123631 Redacted

Tonkin & Taylor

T&T Ref: 851455.005
20 June 2011

Tauranga City Council
PO Box 12022
Tauranga

[redacted]

[redacted]

Slip 1, Oruahine Track, Mauao

Timber Crib Wall Design

Please find enclosed Sketches and accompanying calculations together with a Producer Statement PS1 for timber crib wall required for the Oruahine Track Slip 1 remediation.

We also enclose a copy of an outline design and costings prepared by Phi Group for your information.

Yours faithfully

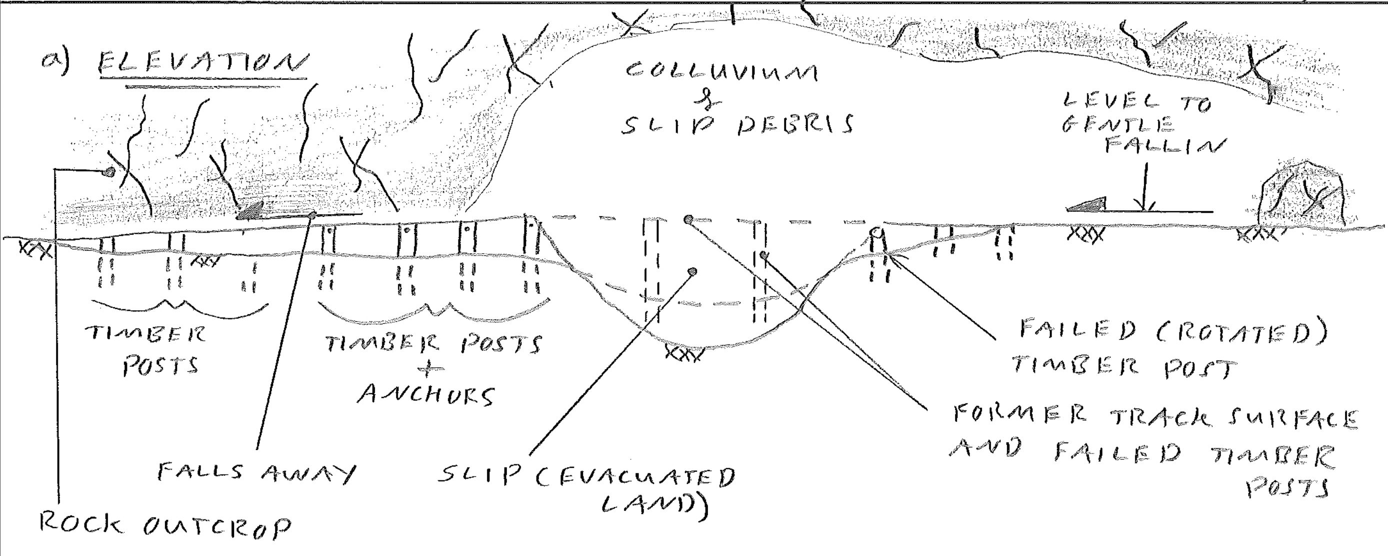
[redacted]

19-Jun-11
t:\tauranga\projects\851455\issueddocuments\[redacted]

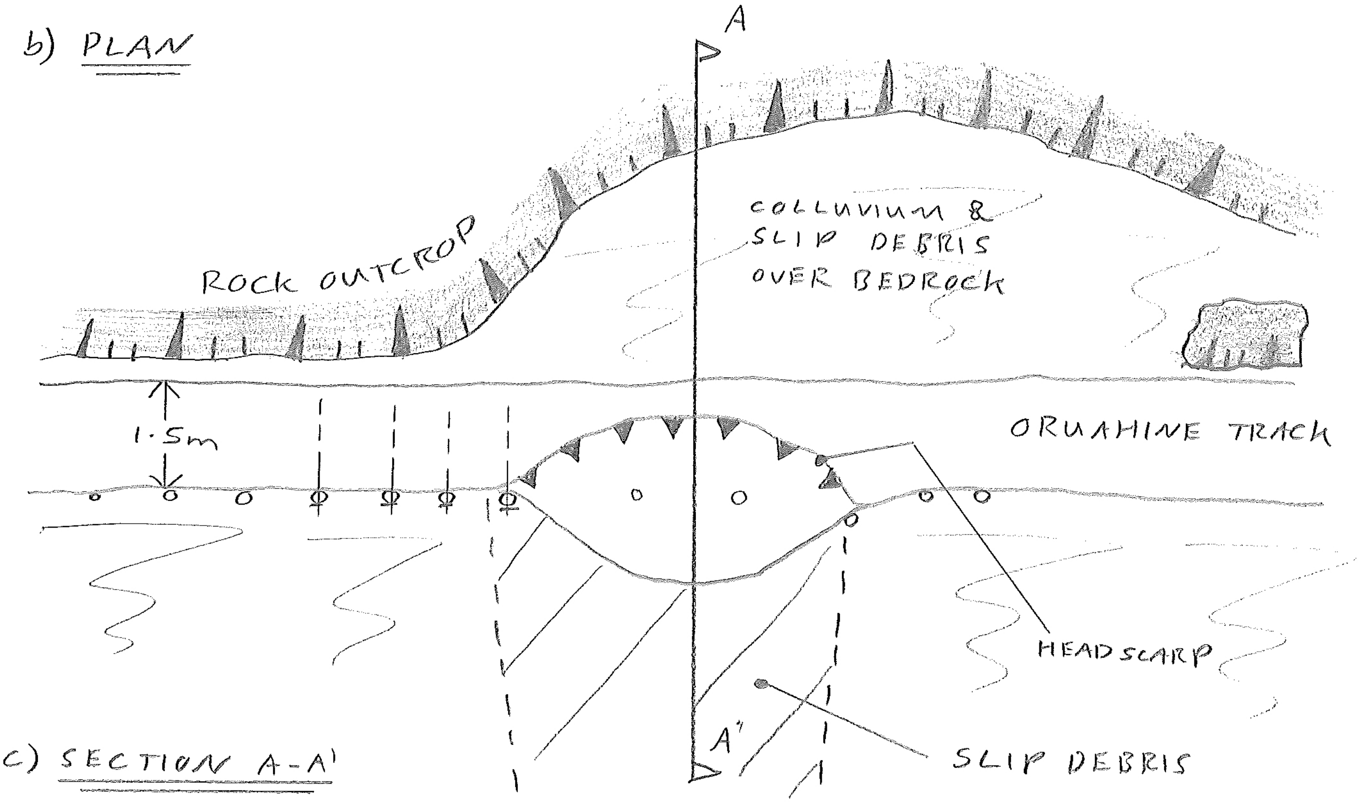
Tonkin & Taylor

Project: Oruahine Slip 1	Computed: [redacted] s 7(2)(a) - Privacy 10/6/2011		Office: TGA
	Checked: 20/6/2011		Job No: 851455.005
Description: Oruahine Track Slip 1 Repair	Revised:	20	File: 1
SKETCH ONE - EXISTING LAYOUT	Checked:	20	Sheet No. 1 of 3

