

Soil Stability and Disturbance in the Matahuru Catchment – Changes from 2002 to 2007

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Executive Summary

Background

1. Environment Waikato has requested an assessment of the extent of erosion and soil conservation measures in a catchment that is representative of the region's Lower Waikato management zone. This zone encompasses the Waikato river and tributaries downstream of Taupiri. The assessment is intended to assist EW with upcoming discussions with the community as to the future promotion of catchment protection programmes in the zone. Matahuru was previously selected as a representative catchment by EW staff in 2000, because its size, landforms and land use are typical of tributaries draining towards the Lower Waikato.
2. EW contracted Mr. A.B. Thompson (Thelton Environmental) to undertake the assessment, with involvement of sub-contractors as needed. The assessment was undertaken as a point sample from aerial photographs. This is now a standard method for assessing erosion and erosion control measures, used by EW as well as other regional councils.
3. The report starts with an overview of soil stability, soil disturbance and bare soil. It then gives results from the 2007 assessment of land use and soil conservation measures for Matahuru, and compares them with results from a previous survey in 2002.

Soil Stability, Soil Disturbance and Bare Soil

1. Between 2002 and 2007, there have been significant changes in soil stability. The proportion of the Matahuru catchment that is stable i.e. free from risk of erosion, dropped from 35% of sample points to 32%. Unstable areas i.e. at risk of erosion though currently inactive, increased from 37% to 52% of points, because of revegetation at points previously classed as eroded (revegetating) or eroding (bare). These decreased from 27% to 10%. A new category, where soil is covered, partly removed or absent, was recorded at 7% of points in 2007.
2. Fresh soil disturbance by land use was recorded at 46% of sample points in 2002 and 23% in 2007. New bare soil was outweighed by revegetation at many of the points previously recorded as disturbed, so the net area of bare soil dropped from 4.0% to 1.9% of catchment area.
3. Fresh soil disturbance by natural processes of erosion or deposition was recorded at 21% of sample points in 2002 and 6% in 2007. Revegetation at eroded points dropped the net area of bare soil from 0.6% to 0.1% of catchment area.
4. In 2007 7% of sample points had soil covered, partly removed or absent due to extensive disturbance by rural buildings, roads, shorelines or water bodies. Soil actually bared by extensive disturbance was 0.2% of catchment area. This category was differentiated for the first time in 2007, so a comparison with 2002 cannot be made.

Changes in land use

1. Area of land in agricultural use has declined in Matahuru from 92% of the catchment in 2002 to 83% in 2007. The decrease is mostly due to scrub reversion, but also to recording of rural roads and buildings separately in 2007.
2. Area of land planted in exotic forest has declined, from just over 3% in 2002 to just under 3% in 2007. The reduction is due to a number of small forest plantations and farm woodlots which have been logged, and either converted to pasture or reverted to scrub.

3. Area of land in natural vegetation (either public or private conservation land) has increased, from 5% in 2002 to 6% in 2007. An additional 1% (undifferentiated in 2002) is residual vegetation (exotic weeds and scrub) in 2007. The increase is mainly scrub reversion on small parts of farms that have been retired, plus regrowth on felled woodlots that have not been replanted.
4. The balance of land in other uses (buildings, roads, quarries, waterbodies) was not recorded separately in 2002. In 2007 it is 7% of the catchment's area.

Land uses' effect

1. On farmland, bare soil caused by land use-related disturbance reduced substantially, from 4.0% of catchment area in 2002 to 1.9% in 2007.
2. In forest plantations, bare soil was measured as 0% of catchment area in 2002, and less than 0.1% in 2007; a very slight increase .
3. On land in natural or residual vegetation, there was a slight decrease in area of bare soil, which remained less than 0.1% at both dates
4. Amongst other uses, the area of bare soil was not measured in 2002. In 2007 it was measured for the first time, as 0.2% of catchment area.

