130

PUBLIC EXCLUDED

19.20.2.1

To: **WHAKATANE DISTRICT COUNCIL MEETING**

Meeting Date: **WEDNESDAY, 7 MARCH 2012**

PUBLIC EXCLUDED REPORT FOR AGENDA

Written by: **ACTING GENERAL MANAGER INFRASTRUCTURE**

Subject: **MATATA REGENERATION AWATARARIKI STREAM - DEBRIS FLOW MITIGATION WORKS**

1.0 REASON FOR THE REPORT

The reason for this report is to provide the Council with an update on the project to mitigate Debris Flows from the Awatarariki Stream and to provide the Council with an independent review of the current Debris Detention Structure (DDS) project.

2.0 BACKGROUND

Following the May 2005 Debris Flow event in Matata the Council agreed to five specific projects to reduce the risk to the community of future Debris Flows and flood events.

The Council had initially flagged the intention to build a Dam in the upper catchment of the Awatarariki Stream. This was very controversial and was not supported by many in the community; in particular the iwi groups. The Council proceeded to complete the other projects and agreed to further investigate options for the Awatarariki catchment. After a considerable amount of research into a number of debris flow systems the concept of the Debris Detention Structure (DDS) was put forward. The system consists of a flexible barrier "ring" net suspended across the Awataririki Stream. The concept was supported by the community and most iwi.

The design philosophy was to construct a scheme that would provide the community of Matata protection from an event of similar size to that of the 2005 event.

These flexible barrier nets are extensively used in Switzerland and Japan and elsewhere in the world. There are also many of these nets in New Zealand, some of which are in Whakatane. The nets in New Zealand and abroad are significantly smaller than that proposed. The proposed Matata net would be the largest ever constructed in New Zealand. The net consists of open rings of approximately 1.2 m in diameter. Therefore people can still walk the length of the stream and gain access through the net, the stream is not blocked in any way during everyday stream flows so the environmental impact during non events is limited to the construction phase.

The primary purpose of the net is to protect the community from destructive flows of a similar size event to 2005. It is now well understood that future events of a similar magnitude are possible in Matata. The scheme is for the protection of residents in Clem Elliott Drive, the western side of Arawa and Richmond Streets, along with road and rail users.

3.0 DISCUSSION

Consents

In mid 2009 the Council lodged a proposed Resource Consent application for a DDS to the consent authorities of regional and district Councils, in order to have their technical staff review the application and request information in an attempt to incorporate any extra information in the formal Resource Consent application. In March 2010 the Council lodged a formal application.

The Bay of Plenty Regional Council and the Whakatane District Council's Independent Commissioner made a decision that the application could be processed on a non notification basis under the Resource Management Act. The consent is now substantially through the consent process. The consent is now on hold. This has been requested by staff to reduce public expectation that may follow from the granting of the consent.

The Council was preparing to lodge (as applicant) a building consent application for the structure in November 2011. However at this point, due to reservations that the engineering consultants had with the DDS design parameters and changes in the proposed structure; the building consent was not lodged.

Review

In February 2012 the Chief Executive commissioned an independent review of the development of the DDS project based on existing literature, reports and interviews with key people involved with the project (report attached). The review was prompted by concern expressed by the Council's consulting engineer about the feasibility of the final proposed structure. The review was undertaken by CPG Ltd.

The CPG report highlights a number of key risks

- Due to the increase in size and the exponential calculation factors now involved the design of the proposed structure is untested;
- There is a high level of risk associated with the strength of the anchoring material and the design;
- The risk to people and property may increase if increased property development occurs within the fan area (should the structure fail or the event is larger than the 2005 event);
- The design life of the structure is less than what would normally be expected for the purpose;
- The construction costs have increased more than three fold since the structure was first proposed and there is a high level of uncertainty with current estimates;
- The cost to clear and repair the net after a large event is substantial;
- Peer review concerns regarding the viability of the proposal

Matters to be considered

A decision to review/replace or not progress with the current DDS project also presents a number of risks to Council. In order to fully understand the implications of a change to the DDS project a range of information is required including;

Legal
Legal Advice regarding Resource and Building consents that have been issued (with the knowledge that Council was planning to construct a DDS);
Contractual obligations;

Advice around the consideration of alternative solutions.

Funding Commitments
Commitments and conditions for funding already received and work (infrastructure) undertaken by other stakeholders in the knowledge that Council was planning to complete debris flow mitigation works.

Financial Implications
Accurate costings and funding impact for the proposed DDS if it is to proceed;
Implications for costs already incurred (and not able to be capitalised) if the proposed DDS does not proceed;
Continued costs vs. the currently provision through the draft LTP and existing budgets.

Communications
Communications Plan to keep the public and those directly affected property owners and stakeholders informed and to enable their concerns/input to be received.

Council Plans
Implications for the Councils LTP and District Plan if the DDS project was to change.

Resourcing
The establishment of a Project Control Group for the Debris Flow Mitigation works and staff/consultant resource required to support a review.

Consenting
Some works planned were reliant on the consent for the construction of the DDS (such as earthworks in the Clem Elliott Road area). Other consents also assumed the construction of the DDS and may contain conditions that will not be appropriate if the structure does not progress.

4.0 ASSESSMENT OF SIGNIFICANCE

This project was included in the 2009-2019 LTCCP due to its high significance. A decision not to proceed in the future is likely to be a decision of significance; both in terms of the financial implications and other criteria under the Policy for Determining Significance.

5.0 OPTIONS

The Council could continue working towards the completion of the DDS, by allowing the consent to be granted and by continuing to work with engineers to enable application of a building consent. However given the risks highlighted by Tonkin and Taylor and CPG Ltd, this is not considered prudent.

The Council can request further information on the implications of a change to the current Debris Flow Mitigation works project to enable future decisions on the future of the project to be made. This will entail further reporting to Council on the implications of a change to the current proposal.

6.0 RISK

As previously discussed the Debris Flow Mitigation works project (DDS) as presented now is extremely high risk, and for this reason a review of the project is recommended.

7.0 FINANCIAL BUDGET IMPLICATIONS

The available funds for the DDS project at year end (2010/2011) was $1,387,829 plus the balance in reserves as at year end 2010/2011 of $807,433. This leaves a total available budget of $2,195,262 for 2011/12; approximately $150,000 is required for the construction of flood walls in the Waitepuru Stream leaving just over $2million for the DDS.

NOTE: The finance team are currently reviewing the reserve accounts to confirm this balance for Hazard Mitigation (reserves balance include, Subsidy from DOC, Interest on Central Government subsidy misc sales and subsidies from NZTA)

The estimated construction cost for the flexible barrier is currently $5–7m.

In 2005 the Council budgeted $200,000 for all Resource Management costs. At that time it was expected that all applications for Matata Regeneration Projects would be treated as non notified.

The summary provided to the Council at the end of the 2009/2010 financial year identified that the total cost for all Resource Management processes at that time was $1,199,628. Two applications were processed under the notification provisions of the Resource Management Act and those two decisions were appealed to the Environment Court occurring considerable extra costs. No additional budget has been allowed to cover these additional costs. Further expenditure on the debris detention project alone for the 2010/11 financial year and year to date 2011/12 is a further $236,707.

8.0 COMMUNITY INPUT

There has been substantial community input in the early stages of the development of this project. More recently work has revolved around the technical and engineering aspects of the design and therefore engagement has been limited to keeping residents up to date with progress through the consent process. Direct discussions with impacted residents and stakeholders is required as part of a communications plan.

9.0 CONCLUSION

As part of a pack of mitigation works the Council provided for the construction of a Debris Flow Mitigation Structure. The scale and cost of the structure has increased significantly since being selected by Council as a preferred option for mitigation in 2008/09.

The Council has applied significant cost and resource towards obtaining an appropriate solution for Awatarariki Stream debris flows. The proposed Debris Detention Structure is currently towards the end of a lengthy consenting process. Consultant engineers and an independent review warn that the structure as currently proposed may not be economically or practically feasible.

PUBLIC EXCLUDED

Before the Council can consider the future of the project it needs to understand the implications of a change to the project. Staff will investigate those implications and report back to the Projects and Services Committee so decisions can be made regarding a future direction for Awatarariki Stream debris flow mitigations works.

RESOLUTION:

1. **THAT** the report "Matata Regeneration Awatarariki Stream - Debris Flow Mitigation Works" be received; and

2. **THAT** the Council request that further information be provided on the implications of a change to the Awatarariki Stream Debris Flow Mitigation Works (Debris Detention Structure) including

   - Legal advice
   - Existing Funding Commitments
   - Financial Implications
   - Communications Plan
   - Implications for the LTP and District Plan
   - Resourcing options
   - Project Control Group
   - Consent commitments

3. **THAT** the Council arrange a meeting of major stakeholders and directly impacted property owners to discuss a review of the Awatarariki Stream detention project.

4. **THAT** following the meeting of major stakeholders and directly impacted property owners the Council release these resolutions to the public.

Paula Chapman
ACTING GENERAL MANAGER
INFRASTRUCTURE

Marty Grenfell
CHIEF EXECUTIVE

Attached to this report:

- Matata Debris Flow Mitigation Structure – Overview Review CPG Limited – March 2012

WHAKATANE DISTRICT COUNCIL

Matata Debris Flows Mitigation Structure

Project Review

13th March 2012

CPG New Zealand Ltd

MatataDebris-flows Mitigation

CPG Project No 705054

This report has been prepared for Whakatane District Council by CPG. No liability is accepted by this company or any employee or subconsultant of this company with respect to its use by any other parties.

This disclaimer shall apply notwithstanding that the report may be made available to other persons for an application for permission or approval to fulfil a legal requirement.

Quality Statement

Task	Responsibility	Signature
Project Manager	Rick Grobecker	
Prepared by	Rick Grobecker	
Reviewed by	Iain McIntosh	
Approved by	Rick Grobecker	

Revision Schedule

Revision No	Date	Description	Prepared by	Reviewed by	Approved by

Prepared by:

CPG New Zealand Ltd
23 Taranaki Street
PO Box 6643
Wellington 6141
New Zealand

Telephone: +64 4 384 2029
Fax: +64 4 384 5065
Email: wellington@nz.cpg-global.com

File No:
Job No 705054
Date:13th March 2012
Ref: X:704054 Matata Debris Structure Review RG

Matata Debris Structure
Project Review

TABLE OF CONTENTS

EXECUTIVE SUMMARY

On May 18th 2005 the most significant debris-flows event ever to have occurred within a New Zealand urban setting impacted the village of Matata. The largest of these debris-flows originated within the catchment of the Awatarariki Stream, located at the western edge of the village. These flows deposited an estimated 250,000m^3 of debris onto the coastal strip within the general area of Clem Elliot Drive.

CPG has been engaged by WDC, "*to confirm or otherwise the T&T concerns and recommendation*" and assess if there is a current "*feasible solution which adequately mitigates risk to people and property*".

It was estimated that the rainfall that caused the debris-flows had a return period of between 200 – 500 years. In addition it was estimated that peak debris and water discharges in the streams flowing to Matata were estimated to have been between 5 and 20 times the theoretical 100 year flood discharges. Debris-flows are more dangerous than floods in that they make the flooding associated with them much worse than it would be without the debris-flows. Hyperconcentrated flows of sediment-laden water can become so highly charged with sands and silts that it no longer behaves like normal water. For effective engineering mitigation the debris path must be predictable and controlled.

Engineering works comprising of dams or bunds can be designed to contain and manage the physical process of a debris-flows. Three options at Awatarariki were reviewed, and cost-benefit comparison for each considered. It is understood that preliminary investigations into solid debris dam type structures, situated up stream of the railway bridge, met with cultural and environmental opposition. The configuration proposed within T&T's 2009 report, was that some 100,000m^3 of material would be retained behind the structure. The system proposed was to consist of a 15m high flexible barrier accompanied by spillway and fanhead diversion structures.
A cost estimate of the netting proposal, provided to WDC May 2008 by Geobrugg, indicated that the netting component alone would cost $2.1m.