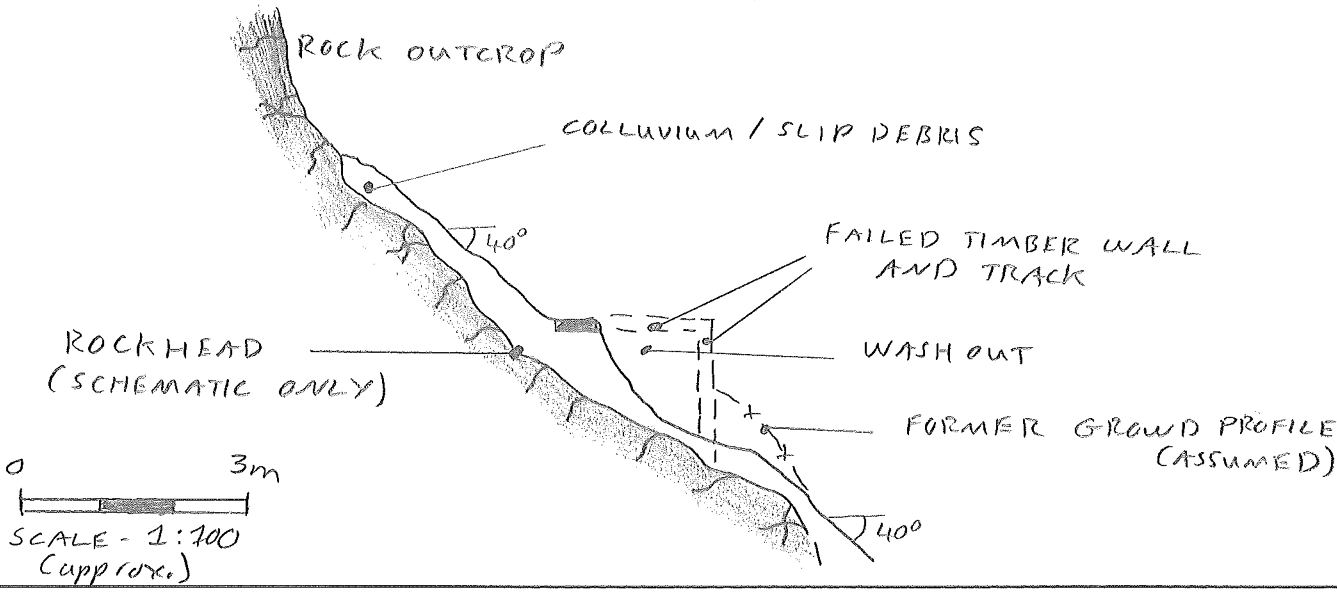
a) ELEVATION



b) PLAN



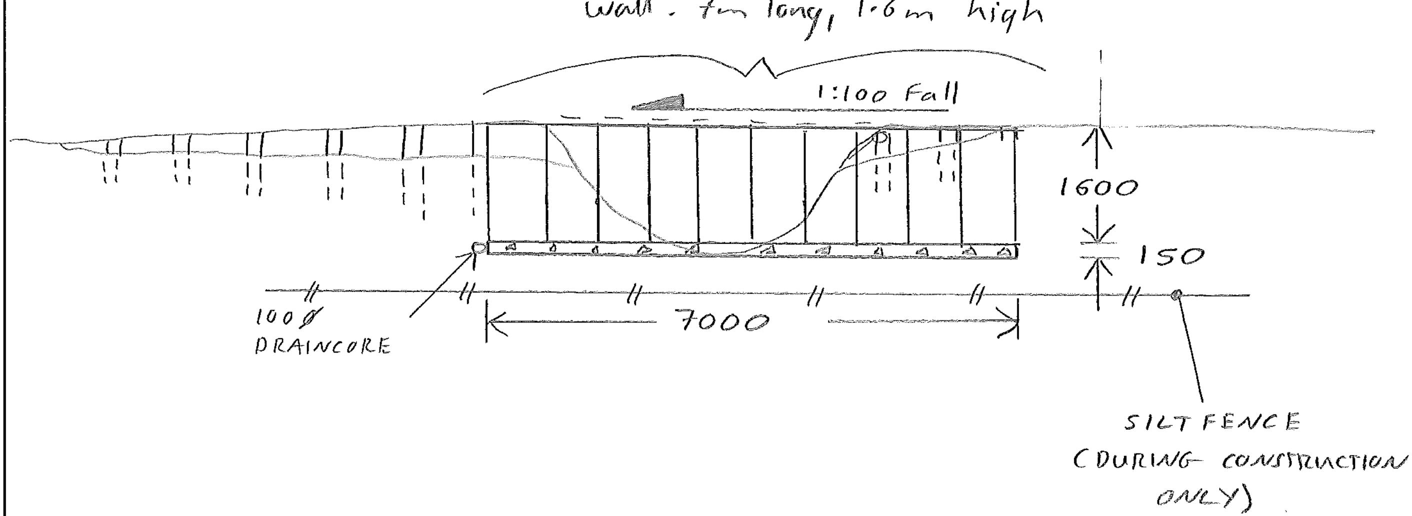
c) SECTION A-A'



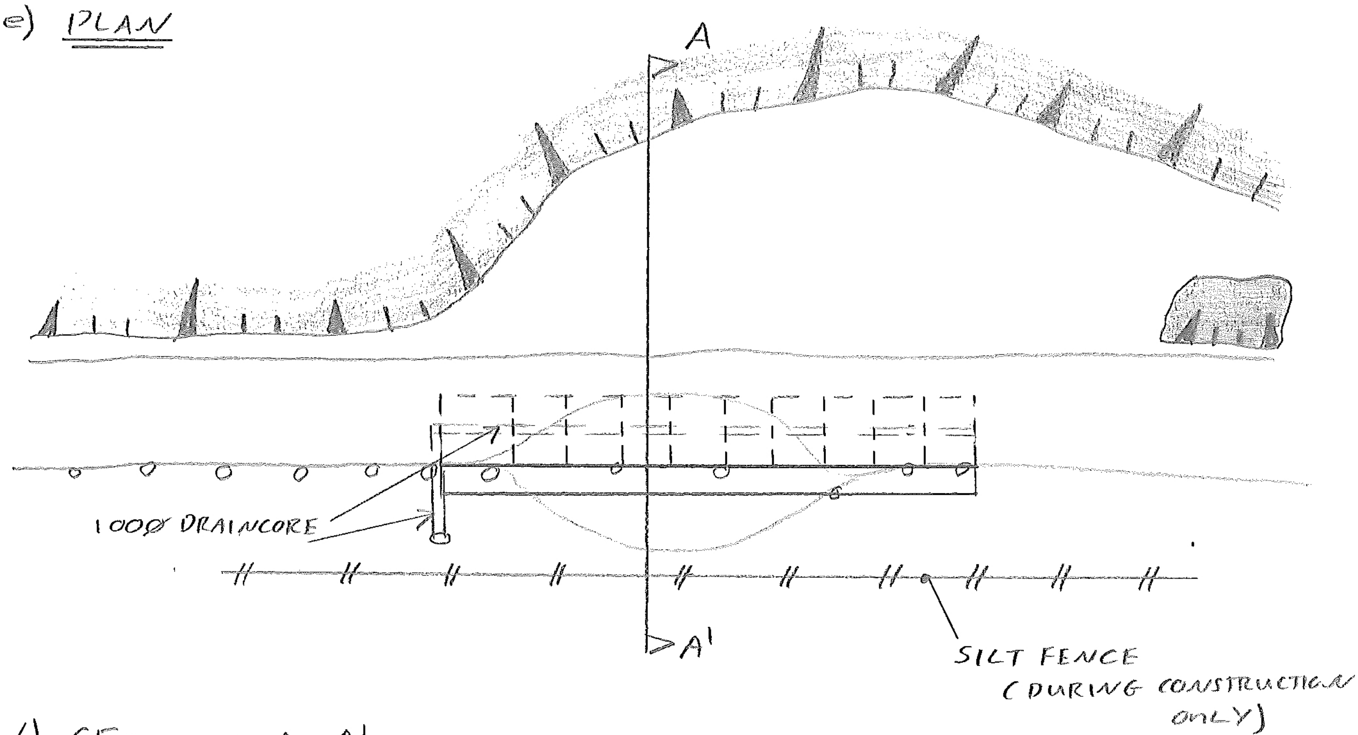
Tonkin & Taylor

Project: Oruahine Slip 1	Computed [redacted] 10/6/2011	Office: TGA
Description: Oruahine Track Slip 1 Repair SKETCH TWO - PROPOSED CRIB	Checked: 20/6/2011	Job No: 851455.005
	Revised: 20	File: 1
	Checked: 20	Sheet No. 2 of 3

