att. Req.	0	
2880	0.11	0.25	0.08	1.47	No Att. Req.	0	
4320	0.08	0.18	0.06	1.47	No Att. Req.	0	

ATTENUATION TANK DESIGN OUTPUT

Concept sizing for 25,000 litre tank



SPECIFICATION

TOTAL STORAGE REQUIRED	5.295	m3	Select largest storage as per analysis
TANK HEIGHT, Htank	2.6	m	Concept sizing for 25,000 litre tank
TANK DIAMETER, Dtank	3.66	m	No. of Tanks 1
TANK AREA, Atank	10.52	m2	Area of ONE tank
TANK MAX STORAGE VOLUME, Vtank	27354	litres	
REQUIRED STORAGE HEIGHT, Ddet	0.50	m	Below overflow
DEAD STORAGE VOLUME, Dds	0.15	m	GD01 recommended minimum
TOTAL WATER DEPTH REQUIRED	0.65	m	
SELECTED TANK OUTFLOW, Qout, l/s	0.00147	m3/s	Selected tank outflow
AVERAGE HYDRAULIC HEAD, Hhy	0.25	m	
AREA OF ORIFICE, Aorifice	1.06E-03	m2	
ORIFICE DIAMETER, Dorifice	37	mm	
VELOCITY AT ORIFICE	3.14	m/s	At max. head level

Project Ref:	C0506	**STORMWATER ATTENUATION TANK DESIGN**	geologix consulting engineers
Project Address:	18 STATION ROAD, KAWAKAWA		
Design Case:	CONCEPT FUTURE DEVELOPMENT	**1 % AEP STORM EVENT, TO PERMITTED ACTIVITY THRESHOLD**	
Date:	4 October 2024 REV 1		

ATTENUATION DESIGN PROVIDED IN ACCORDANCE WITH NEW ZEALAND BUILDING CODE E1 FOR THE RATIONALE METHOD ACCOUNTING FOR THE EFFECTS OF CLIMATE CHANGE (20% FACTOR AS PER FNDC ENGINEERING STANDARDS).
PRE-DEVELOPMENT RUNOFF IS FACTORED BY 80% TO SUIT FNDC STANDARDS
RUNOFF COEFFIENTS DETERMINED FROM FNDC ENGINEERING STANDARDS 2023 TABLE 4-3.

PRE DEVELOPMENT CATCHMENT PARAMETERS				**POST DEVELOPMENT CATCHMENT PARAMETERS**			
ITEM	AREA, A, m2	COEFFICIENT, C	DESCRIPTION	ITEM	AREA, A, m2	COEFFICIENT, C	DESCRIPTION
IMPERVIOUS A	0	0		TO TANK	200	0.96	ROOF
IMPERVIOUS B	0	0		OFFSET	100	0.8	DRIVEWAY - METAL
IMPERVIOUS C	0	0		PERVIOUS	0	0	
EX. PERVIOUS	300	0.48	GRASS & BUSH	EX. CONSENTED	0	0	
0	0	0		0	0	0	
TOTAL	**300**	TYPE C		**TOTAL**	**300**	TYPE C	

RAINFALL INTENSITY, 1% AEP, 10MIN DURATION

1 % AEP RAINFALL INTENSITY, 10 MIN, I, mm/hr	163.0	mm/hr	* CLIMATE CHANGE FACTOR OF 20% APPLIED IN ACCORDANCE WITH FNDC ENGINEERING STANDARDS 4.3.9.1. NIWA HISTORIC RAINFALL INTENSITY DATA, 10MIN, IS MULTIPLIED BY CLIMATE CHANGE FACTOR.
CLIMATE CHANGE FACTOR, 2.1 DEG, 10 MIN*	20	%	
1 % AEP RAINFALL INTENSITY, 10 MIN WITH CC	195.6	mm/hr	

PRE AND POST-DEVELOPMENT RUNOFF, 1%AEP WITH CC, VARIOUS DURATIONS

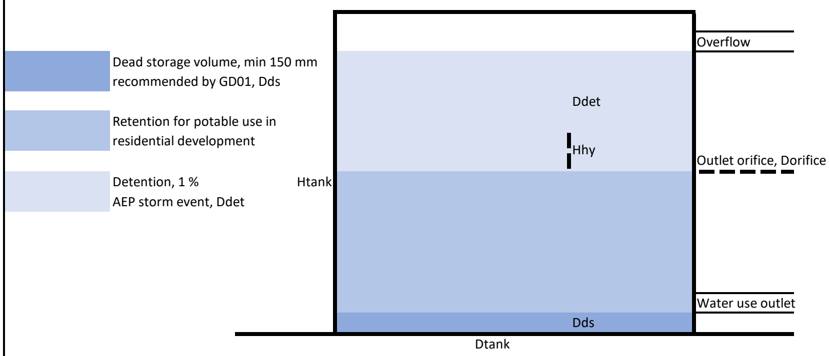
DURATION, min	INTENSITY, mm/hr	CC FACTOR	INTENSITY WITH CC, mm/hr	POST DEV RUNOFF, Qpost, l/s	PRE DEV RUNOFF, Qpre, l/s	80% of PRE DEV RUNOFF, Qpre(80%), l/s	COMMENTS
10	163.00	1.2	195.60	14.78	6.52	5.22	*Critical duration (time of concentration) for the catchments is 10min*
20	118.00	1.2	141.60	10.70	5.66	4.53	
30	97.20	1.2	116.64	8.81	4.67	3.73	
60	68.80	1.2	82.56	6.24	3.30	2.64	
120	47.70	1.2	57.24	4.32	2.29	1.83	
360	25.30	1.2	30.36	2.29	1.21	0.97	
720	16.30	1.2	19.56	1.48	0.78	0.63	
1440	10.20	1.2	12.24	0.92	0.49	0.39	
2880	6.08	1.2	7.30	0.55	0.29	0.23	
4320	4.42	1.2	5.30	0.40	0.21	0.17	

ATTENUATION ANALYSIS, VARIOUS DURATIONS

DURATION, min	OFFSET FLOW, Qoff, l/s	TANK INFLOW , Qin, l/s	ALLOWABLE TANK OUTFLOW, Qpre(80%) - Qoff, l/s	SELECTED TANK OUTFLOW, Qout, l/s	DIFFERENCE (Qin - Qout), l/s	Required Storage, litres	
10	4.35	10.43	0.87	0.87	9.56	5738	*Selected Tank Outflow is selected for critical duration (time of concentration). In this case = 10min*
20	3.15	7.55	1.38	0.87	6.68	8019	
30	2.59	6.22	1.14	0.87	5.35	9633	
60	1.83	4.40	0.81	0.87	3.53	12722	
120	1.27	3.05	0.56	0.87	2.18	15721	*select largest required storage , regardless of duration, to avoid overflow for event of any duration*
360	0.67	1.62	0.30	0.87	0.75	16197	
720	0.43	1.04	0.19	0.87	0.17	7511	
1440	0.27	0.65	0.12	0.87	No Att. Req.	0	
2880	0.16	0.39	0.07	0.87	No Att. Req.	0	
4320	0.12	0.28	0.05	0.87	No Att. Req.	0	

ATTENUATION TANK DESIGN OUTPUT

Concept sizing for 25,000 litre tank



SPECIFICATION

TOTAL STORAGE REQUIRED	16.197	m3	Select largest storage as per analysis	
TANK HEIGHT, Htank	2.6	m	Concept sizing for 25,000 litre tank	
TANK DIAMETER, Dtank	3.66	m	No. of Tanks	1
TANK AREA, Atank	10.52	m2	Area of ONE tank	
TANK MAX STORAGE VOLUME, Vtank	27354	litres		
REQUIRED STORAGE HEIGHT, Ddet	1.54	m	Below overflow	
DEAD STORAGE VOLUME, Dds	0.15	m	GD01 recommended minimum	
TOTAL WATER DEPTH REQUIRED	1.69	m		
SELECTED TANK OUTFLOW, Qout, l/s	0.00087	m3/s	Selected tank outflow	
AVERAGE HYDRAULIC HEAD, Hhy	0.77	m		
AREA OF ORIFICE, Aorifice	3.61E-04	m2		
ORIFICE DIAMETER, Dorifice	21	mm		
VELOCITY AT ORIFICE	5.50	m/s	At max. head level	

Project Ref:	C0506	STORMWATER DISPERSION PIPE/ TRENCH	geologix consulting engineers
Project Address:	18 STATION ROAD, KAWAKAWA		
Design Case:	CONCEPT FUTURE DEVELOPMENT	DISCHARGE DEVICE - LEVEL SPREADER OR TRENCH	
Date:	4 October 2024 REV 1		

DESIGN BASED ON REFERENCED DEVELOPMENT PLANS TO PROVIDE A MINIMUM LENGTH OF ABOVE OR BELOW GROUND STORMWATER TANK OVERFLOW DISCHARGE DISPERSION DEVICE. IN GENERAL ACCORDANCE WITH MODIFIED RATIONAL METHOD AND AUCKLAND COUNCIL TR2013/018.