Changes in soil conservation cover

1. Between 2002 and 2007:
 - Land in natural vegetation (includes reverting land with residual rank grass or exotic scrub) increased from 5% to 7% of the Matahuru catchment.
 - Land in forest plantations (mainly farm woodlots) remained 3%.
 - Farmland with planted soil conservation cover (poplars, willows or other exotic trees in pasture) decreased from 15% to 10%. Some of the decrease is real, though a little is due to transfer of farm buildings or roads which happen to have associated exotic tree plantings, out of farmland into the other uses category (see below).
 - Farmland with natural soil conservation cover (bush, scrub, fern or wetland retained in pasture) decreased from 24% to 19%.
 - Farmland with residual soil conservation cover (rank grass or exotic scrub in pasture) increased from 2% to 8%. This increase is due entirely to reclassification of points with mixed scrub in pasture as residual instead of natural.
 - Farmland where soil conservation cover is needed but absent (unstable land in open pasture) remained the same at just over 16%.
 - Farmland where soil conservation cover is not needed (stable land in open pasture) decreased from 34% to 29%. The decrease is due to recording points with buildings, roads etc. as a separate category in 2007 (see below).
 - Land in other uses was not separately recorded in 2002. In 2007 it was measured for the first time, as 7% of catchment area.

Soil conservation cover's effect

1. Throughout the Matahuru catchment, bare soil caused by natural processes of erosion or deposition decreased, from 0.61% of the catchment's area in 2002 to 0.12% in 2007:

- On land in natural vegetation, bare soil caused by erosion or deposition decreased from 0.02% to 0.0% of the catchment's area.
- On land in forest plantations, bare soil decreased from 0.03% to 0.0% of the catchment's area.
- On farmland with natural soil conservation cover, bare soil decreased from 0.21% to 0.04% of the catchment's area.
- On farmland with residual soil conservation cover, bare soil decreased from 0.03% to <0.01% of the catchment's area.
- On farmland with planted soil conservation cover, bare soil decreased from 0.17% to 0.03% of the catchment's area.
- On farmland where soil conservation cover is needed but absent (unstable land in open pasture), bare soil decreased from 0.16% to 0.04% of the catchment's area.
- On farmland where soil conservation cover is not needed (stable land in open pasture), bare soil remained 0% of the catchment's area.
- On land in other uses, bare soil was not measured in 2002, and was 0% of the catchment's area in 2007.

Conclusions

1. In the Matahuru catchment between 2002 and 2007 :

- Farmland has decreased significantly. Forest plantations have also decreased but not at a statistically significant level. Natural vegetation and residual vegetation (rank grass, weeds and exotic scrub) increased slightly but not significantly. Other uses (buildings, roads and waterbodies) were recorded for the first time in 2007, as occupying 7% of the catchment's area.
- Bare soil caused by land use has decreased significantly, from 4% to 2% catchment-wide. When broken down into categories, most of the decrease is due to a reduction in bare surfaces associated with farmland. Bare soil associated with forest plantations, residual vegetation and natural vegetation was already minimal in 2002, and did not change between then and 2007. Bare soil associated with other uses was measured for the first time in 2007, as 0.2% of the catchment's area.
- Changes in extent of soil conservation cover 2002-2007 are measureable but minor, and not significant for any land use apart from farmland. Farmland with planted soil conservation cover declined from 15% to 10% of the catchment. Farmland with residual conservation cover increased significantly from 2% to 8% of the catchment. Another change in a farmland category (where soil conservation cover is not needed) is attributable to transfer of points with rural buildings, roads and water bodies into a new category (other uses) in 2007.
- Bare soil caused by natural processes in the catchment has declined significantly from 0.6% to 0.1% of its area. Bare soil has decreased for all categories of soil conservation cover. For land uses other than farmland, decreases were not statistically significant because bare soil was already low (less than 0.1% of catchment area) in 2002. On farmland, the decreases were statistically significant, entailing drops in bare soil from 0.1-0.2%, down to less than 0.1%. Low levels of bare soil in 2002, combined with lack of difference amongst the categories, suggests that the drops are due to revegetation in the absence of storms or wet winters 2002-2007.