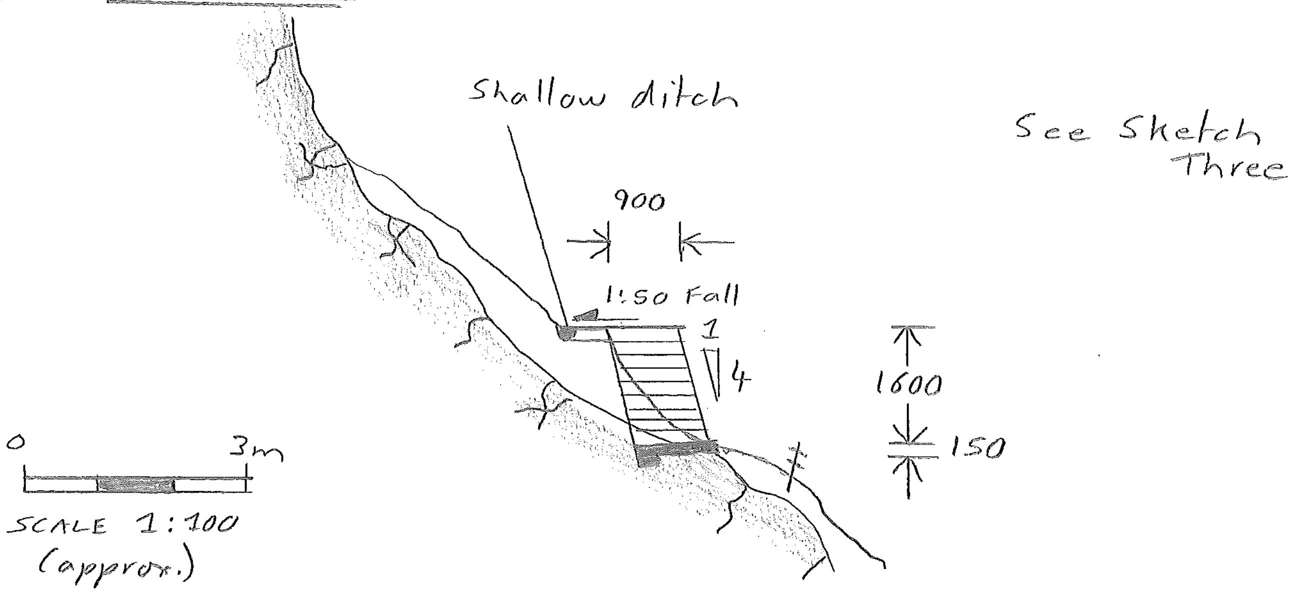
d) ELEVATION



e) PLAN



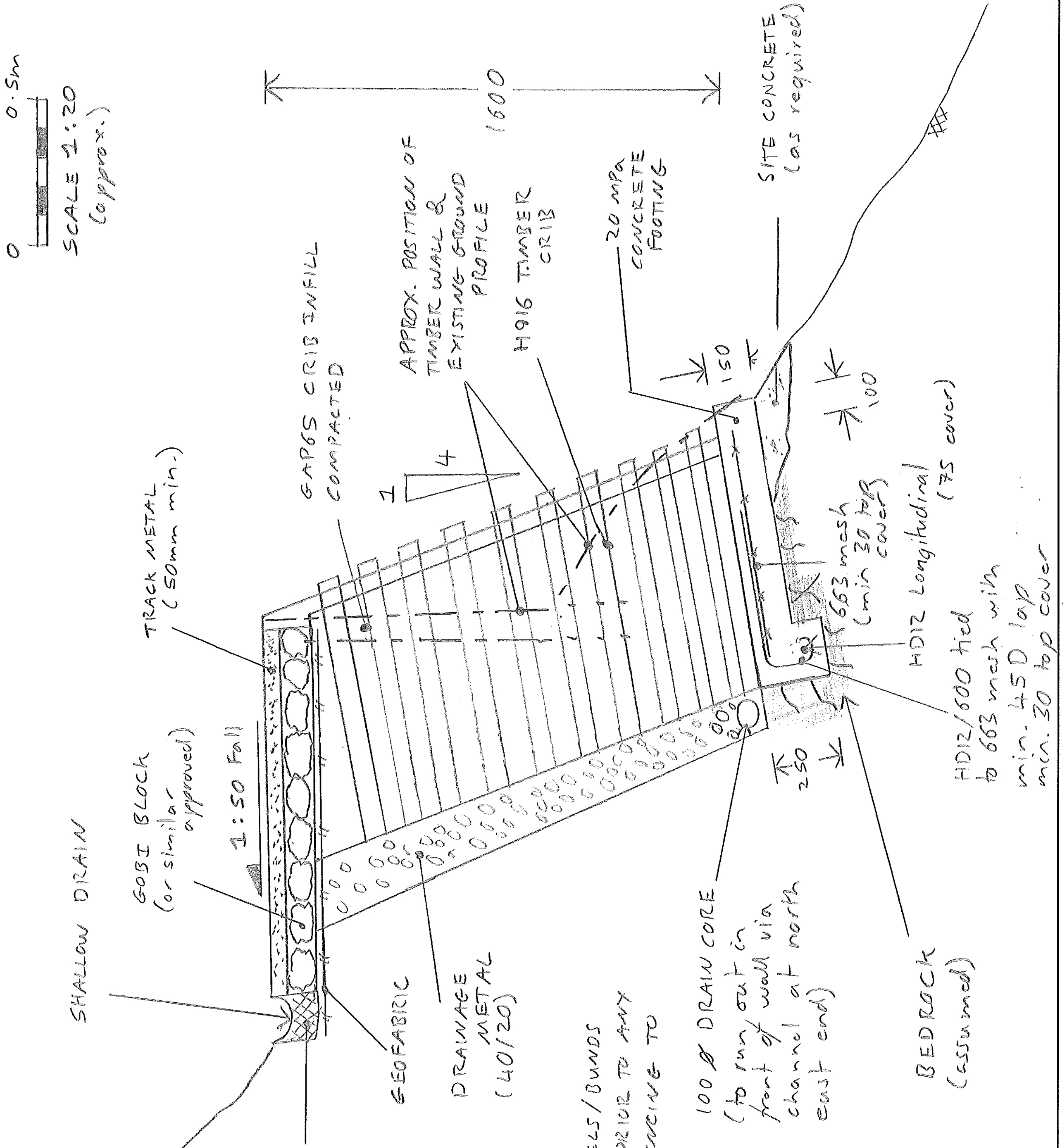
f) SECTION A-A'



See Sketch Three

Tonkin & Taylor

Project: Oruahine Slip 1	Computed [redacted] s 7(2)(a) - Privacy 10/6/2011		Office: TGA
	Checked: 20/6/2011		Job No: 851455.005
Description: Oruahine Track Slip 1 Repair SKETCH THREE – CRIB DETAIL	Revised:	20	File: 1
	Checked:	20	Sheet No. 3 of 3



NOTE:
1) TEMPORARY CHANNELS/BUNDS TO BE CONSTRUCTED PRIOR TO ANY EARTHWORKS COMMENCING TO DIVERT SURFACE WATER TO EXISTING CULVERTS EITHER SIDE OF NEW CRIB WALL. TO BE AGREED BY ENGINEER ON SITE.

IPENZ ENGINEERS NEW ZEALAND | NEW ZEALAND INSTITUTE OF ARCHITECTS INCORPORATED | ACENZ

Building Code Clause(s) ....

PRODUCER STATEMENT – PS1 – DESIGN

(Guidance notes on the use of this form are printed on the reverse side)*

ISSUED BY: Tonkin & Taylor Ltd
(Design Firm)

TO: Tauranga City Council
(Owner/Developer)

TO BE SUPPLIED TO: Tauranga City Council
(Building Consent Authority)

IN RESPECT OF: Timber Crib Wall Design for repair of Slip 1 on the Oruahine Track, Mauao
(Description of Building Work)

AT: Oruahine Track, Mauao
(Address)

.... **LOT** 73 .... **DP** 398815 .... **SO** ....

We have been engaged by the owner/developer referred to above to provide engineering design for timber crib wall .... services in respect of the requirements of
(Extent of Engagement)
Clause(s) B1 .... of the Building Code for
○ All or ◉ Part only (as specified in the attachment to this statement), of the proposed building work.

The design carried out by us has been prepared in accordance with:

☑ Compliance Documents issued by Department of Building & Housing B1/VM4
(verification method / acceptable solution)
.... or

☐ Alternative solution as per the attached schedule ....