DESIGN STORM EVENT **1%** AEP EVENT

SLOPE BETWEEN SOURCE & DISPERSION DEVICE

	ELEVATION	h	CHAINAGE, x	Δ x	h bar	Δ A
	m	m	m	m	m	m2
	9	0	0	0	0	0
	7.7	1.3	6	6	0.65	3.9
		TOTALS	6	6		3.9
		SLOPE, Sc	0.217	m/m		

MANNINGS PIPE FLOW - INCOMING PIPE

Dia, m	d/D	α, rad	P, m	A, m^2	R	1:S	n	V, m/s	Q, m^3/s	Q, l/s	
0.1	0.000	6.283	0.0000	0.0000	0.000	4.61538462	0.009	0.000	0.0000	0.000	0 % full
0.100	0.050	5.381	0.0451	0.0001	0.003	4.615384615	0.0090	1.136	0.0002	0.167	
0.100	0.100	4.996	0.0644	0.0004	0.006	4.615384615	0.0090	1.774	0.0007	0.725	
0.100	0.150	4.692	0.0795	0.0007	0.009	4.615384615	0.0090	2.285	0.0017	1.688	
0.100	0.200	4.429	0.0927	0.0011	0.012	4.615384615	0.0090	2.720	0.0030	3.041	
0.100	0.250	4.189	0.1047	0.0015	0.015	4.615384615	0.0090	3.098	0.0048	4.757	
0.100	0.300	3.965	0.1159	0.0020	0.017	4.615384615	0.0090	3.432	0.0068	6.801	
0.100	0.350	3.751	0.1266	0.0024	0.019	4.615384615	0.0090	3.728	0.0091	9.132	
0.100	0.400	3.544	0.1369	0.0029	0.021	4.615384615	0.0090	3.989	0.0117	11.704	
0.100	0.450	3.342	0.1471	0.0034	0.023	4.615384615	0.0090	4.220	0.0145	14.466	
0.100	0.500	3.142	0.1571	0.0039	0.025	4.615384615	0.0090	4.422	0.0174	17.365	50 % full
0.100	0.550	2.941	0.1671	0.0044	0.026	4.615384615	0.0090	4.596	0.0203	20.342	
0.100	0.600	2.739	0.1772	0.0049	0.028	4.615384615	0.0090	4.742	0.0233	23.333	
0.100	0.650	2.532	0.1875	0.0054	0.029	4.615384615	0.0090	4.861	0.0263	26.270	
0.100	0.700	2.319	0.1982	0.0059	0.030	4.615384615	0.0090	4.952	0.0291	29.077	
0.100	0.750	2.094	0.2094	0.0063	0.030	4.615384615	0.0090	5.012	0.0317	31.669	
0.100	0.800	1.855	0.2214	0.0067	0.030	4.615384615	0.0090	5.040	0.0339	33.947	
0.100	0.850	1.591	0.2346	0.0071	0.030	4.615384615	0.0090	5.030	0.0358	35.787	
0.100	0.900	1.287	0.2498	0.0074	0.030	4.615384615	0.0090	4.972	0.0370	37.015	
0.100	0.950	0.902	0.2691	0.0077	0.029	4.615384615	0.0090	4.842	0.0373	37.318	
0.100	1.000	0.000	0.3142	0.0079	0.025	4.615384615	0.0090	4.422	0.0347	34.730	Flowing full

DISPERSION SPECIFICATION

INCOMING PIPE PROPERTIES:

TANK OUTFLOW, 1 % AEP	10.43	l/s		
MAXIMUM PIPE FLOW	37.32	l/s		
SUFFICIENT CAPACITY IN PIPE	YES			
LONGITUDINAL SLOPE	0.217	m/m		
DESIGN VELOCITY, Dv	5.040	m/s		

LEVEL SPREADER SPECIFICATIONS:

PIPE DIAMETER, m	0.20	m
MANNINGS PIPE ROUGHNESS	0.009	
NUMBER OF ORIFICES	39	No.
DIA. OF ORIFICE, D	20	mm
ORIFICE INTERVALS, C/C	200	mm
DISPERSION PIPE LENGTH, L	**7.6**	**m**

ORIFICE DESIGN FLOW CHECK:

AREA OF SINGLE ORIFICE, A	0.00031	m2			
FLOW OUT OF 1 ORIFICE	0.000272829	m3/s	0.27	l/s	
FLOW OUT OF ALL ORIFICES	0.01064034	m3/s	10.64	l/s	DESIGN OK
VELOCITY FROM SINGLE ORIFICE	0.87	m/s			

BROAD CRESTED WEIR DESIGN FLOW CHECK:

FLOW DEPTH, h	0.1	m			
BASE WIDTH = L	7.6	m			
FLOW AREA	0.76	m2			
WEIR FLOW	0.01418	m3/s	14.18	l/s	DESIGN OK
WEIR VELOCITY	0.019	m/s			

INCOMING PIPE & SPREADER SUMARY:

	LOT 1	
INCOMING PIPE DIAMETER, m	0.100	m
SPREADER PIPE DIAMETER, m	0.200	m
MANNINGS PIPE ROUGHNESS	0.009	
NUMBER OF ORIFICES	39	No.
DIA. OF ORIFICE, D	20	mm
ORIFICE INTERVALS, C/C	200	mm
DISPERSION PIPE LENGTH, L	**7.6**	**m**

HIRDS V4 Intensity-Duration-Frequency Results
Sitename: Custom Location
Coordinate system: WGS84
Longitude: 174.062
Latitude: -35.3805
DDF Model

Parameters:	c	d	e	f	g	h	i
Values:	0.00221238	0.4773044	-0.0216117	-0.00202221	0.25633256	-0.0122614	3.3113602
Example:	Duration (hrs)	ARI (yrs)	x	y	Rainfall Rate (mm/hr)		
	24	100	3.17805383	4.60014923	10.16611663		

Rainfall intensities (mm/hr) :: Historical Data

ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	66	47.5	39	27.4	18.9	9.91	6.34	3.9	2.3	1.7	1.3	1.1
2	0.5	72.3	52.1	42.8	30.1	20.7	10.9	6.98	4.3	2.6	1.9	1.5	1.21
5	0.2	93.8	67.7	55.6	39.2	27	14.2	9.14	5.7	3.4	2.4	1.9	1.59
10	0.1	110	79.2	65.1	45.9	31.7	16.7	10.8	6.7	4	2.9	2.3	1.88
20	0.05	125	90.8	74.6	52.7	36.4	19.3	12.4	7.7	4.6	3.3	2.6	2.17
30	0.033	135	97.6	80.3	56.7	39.3	20.8	13.4	8.3	5	3.6	2.8	2.35
40	0.025	141	103	84.3	59.6	41.3	21.9	14.1	8.8	5.2	3.8	3	2.48
50	0.02	147	106	87.5	61.9	42.8	22.7	14.6	9.1	5.4	4	3.1	2.58
60	0.017	151	109	90	63.7	44.1	23.4	15.1	9.4	5.6	4.1	3.2	2.66
80	0.013	158	114	94.1	66.6	46.1	24.5	15.8	9.8	5.9	4.3	3.4	2.79
100	0.01	163	118	97.2	68.8	47.7	25.3	16.3	10	6.1	4.4	3.5	2.89
250	0.004	183	133	110	77.7	53.9	28.7	18.5	12	6.9	5	4	3.29

Intensity standard error (mm/hr) :: Historical Data

ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	7.3	4.8	3.6	2.6	1.8	1.1	0.76	0.6	0.4	0.3	0.2	0.19
2	0.5	8	5.3	3.9	2.9	2	1.2	0.85	0.7	0.4	0.3	0.3	0.21
5	0.2	11	7.7	5.7	4.1	2.8	1.7	1.2	0.9	0.6	0.4	0.3	0.29
10	0.1	15	10	7.5	5.5	3.5	2.2	1.5	1.1	0.7	0.5	0.4	0.34
20	0.05	19	13	9.9	7.2	4.6	2.9	1.9	1.3	0.8	0.6	0.5	0.41
30	0.033	22	16	12	8.5	5.4	3.4	2.3	1.5	0.9	0.7	0.5	0.45
40	0.025	24	18	13	9.6	6	3.8	2.5	1.6	1	0.7	0.6	0.48
50	0.02	26	19	14	11	6.5	4.1	2.7	1.6	1	0.8	0.6	0.5
60	0.017	28	20	15	11	7	4.4	2.9	1.7	1.1	0.8	0.6	0.52
80	0.013	31	23	17	13	7.8	5	3.3	1.8	1.1	0.8	0.6	0.56
100	0.01	33	25	18	14	8.4	5.4	3.6	1.9	1.2	0.9	0.7	0.59
250	0.004	45	34	25	20	12	7.8	5	2.4	1.5	1.1	0.8	0.73