AECOM New Zealand Ltd was retained by WDC to conduct a peer review of the proposed protection works for the resource consent application. The peer reviewers questioned the validity of the numerical modelling that was undertaken by T&T and had concerns over the net and anchor corrosion. The original philosophy, of partial debris capture, was subsequently replaced with the one of complete "in-stream capture" as presented in Tonkin & Taylors Draft 2011 Design Report.
These changes allowed the spillway and fanhead earthworks to be removed, but at the expense of a larger barrier structure and anchorage systems. The current rough order estimate for the current debris netting proposal is $5-7m

Minimal mention has been made of risk management, within the reports reviewed CPG, specifically those risks to human life. On the basis that a debris structure is constructed, it is presumed that greater property development could be anticipated of the fanhead area and its immediate surrounds. Should this be the case and an event larger than the 2005 event occur, or the structure fail, or not perform as anticipated, then potentially the risk to human life would be greater with the construction of a debris structure, than without.

As such with a return period established in the order of 100's of years and a current building property asset value within the unsafe zone, being less than half the current projected build & debris removal costs ($2.6m vs $5-12m), the proposal to proceed with the scheme as detailed, does not indicate a cost-benefit incentive to proceed. This assessment does not include a value against human life for cost-benefit comparison purposes.

It is CPG's view that there is no current financially viable proposal which adequately mitigates risk to people and property and resolves the cultural environmental concerns over a 120 year design life.

1.0 INTRODUCTION

1.1 Introduction

Matata is a coastal community of approximately 700 people located in the eastern Bay of Plenty. On May 18th 2005 the most significant debris-flows event ever to have occurred within a New Zealand urban setting impacted the village of Matata. The debris-flows destroyed or damaged some 100 homes. The largest of these debris-flows originated within the catchment of the Awatarariki Stream, located at the western edge of the village, and it was here that the majority of damaged homes were situated. These flows deposited an estimated 250,000m^3 of debris onto the coastal strip within the general area of Clem Elliot Drive.

Whakatane District Council (WDC) initially engaged Tonkin and Taylor (T&T) to identify responsibilities associated with natural hazard management in the Bay of Plenty and at the same time identify infrastructure and planning options to be considered in order to manage the risk from potential future debris-flows that the town ship might be exposed to.

Since 2005 T&T have provided a number of reports to WDC. These have progressed from the Preliminary Infrastructure and Planning Options Report, dated Aug 2005, through to the Awatarariki Stream Debris Barrier Design Report, (Draft for Discussion), dated Oct 2011.

CPG has been engaged by WDC, *"to confirm or otherwise the T&T concerns and recommendation"* and assess if there is a current *"feasible solution which adequately mitigates risk to people and property"*.

These concerns are summarised in T&T's letter to CPG dated 28th February 2012, appendix I, but in principal question the decision to proceed with the project as currently envisaged, given that the estimated final costs are projected to be significantly more than initially estimated, and may no longer be either financially viable or advisable to the community of Matata and the Whakatane District Council.

This engagement was not a technical peer review of alternative Debris-flows Mitigation options, but was requested solely to provide a review of the current status of the proposed Awatarariki Stream Debris-flows Mitigation Project and make recommendations accordingly.

2.0 PREVIOUS REPORTS& REVIEWS

2.1 Matata Debris Flows: Hazard and Risk Investigation

Tonkin & Taylor Aug 2005
The purpose of this report was to identify responsibilities associated with natural hazard management in the Bay of Plenty region, and more specifically in the Whakatane District. It concluded that under the Resource management Act (1991) both Regional and District Councils are required to control land use for the purposes of avoidance or mitigation of natural hazards (section 30(1) (c) and 31(1) (b)).

In Matata, it was noted that the ability of Council to control development through the resource Management Act processes, (aside from areas already identified in the district plan as being subject to natural hazards), was limited until such time as a Plan Change / Variation extending the hazard zone was promulgated. Until the District Plan could be used to control land use, provisions of the Building Act could be used to control re-building works. The ability to control land use where the land had already been developed would have been extremely limited. It was noted that the Earthquake Commission could limit its liability for future claims associated with redevelopment of sites that had been subject to natural hazards, and that there may be Council liability associated with failure to control redevelopment on at-risk sites.

The report concluded that *"Whilst the Council's ability to control existing land use is limited, there are opportunities available for improved control of redevelopment of damaged properties, and for future development. The council should exercise these controls to reduce future risk of natural hazards to both people and property."*

2.2 The Matata Debris Flows: Preliminary Infrastructure and Planning Options Report

Tonkin & Taylor Aug 2005
This report was prepared in the 12 weeks following the 18th May 2005 event in Matata. Concepts were identified and developed for various hazard management measures that could provide varying degrees of risk mitigation to the community of Matata, both in terms of risk to property and to human life.

The key facts extracted from the various investigations related to the event as measured at Awakaponga was that:

- 308mm of rain fell in a 20hr period from 10pm 17th May 2005
- 106mm of rain fell between 10pm of 17th May and 6 am 18th May
- After a relatively dry period until noon,150mm of rain fell between 2pm and 6pm, which included 30.5mm in a 15 minute period.

As such it was estimated that the rainfall had a return period of between 200 – 500 years, and that the rainfall depths in the catchments behind Matata may have been up to 30% higher than recorded at Awakaponga. In addition it was estimated that peak debris and water discharges in the streams flowing to Matata were estimated to have been between 5 and 20 times the theoretical 100 year flood discharges.

GNS was commissioned to review catchment processes following the event. GNS concluded *that "the primary causative events that inevitability led to the debris-flows damage at Matata were landslips… triggered by exceptionally heavy rain."*

Debris-flows are more dangerous than floods in that they make the flooding associated with them much worse than it would be without the debris-flows. They travel faster than the flow of water alone and pick up all the flood water in their path. Hyperconcentrated flows of sediment-laden water can become so highly charged with sands and silts that it no longer behaves like normal water.

GNS concluded that "*for effective engineering mitigation the debris path must be predictable and controlled, otherwise restricting building was the only safe option*".
Within their recommendations GNS proposed that a bund be constructed on the Matata side of the Awatarariki stream floodway, and that the communities in the wider Bay of Plenty explore the potential of having locally based weather-radar system for advance warning of severe storms.

The effectiveness of an early warning system, based on rain gauges in the catchment, was not considered feasible for the Matata community, due to the speed at which a debris-flow could be expected to travel, 10m/s, combined with the length of time a debris-flows could travel down the entire catchment from top to fanhead 5-10minutes.

Options for mitigation of the risk were identified these broadly fell into two categories:

- Non structural, e.g. land use controls, catchment management, and early warning systems.
- Structural, i.e. debris retention and control structures.

Land use controls would seek to control and or limit development in the area at risk.

Engineering works would be designed to contain and manage the physical process of a debris-flows, alternatives comprising of debris dams or bunds. Debris dams are structures constructed across a stream to block and intercept debris-flows material, whilst debris bunds are structures on the fanhead, designed to impede the avulsion of streams and associated debris-flows and floods. It is important to recognise that management schemes need to be maintained over an extended period of time to remain effective.

The report identified preliminary design parameters and principles, which in the context of the Awatarariki catchment noted that:

- The rainfall that triggered the event had a return period estimated to be less than 500 years, and may be even more frequently than once in 200 years on average.
- This corresponded to a medium (to low) probability category used in the debris-flows protection studies used for Mount Cook Village.
- The corresponding risk level is broadly similar to the standard adopted for design of houses to withstand wind and earthquake loads, which is 1:500 years

Design parameters Awatarariki Stream:

- Design Debris volumes 200,000m^3 (subsequently increased to 250,000m^3)
- 1:100 yr Floodwater flows 44m^3/s
- Debris flood design flows 66m^3/s

For the Awatarariki Stream, eleven options were identified, these ranged from:

- Retreat from hazard, and limit development on fanhead (Option A1)

- Various Debris Dam and or Bunds configurations to control the flow during an event. (Options A2 – A8a)

Capital cost estimates ranged from $1.5m to $9m and would provide a level of protection for between zero, and 60 properties.

It should be noted that the cost for the Retreat from Hazard (Option A1) at $1.5m, allowed for the clean up of the remaining debris and a single span railway bridge.

2.3 The Matata Debris Flow Mitigation: Cost-benefit analysis of options

NZIER Nov 2005

The focus of the cost-benefit analysis of proposed debris-flows and flood mitigation options for the Awatarariki catchment was limited to three options being: the retreat, the preferred and the second best options.

The cost-benefit comparison for each of the considered options was considered for varying discount rates between 3 – 10% as noted below. The assumed life of each mitigation option being 50 years.

$ m's 50 years	Awatarariki		
	A1 Retreat	A2 Preferred	A5 2nd best
Discount rate = 3%			
Cost	14.36	8.87	11.24
Benefit	3.22	4.15	2.48
Discount rate = 5%			
Cost	13.86	7.94	10.63
Benefit	2.28	2.94	1.76
Discount rate = 10%			
Cost	13.30	6.84	9.91
Benefit	1.24	1.60	0.95

Option A1: Retreat from hazard, relocate households from hazard zone to safer ground.

Option A2: Debris dam in catchment and debris flood channel on fanhead along existing Awatarariki stream watercourse.

Option A5: Debris-flows bund and debris flood channel on fanhead along straightened Awatarariki watercourse.

The benefits of each mitigation option were assessed as the value of avoided losses that might otherwise occur, to a limit of a 1-in-200 year magnitude event.

Property acquisition costs, appropriate to each option, were noted as comprising of only those costs for purchasing properties as part of the mitigation works, including those properties within the proposed future debris deposition area. Property values used were rateable valuation as at September 2004.

Within the three options noted above, the property acquisition costs and appropriate capital works costs were recorded as:

Option A1: Property Acquisition $11.76m Capital Works $ 1.0m

Option A2: Property Acquisition $ 0.44m Capital Works $ 5.6m

Option A5: Property Acquisition $ 5.92m Capital Works $ 3.45m

Within the analysis of the A1 option, a total of 53 properties were included.

2.4 The Matata Debris Flow Mitigation: Awatarariki and Waitepuru Risk Management Options

Tonkin & Taylor Nov 2005
As part of the investigation to support the submission of cost-benefit information to MCDEM and Central Government a further investigation and review of risk management options on the Awatarariki debris fans was undertaken.

The three options at Awatarariki were reviewed, and incorporated results of additional survey data for the Awatarariki fanhead and environs. Analysis of the data indicated that that the volume of material transported during the debris-flows, out of the catchment and onto the fanhead and into the lagoons, was approximated to be between 335,000 – 365,000m^3, of which 330,000m^3 was attributed to the Awatarariki alone.

As a result of the additional information revisions were made to the concept designs of the preferred options, A2 &A5 which increased the cost estimates accordingly.

$ m's	Awatarariki	
	Previous Cost Estimate	Revised Cost Estimate
Option A1	1.5	1.75
Option A2	3.7	5.6
Option A5	2.8	3.45

In conclusion it was noted that with the further information now available the scale of the proposed risk mitigation works for the Awatarariki fan had grown for two main reasons:

1. Revised debris design volumes, up by 65%
2. Additional drainage works on the lower Awatarariki fan and in the western Wildlife Refuge lagoon.

2.5 Debris-flows Control System Awatarariki Stream, Matata. Vol 1&2

Tonkin & Taylor June 2009
It is understood that preliminary investigations into solid debris dam type structures, situated up stream of the railway bridge, met with cultural and environmental opposition. Whilst, at the same time, the application of the debris net concept gained in support. The salient points in favour of a flexible barrier over an earth or concrete structure were noted at the time as being.

The flexible barrier:

- Minimizes the level of construction disturbance within the Awatarariki Stream,
- Has a very small environmental footprint compared to a dam,
- Does not hinder normal storm water flows or sediment transport within the stream,
- Does not affect fish passage,
- Can be installed without negatively affecting cultural sites above the abutments,
- Is cost effective for the retained volume compared to a solid dam structure.

In T&T's 2008 report a barrier height-retained volume relationship was presented, full containment of a 250,000m^3 event upstream of the escarpment would require a retained debris thickness of approximately 15m. On the basis of a 1m freeboard the barrier would need to be 16m high. Full containment was not considered a viable option for a number of reasons. As a result a partial containment option was developed, in conjunction with a spillway designed to divert remaining material to open ground west of Matata.