The proposed building work covered by this producer statement is described on the drawings titled Sketches 1 to 3 Ref No 851455.005 .... and numbered ....;
together with the specification, and other documents set out in the schedule attached to this statement.

On behalf of the Design Firm, and subject to:

(i) Site verification of the following design assumptions 50kPa allowable bearing pressure ....

(ii) All proprietary products meeting their performance specification requirements;

I **believe on reasonable grounds** the building, if constructed in accordance with the drawings, specifications, and other documents provided or listed in the attached schedule, will comply with the relevant provisions of the Building Code.

I, [redacted] ☑ CPEng [redacted]
(Name of Design Professional)
☐ Reg Arch .... #

I am a Member of : ☑ IPENZ ☐ NZIA and hold the following qualifications: ....

The Design Firm issuing this statement holds a current policy of Professional Indemnity Insurance no less than $200,000*.
The Design Firm is a member of ACENZ ◉ **YES** ○ **NO**

SIGNED BY [redacted] ... ON BEHALF OF Tonkin & Taylor Ltd ....
(Design Firm)

Date 20 June 2011 ... (*signature*) [redacted] ....

Note: This statement shall only be relied upon by the Building Consent Authority named above. Liability under this statement accrues to the Design Firm only. The total maximum amount of damages payable arising from this statement and all other statements provided to the Building Consent Authority in relation to this building work, whether in contract, tort or otherwise (including negligence), is limited to the sum of $200,000.*

This form is to accompany **Form 2 of the Building (Forms) Regulations 2004** for the application of a Building Consent.

GUIDANCE ON USE OF PRODUCER STATEMENTS

Producer statements were first introduced with the Building Act 1992. The producer statements were developed by a combined task committee consisting of members of the New Zealand Institute of Architects, Institution of Professional Engineers New Zealand, Association of Consulting Engineers New Zealand in consultation with the Building Officials Institute of New Zealand. The original suite of producer statements has been revised at the date of this form as a result of enactment of the Building Act (2004) by these organisations to ensure standard use within the industry.

The producer statement system is intended to provide Building Consent Authorities (BCAs) with reasonable grounds for the issue of a Building Consent or a Code Compliance Certificate, without having to duplicate design or construction checking undertaken by others.

PS1 Design	Intended for use by a suitably qualified independent design professional in circumstances where the BCA accepts a producer statement for establishing reasonable grounds to issue a Building Consent;
PS2 Design Review	Intended for use by a suitably qualified independent design professional where the BCA accepts an independent design professional's review as the basis for establishing reasonable grounds to issue a Building Consent;
PS3 Construction	Forms commonly used as a certificate of completion of building work are Schedule 6 of NZS 3910:2003[1] or Schedules E1/E2 of NZIA's SCC 2007 [2]
PS4 Construction Review	Intended for use by a suitably qualified independent design professional who undertakes construction monitoring of the building works where the BCA requests a producer statement prior to issuing a Code Compliance Certificate. This must be accompanied by a statement of completion of building work (Schedule 6).

The following guidelines are provided by ACENZ, IPENZ and NZIA to interpret the Producer Statement.

Competence of Design Professional

This statement is made by a Design Firm that has undertaken a contract of services for the services named, and is signed by a person authorised by that firm to verify the processes within the firm and competence of its designers.

A competent design professional will have a professional qualification and proven current competence through registration on a national competence-based register, either as a Chartered Professional Engineer (CPEng) or a Registered Architect.

Membership of a professional body, such as the Institution of Professional Engineers New Zealand (IPENZ)or the New Zealand Institute of Architects (NZIA), provides additional assurance of the designer's standing within the profession. If the design firm is a member of the Association of Consulting Engineers New Zealand (ACENZ), this provides additional assurance about the standing of the firm.

Persons or firms meeting these criteria satisfy the term "suitably qualified independent design professional".

*** Professional Indemnity Insurance**

As part of membership requirements, ACENZ requires all member firms to hold Professional Indemnity Insurance to a minimum level.

The PI insurance minimum stated on the front of this form reflects standard, small projects. If the parties deem this inappropriate for large projects the minimum may be up to $500,000.

Professional Services during Construction Phase

There are several levels of service which a Design Firm may provide during the construction phase of a project (CM1-CM5)[3] (OL1-OL4)[2]. The Building Consent Authority is encouraged to require that the service to be provided by the Design Firm is appropriate for the project concerned.

Requirement to provide Producer Statement PS4

Building Consent Authorities should ensure that the applicant is aware of any requirement for producer statements for the construction phase of building work at the time the building consent is issued as no design professional should be expected to provide a producer statement unless such a requirement forms part of the Design Firm's engagement.

Attached Particulars

Attached particulars referred to in this producer statement refer to supplementary information appended to the producer statement.

Refer Also:

1 *Conditions of Contract for Building & Civil Engineering Construction NZS 3910: 2003*

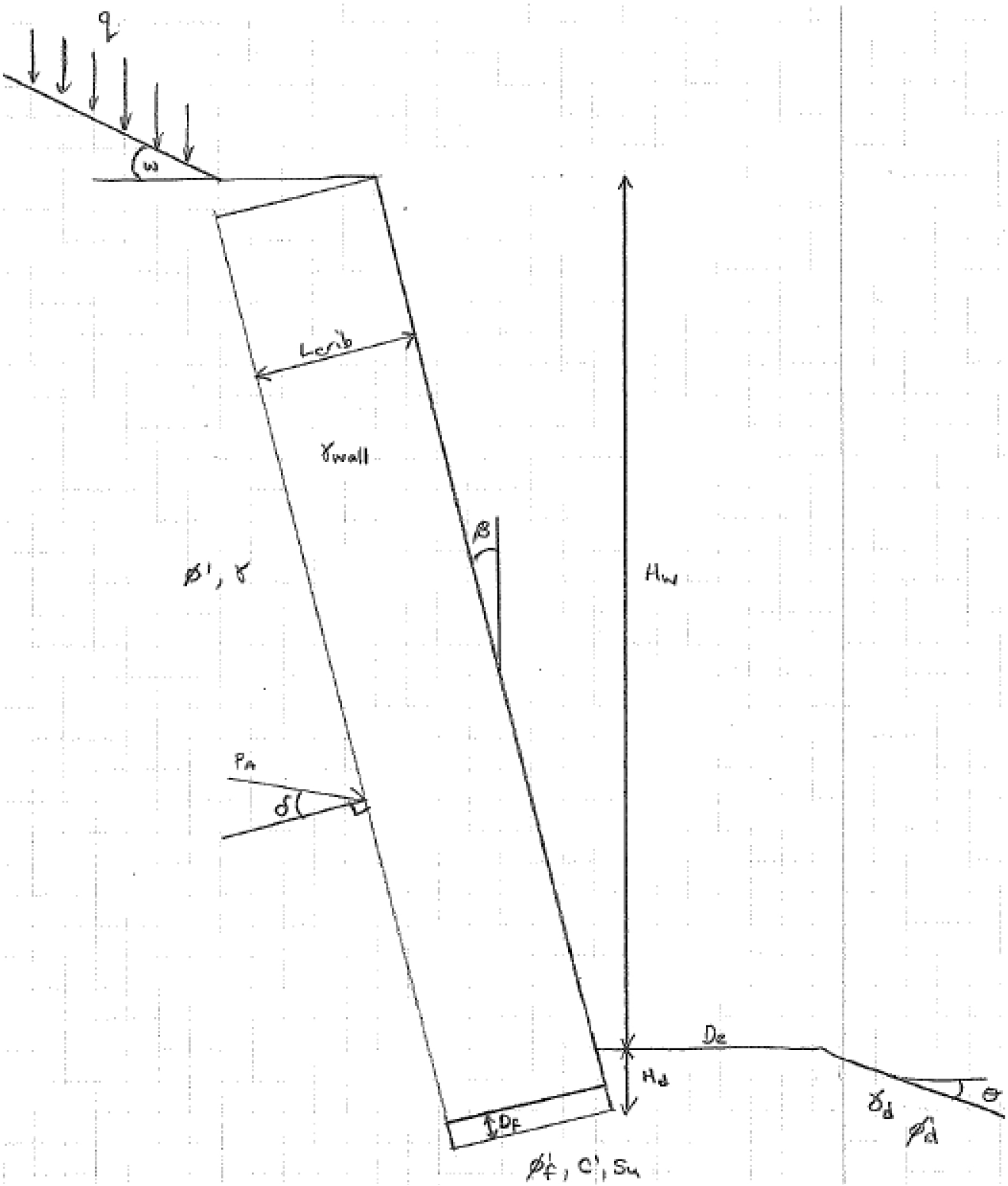
2 *NZIA Standard Conditions of Contract SCC 2007 (1st edition)*