Rainfall intensities (mm/hr) :: RCP2.6 for the period 2031-2050

ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	70.6	50.9	41.7	29.3	20.1	10.5	6.64	4.1	2.4	1.7	1.4	1.12
2	0.5	77.5	55.9	45.8	32.2	22.1	11.5	7.32	4.5	2.7	1.9	1.5	1.24
5	0.2	101	72.8	59.8	42.1	29	15.1	9.64	5.9	3.5	2.5	2	1.64
10	0.1	118	85.3	70.1	49.4	34.1	17.8	11.4	7	4.1	3	2.4	1.94
20	0.05	135	97.9	80.5	56.8	39.2	20.5	13.1	8.1	4.8	3.5	2.7	2.25
30	0.033	145	105	86.7	61.2	42.3	22.2	14.2	8.7	5.2	3.7	3	2.43
40	0.025	153	111	91	64.3	44.4	23.3	14.9	9.2	5.5	4	3.1	2.57
50	0.02	158	115	94.5	66.8	46.1	24.2	15.5	9.6	5.7	4.1	3.2	2.67
60	0.017	163	118	97.2	68.8	47.5	25	16	9.9	5.9	4.2	3.3	2.75
80	0.013	170	123	102	71.9	49.7	26.1	16.7	10	6.1	4.4	3.5	2.89
100	0.01	176	127	105	74.3	51.4	27	17.3	11	6.4	4.6	3.6	2.99
250	0.004	198	144	118	83.9	58.1	30.6	19.6	12	7.2	5.2	4.1	3.41

Rainfall intensities (mm/hr) :: RCP2.6 for the period 2081-2100

ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	70.6	50.9	41.7	29.3	20.1	10.5	6.64	4.1	2.4	1.7	1.4	1.12
2	0.5	77.5	55.9	45.8	32.2	22.1	11.5	7.32	4.5	2.7	1.9	1.5	1.24
5	0.2	101	72.8	59.8	42.1	29	15.1	9.64	5.9	3.5	2.5	2	1.64
10	0.1	118	85.3	70.1	49.4	34.1	17.8	11.4	7	4.1	3	2.4	1.94
20	0.05	135	97.9	80.5	56.8	39.2	20.5	13.1	8.1	4.8	3.5	2.7	2.25
30	0.033	145	105	86.7	61.2	42.3	22.2	14.2	8.7	5.2	3.7	3	2.43
40	0.025	153	111	91	64.3	44.4	23.3	14.9	9.2	5.5	4	3.1	2.57
50	0.02	158	115	94.5	66.8	46.1	24.2	15.5	9.6	5.7	4.1	3.2	2.67
60	0.017	163	118	97.2	68.8	47.5	25	16	9.9	5.9	4.2	3.3	2.75
80	0.013	170	123	102	71.9	49.7	26.1	16.7	10	6.1	4.4	3.5	2.89
100	0.01	176	127	105	74.3	51.4	27	17.3	11	6.4	4.6	3.6	2.99
250	0.004	198	144	118	83.9	58.1	30.6	19.6	12	7.2	5.2	4.1	3.41

Rainfall intensities (mm/hr) :: RCP4.5 for the period 2031-2050

ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	71.8	51.7	42.4	29.8	20.4	10.6	6.72	4.1	2.4	1.8	1.4	1.13
2	0.5	78.8	56.8	46.6	32.8	22.5	11.7	7.41	4.5	2.7	1.9	1.5	1.25
5	0.2	103	74.1	60.9	42.9	29.5	15.4	9.77	6	3.5	2.6	2	1.65
10	0.1	120	86.8	71.4	50.3	34.7	18.1	11.5	7.1	4.2	3	2.4	1.96
20	0.05	138	99.7	82	57.9	39.9	20.9	13.3	8.2	4.8	3.5	2.8	2.27
30	0.033	148	107	88.3	62.4	43	22.5	14.3	8.8	5.2	3.8	3	2.45
40	0.025	156	113	92.7	65.5	45.2	23.7	15.1	9.3	5.5	4	3.1	2.59
50	0.02	161	117	96.2	68	47	24.6	15.7	9.7	5.7	4.2	3.3	2.69
60	0.017	166	120	99	70.1	48.4	25.4	16.2	10	5.9	4.3	3.4	2.78
80	0.013	173	126	104	73.3	50.6	26.5	17	10	6.2	4.5	3.5	2.91
100	0.01	179	130	107	75.7	52.3	27.5	17.6	11	6.4	4.6	3.7	3.02
250	0.004	201	146	121	85.5	59.2	31.1	19.9	12	7.3	5.3	4.2	3.44

Rainfall intensities (mm/hr) :: RCP4.5 for the period 2081-2100

ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	75.5	54.4	44.6	31.4	21.4	11	6.96	4.3	2.5	1.8	1.4	1.16
2	0.5	83	59.8	49.1	34.5	23.6	12.2	7.69	4.7	2.8	2	1.6	1.28
5	0.2	108	78.2	64.2	45.3	31.1	16.1	10.2	6.2	3.7	2.6	2.1	1.7
10	0.1	127	91.7	75.4	53.2	36.5	18.9	12	7.3	4.3	3.1	2.4	2.01
20	0.05	146	105	86.6	61.2	42.1	21.9	13.9	8.5	5	3.6	2.8	2.33
30	0.033	157	113	93.3	65.9	45.4	23.6	15	9.2	5.4	3.9	3.1	2.52
40	0.025	164	119	98	69.3	47.7	24.9	15.8	9.6	5.7	4.1	3.2	2.66
50	0.02	171	124	102	72	49.6	25.8	16.4	10	5.9	4.3	3.4	2.76
60	0.017	176	127	105	74.1	51.1	26.6	16.9	10	6.1	4.4	3.5	2.85
80	0.013	183	133	110	77.5	53.4	27.9	17.7	11	6.4	4.6	3.6	2.99
100	0.01	189	137	113	80.1	55.3	28.8	18.3	11	6.6	4.8	3.8	3.1
250	0.004	213	155	128	90.5	62.5	32.7	20.8	13	7.6	5.5	4.3	3.53

Rainfall intensities (mm/hr) :: RCP6.0 for the period 2031-2050

ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	71.3	51.4	42.1	29.6	20.3	10.5	6.69	4.1	2.4	1.7	1.4	1.13
2	0.5	78.3	56.4	46.3	32.6	22.4	11.6	7.38	4.5	2.7	1.9	1.5	1.25
5	0.2	102	73.6	60.5	42.6	29.3	15.3	9.72	6	3.5	2.6	2	1.65
10	0.1	119	86.2	70.9	50	34.4	18	11.4	7	4.2	3	2.4	1.95
20	0.05	137	99	81.4	57.5	39.6	20.7	13.2	8.1	4.8	3.5	2.7	2.26
30	0.033	147	107	87.6	61.9	42.7	22.4	14.3	8.8	5.2	3.8	3	2.44
40	0.025	154	112	92	65.1	44.9	23.5	15	9.3	5.5	4	3.1	2.58
50	0.02	160	116	95.5	67.5	46.6	24.5	15.6	9.6	5.7	4.1	3.3	2.68
60	0.017	165	119	98.3	69.5	48	25.2	16.1	9.9	5.9	4.3	3.4	2.77
80	0.013	172	125	103	72.7	50.2	26.4	16.9	10	6.2	4.5	3.5	2.9
100	0.01	178	129	106	75.2	51.9	27.3	17.5	11	6.4	4.6	3.6	3.01
250	0.004	200	145	120	84.9	58.7	30.9	19.8	12	7.3	5.3	4.2	3.43

Rainfall intensities (mm/hr) :: RCP6.0 for the period 2081-2100

ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	78.8	56.8	46.6	32.7	22.3	11.4	7.17	4.4	2.6	1.8	1.4	1.18
2	0.5	86.7	62.5	51.3	36.1	24.7	12.6	7.94	4.8	2.8	2	1.6	1.3
5	0.2	113	81.9	67.2	47.4	32.5	16.7	10.5	6.4	3.7	2.7	2.1	1.73
10	0.1	133	96.1	78.9	55.7	38.2	19.7	12.4	7.6	4.4	3.2	2.5	2.05
20	0.05	153	110	90.8	64.1	44	22.8	14.4	8.7	5.1	3.7	2.9	2.38
30	0.033	164	119	97.8	69.1	47.5	24.6	15.5	9.4	5.6	4	3.1	2.58
40	0.025	172	125	103	72.6	50	25.9	16.4	10	5.9	4.2	3.3	2.72
50	0.02	179	130	107	75.5	51.9	26.9	17	10	6.1	4.4	3.4	2.83
60	0.017	184	133	110	77.7	53.5	27.7	17.5	11	6.3	4.5	3.6	2.92
80	0.013	192	140	115	81.3	56	29	18.4	11	6.6	4.8	3.7	3.06
100	0.01	199	144	119	84	57.9	30.1	19	12	6.8	4.9	3.9	3.17
250	0.004	224	162	134	94.9	65.4	34.1	21.6	13	7.8	5.6	4.4	3.62

