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Catchment environmental monitoring report: 2009/10

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Disclaimer

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1 Introduction

1.1 Background

As part of Project Watershed and Peninsula Project implementation, the Catchment Environmental Monitoring (CEM) Programme was developed to demonstrate the long term benefits of soil conservation. To date, monitoring has been established in selected priority catchments for soil conservation in the Waipa, Lower Waikato, Upper Waikato and Coromandel management zones.

The Catchment Environmental Monitoring (CEM) programme allows Environment Waikato to:

- demonstrate the long term benefits of soil conservation and river management work programmes
- better utilise resources and leverage opportunities to co-ordinate monitoring internally and externally (e.g. within Environment Waikato, NIWA and LandCare Research)
- integrate new monitoring requirements into existing regional monitoring networks.

Prior to the CEM programme soil conservation implementation relied on regional monitoring information being reinterpreted at a catchment scale. However, this information is often misleading because regional scale information is being applied at a finer scale (catchment scale).

This report provides CEM programme results for the 2009/2010 year. Copies of reports as described in the list of references can be obtained by contacting Environment Waikato (the Library) on 0800 800 401, or in electronic format from the publications page of the Environment Waikato website www.ew.govt.nz/publications or email: inforeq@ew.govt.nz.

1.2 Report content

This report provides information on the annual monitoring of the environmental effects of soil conservation and river management works implemented in soil conservation priority catchments across the Waikato region. It includes updated results from the 2009/10 monitoring period. Interpretations of the results and identification of trends (where applicable) and results from additional monitoring sites are also included. The report is structured so that each zone can be reviewed independently.

1.3 Monitoring approach

The aim of the CEM programme is to provide a representative (and where possible quantitative) indication of changes in various environmental parameters resulting from soil conservation and river management work. Parameters include changes in the hillslope erosion, stream bank erosion, riparian vegetation and fencing, sedimentation in surface water, water temperature and in-stream ecological habitat. Monitoring has been selected to measure changes on land and in surface water to provide some indication of the resulting on-site and off-site benefits. Details of the methods used are provided in the internal series report Catchment Environmental Monitoring Methods (Grant, Littler and Hill, 2009a).

It is important to note that not all priority soil conservation catchments are monitored. However, the results for the monitored catchments should be more applicable to other priority catchments in a given zone than monitoring results from elsewhere in the region. A standard monitoring approach is recommended for all monitored catchments

but the specific suite of monitoring will differ from catchment to catchment depending on the type of soil conservation and river management issues within each catchment. There are several key outcomes of the CEM programme:

- An understanding of the long-term benefits of soil conservation, river management and catchment issues in the Waikato region.

- A long-term picture of the land and water quality benefits of soil conservation and river management initiatives provided by Environment Waikato.

- A regional framework for obtaining, managing and implementing catchment scale monitoring information.

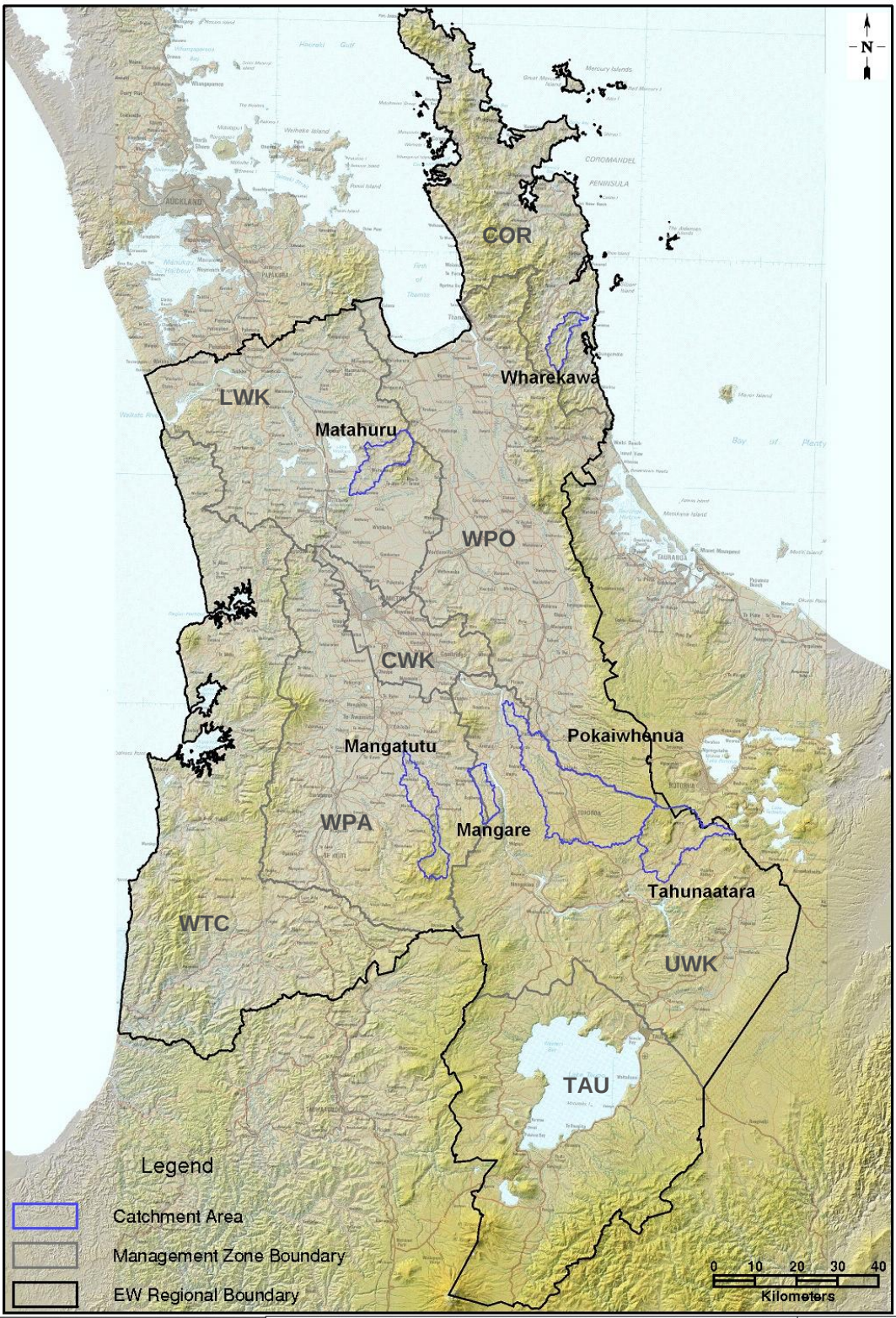
- Efficient integration of existing State of the Environment regional monitoring, Crown Research Institute catchment monitoring, Environment Waikato implemented works consent monitoring, and Environment Waikato initiatives specific catchment monitoring (e.g. Peninsula Project).