3 *Guideline on the Briefing & Engagement for Consulting Engineering Services (ACENZ/IPENZ 2004)*

www.acenz.org.nz
www.ipenz.org.nz
www.nzia.co.nz

CRIB RETAINING WALL

INPUTS



Limit state Load Factors

Static Active Earth Thrusts $LF_{soil} := 1.5$

Seismic Active Earth Thrusts $LF_{seis} := 1$

Live loads $LF_{sur} := 1.5$

Dead loads that Improve Stability $LF_{wall} := 1$

Strength reduction factors

Static and seismic bearing failure $SRF_{bearing} := 0.5$

Static and seismic sliding failure $SRF_{sliding} := 0.8$

Static and seismic passive earth pressure $SRF_{passive} := 0.5$

Upslope parameters

Soil density $\gamma := 18.0 \frac{kN}{m^3}$

Backslope gradient $\omega := 0°$

Surcharge above wall (within active wedge) $q := 2.50 \frac{kN}{m^2}$

Friction angle $\phi' := 30°$

Downslope parameters

Downslope gradient $\theta := 32°$

Downslope Friction angle $\phi'_d := 40°$

Downslope soil density $\gamma_d := 21 \frac{kN}{m^3}$

Distance from toe to sloping ground $D_e := 0m$

Foundation parameters

Foundation friction angle $\phi'_f := 40°$

Surcharge at base $q_f := 0 \frac{kN}{m^2}$

Effective Stress cohesion $c' := 5kPa$

Undrained shear strength of foundation $S_u := 50 \frac{kN}{m^2}$

Wall Parameters

Standard Crib Sizes
900mm
1200mm
1500mm

Wall Height $H_w := 1.8m$

Crib size $L_{crib} := 0.825m$

Wall Length $L_w := 10.0m$

Wall gradient $\beta := 14°$

Wall density $\gamma_{wall} := 18.5 \frac{kN}{m^3}$

Wall friction angle $\delta := 15°$

Thickness of foundation $D_f := 0.15m$

Buried Height $H_d := 0.0m$

Note: Ignore passive earth pressure if there is a possibility of the soil in front of the foundation being removed by erosion or by building or landscaping work in the future.

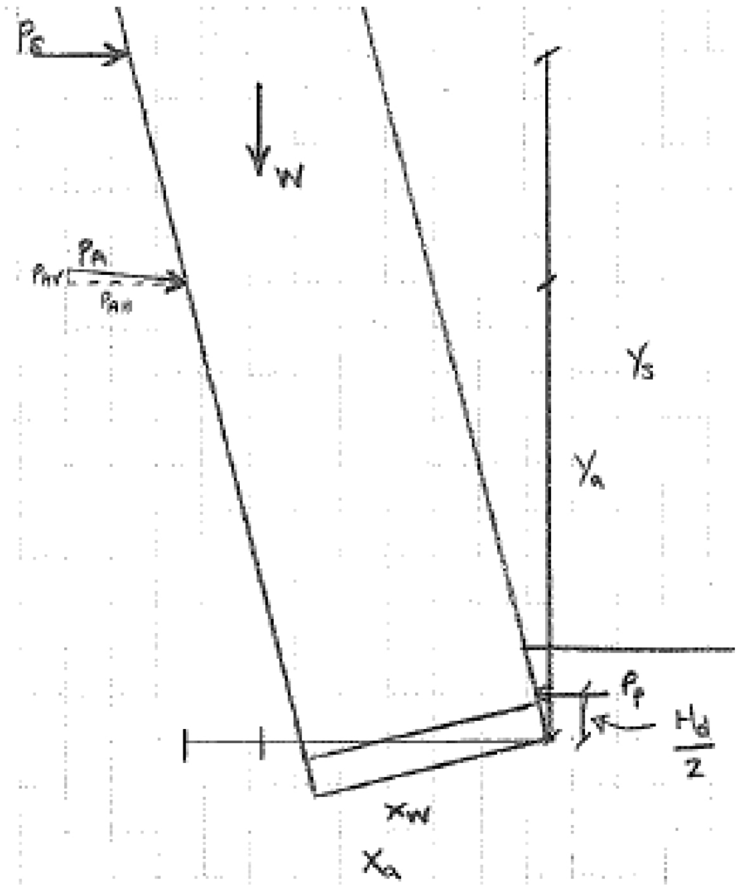
Earth Pressure Coefficients

Calculate K_A and K_P using Coulomb Earth Pressure for cohesionless soil with constant backfill slope.

$$K_A := \frac{(\cos(\phi' + \beta))^2}{\cos(\beta)^2 \cdot \cos(\delta - \beta) \cdot \left(1 + \sqrt{\frac{\sin(\phi' + \delta) \cdot \sin(\phi' - \omega)}{\cos(\delta - \beta) \cdot \cos(\omega + \beta)}}\right)^2} \qquad K_A = 0.214$$

$$K_P := \frac{\left(\cos\left(\phi'_d - \beta\right)\right)^2}{\cos(\beta)^2 \cdot \cos(\delta - \beta) \cdot \left(1 - \sqrt{\frac{\sin\left(\phi'_d - \delta\right) \cdot \sin\left(\phi'_d + \theta\right)}{\cos(\delta - \beta) \cdot \cos(\theta + \beta)}}\right)^2} \qquad K_P = 14.989$$

CALCULATIONS



Wall Geometry

Width of wall at ground level	$B_h := \frac{L_{crib}}{\cos(\beta)}$	$B_h = 0.85\,m$
Footing width	$B := L_{crib} \cdot \cos(\beta)$	$B = 0.8\,m$
Total Height of wall	$H := H_w + H_d$	$H = 1.8\,m$
Vertical distance of weight from toe	$\Upsilon_w := \frac{H}{2} - \frac{L_{crib}}{2} \cdot \sin(\beta)$	$\Upsilon_w = 0.8\,m$
Horizontal distance of weight from toe	$X_w := \frac{B_h}{2} + \Upsilon_w \cdot \tan(\beta)$	$X_w = 0.625\,m$
Vertical distance of surcharge from toe	$\Upsilon_s := \frac{H}{2}$	$\Upsilon_s = 0.9\,m$
Horizontal distance of surcharge from toe	$X_s := B_h + \Upsilon_s \cdot \tan(\beta)$	$X_s = 1.075\,m$
Vertical distance of active pressure from toe	$\Upsilon_a := \frac{H}{3}$	$\Upsilon_a = 0.6\,m$
Horizontal distance of active pressure from toe	$X_a := B_h + \Upsilon_a \cdot \tan(\beta)$	$X_a = 1\,m$

Active thrusts

Unfactored active thrusts

Unfactored static active thrust per m from upslope soil (backfill)	$P_{auf} := K_A \cdot \gamma \cdot \frac{H^2}{2}$	$P_{auf} = 6.233 \cdot \frac{kN}{m}$
Unfactored static active thrust per m from surcharge	$P_{suf} := K_A \cdot q \cdot H$	$P_{suf} = 0.962 \cdot \frac{kN}{m}$
Total unfactored static thrust per m of wall	$P_{Tuf} := P_{suf} + P_{auf}$	$P_{Tuf} = 7.195 \cdot \frac{kN}{m}$