Rainfall intensities (mm/hr) :: RCP8.5 for the period 2031-2050

ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	72.7	52.4	42.9	30.2	20.7	10.7	6.78	4.2	2.5	1.8	1.4	1.14
2	0.5	79.8	57.5	47.2	33.2	22.8	11.8	7.48	4.6	2.7	1.9	1.5	1.26
5	0.2	104	75.1	61.7	43.4	29.9	15.5	9.86	6	3.6	2.6	2	1.66
10	0.1	122	88	72.3	51	35.1	18.3	11.6	7.1	4.2	3	2.4	1.97
20	0.05	140	101	83.1	58.7	40.4	21.1	13.4	8.2	4.9	3.5	2.8	2.28
30	0.033	150	109	89.5	63.2	43.6	22.8	14.5	8.9	5.3	3.8	3	2.47
40	0.025	158	114	94	66.4	45.8	24	15.3	9.4	5.6	4	3.2	2.6
50	0.02	164	118	97.5	69	47.6	24.9	15.9	9.8	5.8	4.2	3.3	2.71
60	0.017	168	122	100	71	49	25.7	16.4	10	6	4.3	3.4	2.79
80	0.013	176	127	105	74.3	51.3	26.9	17.1	11	6.3	4.5	3.6	2.93
100	0.01	181	132	108	76.7	53	27.8	17.7	11	6.5	4.7	3.7	3.04
250	0.004	204	148	122	86.7	59.9	31.5	20.1	12	7.4	5.3	4.2	3.46

Rainfall intensities (mm/hr) :: RCP8.5 for the period 2081-2100

ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	86.3	62.1	51	35.8	24.3	12.3	7.65	4.6	2.7	1.9	1.5	1.22
2	0.5	95.1	68.5	56.2	39.5	27	13.6	8.5	5.1	3	2.1	1.7	1.36
5	0.2	125	90.1	74	52.1	35.6	18.1	11.3	6.8	4	2.8	2.2	1.81
10	0.1	147	106	87	61.4	42	21.4	13.4	8.1	4.7	3.4	2.6	2.15
20	0.05	168	122	100	70.8	48.5	24.8	15.5	9.3	5.5	3.9	3.1	2.5
30	0.033	181	131	108	76.4	52.3	26.8	16.8	10	5.9	4.2	3.3	2.71
40	0.025	190	138	114	80.2	55	28.2	17.7	11	6.2	4.5	3.5	2.86
50	0.02	198	143	118	83.4	57.2	29.3	18.4	11	6.5	4.6	3.6	2.98
60	0.017	203	147	121	85.9	58.9	30.3	19	11	6.7	4.8	3.7	3.07
80	0.013	213	154	127	89.9	61.7	31.7	19.9	12	7	5	3.9	3.23
100	0.01	220	159	131	92.9	63.8	32.8	20.6	12	7.3	5.2	4.1	3.34
250	0.004	247	180	148	105	72.2	37.2	23.4	14	8.3	5.9	4.6	3.81

HIRDS V4 Depth-Duration-Frequency Results
Sitename: Custom Location
Coordinate system: WGS84
Longitude: 174.062
Latitude: -35.3805

DDF Model								
Parameters:	c	d	e	f	g		h	i
Values:	0.00221238	0.4773044	-0.0216117	-0.00202221		0.25633256	-0.0122614	3.31136
Example:	Duration (hrs)	ARI (yrs)	x	y	Rainfall Depth (mm)			
	24	100	3.17805383	4.60014923		243.9867992		

Rainfall depths (mm) :: Historical Data

ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	11	15.8	19.5	27.4	37.7	59.4	76.1	94	112	121	127	131
2	0.5	12.1	17.4	21.4	30.1	41.4	65.3	83.7	104	123	134	140	145
5	0.2	15.6	22.6	27.8	39.2	54.1	85.5	110	136	162	176	185	191
10	0.1	18.3	26.4	32.5	45.9	63.4	100	129	160	191	208	218	225
20	0.05	20.9	30.3	37.3	52.7	72.9	116	149	185	221	240	252	261
30	0.033	22.5	32.5	40.2	56.7	78.5	125	161	200	238	259	273	282
40	0.025	23.6	34.2	42.2	59.6	82.6	131	169	210	251	273	287	297
50	0.02	24.4	35.4	43.7	61.9	85.7	136	176	218	261	284	299	309
60	0.017	25.1	36.5	45	63.7	88.2	140	181	225	269	293	308	319
80	0.013	26.3	38.1	47	66.6	92.3	147	189	236	282	307	323	334
100	0.01	27.1	39.3	48.6	68.8	95.4	152	196	244	292	318	335	346
250	0.004	30.5	44.3	54.8	77.7	108	172	222	277	332	362	382	395

Depth standard error (mm) :: Historical Data

ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	1.3	1.6	1.7	2.6	3.5	6.5	8.9	14	18	21	22	23
2	0.5	1.4	1.7	1.9	2.8	3.8	7.2	9.8	16	21	23	25	25
5	0.2	2	2.4	2.8	4	5.4	10	14	22	28	31	33	35
10	0.1	2.6	3.2	3.8	5.3	7	13	18	26	33	37	39	41
20	0.05	3.3	4.3	5.1	7	9.2	17	23	31	39	44	46	49
30	0.033	3.8	5	6.1	8.2	11	20	27	35	43	49	51	54
40	0.025	4.3	5.6	6.8	9.2	12	22	30	37	46	52	54	58
50	0.02	4.6	6.1	7.5	10	13	24	32	39	49	55	57	61
60	0.017	4.9	6.6	8	11	14	26	35	41	51	57	59	63
80	0.013	5.4	7.3	9	12	16	29	39	44	55	62	63	68
100	0.01	5.8	8	9.8	13	17	32	43	46	58	65	67	71
250	0.004	8	11	14	19	24	45	61	58	71	80	82	88

Rainfall depths (mm) :: RCP2.6 for the period 2031-2050

ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	11.8	17	20.9	29.3	40.2	62.7	79.7	98	116	125	131	135
2	0.5	12.9	18.6	22.9	32.2	44.3	69.1	87.9	108	128	138	144	149
5	0.2	16.8	24.3	29.9	42.1	58	90.8	116	142	168	182	191	197
10	0.1	19.7	28.4	35	49.4	68.1	107	136	168	199	215	226	233
20	0.05	22.5	32.6	40.2	56.8	78.4	123	157	194	230	249	262	270
30	0.033	24.2	35.1	43.3	61.2	84.5	133	170	209	249	270	283	292
40	0.025	25.4	36.9	45.5	64.3	88.8	140	179	221	262	284	298	308
50	0.02	26.4	38.3	47.2	66.8	92.3	145	186	229	272	296	310	320
60	0.017	27.2	39.4	48.6	68.8	95	150	192	236	281	305	320	330
80	0.013	28.4	41.1	50.8	71.9	99.4	157	201	248	295	320	335	346
100	0.01	29.3	42.5	52.5	74.3	103	162	208	256	305	331	348	359
250	0.004	32.9	47.9	59.2	83.9	116	184	236	291	347	377	396	409

Rainfall depths (mm) :: RCP2.6 for the period 2081-2100

ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	11.8	17	20.9	29.3	40.2	62.7	79.7	98	116	125	131	135
2	0.5	12.9	18.6	22.9	32.2	44.3	69.1	87.9	108	128	138	144	149
5	0.2	16.8	24.3	29.9	42.1	58	90.8	116	142	168	182	191	197
10	0.1	19.7	28.4	35	49.4	68.1	107	136	168	199	215	226	233
20	0.05	22.5	32.6	40.2	56.8	78.4	123	157	194	230	249	262	270
30	0.033	24.2	35.1	43.3	61.2	84.5	133	170	209	249	270	283	292
40	0.025	25.4	36.9	45.5	64.3	88.8	140	179	221	262	284	298	308
50	0.02	26.4	38.3	47.2	66.8	92.3	145	186	229	272	296	310	320
60	0.017	27.2	39.4	48.6	68.8	95	150	192	236	281	305	320	330
80	0.013	28.4	41.1	50.8	71.9	99.4	157	201	248	295	320	335	346
100	0.01	29.3	42.5	52.5	74.3	103	162	208	256	305	331	348	359
250	0.004	32.9	47.9	59.2	83.9	116	184	236	291	347	377	396	409

Rainfall depths (mm) :: RCP4.5 for the period 2031-2050

ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	12	17.2	21.2	29.8	40.9	63.6	80.6	99	117	126	132	136
2	0.5	13.1	18.9	23.3	32.8	45	70.1	89	109	129	139	146	150
5	0.2	17.1	24.7	30.4	42.9	59	92.1	117	144	170	184	193	199
10	0.1	20	28.9	35.7	50.3	69.3	108	138	170	201	218	228	235
20	0.05	23	33.2	41	57.9	79.8	125	159	196	232	252	264	272
30	0.033	24.7	35.8	44.1	62.4	86	135	172	212	251	272	285	294
40	0.025	25.9	37.6	46.4	65.5	90.4	142	181	223	265	287	301	311
50	0.02	26.9	39	48.1	68	93.9	148	188	232	275	298	313	323
60	0.017	27.7	40.1	49.5	70.1	96.7	152	194	239	284	308	323	333
80	0.013	28.9	41.9	51.8	73.3	101	159	203	251	298	323	339	350
100	0.01	29.8	43.3	53.5	75.7	105	165	211	260	308	334	351	362
250	0.004	33.6	48.8	60.3	85.5	118	187	239	295	351	381	400	413