1 Introduction

Environment Waikato has requested an assessment of the extent of erosion and soil conservation measures in a catchment that is representative of the region's Lower Waikato management zone. This zone encompasses the Waikato river and tributaries downstream of Taupiri. The assessment is intended to assist EW with upcoming discussions with the community as to the future promotion of catchment protection programmes in the zone. Matahuru was previously selected as a representative catchment by EW staff in 2000, because its size, landforms and land use are typical of tributaries draining towards the Lower Waikato.

97 square kilometers in area, the Matahuru is mostly farmland diversified by exotic forest woodlots, reverting scrub patches, and bush remnants. Its terrain rises from a narrow stream floodplain, through extensive ash-mantled terraces and downlands in the lower catchment, towards moderate greywacke hill country in the headwaters. Soil conservation works were implemented in the catchment by the former Waikato Valley Authority from the 1960s through the 1980s. A previous assessment (Hicks 2005) provided basic information about their extent and condition, relative to the areas of unstable land in the catchment. The new assessment is intended to up-date EW and landowners about any changes in soil erosion, extent of soil conservation measures, and their effectiveness, during the past five years.

EW contracted Mr. A.B. Thompson (Thelton Environmental) to undertake the assessment, with involvement of Dr. D. Hicks as needed for analysis procedure and comparisons.

2 Method

The assessment has been undertaken as a point sample from aerial photographs. This is now a standard method for assessing erosion and erosion control measures, used by EW as well as other regional councils. Interpretation and measurement procedures are described in the Land Monitoring Forum's Manual (Burton et al 2009). The advantage of a point sample, is that it can provide statistically sound measures of unstable land, soil conservation plantings, and erosion's extent, without resorting to field surveys which would be time-consuming and expensive.

The previous assessment utilised 482 points randomly selected on aerial photographs taken in 2002 (a sampling density of 5 points per square kilometer). Re-assessment of the Matahuru catchment from 2007 aerial photographs has been carried out for 500 points.

Assessment was carried out by Mr. Thompson on Environment Waikato's Geographic Information System, using a Geomedia workspace and Manifold sampling procedure created by EW's GIS analyst Mr. D. Borman. Data analysis and report drafting were carried out jointly by Mr. Thompson and Dr. Hicks. A parallel assessment for the entire Lower Waikato management zone (from a subset of EW's regional point sample) was carried out by Ms. S. Hicks (ecological survey contractor, Dunedin) under Dr. Hicks' supervision. The report will be peer-reviewed by Dr. R. Hill of EW's Resource Information Group.

Contents of the Report

The report starts with an overview of soil stability, soil disturbance and bare soil. It then gives results from the 2007 assessment of soil conservation measures, and compares them with the previous results from 2002. Results and comparisons are split according to whether land is farmed, planted in forest, or under natural vegetation, then grouped as a single catchment-wide summary.

Report tables contain key numbers which may be useful for staff discussions and public presentations. They have been extracted from more detailed analyses, which appear as spreadsheets in Appendix A :

- Changes in soil stability and disturbance.
- Changes in bare soil
- Land uses' extent and effect
- Soil conservation cover's extent and effect

Appendix B contains equivalent analyses for the whole Lower Waikato catchment management zone.

3 Soil Stability, Soil Disturbance and Bare Soil

3.1 Soil stability

Table 1 Soil stability in Matahuru catchment

	As percent of catchment :			
	Stable	Unstable	Eroded & eroding	Soil covered, removed or absent
Matahuru 2002	35.1	38.2	26.8	0.0
Matahuru 2007	31.8	51.6	10.2	6.4

In 2002, 35.1% of sample points in the Matahuru catchment had soil that was stable i.e. free from risk of erosion (this includes 24.5% where recent or fresh land use disturbance was present). In 2007 31.8% of sample points were assessed as stable (including 7.4% where recent or fresh land use disturbance was present). The apparent decrease in stable land is due to reclassification of points as "soil covered, removed or absent" (consistent with standard LMF procedure) where features such as roads, buildings and waterbodies were recorded.