Factored active thrusts

Factored static active thrust per m from upslope soil (backfill)	$P_a := P_{auf} \cdot LF_{soil}$	$P_a = 9.349 \cdot \frac{kN}{m}$
Factored static active thrust per m from surcharge	$P_s := P_{suf} \cdot LF_{sur}$	$P_s = 1.443 \cdot \frac{kN}{m}$
Total factored static thrust per m of wall	$P_T := P_s + P_a$	$P_T = 10.792 \cdot \frac{kN}{m}$

Weights and Vertical Forces

Unfactored weight of wall	$W_{wuf} := \gamma_{wall} \cdot H \cdot B_h$	$W_{wuf} = 28.314 \cdot \frac{kN}{m}$
Factored vertical component of active soil thrust	$P_{avuf} := P_{auf} \cdot \sin(\delta - \beta)$	$P_{avuf} = 0.109 \cdot \frac{kN}{m}$
Factored weight of wall and soil above wall	$W_w := W_{wuf} \cdot LF_{wall}$	$W_w = 28.314 \cdot \frac{kN}{m}$
Factored vertical component of active soil thrust	$P_{av} := P_{avuf} \cdot LF_{soil}$	$P_{av} = 0.163 \cdot \frac{kN}{m}$
Factored vertical force on foundation	$V_r := W_w + P_{av}$	$V_r = 28.477 \cdot \frac{kN}{m}$

Horizontal Forces applied to the foundation

Unfactored horizontal component of active soil thrust	$P_{ahuf} := P_{auf} \cdot \cos(\delta - \beta)$	$P_{ahuf} = 6.232 \cdot \frac{kN}{m}$
Factored horizontal component of active soil thrust	$P_{ah} := P_{ahuf} \cdot LF_{soil}$	$P_{ah} = 9.348 \cdot \frac{kN}{m}$
Factored Passive thrust from downslope soil	$P_p := K_P \cdot \gamma_d \cdot \frac{{H_d}^2}{2} \cdot SRF_{passive}$	$P_p = 0 \cdot \frac{kN}{m}$

Moments about toe

Overturning moment	$M_o := P_{ah} \cdot \Upsilon_a + P_s \cdot \Upsilon_s$	$M_o = 6.907 \cdot kN$
Restoring Moment	$M_r := W_w \cdot X_w + P_{av} \cdot X_a + P_p \cdot \frac{H_d}{2}$	$M_r = 17.849 \cdot kN$

Check := | "Overturning moment does not exceed resisting moment" if $M_o < M_r$
| "Overturning moment exceeds resisting moment" otherwise

Check = "Overturning moment does not exceed resisting moment"

Horizontal distance (from foundation downslope toe) of vertical reaction	$\varepsilon := \frac{M_r - M_o}{V_r}$	$\varepsilon = 0.384\, m$

Check := | "Resultant force acts within middle third - position is stable" if $|\varepsilon| > \frac{B}{6}$
| "Resultant force doesn't act within middle 1/3 - consider potensial for consolidations" otherwise

Check = "Resultant force acts within middle third - position is stable"

Bearing strength of strip foundation - using B1/VM4 method

Ultimate bearing strength

Analysis type Drained, $A_n = 1$, undrained $A_n = 0$ $A_n := 1$

$$q_u := \begin{cases} c' \cdot \lambda_{cs} \cdot \lambda_{cd} \cdot \lambda_{ci} \cdot \lambda_{cg} \cdot N_c + q' \cdot \lambda_{qs} \cdot \lambda_{qd} \cdot \lambda_{qi} \cdot \lambda_{qg} \cdot N_q + 0.5\gamma \cdot B' \cdot \lambda_{\gamma s} \cdot \lambda_{\gamma d} \cdot \lambda_{\gamma i} \cdot \lambda_{\gamma g} \cdot N_\gamma & \text{if } A_n = 1 \\ S_u \cdot \lambda_{cs} \cdot \lambda_{cd} \cdot \lambda_{ci} \cdot \lambda_{cg} \cdot N_c + q' \cdot \lambda_{qg} & \text{otherwise} \end{cases}$$

$$\phi'_{fa} := \begin{cases} \phi'_f & \text{if } A_n = 1 \\ 0 & \text{otherwise} \end{cases}$$

Effective footing width $B' := 2\varepsilon$ $B' = 0.768\,m$

To assume that the foundation is long compared to width then set L'=1 $L' := 1m$

Effective footing area $A' := B' \cdot L'$ $A' = 0.768\,m^2$

Effective stress surcharge pressure in front of wall $q' := \gamma_d \cdot D_f + q_f$ $q' = 3.15 \cdot \frac{kN}{m^2}$

Unfactored horizontal load $H_{uf} := (P_{suf} + P_{ahuf}) \cdot L'$ $H_{uf} = 7.194 \cdot kN$

Unfactored vertical load $V_{uf} := (W_{wuf} + P_{avuf}) \cdot L'$ $V_{uf} = 28.422 \cdot kN$

Factored horizontal load $H' := (P_s + P_{ah}) \cdot L'$ $H' = 10.79 \cdot kN$

Bearing capacity factors

Surcharge factor $N_q := e^{\pi \tan(\phi'_{fa})} \cdot \left(\tan\left(45° + \frac{\phi'_{fa}}{2}\right)\right)^2$ $N_q = 64.195$

Cohesion factor $N_c := \begin{cases} 5.14 & \text{if } \phi'_{fa} = 0° \\ \left[(N_q - 1)\cot(\phi'_{fa})\right] & \text{otherwise} \end{cases}$ $N_c = 75.313$

Self weight factor $N_\gamma := 2 \cdot (N_q - 1) \cdot \tan(\phi'_{fa})$ $N_\gamma = 106.054$

Shape factors

Surcharge factor $\lambda_{qs} := \begin{cases} 1 & \text{if } L' = 1m \\ 1 + \left(\frac{B'}{L'}\right)\tan(\phi'_{fa}) & \text{otherwise} \end{cases}$ $\lambda_{qs} = 1$

Cohesion factor $\lambda_{cs} := \begin{cases} 1 & \text{if } L' = 1m \\ 1 + \left(\frac{B'}{L'}\right) \cdot \left(\frac{N_q}{N_c}\right) & \text{otherwise} \end{cases}$ $\lambda_{cs} = 1$

Self weight factor $\lambda_{\gamma s} := \begin{cases} 1 & \text{if } L' = 1m \\ 1 - 0.4\left(\frac{B'}{L'}\right) & \text{otherwise} \end{cases}$ $\lambda_{\gamma s} = 1$

Depth factors

$$k := \begin{cases} \operatorname{atan}\left(\frac{D_f}{B'}\right) & \text{if } \frac{D_f}{B'} > 1 \\ \frac{D_f}{B'} \end{cases}$$ $k = 0.195$

Surcharge factor $\lambda_{qd} := 1 + 2.\tan(\phi'_{fa})\cdot(1 - \sin(\phi'_{fa}))^2\cdot k$ $\lambda_{qd} = 1.042$

Cohesion factor

$$\lambda_{cd} := \begin{cases} 1 + 0.4\cdot k & \text{if } \phi'_{fa} = 0° \\ \lambda_{qd} - \frac{(1 - \lambda_{qd})}{N_q\cdot\tan(\phi'_{fa})} & \text{otherwise} \end{cases}$$ $\lambda_{cd} = 1.043$

Self weight factor $\lambda_{\gamma d} := 1$ $\lambda_{\gamma d} = 1$

Load Inclination Factors

Surcharge factor for horizontal loading parallel to the x direction (parallel to B)

$$\lambda_{qi} := \begin{cases} 1 & \text{if } \phi'_{fa} = 0° \\ \left(1 - \frac{0.7H_{uf}}{V_{uf} + A'\cdot c'\cdot\cot(\phi'_{fa})}\right)^3 & \text{otherwise} \end{cases}$$ $\lambda_{qi} = 0.609$

Cohesion factor
For horizontal loading parallel to L

$$\lambda_{ci} := \begin{cases} \text{if } \phi'_{fa} = 0° \\ \quad \begin{cases} 0.5\left(1 + \sqrt{1 - \frac{H'}{A'\cdot S_u}}\right) & \text{if } 1 - \frac{H'}{A'\cdot S_u} \geq 0 \\ 0.5\left(1 + \sqrt{1 - 1}\right) & \text{otherwise} \end{cases} \\ \frac{\lambda_{qi}\cdot N_q - 1}{N_q - 1} & \text{otherwise} \end{cases}$$ $\lambda_{ci} = 0.602$