Rainfall depths (mm) :: RCP4.5 for the period 2081-2100

ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	12.6	18.1	22.3	31.4	42.8	66.2	83.5	102	120	129	135	139
2	0.5	13.8	19.9	24.5	34.5	47.3	73.1	92.3	113	132	143	149	153
5	0.2	18.1	26.1	32.1	45.3	62.1	96.4	122	149	175	189	198	203
10	0.1	21.1	30.6	37.7	53.2	73.1	114	144	176	207	224	234	241
20	0.05	24.3	35.1	43.3	61.2	84.2	131	166	203	240	259	271	279
30	0.033	26.1	37.8	46.7	65.9	90.8	142	180	220	259	280	294	302
40	0.025	27.4	39.7	49	69.3	95.4	149	189	231	273	296	309	319
50	0.02	28.4	41.2	50.9	72	99.2	155	197	241	284	308	322	332
60	0.017	29.3	42.4	52.4	74.1	102	160	203	248	293	318	332	342
80	0.013	30.6	44.4	54.8	77.5	107	167	212	260	308	333	348	359
100	0.01	31.6	45.8	56.6	80.1	111	173	220	269	319	345	361	372
250	0.004	35.5	51.6	63.8	90.5	125	196	250	306	363	393	412	424

Rainfall depths (mm) :: RCP6.0 for the period 2031-2050

ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	11.9	17.1	21.1	29.6	40.6	63.2	80.3	99	116	126	131	135
2	0.5	13.1	18.8	23.2	32.6	44.7	69.7	88.5	109	128	139	145	150
5	0.2	17	24.5	30.2	42.6	58.6	91.6	117	143	169	183	192	198
10	0.1	19.9	28.7	35.4	50	68.8	108	137	169	200	217	227	234
20	0.05	22.8	33	40.7	57.5	79.2	124	159	195	231	251	263	271
30	0.033	24.5	35.5	43.8	61.9	85.4	134	171	211	250	271	284	293
40	0.025	25.7	37.3	46	65.1	89.8	141	180	222	264	286	300	309
50	0.02	26.7	38.7	47.8	67.5	93.3	147	187	231	274	297	312	322
60	0.017	27.5	39.8	49.2	69.5	96	151	193	238	283	307	322	332
80	0.013	28.7	41.6	51.4	72.7	100	158	202	249	296	322	337	348
100	0.01	29.6	43	53.1	75.2	104	164	209	258	307	333	350	361
250	0.004	33.3	48.4	59.9	84.9	117	186	238	294	349	379	398	411

Rainfall depths (mm) :: RCP6.0 for the period 2081-2100

ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	13.1	18.9	23.3	32.7	44.6	68.5	86.1	105	122	131	137	141
2	0.5	14.4	20.8	25.6	36.1	49.3	75.8	95.3	116	135	146	152	156
5	0.2	18.9	27.3	33.6	47.4	64.9	100	126	153	180	194	202	208
10	0.1	22.1	32	39.5	55.7	76.4	118	149	181	213	230	239	246
20	0.05	25.4	36.8	45.4	64.1	88.1	137	172	209	247	266	278	285
30	0.033	27.4	39.6	48.9	69.1	95	147	186	227	267	288	301	309
40	0.025	28.7	41.6	51.4	72.6	99.9	155	196	239	281	304	317	326
50	0.02	29.8	43.2	53.4	75.5	104	161	204	248	293	316	330	339
60	0.017	30.7	44.5	54.9	77.7	107	166	210	256	302	326	341	350
80	0.013	32.1	46.5	57.5	81.3	112	174	220	268	317	342	357	368
100	0.01	33.1	48.1	59.4	84	116	180	228	278	328	354	370	381
250	0.004	37.3	54.1	66.9	94.9	131	204	259	316	373	403	422	434

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

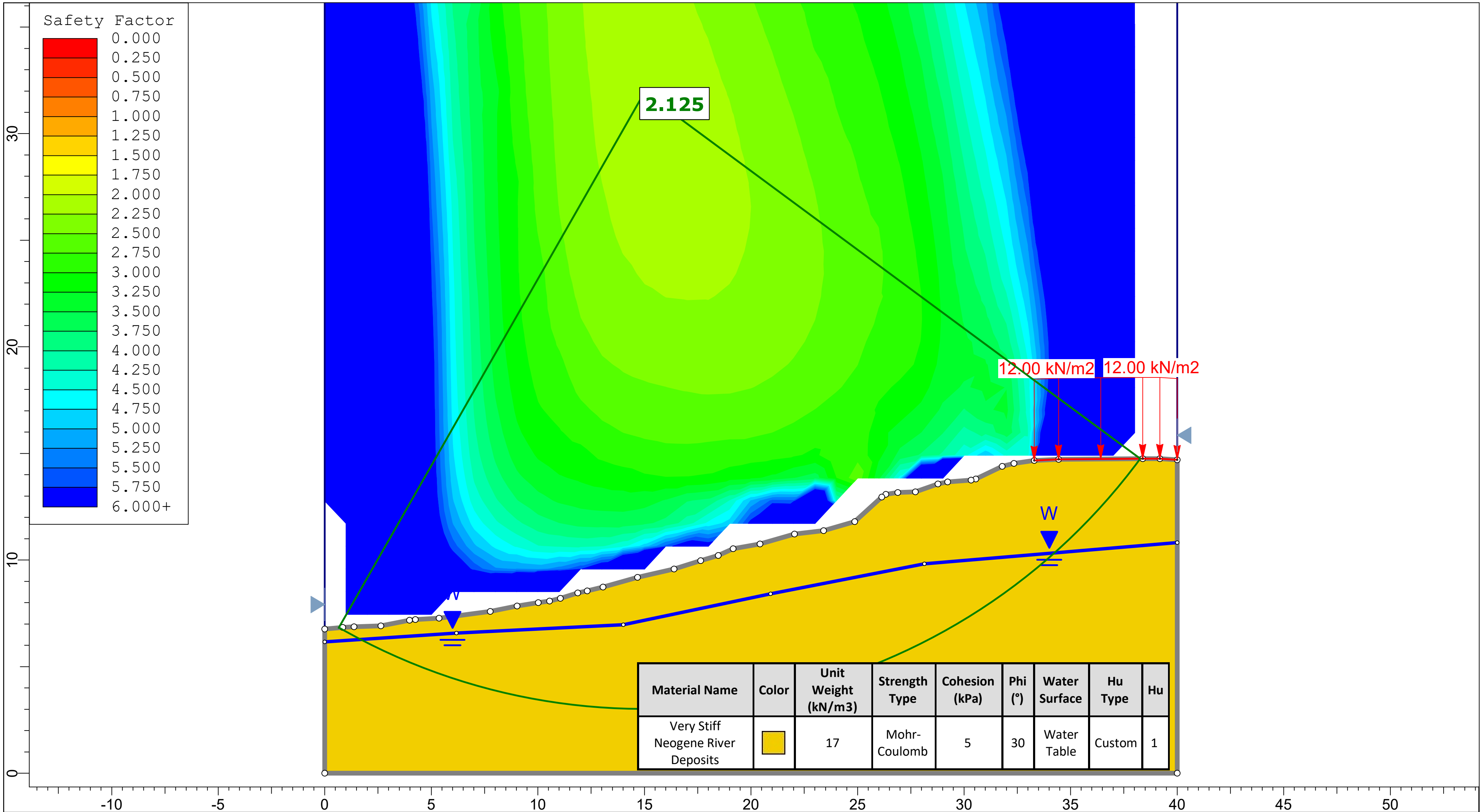
ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	12.1	17.5	21.5	30.2	41.3	64.2	81.3	100	117	127	132	136
2	0.5	13.3	19.2	23.6	33.2	45.6	70.8	89.7	110	130	140	146	151
5	0.2	17.3	25	30.8	43.4	59.7	93.1	118	145	171	185	194	200
10	0.1	20.3	29.3	36.2	51	70.2	110	139	171	202	219	229	236
20	0.05	23.3	33.7	41.5	58.7	80.8	127	161	198	234	253	266	274
30	0.033	25	36.2	44.7	63.2	87.1	137	174	214	253	274	287	296
40	0.025	26.3	38.1	47	66.4	91.6	144	183	225	267	289	303	312
50	0.02	27.3	39.5	48.8	69	95.1	149	190	234	278	301	315	325
60	0.017	28	40.6	50.2	71	98	154	196	241	286	310	325	335
80	0.013	29.3	42.5	52.5	74.3	103	161	206	253	300	325	341	352
100	0.01	30.2	43.9	54.2	76.7	106	167	213	262	311	337	353	364
250	0.004	34	49.4	61.1	86.7	120	189	242	298	354	384	403	416