In 2002 38.2% of sample points in the Matahuru had soil that was unstable i.e. at risk of erosion but currently undisturbed by natural processes (this includes 21.4% where recent or fresh land use disturbance was present). In 2007 51.6% of sample points were unstable (including 16.0% where recent or fresh land use disturbance was present). The increase is due to revegetation of points previously recorded as eroded or eroding.

In 2002 26.8% of sample points in the Matahuru had soil that was eroded (revegetating) or eroding (bare scars). In 2007 10.2% of sample points were eroded or eroding. The large decrease is due to a significant drop in points where fresh erosion was observed (21.4% down to 6.0%). Many of these points have been reclassified as unstable where revegetation is now complete

In 2002 no sample points had soil recorded as covered by buildings and pavements, removed by roadworks and quarries, or absent along shorelines and waterbodies. In 2007 6.4% of sample points were recorded in this category due to application of the standard LMF measurement procedure.

3.2 Soil disturbance

Table 2: Soil disturbance in the Matahuru catchment

	Percent of catchment with :			
	recent land use disturbance	fresh land use disturbance	recent natural disturbance	fresh natural disturbance
Matahuru 2002	-	45.9	5.4	21.4
Matahuru 2007	-	23.4	4.2	6.0

In 2002 0% of sample points in the Matahuru catchment had recently disturbed (revegetating) soil caused by land use. In 2007 these points were re-assigned to other categories (consistent with standard LMF procedure).

45.9% of sample points in the Matahuru catchment had freshly disturbed (bare) soil caused by land use in 2002. This reduced to 23.4% in 2007; a substantial and significant change, due to reduced disturbance associated with grazing, harvesting and tracks. Some was counter-balanced by an increase in cultivation, although the increase was not statistically significant.

In 2002 5.4% of sample points in the Matahuru had soil recently disturbed by natural processes of erosion or deposition. This reduced slightly to 4.2% in 2007; not a significant change.

Soil with fresh natural disturbance was observed at 21.4% of points in 2002 and this reduced significantly to 6.0% in 2007. There were significant reductions in incidence of landslides, gullies, tunnel gullies and streambank scour.

Soil with fresh extensive disturbance was recorded separately for the first time in 2007, at 1.8% of sample points. It was entirely land use disturbance.

3.3 Bare soil

Table 3: Bare soil in the Matahuru catchment

	Percent of catchment with bare soil due to fresh :		
	land use disturbance	natural disturbance	extensive disturbance
Matahuru 2002	4.03	0.61	-
Matahuru 2007	1.94	0.12	0.25

In 2002, 4.03% of the Matahuru catchment's area had bare soil due to fresh disturbance by land use. In 2007 bare soil decreased significantly to 1.94%. A significant decrease in soil bared by grazing pressure, harvest, tracks and drains, was partly off-set by a small but insignificant increase in soil bared by cultivation.

In 2002 0.61% of the Matahuru catchment's area had bare soil due to disturbance by natural processes. In 2007 bare soil was 0.12%. The overall decrease was significant (to about one fifth of the 2002 level), and was due to significant drops in soil bared by landslides, tunnel gullies, gullies and streambank scour. Drops in soil bared by slumps and streambank deposits were also measured but were statistically insignificant.

Bare soil due to extensive disturbance was not recorded in 2002. In 2007 0.25% of the Matahuru catchment's area had bare soil due to extensive disturbance by land-use

activities such as roading, quarries and buildings. None of this extensive disturbance was due to natural processes.