The configuration proposed within T&T's 2009 report was that some 100,000m^3 of material would be retained behind the structure. It was estimated that up to 50,000m^3 of predominantly fine grained (muddy and sandy) material would pass through or over the open structure. The material passing over the spillway was envisaged to then flow through the SH2 underpass beneath the rail bridge to open ground (the fanhead). The thickness and distribution of this flow within the Clem Elliot Drive area being dependant upon the detail of control structures placed on the fan head.

Three options were considered:

- Option 1 No Control
- Option 2 Partial Control
- Option 3 Full Diversion

Fanhead control via Option 2 was understood to be WDC's preference, as it achieved the objectives of preventing destructive flows from reaching the Clem Elliot Drive area without the negative physical, financial and connectivity impacts of Option 3.

As part of the detailed modelling, the output of which is included in appendix I, consideration was afforded to a number of possible sequences that could occur during the design debris-flows event. T&T considered that the modelling determined the interaction between the flow, the barrier, spillway and diversion berms. It is noted that the modelling presented in T&T 2009 report was completed prior to the full development of the barrier and berm locations described within the 2009 report. Detail design of the barrier system being the responsibility of Geobrugg

.

In summary the basis of the proposed debris-flows control system was as follows:

- Designed to protect Matata from a debris-flows event similar in size and nature to that which occurred within the Awatarariki Stream in May 2005.
- The design event was defined as 250,000m^3 delivered to the barrier location
- The system would consist of a 15m high flexible barrier accompanied by spillway and fanhead diversion structures
- The barrier would be supported by overhead cable and anchored into slopes on either side of the stream.
- A maximum volume of 100,000m^3 would be retained upstream of the barrier.
- Up to 50,000m^3 of finer grained debris material was assumed to pass through the barrier.
- Material in excess of that able to be retained or passed by the barrier would be diverted over the spillway.
- The partial control option, Option 2, is the preferred solution for controlling flow once it exits the spillway

Include within its 2009 design report, T&T recorded that a limited amount of geotechnical investigation had been undertaken in the period since 2005. This investigation mainly consisted of test pits, but included two bore holes, and a single anchor pullout test.

Two options were considered for the overhead support cable and netting system:

1. A main support cable that spanned only the Awatarariki Stream. Left hand abutment secured by a piled structure. The right hand side by multiple ground anchors.
2. A main support cable that spanned both the Awatarariki Stream and spillway. The overhead support cable being secured by multiple ground anchors at both ends.

The netting system proposed was to be formed from 1m diameter rings, each ring being made from up to 19 hoops of 3mm diameter high strength steel wire. Each ring being intertwined with two rings located immediately above and the two rings below. Adjacent rings on the same row are not connected. The net was not proposed to terminate at stream level, but would extend horizontally back upstream, approximately 12-15m.

Preliminary estimates of main cable loads were approximated at 15MN for each anchor location. It was estimated that each anchor system would consist of a total bond length of 250m, envisaged to be apportioned between 12 anchors, each with a bond length of 21m.

Cost estimate
A cost estimate of the netting proposal, provided to WDC May 2008 by Geobrugg, indicated that the netting component alone would cost $2.1m.

Within the 2009 design report the debris net together with the preferred partial diversion option was estimated at $2.8m

2.6 Awatarariki Stream Debris Barrier: Technical Addendum to Peer Review Response

Tonkin & Taylor Dec 2010
An application for resource consent was made to Whakatane District Council and Environment Bay of Plenty for the Awatarariki Stream Debris-flows Control System in March 2010. As part of the

peer review process dialogue between the reviewers and designer continued in order to reach agreement as to the design philosophy, flow characters and system performance.

One of the areas of concern, for the reviewers, was their lack of confidence that the debris-flows event would not proceed as modelled, specifically regarding the potential for blocking of the spillway, with subsequent overtopping of the barrier and possible inundation of the lower Awatarariki Stream.

It remained T&T's contention that the spillway was far more likely to work as intended, than become inoperable, based on the underestimation of the "debris vs storage volume" curve originally developed in 2006.

Subsequent to their 2006 report, T&T's modelling, estimated that 245,250m^3 of storage volume was available should the spillway become blocked. As more than 5,000m^3, and up to 50,000m^3, of material could be expected to pass through the barrier, and coupled with adopting a debris slope marginally greater than zero degrees, the storage capacity would increase to in excess of 250,000m^3.

2.7 Awatarariki Stream Debris-flows Control System; Peer Review of Resource Consent Application Technical Proposal

AECOM Feb 2011

AECOM New Zealand Ltd was retained by WDC to conduct a peer review of the proposed protection works for the resource Consent application.
The review was undertaken in conjunction with Professor Tim Davies of the University of Canterbury. The peer review undertaken was a high level concept review only, as limited formal engineering design had been completed at that time.

Within the introduction the reviewers comment that "*Debris-flows are generally poorly understood phenomena and are the domain of a limited number of technical specialists. Debris events are rare, triggering mechanisms are poorly understood, flow behaviour is complex and is substantially different from traditional fluid (water) flow, and scale effects further complicates their understanding*"

The concept of the proposed barrier at Awatarariki was based on a proprietary system developed by Geobrugg, and was founded from their experience gained in Europe and elsewhere. The barrier would be required to retain 250,000m^3 of material, and would be a significant departure in scale from previous netting barriers.

The peer reviewers questioned the validity of the numerical modelling that was undertaken by T&T and had concerns over the net and anchor corrosion. Periodic removal of any retained material and debris was also identified as a feature that would have to be incorporated into the final design solution.

In conclusion the Peer reviewers commented that:

- The development process followed by the designers appears reasonable and applies international experience to a unique situation presented at Matata.
- Similar, but not identical and significantly smaller, systems to that proposed have been successfully installed and preformed as intended in a number of countries
- Key issues with the success of the net include:

  1) The base of the net will be secured by ground anchors.

2) That the final retained level of the debris dam is sufficiently high to ensure that any excess flow is diverted over the spillway.

3) That deposition of the courser material on the approach to the spillway does not impede the use of the spillway.

4) Ongoing inspection and maintenance including corrosion protection and removal of debris will be required to ensure the net will operate as intended throughout its operational life.

- Flood damage to the western end of Matata from silt laden water could still be expected.
- The overall the concept is reasonable, but is a substantial departure from international experience.

2.8 Awatarariki Stream Debris-flows Barrier: Response to Peer Review

Tonkin & Taylor Jan – March 2011
Within its responses to various concerns raised by the peer reviewer team, T&T sought to clarify that the design case was to retain a debris volume of 100,000m^3, and that the designed storage volume of 250,000m^3 was in response to the questions raised, by the reviewers, regarding the 'what if scenario" should the spillway block and became inoperable.

T&T again reiterated a section of their 2009 Design report summary that *"A full flow volume containment system is not considered viable for a number of cultural, environmental, engineering and financial reasons"*

Cost estimate update

In June 2011 the revised cost estimate for the Debris Net Structure alone was estimated at $3.79m.

In September 2009 WDC requested that contract documents for Partial Diversion Earthwork Structures downstream of the spillway be prepared for tender. The tender estimate for this element of works at the time was estimated at between * $0.5m - $1.5m (* WDC to confirm)

2.9 Awatarariki Stream Debris Barrier Design Report DRAFT for Discussion

Tonkin &Taylor Oct 2011
In order to support the application for building consent for the Awakarariki stream debris barrier T&T produced a report which provided an overview of the design philosophy, the standards adopted, the assumptions made, verification calculations and supporting information.

In summary:

- The design life of the barrier structure would be 120 years
- The event adopted for the basis of design of the barrier was one of the same magnitude and of broadly similar characteristics as the 18th May 2005 Awatarariki Stream event.
- A design velocity of 7m/s was used for the first of five flow surges used to simulate the design event. Geobrugg considered 4m/s to be an appropriate velocity.
- A sixth surge was adopted as an over-design case.
- The barrier was to consist of large steel "ring net" suspended within the channel of the Awakarariki Stream from twin overhead cables. Max net width 38m, height 14m

- The net and cable to be connected by vertical wire hangers. Cable span 71m, hanger length 4m
- An estimated 265,000m^3 of debris would accumulate behind the barrier prior to overtopping. This would extend 640m upstream of the net location.
- Peak design loads to the support cables are 15.4MN and 16.6MN for western and eastern anchorages respectively.
- Required geotechnical anchorage capacity 46.5MN western, 49.8MN eastern.

This information was presented at the pre Building Consent application meeting of 19thOctober 2011, attended by WDC (applicant) their designers, Tonkin & Taylor, Geovert and Geobrugg, WDC (consent authority) and their peer reviewers Aecom – Prof T Davies.

The design parameters that were confirmed at this point in time included:

- No engineered spillway.
- No diversion bund on SH2.
- No raising of Clem Elliot Drive road
- That 1.0 degree be used for the angle of repose for debris retained by the net.
- Factor of safety for design event is 1.5

2.10 Matata – Debris-flows Mitigation

GEOBRUGG Jan 2012
Following the meeting of 19th October 2011 Geoburgg revised their design calculations for various load scenarios. The design event has been considered at an impact velocity of 7m/s at a peak discharge rate of 875m^3/sand decreasing surge velocities and peak discharge rates after the first main surge. Geoburgg determined that the main cable ground anchor design case load, was that under which overtopping of the barrier would occur, the appropriate anchorage loadings were 21MN eastern, 19MN western.

The material specification for the various component parts being:

- Suspension ropes – Two VVS-3 ropes nominal dia 110mm required capacity 24.9MN
- Vertical Hangers ropes – Spiral wire 36mm dia. ZnAl coated
- Whale Net Rings - 1m dia made up from between 45 – 76 pcs 3mm wire per ring ZnAl coated above ground, stainless steel below ground application.
- Lateral Anchors – 22.5mm wire rope anchors

A schematic drawing of the net proposal together with revised main cable anchorages is provided in appendix II

Cost estimate
A revised cost estimate of the netting system currently proposed is awaited from Geobrugg, However it is anticipated to be in the region of $3-4m.
A rough order estimate by T&T of the anchorage system now proposed is $2-3m.

As such the rough order estimate for the current debris netting proposal is $5-7m.

3.0 CPG REVIEW

CPG were commissioned to review the present status of the project and confirm or otherwise T&T's concerns and recommendations not to proceed.

Rick Grobecker of CPG has met or discussed the current proposal with:

- Kevin Hind – Designer for Tonkin & Taylor
- Justin Wilson – Operations Manager for Geovert which represents Geobrugg in NZ
- Barbara Dempsey – formally WDC's Project Manager
- Jeff Farrell – WDC Consent Authority
- Prof Tim Davies – University of Canterbury Peer reviewer.

In addition CPG inspected the site with Paul Smith, of WDC, on 9th Feb 2012 and has been given access to the documents listed in section 2 above together with various Council minutes ande-mail documentation.

3.1 Design Philosophy

The initial design requirement for the mitigation scheme was that a debris-flows control system be implemented that would mitigate the risk of devastation of the community of Matata should an **event of similar size to May 2005** reoccur.

In its 2009 design report T&T stated that the philosophy was based on one of partial capture, 100,000m^3, and diversion. The diversion proposed was by means of a spillway channel formed by altering previous quarry workings immediately adjacent to the stream's western embankment.

This original philosophy was subsequently replaced with the one of complete "in-stream capture" as presented in the Draft Design Report (2011).

These changes have allowed the spillway and fanhead earthworks to be removed, but at the expense of a larger barrier structure and anchorage systems.

Within the T&T reports of 2005 it is noted that within the catchment area there is significant volume of material that has potential to form debris avalanches on the slopes, this together with the irrefutable physical evidence of previous debris-flows at Matata begs the question of "when not if" the next event will occur.

Little mention has been made of risk management, within the various reports, specifically those risks to human life. On the basis that a debris structure is constructed, it is presumed that greater property development could be anticipated in the fanhead area and its immediate surrounds. Should this be the case and an event larger than the 2005 event occur, or the structure fail ornot perform as anticipated, then potentially the risk to human life would be greater with the construction of a debris structure, than without.

This report has not been commissioned to undertake a risk management process, which could better address the long term risk to human life and or property, or assess a projected whole of life cost-benefit analysis for the debris detention structure as it is currently envisaged.

3.2 Option Selection

It is understood that early objection to the physical blocking of the Awatarariki Stream by a solid dam type structure together with other environmental and cultural aspects quickly ruled out a solid dam structure from the preferred option list.