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

ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	14.4	20.7	25.5	35.8	48.6	73.9	91.8	111	129	137	143	147
2	0.5	15.8	22.8	28.1	39.5	53.9	81.8	102	123	143	153	159	163
5	0.2	20.8	30	37	52.1	71.2	109	136	163	190	204	212	218
10	0.1	24.4	35.3	43.5	61.4	84	128	161	194	225	242	252	259
20	0.05	28.1	40.6	50.1	70.8	97	149	186	224	262	281	293	300
30	0.033	30.2	43.8	54	76.4	105	161	201	242	283	304	317	325
40	0.025	31.7	46	56.8	80.2	110	169	212	256	298	321	334	343
50	0.02	33	47.8	59	83.4	114	176	220	266	311	334	348	357
60	0.017	33.9	49.2	60.7	85.9	118	182	228	274	321	345	359	368
80	0.013	35.5	51.4	63.5	89.9	123	190	238	287	337	362	377	387
100	0.01	36.6	53.1	65.6	92.9	128	197	247	298	349	375	391	401
250	0.004	41.2	59.9	74	105	144	223	280	339	397	427	446	457

APPENDIX D

Slope Stability Analysis



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)	Water Surface	Hu Type	Hu
Very Stiff Neogene River Deposits		17	Mohr-Coulomb	5	30	Water Table	Custom	1

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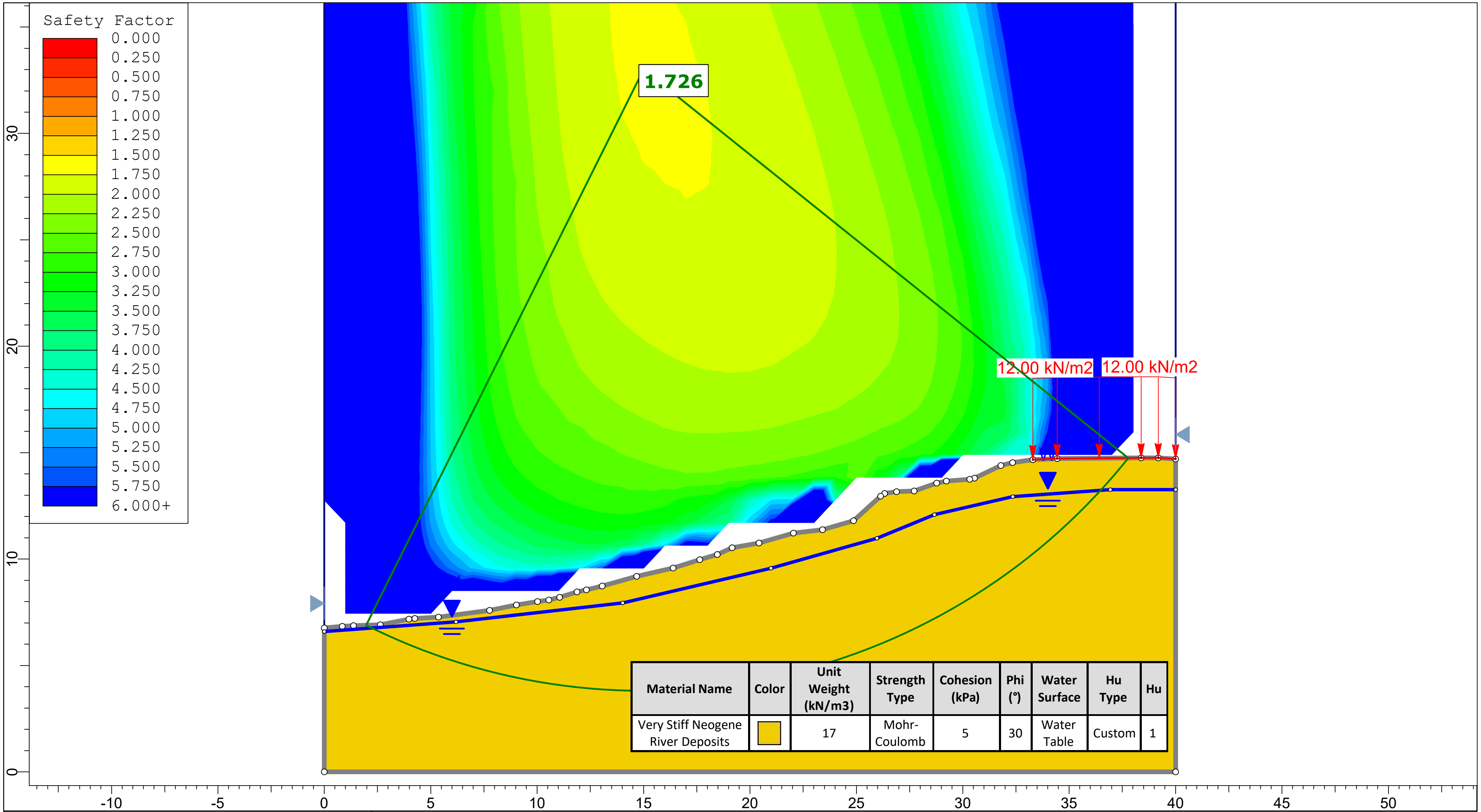
SLIDEINTERPRET 9.034

Project	18 Station Road, Kawakawa		
Group	Existing Condition	*Scenario*	Normal GW
Drawn By	DBT	*Company*	Geologix
Date	16/07/2024, 11:33:39 am	*File Name*	Section A.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)	Water Surface	Hu Type	Hu
Very Stiff Neogene River Deposits		17	Mohr-Coulomb	5	30	Water Table	Custom	1

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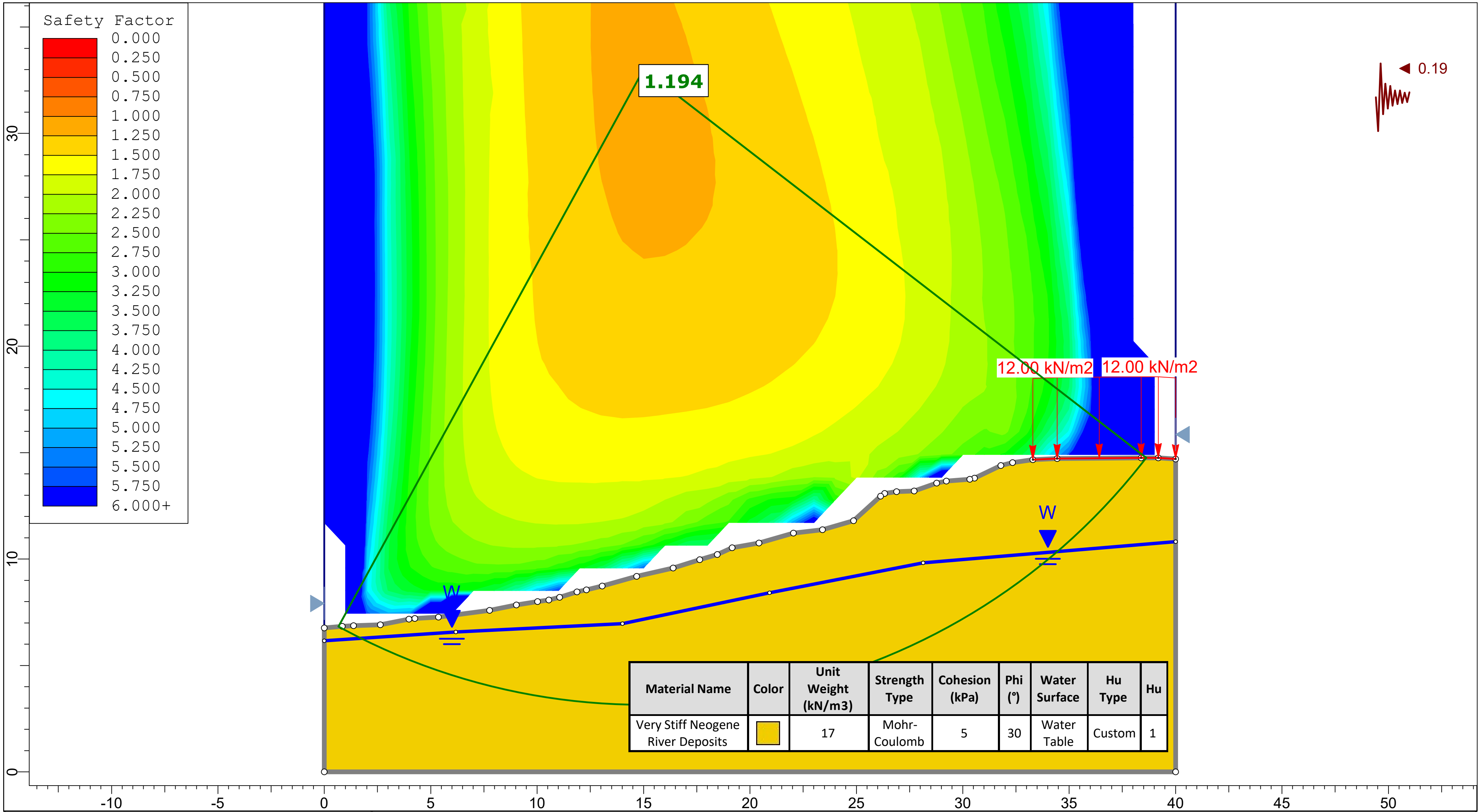
SLIDEINTERPRET 9.034