4 Land uses' extent and effect catchment-wide

Table 4 Land uses' extent and effect

	Land in category, as % of catchment		Bare soil caused by land use, as % of category	
	Matahuru 2002	Matahuru 2007	Matahuru 2002	Matahuru 2007
Natural vegetation	5.0	6.4	0.06	0.01
Residual vegetation	0.0	1.4	0.0	0.0
Forest plantations	3.1	2.8	0.00	0.01
Farmland	91.9	82.6	3.98	1.87
Rural buildings, etc.	-	6.4	-	0.28
Shorelines, etc.		0.4	-	0.00

Between 2002 and 2007 :

- Area of land in agricultural use has declined significantly in Matahuru from 91.9% of the catchment in 2002 to 82.6%. The decrease is mostly due to scrub reversion, but also to recording of rural roads and buildings separately in 2007. On farmland, bare soil caused by land use-related disturbance reduced substantially, from 3.98% of catchment area to 1.87%; a significant change.
- Land planted in exotic forest has declined, from 3.1% to 2.8%. The reduction is due to a number of small forest plantations and farm woodlots which have been logged, and either converted to pasture or reverted to scrub. In forest plantations, bare soil caused by land use-related disturbance was measured as 0.00% of catchment area in 2002, and 0.01% in 2007; a very slight and insignificant increase .
- Land in natural vegetation (either public or private conservation land) has increased, from 5.0% to 6.4%. An additional 1.4% (undifferentiated in 2002) is residual vegetation (exotic weeds and scrub) in 2007. The increase is mainly scrub reversion on small parts of farms that have been retired, plus regrowth on felled woodlots that have not been replanted. On land in natural or residual vegetation, there was a slight decrease in area of bare soil, from 0.06% of catchment area in 2002 to 0.01% in 2007, but the decrease was statistically insignificant.
- The balance of land in other uses (buildings, roads, quarries, waterbodies) was not recorded separately in 2002. In 2007 it was 6.8% of the catchment's area. The area of bare soil caused by extensive disturbance associated with these uses was measured for the first time in 2007, as 0.25% of catchment area.

5 Soil conservation cover's extent and effect catchment-wide

Table 5 Soil conservation cover's extent and effect

	Land in category, as % of catchment		Bare soil caused by erosion or deposition, as % of category	
	Matahuru 2002	Matahuru 2007	Matahuru 2002	Matahuru 2007
Natural vegetation	5.0	6.4	0.02	0.00
Residual vegetation	0.0	1.4	0.00	0.00
Forest plantations	3.1	2.8	0.03	0.00
Farmland with planted s.c. cover	14.7	10.2	0.17	0.03
Farmland with residual s.c. cover	2.3	8.2	0.03	<0.01
Farmland with natural s.c. cover	24.3	18.6	0.21	0.04
Farmland, s.c. cover needed but absent	16.2	16.4	0.16	0.04
Farmland, s.c. cover not needed	34.4	29.2		0.00
Rural buildings, etc.	-	6.4	-	0.00
Shorelines, etc.	-	0.4	-	0.00

Between 2002 and 2007 :

- Land in natural vegetation changed from 5.0% to 6.4% of the Matahuru catchment. Bare soil caused by erosion or deposition decreased from 0.02% to 0.0% of the catchment's area.
- Land in residual vegetation (rank grass, weeds and exotic scrub) changed from 0% to 1.4%. Bare soil caused by erosion or deposition was 0% of the catchment's area at both dates.
- Land in forest plantations changed from 3.1% to 2.8%. Bare soil caused by erosion or deposition decreased from 0.03% to 0% of the catchment's area.
- Farmland with planted soil conservation cover (poplars, willows or other exotic trees in pasture) changed from 14.7% to 10.2%. Some of the decrease is real, though a little is due to transfer of farm buildings or roads which happen to have associated exotic tree plantings, out of farmland into the other uses category (see below). Bare soil amongst planted soil conservation cover decreased from 0.17% to 0.03% of the catchment's area; a significant change.