It would appear that the "do nothing" options contained within T&Ts report of 2005, Option A1: "Retreat from hazard", and the Cost Benefit Analysis of Options NZIER report Option A1 "Retreat" may have been deemed one and the same, and as such influenced the early decision making to proceed with option A2.

In reality the two A1retreat options are vastly different, from a cost to Council perspective. The cost-benefit analysis of NZIER included property acquisition costs: which comprised of purchasing those properties as part of the mitigation works, including those within the proposed future debris deposition areas.

Within T&T original August 2005 report, and revised within their Nov 2005 update, the A1 option included for, the remaining clean up costs together with the replacement of a single span railway bridge.

It is not clear at precisely what point in time the netting proposal gained support, however, with the early objections to a solid type structure and the then projected capital cost estimate of the netting option, it is appreciated that the netting solution became the preferred option.

3.3 Peer Review

Aecom and Prof Tim Davies of University of Canterbury were separately engaged and commissioned to undertake a peer review of the proposed protection works for the Resource Consent and Building Consent applications.

The review process challenged the design team on the validity of their flow modelling and design assumptions and posed a number of "what if scenarios" for the design team to resolve. As a consequence of the review, and the interaction between the reviewers and design team, the concept design has continued to be modified and now consists solely of a debris net solution with no down stream earth work bunding being deemed necessary.

It is understood that detail drawings for the whole of the project works are currently on hold.

3.4 Resource Consent

An application for resource consent was made to Whakatane District Council and Environment Bay of Plenty for the Awatarariki Stream Debris-flows Control System in March 2010. Alterations were made to this proposal in March 2011.

On the basis that the cultural effects were considered minor and the adverse effects were also not more than minor, it was considered that the application could be made on a "non notified" basis.

In order to progress the application, and in compliance with Schedule G of the Council's Delegations Schedule, the services of a commissioner was engaged to review the technical aspects of the proposal. A Resource Consent Prehearing meeting was held on 19th October 2011 attended by Alan Bickers (Commissioner); WDC and supporting technical personnel (Applicant) WDC and supporting technical personnel(Consent Authority)

It is understood that both Resource and Building consent applications are currently on hold.

3.5 Cost Estimate

Construction Costs
The current cost estimate has to date only been provided in very rough order amounts.

The current, out of date, estimate from Geobrugg is that of June 2011 $3.786m.

It is understood that Geobrugg are updating this estimate to take into account the design changes included within their Jan 2012 design proposal.

Geovert are in the process of providing an estimate for the supply and installation of the main anchorage support system, excluded from any netting supply and install estimate provide by Geobrugg.

It is T&Ts assessment that the ground anchorage system as currently envisaged, appendix II, would cost in the order of $2-3m.

As such the current scheme rough order construction cost is estimated in the range of $5-7m

Maintenance Costs
It is anticipated that following a debris-flows event that the debris retained behind the netting structure be removed such that protection from a subsequent event is restored.

On the basis of an event similar in size to 2005, in excess of 250,000m^3 of debris could be expected to be retained by the structure and within 640m upstream of its location.

Based a nominal $20/$m^3$ allowance to remove and dispose of this debris material, reinstatement of the structure to provide future storage capacity for an other subsequent debris event would cost $5m ($20x250,000) excluding any repair cost to the structure itself.

There is no data available on which to assess routine debris clearance, from behind the netting structure, and or projected maintenance costs of the netting structure itself. However ongoing silt removal from the down stream lagoons is currently assessed in the order of $140k annually. (10,000$m^3$ @ $14/$m^3$)

As such should an event similar in size to 2005 occur within a few years of completing the structure the rough order cost to reinstate the structure to its as installed functional capacity, would be in the order of $5m. This is additional to the construction costs noted above. No assessment has been made for routine inspections of the structure and periodic replacement of component parts.

3.6 Asset-Property Value

CPG requested that WDC provide a summary of properties and WDC asset valuation that would potentially be affected by a debris event similar to that of May 2005. This information is contained in Appendix IV, a summary of which is presented below

Land Property &WDC Asset Valuation Feb 2012 Within fanhead area potentially affected by design debris-flows event in the absence of any mitigation measures.			
Unsafe			
Houses affected		11	
Combined Building Valuation	$	2,509,000	a
Land Plots affected		36	
Combined Land Valuation	$	5,931,000	b
Restricted Use			
Houses affected		16	
Combined Building Valuation	$	3,406,000	c
Land plot affected		17	
Combined land Valuation	$	2,435,500	d
Roading Asset Valuation	$	94,389	e
Combined building and WDC asset value within Unsafe zone	**$**	**2,603,389**	a+e
Gross Total Property &WDC asset valuation within fanhead	$	14,375,889	sum a:e

4.0 FUNDING Central Government

It is understood that Central Government provided funding for the Matata Regeneration Works in the order of $1.7m.

It is not know on what basis these funds were provided, if they were conditional on any or all aspects of the then proposed works being undertaken.

4.2 LTNZ

It is understood that LTNZ, formally Transit, were approached for assistance to fund the proposed debris-flows mitigation works, but no commitment has been forthcoming.

It is further understood that LTNZ declined to progress a proposal to install an early warning road closure system on the basis of likely expenditure vs. risk and associated return period.

4.3 KiwiRail

It is understood that KiwiRail were approached for assistance to fund the proposed debris-flows mitigation works, but no commitment has been forthcoming.

It is further understood that KiwiRail declined to progress a proposal to install an early warning rail closure system on the basis of likely expenditure vs risk and associated return period.

4.4 WDC

It is not known what funding WDC has currently available to progress the proposed Debris-flows Mitigation works at Matata.

It is not known what rating model-base WDC may have elected to adopt or may adopt for the financing the scheme, or over what period. Clearly rating only the 27 property owners whose houses are located within the Unsafe (11) and Restricted Use (16) zones would not be economically viable.

CONCLUSION

The debris event of May 2005 caused the deposition of significant amounts of debris material to be deposited across the fanhead which encompassed the area adjacent to the Awatarariki Stream predominately in the Clem Elliot Drive, Kaokaora Street area of Matata.

An estimated 330,000m^3 of debris material was attributed to have flowed from the Awatarariki Stream during this event. Whilst a number of buildings were damaged, no loss of life occurred during this event.
The rainfall conditions which triggered the debris-flows are estimated to have had a return period in the order of 200-500yrs.

Floods in Matata have been recorded on at least eight occasions since 1891 and there is clear evidence of previous debris-flows at Matata prior to the 2005 event. With the Awatarariki catchment area there is significant volume of material that has potential to form debris avalanches on the slopes. As such it is a matter of, "when not if", and of what size will the next debris-flows be.

Due to the speed at which debris-flows travel and the limited travel distance of any debris-flows within the Awatarariki Stream, it is not considered feasible to install a viable early warning system that would allow adequate evacuation of the fanhead area in the time available.

WDC has sought to mitigate the effects of an event similar to the 2005 event by means of constructing a debris detention structure. Debris-flows events are poorly understood natural phenomena which include complex flow behaviour, and are substantially different from traditional fluid flows. Debris-flows events of 250,000m^3 are not common, and the flow behaviour may not be as predicted by current modelling. The peer review process has determined that containment of some 250,000m^3 of debris is deemed necessary to satisfy the initial design aspirations.

The debris netting systems, similar to that as proposed by Geoburgg, have been successfully installed in a number of locations around the world, although it should be noted on a significantly smaller scale.(Retention volumes in the order of 1,000m^3 not 250,000m^3) As such there are inherent risks incurred in adopting a design solution that has not been physically proven by field application with comparable loads and external conditions.

The current valuation of WDC's asset that are likely to be effected by a debris event of comparable size to that of 2005, should no debris detention structure be installed, is assessed at $ 94k. Whilst these assets will suffer some damage, as a consequence of an uncontrolled event, the cost of repair to the existing asset is assessed at $ 20k. (20% of the asset value). This sum is insignificant in comparison to the current capital expenditure that would be required to construct the proposed debris detention structure.

The current combined valuation of land and properties located within a projected debris-flows fanhead, should no detention structure be installed is assessed at $14.4m. Of this amount some $5.9m is attributed to 27 buildings, 16 of which are valued at $3.4m and are located within the "restricted use" zone, the remaining 11 are valued at $2.5m are in the direct debris-flow fanhead flow path.

The current cost estimate of the proposed debris netting system is assessed at $5-7m.
The current cost estimate to remove debris, post construction from a further 2005 event, is assessed at $5m

On the basis that a debris netting structure be constructed, it is presumed that greater property development could be anticipated of the fanhead area and its immediate surrounds. Should this be the case and an event larger than the 2005 event occur, or the structure fail or not perform as

anticipated, then potentially the risk to human life would be greater with the construction of a debris structure as currently envisaged, than without.

As such with a return period established in the order of 100's of years and a current building property asset value within the unsafe zone, being less than half the current projected build & debris removal costs ($2.6m vs $5-12m), the proposal to proceed with the scheme as detailed, does not indicate a cost-benefit incentive to proceed. This assessment does not include a value against human life for cost-benefit comparison purposes.

It is CPG's view that there is no current financially viable proposal which adequately mitigates risk to people and property and resolves the cultural environmental concerns over a 120 year design life.

RECOMMENDATIONS

We recommend that:

1) Council be appraised of the current status of the Matata Debris Mitigation Scheme including rough order cost of the project as currently envisaged
2) That Resource Consent, Building Consent and Design - construction drawings/specifications for the Debris Detention Structure remain on hold until such time as a clear directive from Council is determined
3) Council seek further advice to understand the implications of placing the Debris Mitigation Scheme project on hold/or not proceeding with the project.

APPENDIX I
Tonkin & Taylor:
Letter to CPG 28 February 2012

Tonkin & Taylor

T&T Ref: 22674.501
28 February 2012

CPG New Zealand Ltd
PO Box 562
Palmerston North 4440

Attention: Rick Grobecker

Dear Rick

Matata Debris Flow Detention Structure

On 16 January 2012, Mr Kevin Hind of Tonkin and Taylor Limited (T&T) met with Marty Grenfell CEO Whakatane District Council (WDC) at WDC offices. This was the first opportunity that T&T had to discuss this significant project with Marty since his appointment as CEO.

The discussion was initiated to address our concern that T&T had been given a directive by WDC to proceed with the finalisation of the detailed design and Building Permit application for the barrier. This was despite it becoming apparent in 2011 that there had been a large increase in the cost and engineering complexity of the project compared to the original concept.

We understand that CPG have been commissioned by WDC to review the project in light of the concerns raised by T&T at the January 2012 meeting. In particular CPG were to:

- *"..confirm or otherwise the T&T concerns and recommendations to not proceed";* and
- *"..there is no feasible solution which adequately mitigates risk to people and property"*

We understand that the brief statements given above were WDC's opinion of T&T's position at the 16 January 2012 meeting.

We believe that T&T's position are better captured by the following:

1) The project, as it currently exists (Jan 2012), was very different to the one that had been envisaged at the commencement of the design and consenting process in 2009[1];

2) The cost of the barrier and its anchorages had increased significantly as a result of the requirement to increase the capacity of the barrier[2];

[1] The most significant difference being the change in May 2011 from a partial containment system (100,000m^3) to a full containment system (250,000m^3) in order to satisfy peer reviewer concerns regarding spillway performance.

3) Estimated final project costs, were in our opinion, likely to be of a magnitude whereby the original decision to proceed with the project could be call into question;

4) Technical data provided by Geobrugg in 2011 indicated a design life of possibly no more than 50 years for the flexible barrier. It is therefore very likely that the structure would need to be replaced well before it was subject to the design event debris flow (return period possibly in the order of 200 to 500 years). Other construction options (e.g. dams) provide near-permanent design life spans;

5) Given points 1 to 4 above, T&T are concerned that the project is now so different to that originally envisaged by WDC that the directive given by WDC in late 2011 to complete the detailed design phase and prepare a building consent application ASAP should be reviewed;

6) T&T recommended a hold be put on our works until such time that a review was completed and that T&T would not proceed with the instruction to complete the detailed design phase and prepare a building consent application until a review of the project had been completed;

7) We took this position as the project parameters and financial estimates for the current proposal had changed so significantly when compared those used when the flexible barrier (DDS) was selected as a preferred option in 2008/2009;

8) As such, we consider it possible that use of the DDS to manage the hazard of debris flows on the Awatarariki Stream fan head may no longer be more the most cost effective / feasible / preferred option; and

9) We also note that given the cost increase and given our understanding that other debris flow mitigation options were not acceptable to the community, it may be difficult to find a feasible solution which adequately mitigates risk to people and property.