Self weight factor for horizontal loading parallel to the x direction (parallel to B)

$$\lambda_{\gamma i} := \begin{cases} 1 & \text{if } \phi'_{fa} = 0° \\ \left(1 - \frac{H_{uf}}{V_{uf} + A'\cdot c'\cdot\cot(\phi'_{fa})}\right)^3 & \text{otherwise} \end{cases}$$ $\lambda_{\gamma i} = 0.478$

Ground inclination factors

Surcharge factor

$$\lambda_{qg} := \begin{cases} 1 & \text{if } D_e > 2B \\ \left[1 - \tan\left[\theta\cdot\left(1 - \frac{D_e}{2\cdot B}\right)\right]\right]^2 & \text{otherwise} \end{cases}$$ $\lambda_{qg} = 0.141$

Cohesion factor

$$\lambda_{cg} := \begin{cases} 1 & \text{if } D_e > 2B \\ 1 - \frac{\theta}{150}\cdot\left(1 - \frac{D_e}{2B}\right) & \text{otherwise} \end{cases}$$ $\lambda_{cg} = 0.996$

Self weight factor $\lambda_{\gamma g} := \lambda_{qg}$ $\lambda_{\gamma g} = 0.141$

Ultimate bearing strength of foundation

$$q_u := \begin{cases} c' \cdot \lambda_{cs} \cdot \lambda_{cd} \cdot \lambda_{ci} \cdot \lambda_{cg} \cdot N_c + q' \cdot \lambda_{qs} \cdot \lambda_{qd} \cdot \lambda_{qi} \cdot \lambda_{qg} \cdot N_q + 0.5\gamma \cdot B' \cdot \lambda_{\gamma s} \cdot \lambda_{\gamma d} \cdot \lambda_{\gamma i} \cdot \lambda_{\gamma g} \cdot N_\gamma & \text{if } A_n = 1 \\ S_u \cdot \lambda_{cs} \cdot \lambda_{cd} \cdot \lambda_{ci} \cdot \lambda_{cg} \cdot N_c + q' \cdot \lambda_{qg} & \text{otherwise} \end{cases}$$

$$q_u = 303.005 \cdot \frac{kN}{m^2}$$

Design bearing strength $q_{dbs} := q_u \cdot SRF_{bearing}$ $q_{dbs} = 151.503 \cdot \frac{kN}{m^2}$

Ignore local shear - i.e. assume a general shear failure of the soil

Design bearing pressure $q_d := \frac{W_w}{B'}$ $q_d = 36.843 \cdot \frac{kN}{m^2}$

Check := | "Design bearing pressure does not exceed design bearing strength" if $q_d < q_{dbs}$
| "Design bearing pressure exceeds design bearing strength" otherwise

Check = "Design bearing pressure does not exceed design bearing strength"

Sliding resistance

Component of factored vertical force normal to foundation base per metre $V_{sy} := V_r \cdot \cos(\beta)$ $V_{sy} = 27.631 \cdot \frac{kN}{m}$

Component of factored vertical force parallel to foundation base per metre $V_{sx} := V_r \cdot \sin(\beta)$ $V_{sx} = 6.889 \cdot \frac{kN}{m}$

Component of factored passive force parallel to foundation base per metre $P_{ps} := \frac{P_p}{\cos(\beta)}$ $P_{ps} = 0 \cdot \frac{kN}{m}$

Component of factored horizontal force parallel to foundation base per metre $H'_s := \frac{H'}{L' \cdot \cos(\beta)}$ $H'_s = 11.121 \cdot \frac{kN}{m}$

Ultimate shear strength between the base of the foundation and the ground per metre $S_r := c' \cdot B' + V_{sy} \cdot \tan(\phi'_f)$ $S_r = 27.027 \cdot \frac{kN}{m}$

Assume foundations are cast insitu then angle of shearing resistance between foundation and soil is the same as the friction angle of the soil

Ultimate design sliding resistance $S := SRF_{sliding} \cdot S_r + SRF_{passive} \cdot P_{ps} + V_{sx} \cdot SRF_{sliding}$

$$S = 27.133 \cdot \frac{kN}{m}$$

Check := | "Design horizontal load does not exceed the design sliding resistance" if $H'_s \leq S$
| "Design horizontal load exceeds the design sliding resistance" otherwise

Check = "Design horizontal load does not exceed the design sliding resistance"

Phi Group
engineering for the environment

PHI GROUP NZ LTD
46 View Rd, Waiheke
PO Box 304, Waiheke, Auckland,
NEW ZEALAND
Fax 64 (9) 372 6943 Ph 64 (9) 372 6941
E-mail : phigroupnz@xtra.co.nz
www.phigroup.co.nz

Email

To:	Tonkin & Taylor : Tauranga	**From:**	[redacted]
Email:	[redacted]	**Pages:**	1 of 6
Attn:		**Date:**	16th June 2011
Re:	Permacrib Proposal - Second Oruahine Track Slip, Mt Maunganui		

Visit our Website at : ***www.phigroup.co.nz***

Hi [redacted]

Further to your 13.6.11email I am pleased to provide our design proposal and quotation based on the information received. As instructed I have adopted the H916 Permacrib size in keeping with the first Oruahine Track Slip wall which was constructed in April/May this year.

1. DESIGN

Please find attached : a) elevation ; b) typical section ; c) engineering calculations.

I have adopted a conservative design soil friction angle (inclusive of an allowance for cohesion) of 30 degrees. A 2.5kPa track traffic surcharge has been applied right to the front face of the wall. The foundation design is based on allowable bearing capacities of 50kPa.

Please note that overall global stability of the slope below the wall is outside the scope of this design proposal and is left to your expert assessment.

As a matter of course I normally include a draincoil at the rear of the wall, however in this instance I am happy to leave this aspect of the design to your care. As per standard engineering practice, it is important that any up-slope surface water is adequately controlled to flow around or away from the retaining wall, both during construction and after completion.

Should a fence be required to be positioned close to the wall face, fence posts can be set directly into the crib infill via appropriate diameter plastic pipe formers, inserted during wall construction at the correct horizontal spacing. The posts are then concreted into the former pipes after the wall has been completed. Please note that fence cladding should be wind permeable (mesh or hit & miss). Solid fencing is not recommended due to high potential wind loadings.

Please note that while our design service is free of charge, it is exclusive to our proprietary Permacrib System. In order to avoid conflicts with our intellectual property and patents, any alternative retaining wall system must be required to prepare their own design specific to their own system.

2. PERMACRIB QUOTATION

[redacted]

s 7(2)(b)(ii) - Commercial Position

3. CONSTRUCTION COSTS

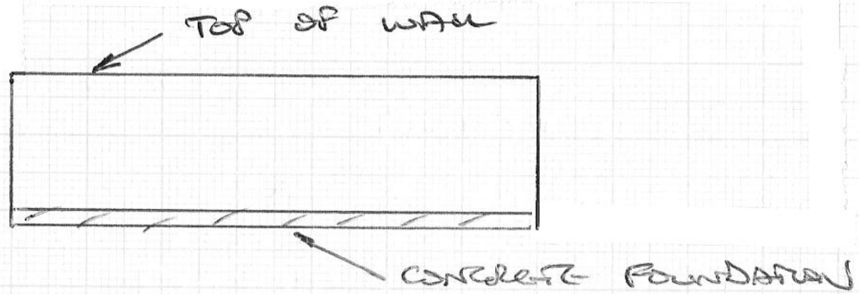
[redacted]

s 7(2)(b)(ii) - Commercial Position

I look forward to being of further assistance.