- Farmland with residual soil conservation cover (rank grass, marram or exotic scrub in pasture) changed from 2.3% to 8.2%. This increase is due entirely to reclassification of points with mixed scrub in pasture as residual instead of natural. Here bare soil decreased slightly, from 0.03% to <0.01% of the catchment's area.
- Farmland with natural soil conservation cover (bush, scrub, fern or wetland retained in pasture) changed from 24.3% to 18.6%. On this land bare soil decreased from 0.21% to 0.04% of the catchment's area between dates; a significant change.
- Farmland where soil conservation cover is needed but absent (unstable land in open pasture) remained about the same at 16.2% and 16.4% respectively. On this land bare soil decreased from 0.16% to 0.04% of the catchment's area between 2002 and 2007; also a significant change.
- Farmland where soil conservation cover is not needed (stable land in open pasture) decreased from 34.4% to 29.2%. The decrease is due to recording points with buildings, roads etc. as a separate category in 2007 (see below). Where soil conservation cover is not needed, bare soil remained 0% of the catchment's area.
- Land occupied by other uses (rural buildings, roads and water bodies) was recorded for the first time in 2007, as 6.8% of the catchment's area. Here bare soil caused by extensive natural disturbance was 0% of the catchment's area.

6 Conclusions

In the Matahuru catchment between 2002 and 2007, the area recorded as farmland has decreased significantly, partly due to scrub reversion on patches of land that have been retired; though also because sample points with buildings, roads and waterbodies have been transferred out of the farmland category into a new category (other uses). The area in forest plantations has also decreased but not at a statistically significant level. Areas of natural vegetation and residual vegetation (rank grass, weeds and exotic scrub) increased slightly but not significantly. Other uses were recorded on 7% of the catchment's area in 2007.

Bare soil caused by land use has decreased significantly, from 4% to 2% catchment-wide. When broken down into categories, most of the decrease is due to a reduction in bare surfaces associated with farmland. Bare soil associated with forest plantations, residual vegetation and natural vegetation was already minimal in 2002, and did not change between then and 2007. Bare soil associated with other uses was measured for the first time in 2007, as 0.2% of the catchment's area. Overall, bare soil caused by land use in the catchment has declined significantly from 4.0% to 1.9% of its area.

Changes in extent of soil conservation cover 2002-2007 are measureable but minor, and not significant for any land use apart from farmland. Farmland with planted soil conservation cover declined from 15% to 10% of the catchment. Some of the decline is real, though a little is due to transfer of farm buildings or roads which happen to have associated exotic tree plantings, out of farmland into the other uses category. Farmland with residual conservation cover increased significantly from 2% to 8% of the catchment. This appears due to reclassification of points with a mix of exotic and native scrub in pasture, as exotic in 2007. Another change in a farmland category (where soil conservation cover is not needed) is attributable to transfer of points with rural buildings, roads and water bodies into a new category (other uses) in 2007.

Overall, the extent of bare soil caused by natural processes in the catchment has declined significantly from 0.6% to 0.1% of its area. Bare soil has decreased for all categories of soil conservation cover between 2002 and 2007. For land uses other than farmland, decreases were not statistically significant because bare soil was

already low (less than 0.1% of catchment area) in 2002. On farmland, the decreases were statistically significant for three categories (planted conservation cover, natural cover and absent cover), entailing drops in bare soil from 0.1-0.2% of catchment area, down to less than 0.1%. Low levels of bare soil in 2002, combined with lack of difference amongst the categories, suggests that the drops are due to revegetation in the absence of storms or wet winters 2002-2007.