We trust we have provided clarification of T&T position with regard to the Matata Debris Flow Detention Structure project and that our recommendation for a review of the project is considered constructive and timely. Should you have any questions please contact Kevin Hind directly.

Yours sincerely

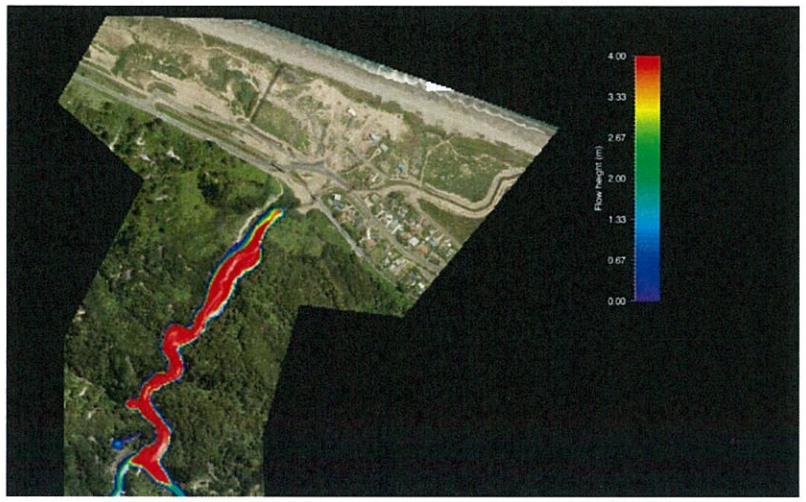
Kevin J. Hind
Project Director

28-Feb-12 p:\22674\22674.951\issueddocuments\kjh.28022012.cpg_letter.docx

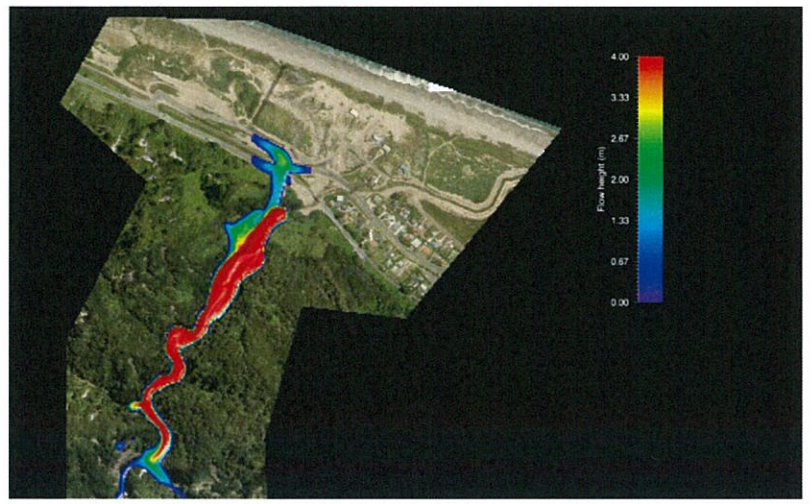
[2] The Geobrugg cost estimate increased from $2.4M in 2009 to $3.8M in March 2011. T&T were of the opinion in January 2012 that construction of the large cable anchors alone could reach $2M. The final construction budget was therefore estimated to be in the order of $6M. This cost estimate excluded existing and future design and consenting costs.

APPENDIX II
Tonkin & Taylor:
Design Debris-flows Event– Flow Sequence

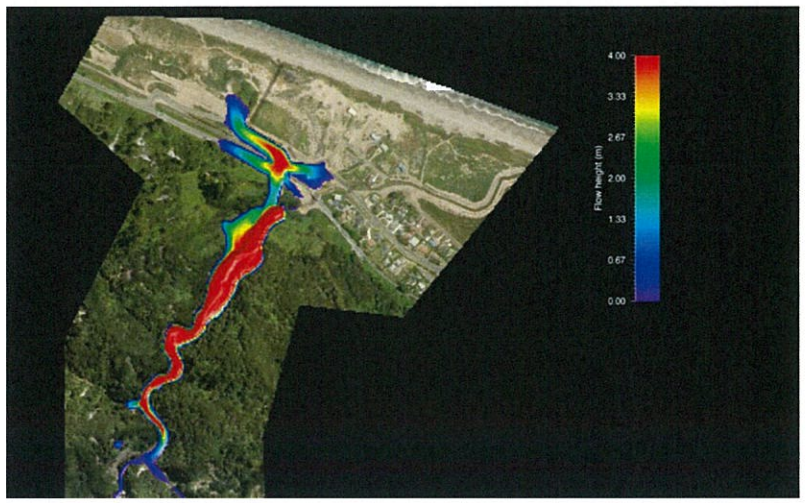
Table E1: Design Debris Flow Event – Flow Sequence