Project	18 Station Road, Kawakawa		
Group	Existing Condition	*Scenario*	Elevated GW
Drawn By	DBT	*Company*	Geologix
Date	16/07/2024, 11:33:39 am	*File Name*	Section A.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)	Water Surface	Hu Type	Hu
Very Stiff Neogene River Deposits		17	Mohr-Coulomb	5	30	Water Table	Custom	1

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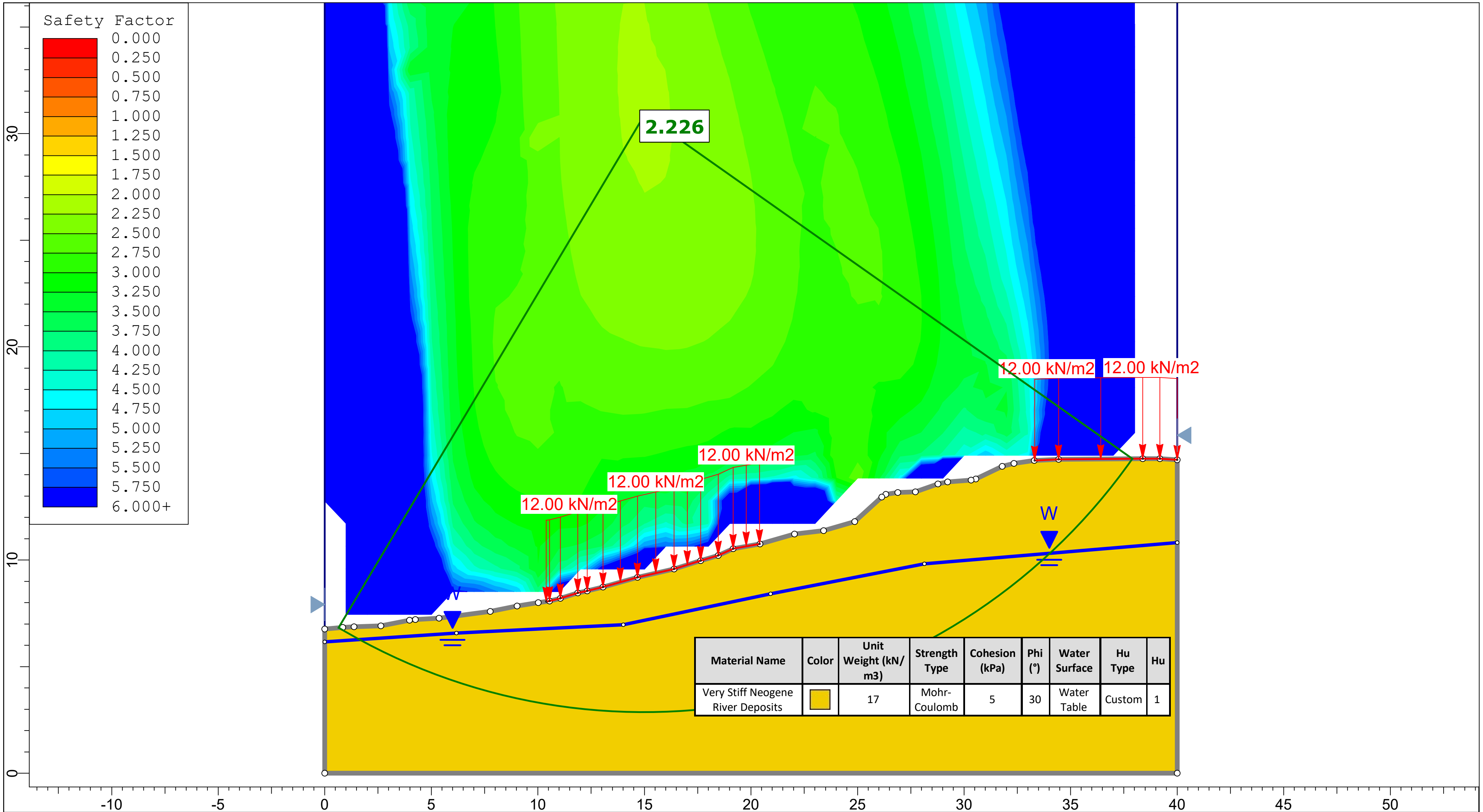
SLIDEINTERPRET 9.034

Project	18 Station Road, Kawakawa		
Group	Existing Condition	*Scenario*	Seismic
Drawn By	DBT	*Company*	Geologix
Date	16/07/2024, 11:33:39 am	*File Name*	Section A.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)	Water Surface	Hu Type	Hu
Very Stiff Neogene River Deposits		17	Mohr-Coulomb	5	30	Water Table	Custom	1

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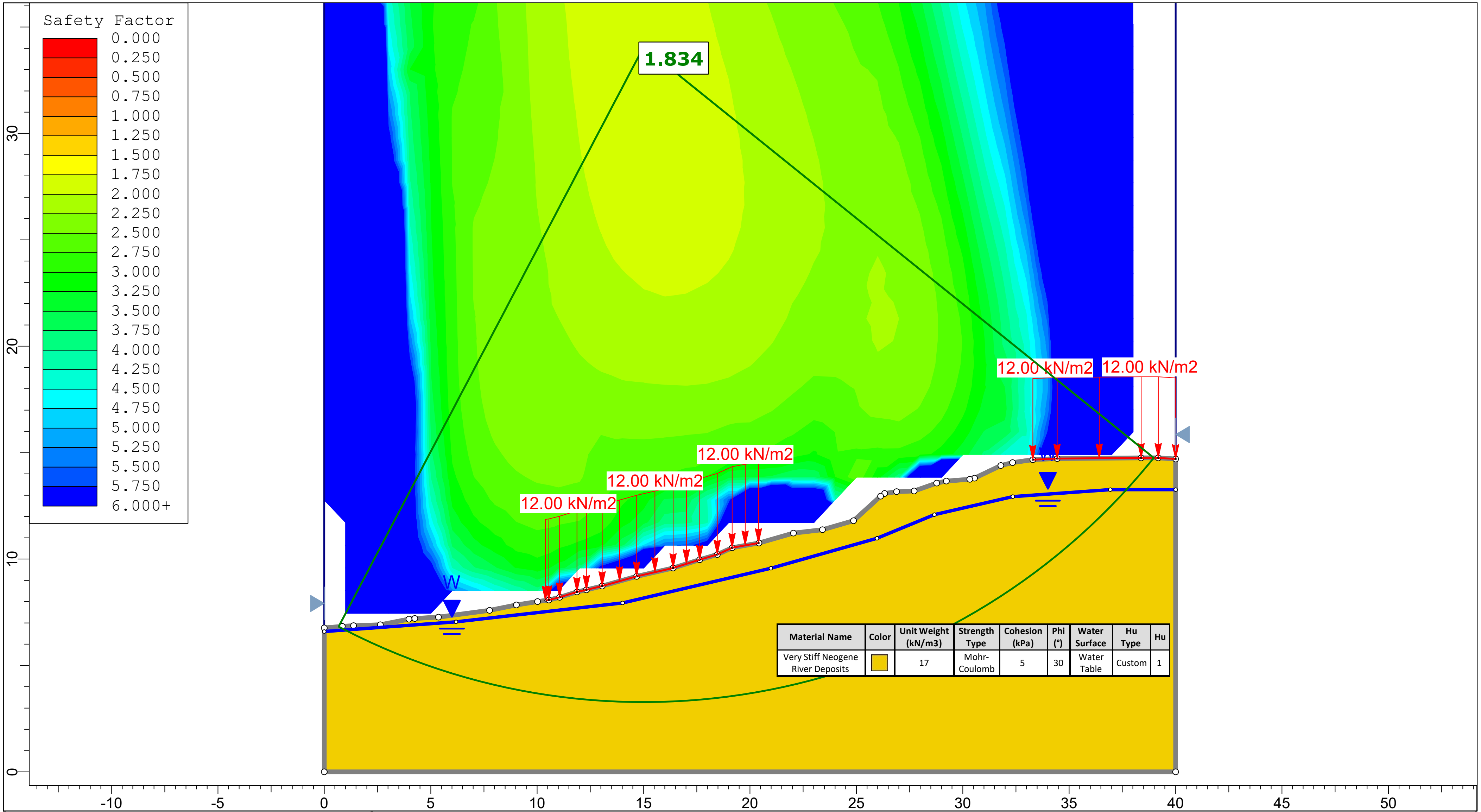
SLIDEINTERPRET 9.034

Project	18 Station Road, Kawakawa		
Group	Proposed Condition	*Scenario*	Normal GW
Drawn By	DBT	*Company*	Geologix
Date	16/07/2024, 11:33:39 am	*File Name*	Section A.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)	Water Surface	Hu Type	Hu
Very Stiff Neogene River Deposits		17	Mohr-Coulomb	5	30	Water Table	Custom	1