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Appendices

Appendix A Data Summary Tables for Matahuru Catchment

Table 1 Changes in Soil Stability & Disturbance, Matahuru Catchment

	Points :		Points as % of sample :		Significant change? :
	2002	2007	2002	2007	
Stable surfaces					
with intact soil	51	122	10.6	24.4	
95% conf.			2.7	3.8	Y
with soil disturbed by land use	118	37	24.5	7.4	
95% conf.			3.8	2.3	Y
Erosion-prone surfaces					
with intact soil	81	178	16.8	35.6	
95% conf.			3.3	4.2	Y
with soil disturbed by land use	103	80	21.4	16.0	
95% conf.			3.7	3.2	N
Eroded and eroding surfaces					
with revegetating soil	26	21	5.4	4.2	
95% conf.			2.0	1.8	N
with soil disturbed by natural processes	103	30	21.4	6.0	
95% conf.			3.7	2.1	Y
Surfaces where soil is covered, removed or absent					
with soil currently undisturbed	not rec.	23	0.0	4.6	
95% conf.			0.0	1.8	-
with soil currently disturbed	not rec.	9	0.0	1.8	
95% conf.			0.0	1.2	-
All surfaces					
as percentage of sample	482	500	100.0	100.0	

Note 1 : "% of sample" sub-totals/totals may differ by 0.1% due to rounding

Note 2 : confidence limits are not additive

Table 2 Changes in Bare Soil, Matahuru Catchment

	Disturbed points		Bare soil as % of catchment :		Significant change? :
	2002	2007	2002	2007	
By land use :					
grazing pressure	100	12	0.64	0.06	
95% conf.			0.15	0.04	Y
cultivation	13	11	0.80	1.26	
95% conf.			0.64	0.84	N
harvest	13	1	1.27	<0.01	
95% conf.			0.79	0.01	Y
spraying					
95% conf.					
drains	6	0	0.06	0.00	
95% conf.			0.06	0.00	Y
tracks	77	90	1.15	0.56	
95% conf.			0.28	0.13	Y
earthworks	12	1	0.10	0.03	
95% conf.			0.07	0.06	N
All rural land use disturbance	221	115	4.03	1.94	
95% conf.			1.02	0.85	Y
By natural processes :					
landslide	26	10	0.16	0.04	
95% conf.			0.07	0.03	Y
debris avalanche					
95% conf.					
slump or earthflow	6	1	0.06	<0.01	
95% conf.			0.06	0.01	N
tunnel gully	19	2	0.08	0.01	
95% conf.			0.04	0.01	Y
gully	23	4	0.15	0.01	
95% conf.			0.07	0.02	Y
streambank scour	22	7	0.11	0.03	
95% conf.			0.05	0.02	Y
streambank deposit	5	4	0.05	0.02	
95% conf.			0.05	0.02	N
sandblow					
95% conf.					
sheetwash					
95% conf.					
rockfall or bare rock	2	2	0.01	0.01	
95% conf.			0.01	0.01	N
geothermal					
95% conf.					

All rural natural disturbance	103	30	0.61	0.12	
95% conf.			0.12	0.05	Y
Extensive disturbance :					
by land use	not rec.	9	-	0.25	
95% conf.			-	0.30	-
by natural processes	not rec.	0	-		
95% conf.			-		
All extensive disturbance	not rec.	9	-	0.25	
95% conf.			-	0.30	-
All disturbance :	324	154	4.64	2.33	
95% conf.			1.01	0.90	Y

Note 1 : "% of sample" sub-totals/totals may differ by 0.1% due to rounding
Note 2 : confidence limits are not additive

Table 3 Land Uses' Extent and Effect, Matahuru Catchment

	Sample points		Land in category		Signif. change?	Bare soil caused by land use		
	2002	2007	as % of catchment			as % of catchment		Signif. change?
	2002	2007	2002	2007	Signif. change?	2002	2007	Signif. change?
Natural vegetation	24	32	5.0	6.4		0.06	0.01	
95% c.i.			1.9	2.1	N	0.07	0.02	N
Residual vegetation	0	7	0.0	1.4		0.00	0.00	
95% c.i.			0.0	1.0	Y	0.00	0.00	N
Forest plantations	15	14	3.1	2.8		0.00	0.01	
95% c.i.			1.6	1.4	N	0.00	0.01	N
Farmland	443	413	91.9	82.6		3.98	1.87	
95% c.i.			2.4	3.3	Y	1.02	0.85	Y
Rural buildings, urban areas etc.	-	32	0.0	6.4		-	0.28	
95% c.i.			0.0	2.1	Y		0.30	-
Shorelines, etc.	-	2	0.0	0.4		-	0.00	
95% c.i.			0.0	0.6	N		0.00	-
All land in catchment	482	500	100.0	100.0		4.03	2.19	
95% c.i.			-	-		1.02	0.90	Y

