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## GEOTECHNICAL

Tauranga District Council  
 Private bag 12022  
 Tauranga

14 November 2006

For the attention of [REDACTED]

### **Mauao Slopes; Monitoring Report; November 2006**

As requested Avalon's geotechnical team spent the 8<sup>th</sup> & 9<sup>th</sup> of November on Mauao carrying out the ongoing slope inspection/rockfall monitoring program

Regular inspection items completed included:

1. Discuss developments with Ranger ([REDACTED]).
2. Full walkover reviewing slopes from all tracks. Spring flows, slip movements, rockfall evidence, vegetation development etc recorded and photographed.
3. Laser EDM survey carried out at 6 benchmark group locations on; West, North, East Bluffs and Zone 6.
4. Sets of photos from locations A to M around summit for scour monitoring.
5. Visit all 2005 slip sites and check for re-vegetation, stability and tension crack development.

A summary of findings regarding these items would be:

1. No significant events reported by Ranger.
2. Occasional evidence of minor rockfall. No new slips.
3. No significant movement on rock bluff benchmarks (within accuracy of measurement). Ongoing settlement of the Zone 6 scaled boulder, which presents no hazard and continues as anticipated.
4. Scour continuing to develop on steep ground with no vegetation cover.
5. Minor continuing movement and surface ravelling on some of the May 2005 flood event slips.

Attached is a summary of the benchmark and slip monitoring data.

In addition to the regular inspection items we reviewed the recent Waikorere Track remedial works (below the Camp Bluff; subject of Terrane letter report dated 21/8/06). We could not find any evidence of further movement or developing instability and the remedial works appear to have been well executed.

In the period since the herbicide spraying programme has been 'on hold', vegetation has generally been re-establishing more rapidly. Although the fastest growth has been in some weed species, they are beneficial from a geotechnical point of view in reducing scour and increasing stability.

Scour of sand from non-vegetated patches has continued as previously and certainly has been the source of much minor rockfall over the winter, however, the vast majority of this will have occurred during inclement weather, at which times there are few persons on the tracks. The majority of the rock likely to fall from these loose surfaces is in the smaller size range (say <150mm).

There has been no wide area loose rock scaling carried out since the initial, 2003 operation and that some slope areas now have significant quantities of loose surface rock.

The rockfall hazard probably continues to be highest in the northern areas where rock climbers exiting from the top of routes will walk over unstable slopes from which any disturbed rock freefalls onto the Oruahine with no warning. This hazard is exacerbated by the fact that peak climbing activity will coincide with track walking (ie at weekends during fair weather).

Recommendations:

As per Avalon's May 2006 Review Report:

*Although the rockfall risks to individuals on single visits may be acceptable, TDC has to consider that the very high visitor numbers lead to significant total exposure.*

*A calculated fatality return periods in the order of ten years may alone be unacceptable.*

*For a person walking the upper tracks once a week the rockfall risk appears marginal on the Waikorere track and likely to be unacceptable on the Western Oruahine Track, under the rock climbing areas.*

*The rockfall risk to campers appears to possibly be acceptable unless camping on the boundary row for a month or more per year.*

*Some contributing factors to the current level of rockfall risk can be mitigated relatively easily:*

- *It is recommended that rockfall mitigation options be considered for the North West Oruahine Track, the highest risk area. Measures should include access restriction, rock scaling and possibly the consideration of fences.*
- *The hazard to the Campground is likely to be most cost effectively mitigated by monitoring and controlled scaling at the rockfall source areas (if necessary) although catch fences continue to be an option.*
- *TDC's planting and weed control programme should give priority to establishing grass to help stabilise the loose colluvium.*
- *Public off track access to the steep upper slopes should be prohibited.*
- *Effective track closures must be in place before any TDC staff or contractors access the steep upper slopes off track. Any persons entering these areas must be suitably experienced, competent, trained, equipped, insured etc.*
- *Monitoring and inspection should continue six monthly.*

November 15, 2006

- *Annual rock scaling is recommended.*

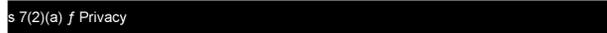
*Landslip hazard appears to possibly present a greater threat to the campground than rockfall and requires further consideration.*

*Any excavation at the toe of a slope reduces stability. It is strongly recommended that no earthworks or drainage works be carried out in or above the campground without serious consideration of the potential consequences.*

Our next programmed monitoring will be due in March/April next year. I will forward our invoice and if anyone has any queries at all please give me a call.

I look forward to receiving the revised plan & specification for the vegetation management.

Regards

 s 7(2)(a) f Privacy

For Avalon Industrial Services Ltd.

Attached: Site records for Nov 2006 Slope Monitoring.