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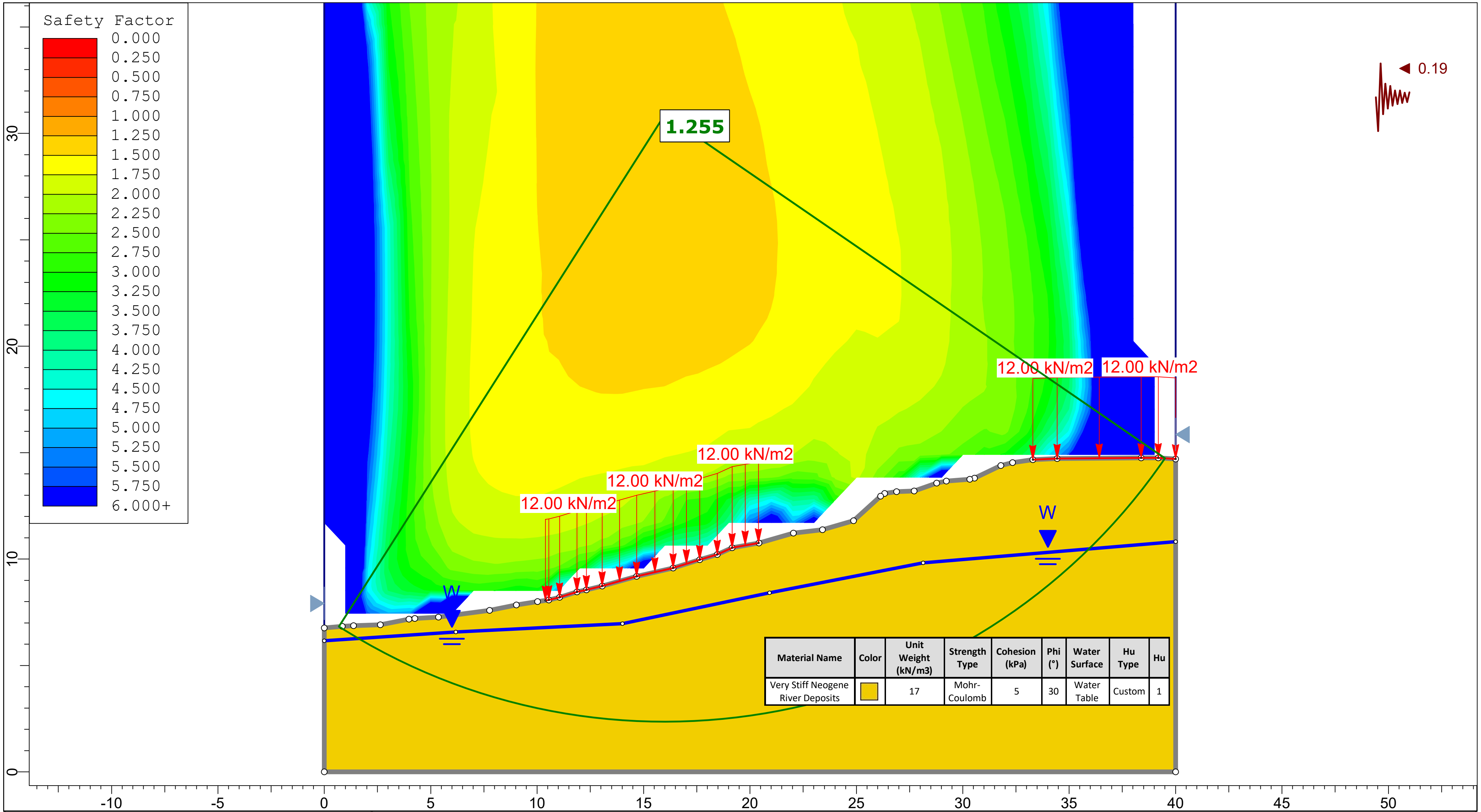
SLIDEINTERPRET 9.034

Project	18 Station Road, Kawakawa		
Group	Proposed Condition	*Scenario*	Elevated GW
Drawn By	DBT	*Company*	Geologix
Date	16/07/2024, 11:33:39 am	*File Name*	Section A.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)	Water Surface	Hu Type	Hu
Very Stiff Neogene River Deposits		17	Mohr-Coulomb	5	30	Water Table	Custom	1

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SLIDEINTERPRET 9.034

Project	18 Station Road, Kawakawa		
Group	Proposed Condition	*Scenario*	Seismic
Drawn By	DBT	*Company*	Geologix
Date	16/07/2024, 11:33:39 am	*File Name*	Section A.slmd

APPENDIX E

Assessment of Environmental Effects and Assessment Criteria

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Table 15: Operative FNDC Subdivision Stormwater Assessment Criteria, to rule 13.10.4

Assessment Criteria	Comments
(a) Whether the application complies with any regional rules relating to any water or discharge permits required under the Act, and with any resource consent issued to the District Council in relation to any urban drainage area stormwater management plan or similar plan.	Complies.
(b) Whether the application complies with the provisions of the Council's "Engineering Standards and Guidelines" (2004) - Revised March 2009 (to be used in conjunction with NZS 4404:2004).	Concept design complies and has adopted latest FNDC engineering standards (2023) for runoff curves and proposed area within all undeveloped lots will be attenuated to 80 % of pre-development levels for specified design storms by FNDC standards and NRP. Existing development Lot 2 runoff below permitted activity threshold.
(c) Whether the application complies with the Far North District Council Strategic Plan - Drainage.	Complies.
(d) The degree to which Low Impact Design principles have been used to reduce site impermeability and to retain natural permeable areas.	Proposed impervious areas within subdivision proposal are limited to necessity only. RoW Access to new lot 1 is formed on existing impervious surface area.. All impervious areas within new lot are to be attenuated by on site storage devices and dispersed to the environment in controlled non-concentrated manner.
(e) The adequacy of the proposed means of disposing of collected stormwater from the roof of all potential or existing buildings and from all impervious surfaces.	Low impact design adopted – attenuation within on-site tanks for undeveloped proposed lot 1. Efficient and controlled discharge outlets. Current stormwater management devices on lot 2 are in good condition with no additional impervious surfaces proposed.
(f) The adequacy of any proposed means for screening out litter, the capture of chemical spillages, the containment of contamination from roads and paved areas, and of siltation.	Stormwater quality treatment measures are included within rainwater tanks. New driveway for Lot 1 is limited in length and surface area posing very little effect to water quality.
(g) The practicality of retaining open natural waterway systems for stormwater disposal in preference to piped or canal systems and adverse effects on existing waterways.	Surface drainage preferred and adopted where practical and safe. The only pipeline adopted is the connection from roof to rainwater tanks, and 6m length to a dispersion (level spreader) device for good control of discharge.
(h) Whether there is sufficient capacity available in the Council's outfall stormwater system to cater for increased run-off from the proposed allotments.	No connection to public stormwater proposed.
(i) Where an existing outfall is not capable of accepting increased run-off, the adequacy of proposals and solutions for disposing of run-off.	NA.
(j) The necessity to provide on-site retention basins to contain surface run-off where the capacity of the outfall is incapable of accepting flows, and where the outfall has limited capacity, any need to restrict	Attenuation provided through storage tanks to ensure hydraulic neutrality from new impervious

the rate of discharge from the subdivision to the same rate of discharge that existed on the land before the subdivision takes place.	area. Receiving catchment, which includes a wetland, will bear no effect and remains the same.
(k) Any adverse effects of the proposed subdivision on drainage to, or from, adjoining properties and mitigation measures proposed to control any adverse effects.	No adverse effects anticipated on neighbouring properties or downstream environment.
(l) In accordance with sustainable management practices, the importance of disposing of stormwater by way of gravity pipelines. However, where topography dictates that this is not possible, the adequacy of proposed pumping stations put forward as a satisfactory alternative.	All devices adopt and are designed for gravity flows.
(m) The extent to which it is proposed to fill contrary to the natural fall of the country to obtain gravity outfall; the practicality of obtaining easements through adjoining owners' land to other outfall systems; and whether filling or pumping may constitute a satisfactory alternative.	No fill is required for the stormwater management purpose.
(n) For stormwater pipes and open waterway systems, the provision of appropriate easements in favour of either the registered user or in the case of the Council, easements in gross, to be shown on the survey plan for the subdivision, including private connections passing over other land protected by easements in favour of the user.	All new stormwater pipes are contained in the owner lot. No easements required for right to drain.
(o) Where an easement is defined as a line, being the centre line of a pipe already laid, the effect of any alteration of its size and the need to create a new easement.	NA.
(p) For any stormwater outfall pipeline through a reserve, the prior consent of the Council, and the need for an appropriate easement.	NA.
(q) The need for and extent of any financial contributions to achieve the above matters.	TBC.
(r) The need for a local purpose reserve to be set aside and vested in the Council as a site for any public utility required to be provided.	NA.