Table 4 Soil Conservation Cover's Extent and Effect, Matahuru Catchment

	Sample points		Land in category		Signif. change?	Bare soil caused by natural processes		
	2002	2007	as % of catchment			as % of catchment		Signif. change?
	2002	2007	2002	2007	Signif. change?	2002	2007	Signif. change?
Natural vegetation	24	32	5.0	6.4		0.02	0.00	
95% c.i.			1.9	2.1	N	0.03	0.00	N
Residual vegetation	0	7	0.0	1.4		-	0.00	
95% c.i.			0.0	1.0	N	-	0.00	
Forest plantations	15	14	3.1	2.8		0.03	0.00	
95% c.i.			1.6	1.4	N	0.03	0.00	N
Farmland with planted soil conservation cover	71	51	14.7	10.2		0.17	0.03	
95% c.i.			3.2	2.7	N	0.07	0.02	Y
Farmland with residual soil conservation cover	11	41	2.3	8.2		0.03	<0.01	
95% c.i.			1.3	2.4	Y	0.04	0.01	N
Farmland with natural soil conservation cover	117	93	24.3	18.6		0.21	0.04	
95% c.i.			3.8	3.4	N	0.09	0.03	Y
Farmland, soil conservation cover absent	78	82	16.2	16.4		0.16	0.04	
95% c.i.			3.3	3.2	N	0.06	0.02	Y
Farmland, soil conservation cover not needed	166	146	34.4	29.2		0.00	0.00	
95% c.i.			4.2	4.0	N	0.00	0.00	N
Rural buildings, urban areas etc.	-	32	0.0	6.4		-	0.00	
95% c.i.			0.0	2.1	Y		0.00	-
Shorelines etc.	-	2	0.0	0.4		-	0.00	
95% c.i.			0.0	0.6	N		0.00	-
All land in catchment	482	500	100.0	100.0		0.61	0.12	
95% c.i.			-	-	-	0.13	0.05	Y

Appendix B Data Summary Tables for Lower Waikato Zone

Table 1

	A	B	C	D	E	F	G	H	I
1	SPREADSHEET 1	CHANGES IN SOIL STABILITY & DISTURBANCE, LOWER WAIKATO CATCHMENT MANAGEMENT ZONE							
2									
3									
4		Points :		Points as % of sample :		Significant change? :			
5		2002	2007	2002	2007				
6									
7	Stable surfaces								
8	with intact soil	345	248	48.7	35.0				
9	95% conf.			3.7	3.5	Y			
10	with soil disturbed by land use	36	117	5.1	16.5				
11	95% conf.			1.6	2.7	Y			
12									
13	Erosion-prone surfaces								
14	with intact soil	225	172	31.7	24.3				
15	95% conf.			3.4	3.2	Y			
16	with soil disturbed by land use	17	53	2.4	7.5				
17	95% conf.			1.1	1.9	Y			
18									
19	Eroded and eroding surfaces								
20	with revegetating soil	21	26	3.0	3.7				
21	95% conf.			1.2	1.4	N			
22	with soil disturbed by natural processes	16	28	2.3	3.9				
23	95% conf.			1.1	1.4	N			
24									
25	Extensively disturbed surfaces								
26	with soil currently undisturbed	46	41	6.5	5.8				
27	95% conf.			1.8	1.7	N			
28	with soil currently disturbed	3	24	0.4	3.4				
29	95% conf.			0.5	1.3	Y			
30									
31	All surfaces								
32	as percentage of sample	709	709	100.0	100.0	-			
33									
34				Note 1 : "% of sample" sub-totals/ totals may differ by 0.1% due to rounding					
35				Note 2 : confidence limits are not additive					
36									