[redacted]

s 7(2)(a) - Privacy



DISTANCE	0.0	7.0
HEIGHT	1.8	1.8
PERMACRIB	H916 13m²	

PERMACRIB ELEVATION

SECOND ORUAHINE TRACK SLIP - MT MAUNGANUI

SCALE 1:100

DRAWING 1899-1

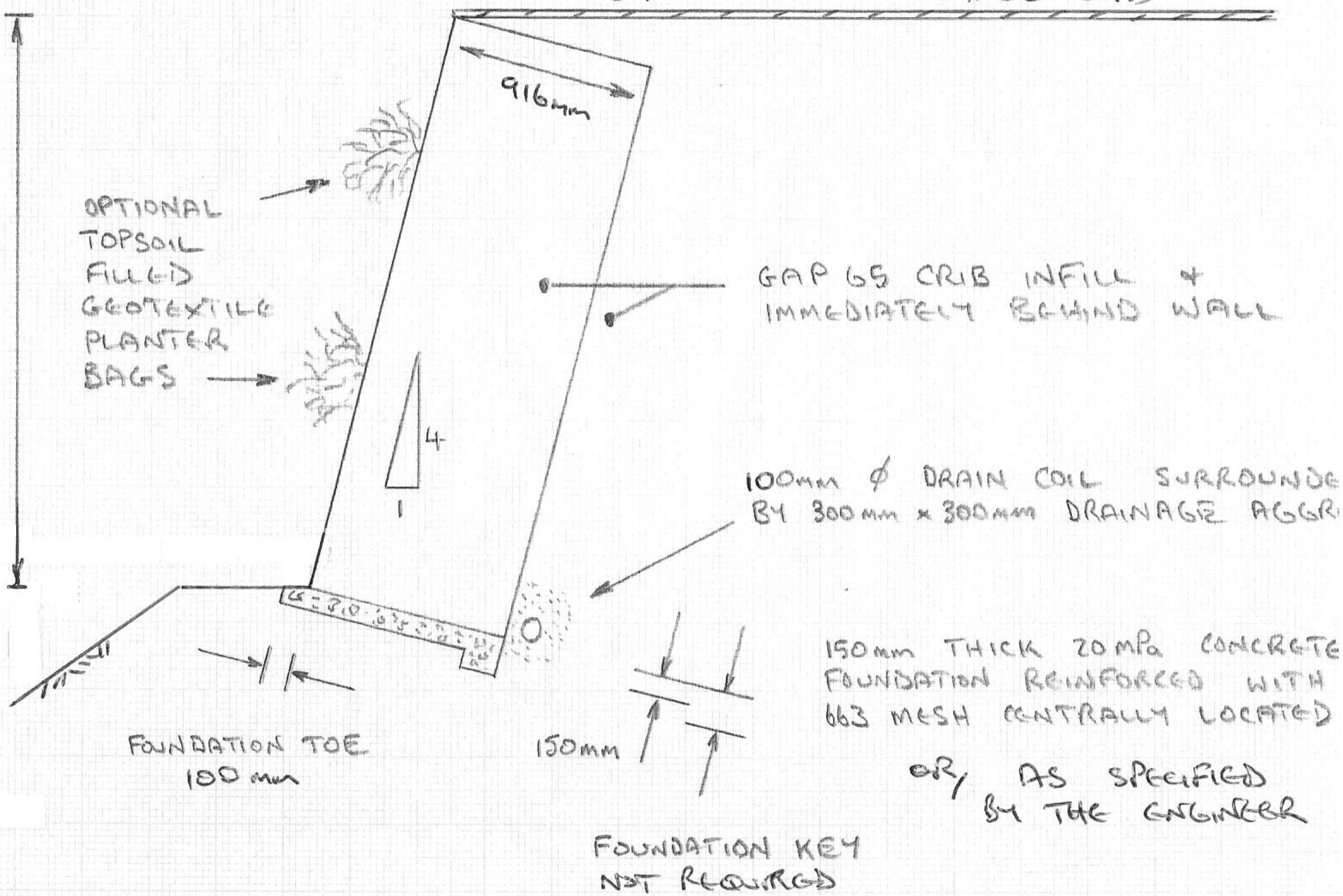
DATE 16.E.11

Phi Group
engineering for the environment
Phi Group NZ Limited
46 View Road
P.O. Box 304, Waiheke
Auckland, New Zealand
Telephone: 64 (9) 372 6941
Facsimile: 64 (9) 372 6943
Email: phigroupnz@xtra.co.nz
www.phigroup.co.nz

Phi Group
engineering for the environment
Phi Group NZ Limited
46 View Road
P.O. Box 304, Waiheke
Auckland, New Zealand
Telephone: 64 (9) 372 6941
Facsimile: 64 (9) 372 6943
Email: phigroupnz@xtra.co.nz
www.phigroup.co.nz

TYPICAL PERMACRIB SECTION

SECOND ORUAHINE TRACK SLIP, MT MAUNGANUI



NOT TO SCALE

DRAWING 1899-2

DATE 16.6.11

PHI GROUP NZ LTD.
PERMACRIB CRIBWALL DESIGN
Version 8.0 May, 2000

PHI GROUP NZ LTD
AUCKLAND, NZ
Tel: +64-9-372 6941

CLIENT:	Tonkin & Taylor Tauranga	**DATE:**	16-Jun-11
		PAGE:	1
PROJECT:	Second Oruahine Track Slip Wall Mt Maunganui	**REF:**	H916 to 1.8m Maximum Height

Wall Infill Density 18.0 kN/m³

INPUT PARAMETERS

RETAINED SOIL PARAMETERS

Angle of Internal Friction (phi)	30	deg
Density	18.0	kN/m³

BASE SOIL PARAMETERS

Angle of Internal Friction	30	deg
Bearing Cap-allowable	50	kPa
Bearing Cap-ultimate	150	kPa

FOOTING GEOMETRY

Toe width	t	0.10	m
Toe depth	f(f)	0.15	m
Heel depth	f(h)	0.15	m
Depth passive resist.	T+f(f)-x	0.00	

WALL GEOMETRY

Height	H	1.80	m
Buried depth	T	0.00	m
Batter slope	alpha	104.04	deg

SURCHARGE LOADS

Backfill		
Surcharge angle beta	0.00	deg
Top set back S	0.00	m
Length of surcharge slope L(s)	0.00	m
Uniform surcharge q	2.50	kPa
Surcharge offset s(q)	0.00	m

SEISMIC REQUIREMENTS

Seismic coefficient CF	0.00	CF

INPUT SINGLE DEPTH	Model
Trial	916

INPUT MULTI DEPTH	Model
Front	0
Second depth	0
Third depth	0
Ratio xb/xf	0 %

STACKED WALL (Y/N)=> N
REVERSE WALL (Y/N)=> N

STACKED WALL	Model
Top Header	0
Mid Header	0
Lower Header	0

REVERSE WALL	Model	Tier Height metres	
Front Header	0	0.00	T1
Middle Header	0	0.00	T2
Rear Header	0	AUTO	T3

Information in this design aid does not constitute a complete design and is tendered as advice only.

ENTER DESIGN METHOD (D.M.)
D.M. = F
(L = Limit State, F = Factors of Safety)

ENTER DESIGN CODE Titles = 10
SEISMIC DESIGN (Y/N) = N

REQUIRED FACTORS OF SAFETY

Overturning FOSOT = 2.0
Sliding FOSSL = 1.5

Active Earth Pressure Ka = 0.208
Wall/Soil Friction delta = 20 deg
Wall/Soil Base COF = 0.36

SINGLE DEPTH H = 1.80 m
STATIC CONDITIONS, UNIFORM SURCHARGE = 2.50 kPa

DESIGN SELECTED Header 916
Header
Header

	Effect depth	FOS OT	FOS SL	Bearing Pressure at toe	at heel
Total Wall	0.803	4.85	2.28	26	41
Top Section	N.A.	N.A.	N.A.		
Mid section	N.A.	N.A.	N.A.		
Sliding of wall on footing			3.30		

Reaction in middle third of wall at base of crib ? OK
at base of mid. section ? N.A.
at base of top section ? N.A.

LOADS

(Horiz. Component)	Pa(total) =	8.34	kN
(Horiz. Component)	Pa(surcharge) =	1.10	kN
	OTM(O) =	3.43	kN.m
	MR(O) =	16.67	kN.m
	W =	26.49	kN