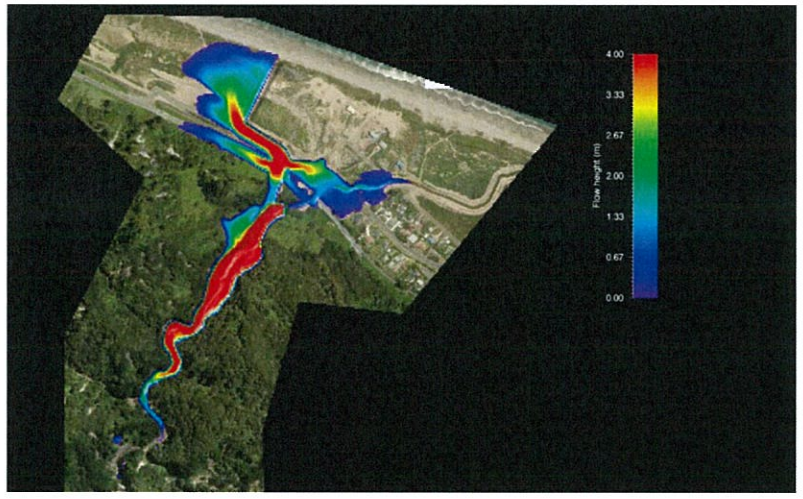
Step 17



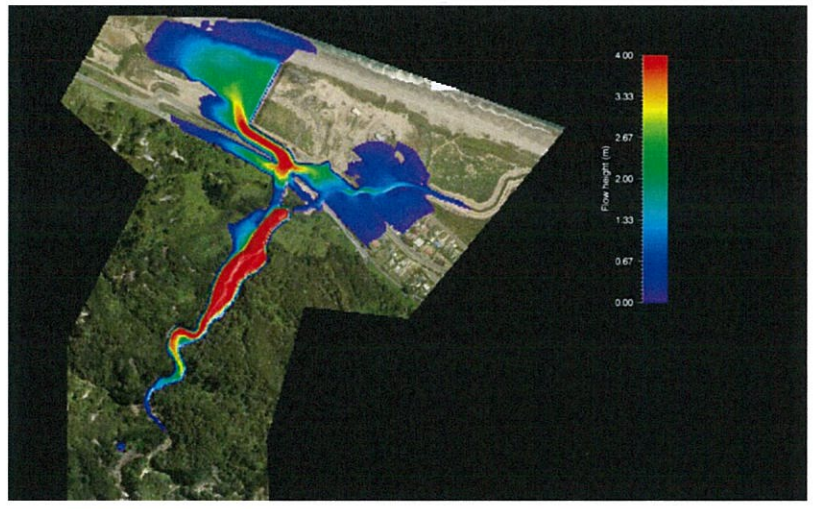
Step34



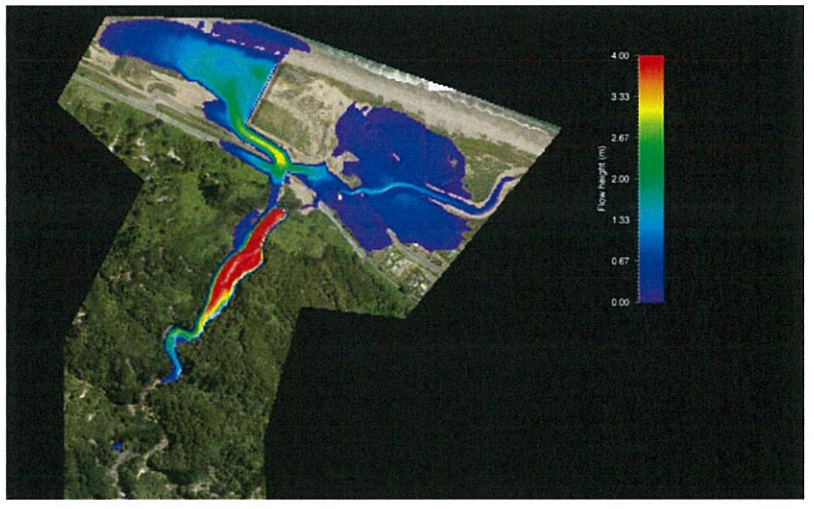
Step50



Step95



Step155



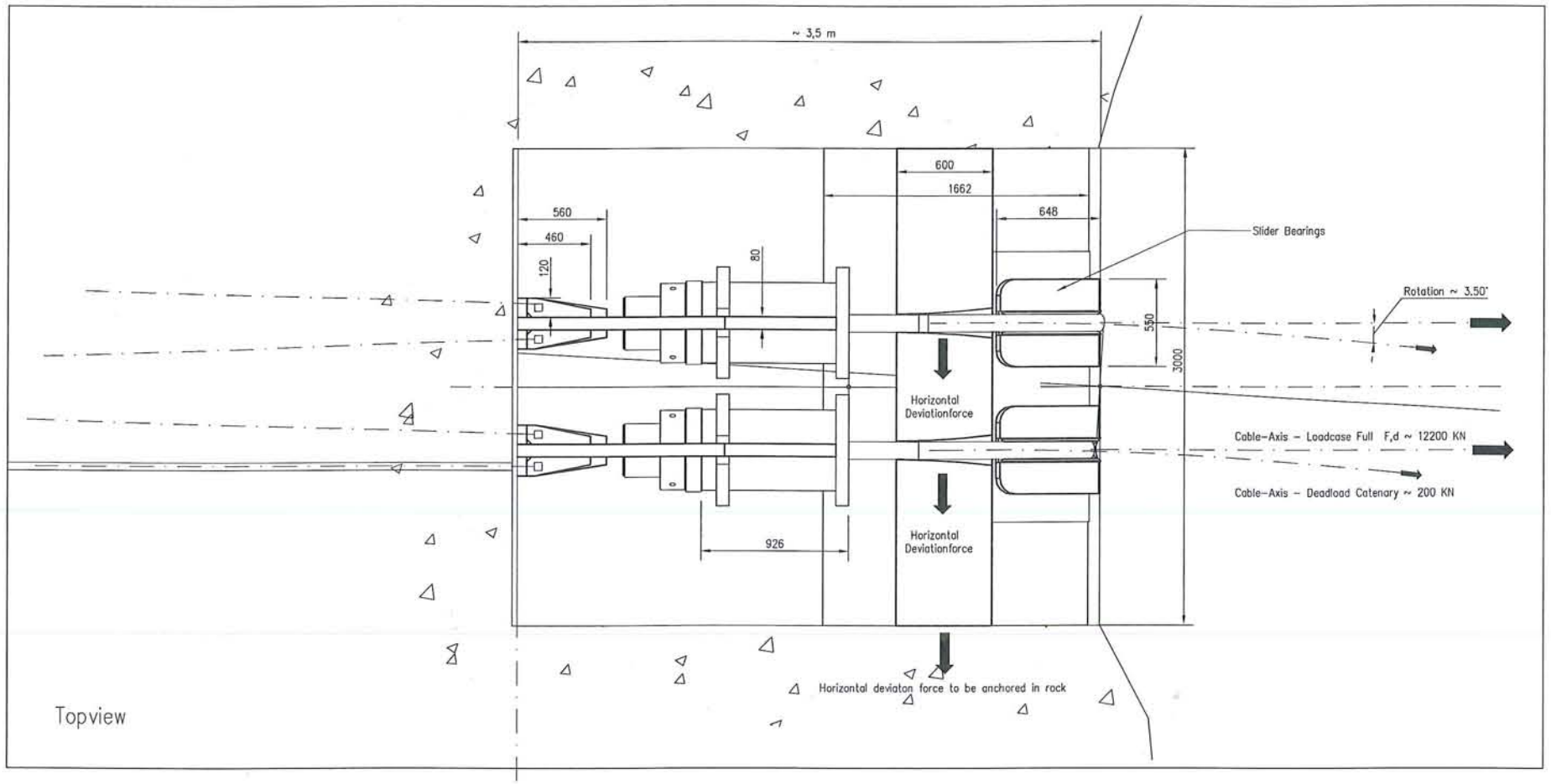
Step 300

CPG

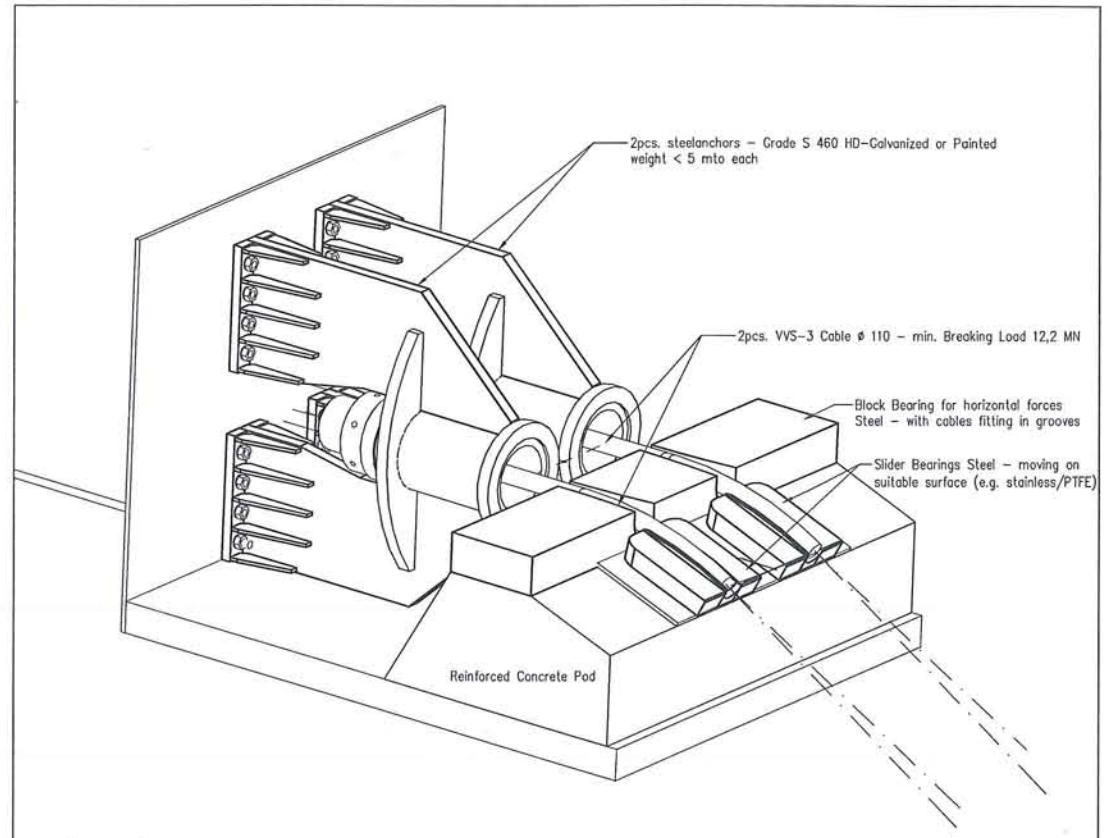
APPENDIX III
Geobrugg : MatataDebris-flows Mitigation Netting MatataDebris-flows Mitigation Cable Anchoring

Tonkin & Taylor
Concept Sketch Cable-Anchorage

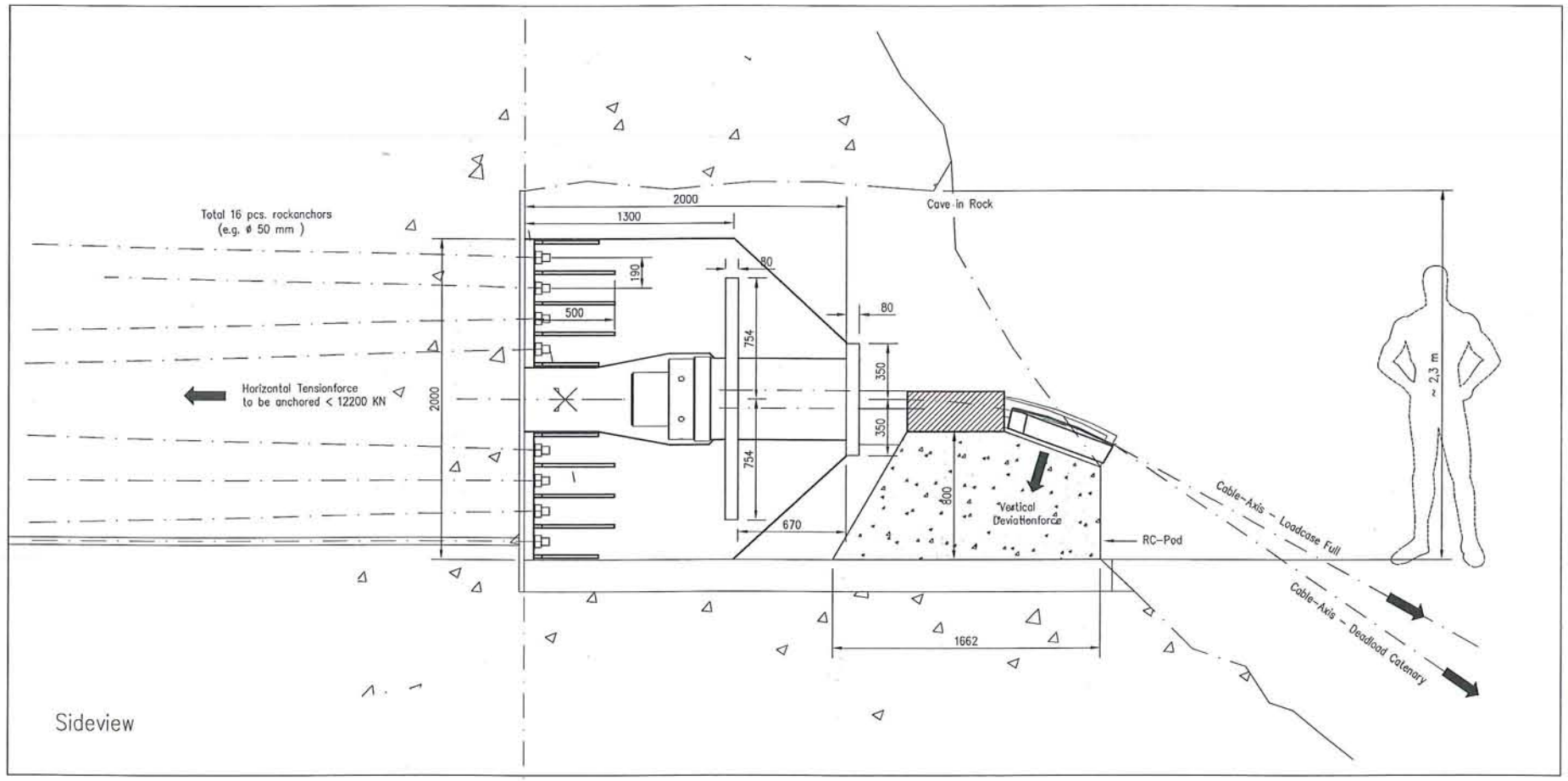
Matata – Debris Flow Mitigation – Cableanchoring



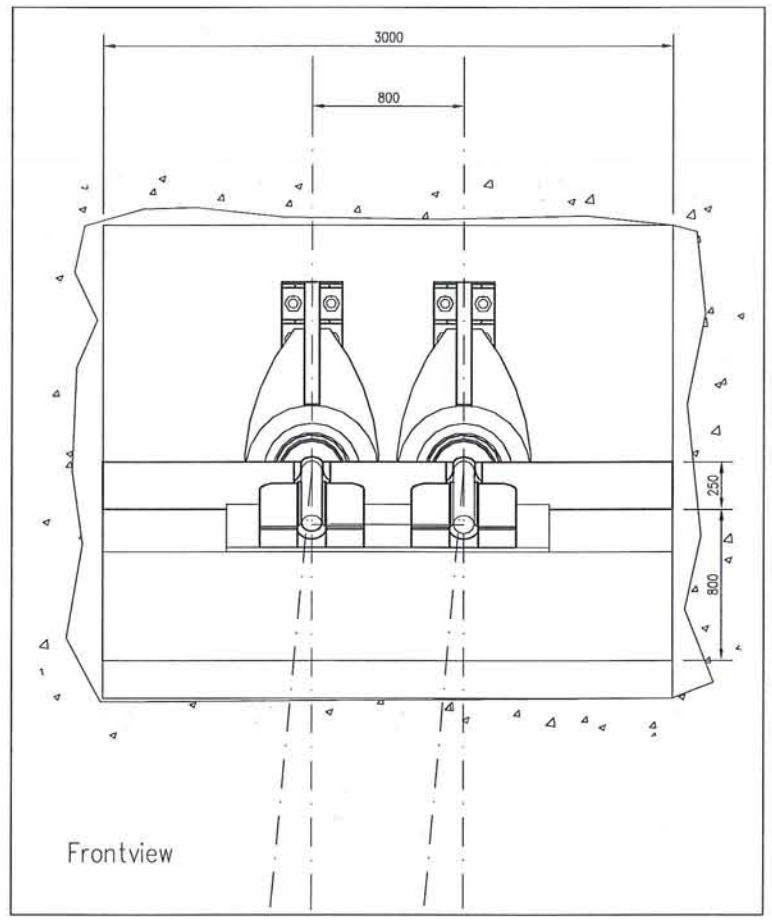
Topview



Isometry



Sideview



Frontview

Index	Datum	Name	Änderung
e			
d			
c			
b			
a			

File:

entwurf+planung/design+engineering

büro für leichtbau – *lightweight design*

Tritthardt + Richter *design+engineering*

D-78315 Radolfzell, Westendstraße 3 www.bfl-tr.com
Telefon: 49(0)7732/94089-00 Fax: /94089-19