**Avalon Industrial Services Ltd**

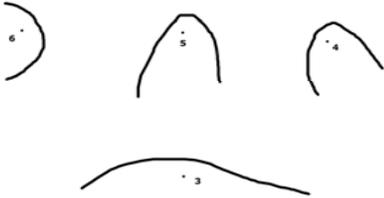
Mauao Survey Benchmark Monitoring

9-Nov-06

**Area 1a; Camp Bluff**

Installed post blasting, November 2003

1a The Camp Bluff



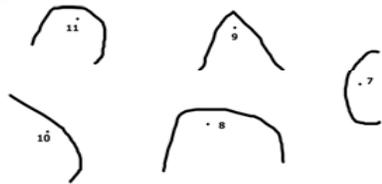
Distance measurement mm

	Nov-03	Jan-04	Nov-04	Mar-05	Dec-05	Mar-06	Nov-06
3 → 4		5211	5209	5208	<i>not possible</i>	5207	5208
3 → 5		4320	4320	4321	<i>due to</i>	4320	4323
3 → 6		5179	5180	5178	<i>public</i>	5180	5181
4 → 5		2258	2260	2260	<i>below</i>	2260	2260

**Area 2a; Blasted Column**

Installed post blasting, November 2003

2a Columns



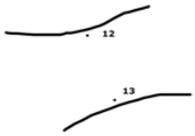
Distance measurement mm

	Nov-03	Jan-04	Nov-04	Mar-05	Dec-05	Mar-06	Nov-06
8 → 11		7917	7910	7907	<i>not possible</i>	7906	7915
8 → 9			9968	9969	<i>due to</i>	9970	9968
10 → 8			3111	3111	<i>public</i>	3112	3126
10 → 9			11636	11636	<i>below</i>	11633	11635
10 → 11			8325	8325		8325	8325

**Area 2i; Elephants Joint**

Installed March 2003

2i Elephant joint



		Distance measurement mm								
12	→	13	Mar-03	Nov-03	Jan-04	Nov-04	Mar-05	Dec-05	Mar-06	Nov-06
			2885		2884	2882	2887	2887	2887	2887

Area 3a; Noth East Bluff

Installed March 2003

3a Bluff top



		Distance measurement mm								
14	→	17	Mar-03	Nov-03	Jan-04	Nov-04	1/03/2005 *	Dec-05	Mar-06	Nov-06
14	→	17	8110			8122	8124	8129	8129	8135
15	→	17	5050			5050	5049	5050	5050	5056
16	→	17	4868			4874	4877	4879	4879	4868
15	→	16	3575			3581	3571	3577	3577	3575
15	→	14	7560			7478	7488	7485	7485	7484

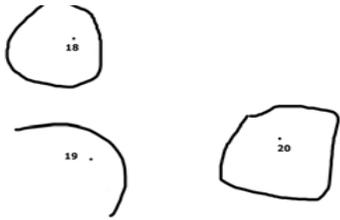
\*EDM

Blocks above Area 3d; North Promentary

Installed March 2003

Above 3d





Distance measurement mm

			Mar-03	Nov-03	Jan-04	Nov-04	1/03/2005 *	Dec-05	Mar-06	Nov-06
18	→	19	5248			5265	5256	5256	5254	#
20	→	19	3380			3385	3373	3376	3376	3377
20	→	18	8038			8065	8050	8056	8050	8053

\* EDM WITH BLOCK (= -10)  
# not recorded

**Zone 6 Boulder 6b**

Installed December 2005

23 (LH outcrop)      22 (RH Outcrop)  
21 (boulder)

				Dec-05	Mar-06	Nov-06
21	→	23		7560	7590	7615
21	→	22		5799	5830	5865



CHECK ON MAY 2005 SLIPS

site No 2:

Slip from the 4WD track to base track.  
Protective plastic sheet failed.  
No new movement; no flow at site visit.

sites 51 and 49:

No new movement.

site 11: \*\*

The slip doesn't appear to be moving any more BUT the rain is scouring the bare ground.  
Impacts of boulders found on the track and 3 boulders (diam. ~200mm) found at the sea level (been pushed ?)

site 12 and 13:

No new movement

site 15: \*\*\*

The water running through the slip is collected in a concrete pipe (~6-7L/min measured) at the base track.  
On the top of the main slip, a steel pipe is flowing (~200mL/min estimated) in the middle of the upper section of the slip.  
A small slip is starting to come down on the right side of the main slip.

site 14:

No new movement

site 19: \*\*\*\*

The water running on the surface of the slip from the crest of the slope is collected in a concrete pipe (~800mL/min measured) on the bottom track.  
The surface of the slip is loose and ravelling.  
The tension crack appears fresh at some places.

site 22: \*\*\*

The rain is scouring the ground, slowly revealing more boulders in upper high slip area.

site 30m West of site 25:

Tension crack developing in the bench 1.5-2m above the track.

site 25 and further east:

The ground is wet and a little of water is coming through the old slip. No new movement.

site 27-28:

Rain is scouring the old slip surface.

A few cubic metres of the bench is close to failure approximately 1.5m over the track; no hazard

site 33 and around:

No new movement; seepage from old slip debris coming out at track level.



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high / difficult access

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