projekt/project

Matata

Debris Flow Mitigation

bauherr/building owner

* *

* www.*.*

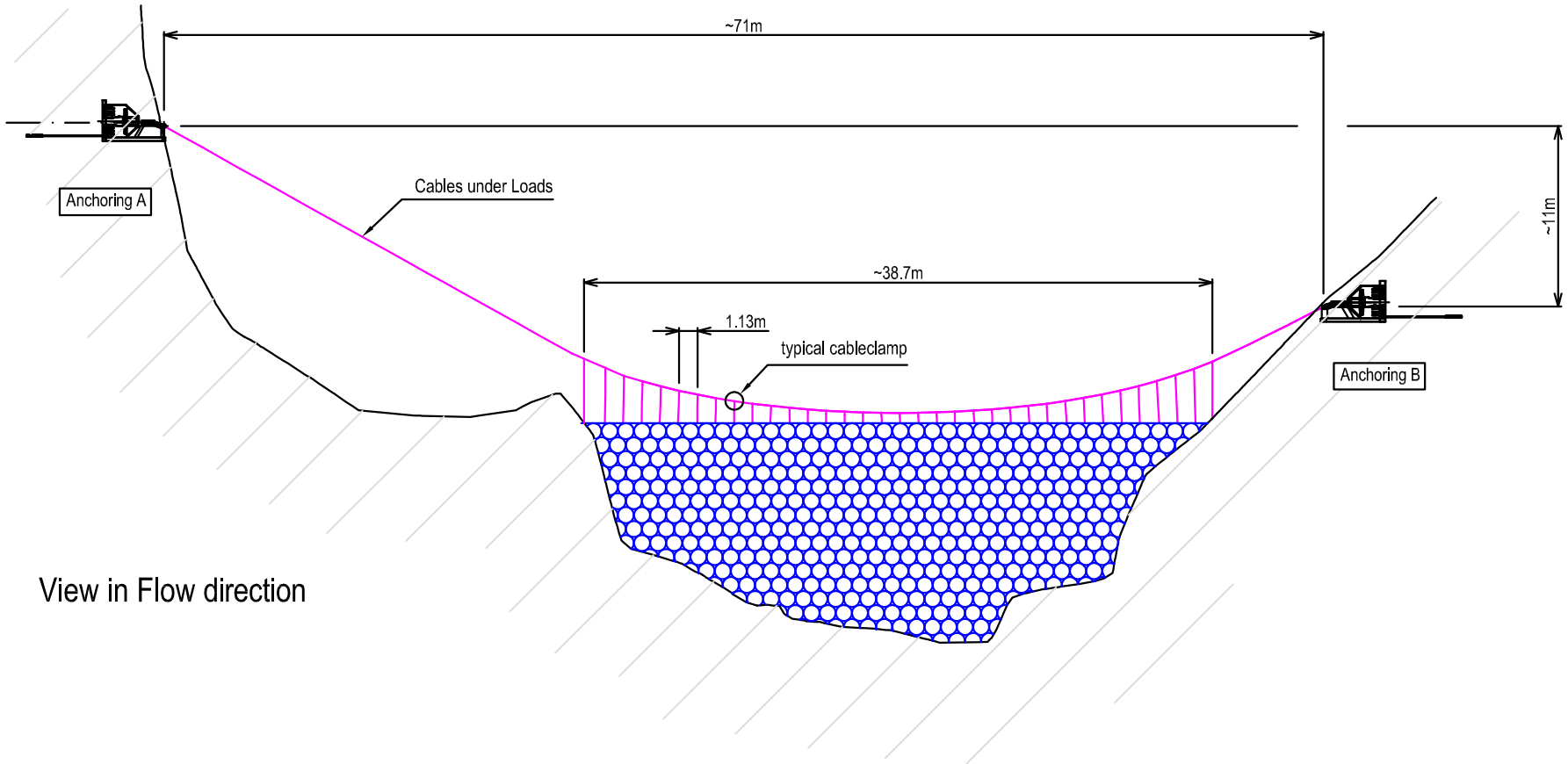
Telefon: +49* Fax: *

bezeichnung/drawing title

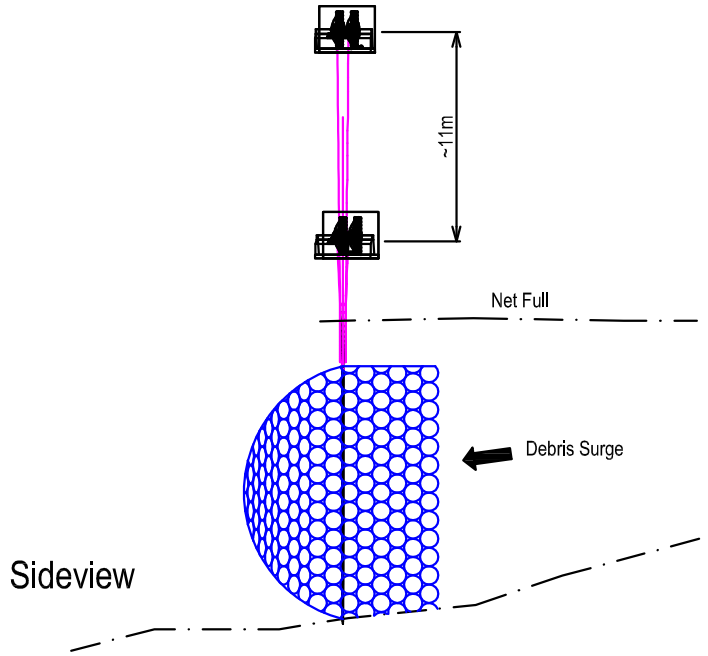
Cable–Anchoring

gez	drk	A1 original M 1:200	datum/date 14.10
gepr		A3 verkleinert M 1:400	Jahr 2011

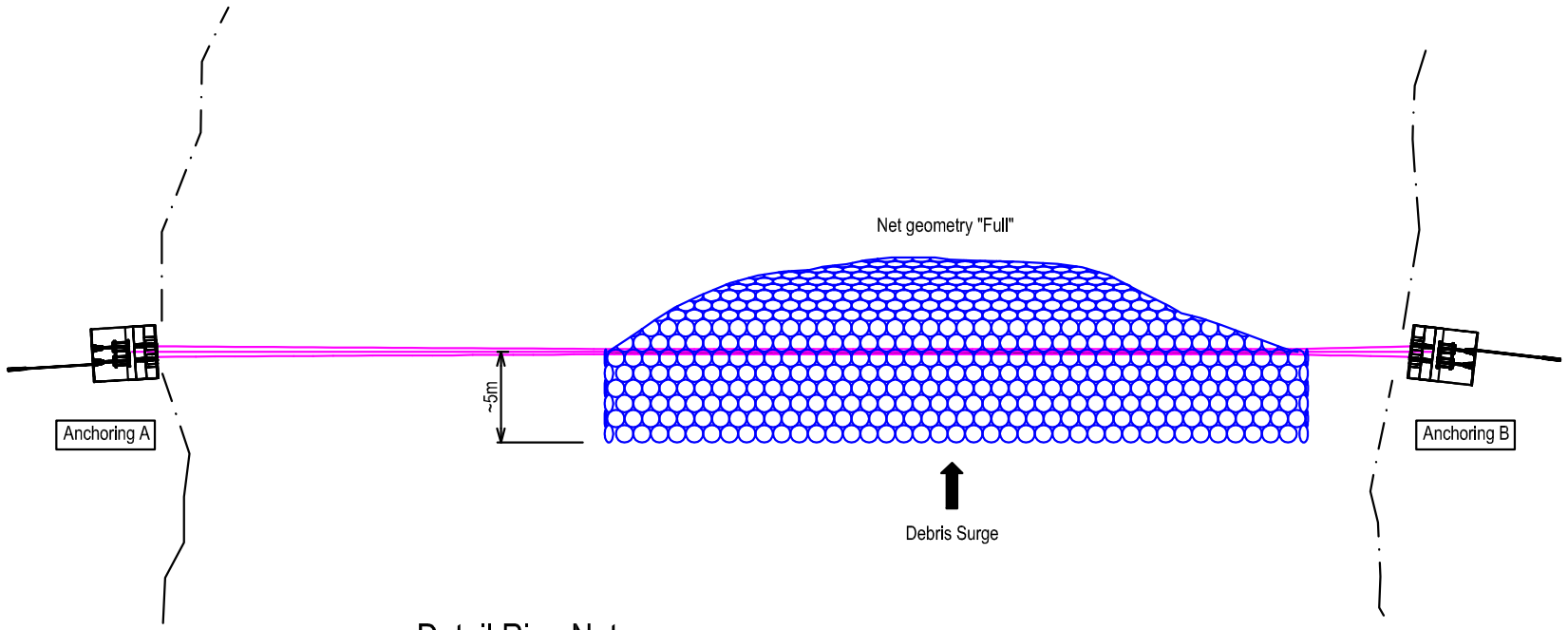
projektnummer: 0000– | plan/drawing: 200 | änd/rev



View in Flow direction

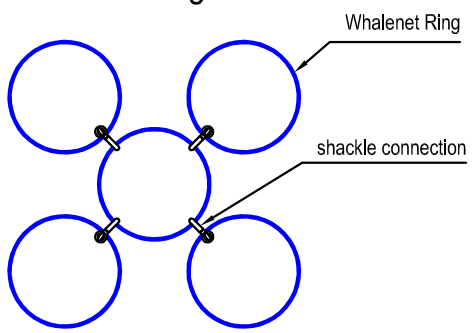


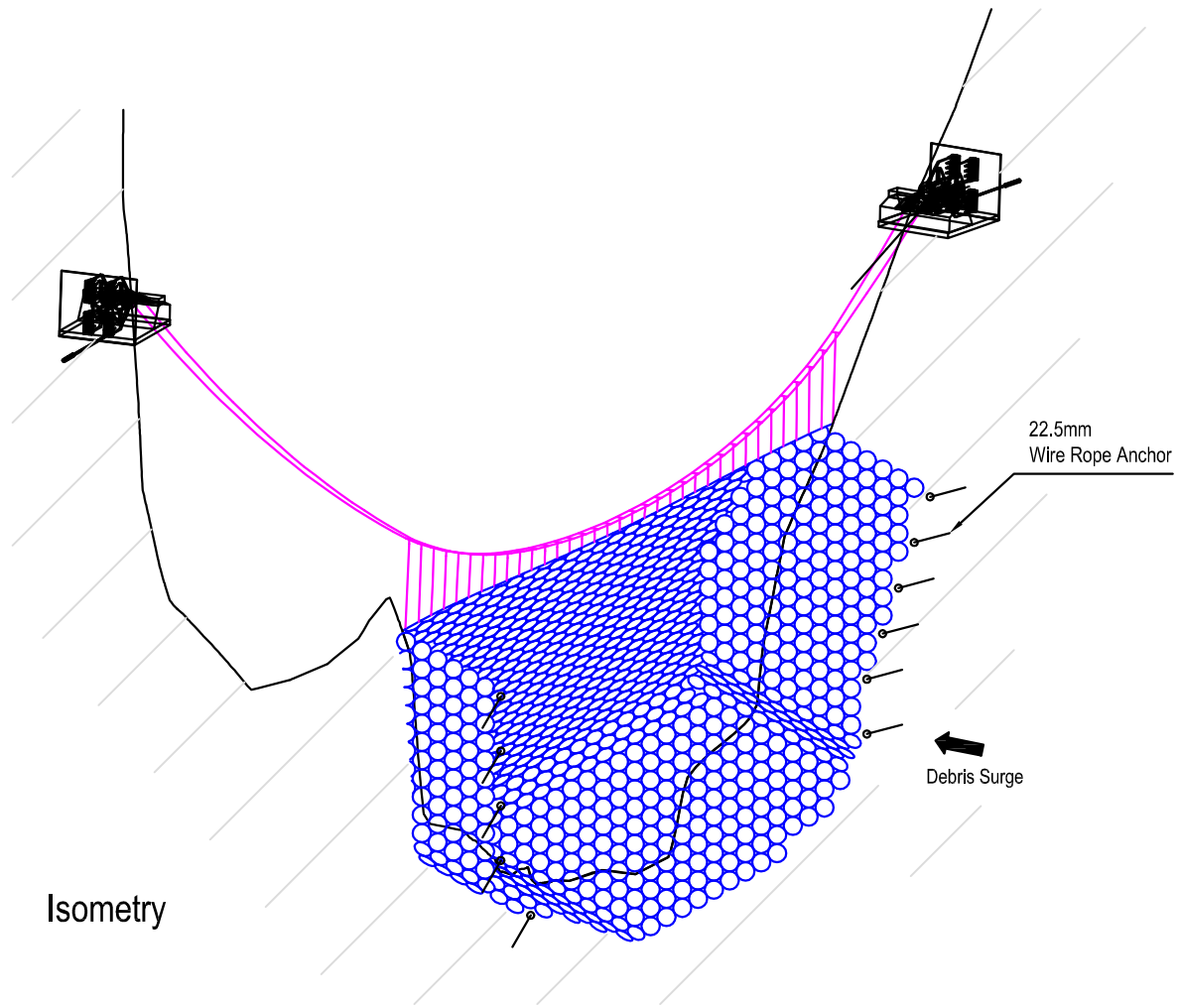
Sideview



Top view

Detail Ring Net





Isometry

modification:	M:%	substitute for:
-		replaced by:

Matata
Debris Flow Mitigation
-

drawn	12.01.12	hb
checked	12.01.12	
approved	12.01.12	

GEOBRUGG AG
CH-8590 Romanshorn

GEOBRUGG

GD-9069e

Tonkin & Taylor

Project: MATATA DEBRIS.

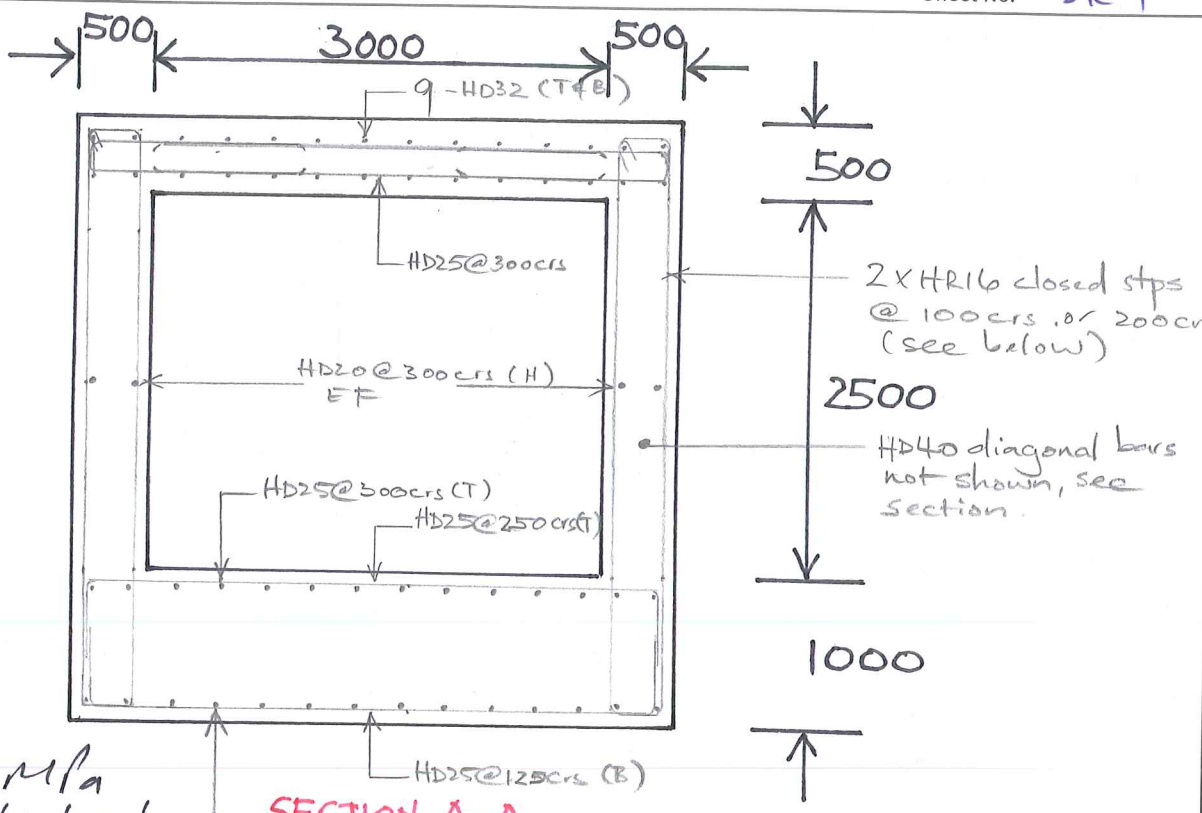
Description: Concept sketch.

Computed: JTVG 23/01 2012 Office: AK

Checked: GHK 24/1 20 Job No: 22674.950

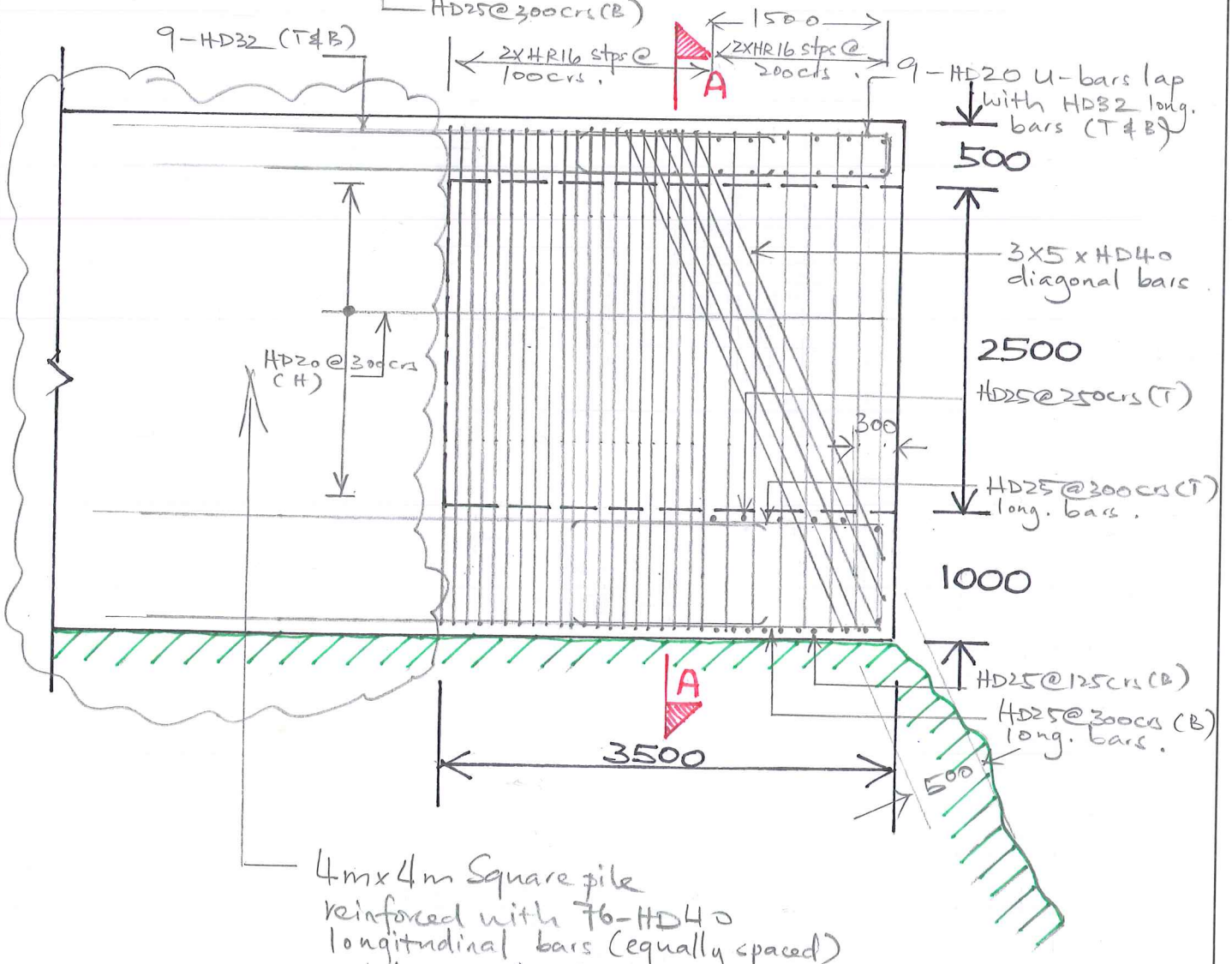
Revised: 20 File:

Checked: 20 Sheet No. SK 1



f'_c = 50MPa for pile eculent.

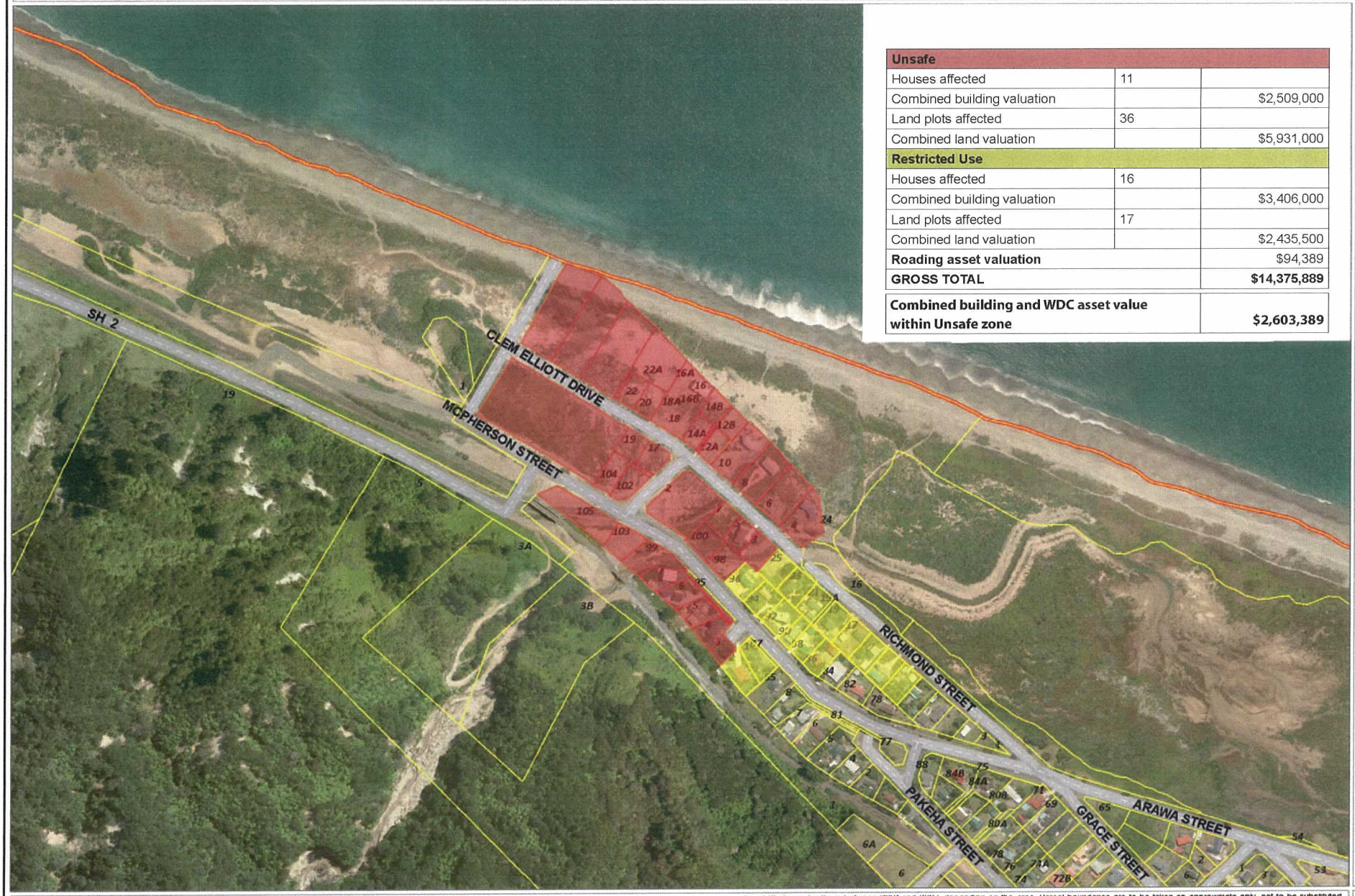
SECTION A-A



APPENDIX IV
WDC: Land Property and Asset Valuation

Whakatane District Council - Property Map

Date Printed: 21 February 2012



Unsafe		
Houses affected	11	
Combined building valuation		$2,509,000
Land plots affected	36	
Combined land valuation		$5,931,000
Restricted Use		
Houses affected	16	
Combined building valuation		$3,406,000
Land plots affected	17	
Combined land valuation		$2,435,500
Roading asset valuation		$94,389
GROSS TOTAL		**$14,375,889**

Combined building and WDC asset value within Unsafe zone	**$2,603,389**

Legend

- Parcel
- Unsafe
- Restricted use

SCALE 1: 4,000

203.2 0 203.2 Meters

Projection: NZGD_2000_New_Zealand_Transverse_Mercator

Prepared By: MP

Aerial Photography flown between 2001 and 2007, depending on the area. Parcel boundaries are to be taken as approximate only, not to be substituted for site specific survey. May contain LINZ data: Crown Copyright Reserved Note: Placenames may not conform to LINZ guidelines 2008. DISCLAIMER: While Whakatane District Council (WDC), has exercised all reasonable skill and care in controlling the contents of this information, WDC accepts no liability in contract, tort or otherwise howsoever, for any loss, damage, injury or expense (whether direct, indirect or consequential) arising out of the provision of this information or its use by you. *Position of all assets & historical sites are approximate, actual positions are to be verified on site.