1.4 Management zone boundaries

The monitored catchments are positioned in four management zones, as described in Table 1. Zones which do not contain monitored catchments at this stage are Central Waikato (CWK), West Coast (WTC), Waihou-Piako (WPO) and Lake Taupo (TAU) zones. The priority catchments covered in this report are shown in Figure 1, in addition to the management zone boundaries.

Table 1: Location of the monitored catchments as at 2009/2010.

Monitored catchment	Management zone
Matahuru	Lower Waikato (LWK)
Mangare	Upper Waikato (UWK)
Pokaiwhenua	Upper Waikato (UWK)
Tahunaatara	Upper Waikato (UWK)
Mangatutu	Waipa (WPA)
Wharekawa	Coromandel (COR)



Monitored Catchments

Created by: Philippa Status: Complete **A4**
Projection: NZTM Request No.: 17058
Date: 25/08/2008 File name:17058CatchmentsSallyG

ACKNOWLEDGEMENTS AND DISCLAIMERS

The catchment boundary is a watershed delineation and has no relationship to Environment Waikato's Regional boundary, or to any property boundaries. This catchment boundary is not an Environment Waikato legal boundary. The boundary has been captured from the NZMS260 map sheet series and is accurate to +/- 200 metres at best. The boundary is very subjective in areas with sinkholes, underground streams or drains. The boundary is not suitable for use in detailed, property-specific analysis.

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Figure 1: Monitored priority catchment locations, with management zone boundaries (labels explained in Table 1).

2 Monitoring information

The reported monitoring information is provided through specific catchment scale monitoring in selected soil conservation priority catchments. In addition, on-going regional monitoring information (Table 2) is utilised to increase our knowledge of the state and changes in soil erosion and sedimentation of water within the various management zones.

Table 2: Environment Waikato regional land and water monitoring programmes

Programme	Main measures	Last assessment/ frequency
Regional soil stability assessment	Soil stability and soil conservation	2002/03; assessment 5-10 yearly
Regional riparian characteristics assessment	Riparian fencing, vegetation and erosion	2009/10; assessment 5-10 yearly
Permanent suspended sediment sites	Water quality including sediment and peak flows	8 sites; reviewed annually
River ecological monitoring sites (REMS)	Stream biological and habitat condition	Ongoing (~10yrs data)
Regional rivers	Water quality including sediment	Ongoing (>10yrs data)

3 Lower Waikato zone

3.1 Introduction

Monitoring is present in one catchment in the Lower Waikato zone; Matahuru catchment.

3.2 Matahuru catchment

3.2.1 Monitoring progress

Monitoring is focused on the lower section of the Matahuru catchment (refer to Grant, Kotze and Hill, 2009b for survey locations). Table 3 presents monitoring completed by the end of the 2009/10 financial year.

Table 3: Lower Waikato zone monitoring completed by 2009/10.

Monitoring	Activity	Completion	Included in this report (or year last reported)
Soil stability	Soil stability and soil conservation assessment	2005	(2005/06)
Riparian characteristics assessment	Complete assessment along the lower section of the Matahuru Stream	2003/04, 2005/06 2007/08, 2009/10	✓
Photo points	Complete assessment along the lower section of the Matahuru Stream	2003/04, 2004/05 2005/06, 2007/08 2009/10	✓
Permanent suspended sediment sampling site	Event driven sampling	Installed 2003 and ongoing	✓
Suspended sediment snapshots	• Low flow snapshot • Medium flow snapshot • High flow snapshot at next relevant rainfall event	2003 2008 Not undertaken	(2005/06) (2007/08)
Water temperature	Install loggers and record stream temperatures along the lower section of the Matahuru Stream	2003/04, 2004/05 2005/06, 2006/07 2007/08, 2008/09 2009/10	✓

3.2.2 Soil stability

Refer to Hill, Blair and Hopkins (2006) for the most recent assessment report for this catchment.

3.2.3 Riparian characteristics

Introduction

Eleven 1km samples of the riparian margin have been assessed in the lower section of the Matahuru Stream. These are locations where Project Watershed funded works have been completed or are scheduled, where stream riparian margin access is possible, and where landowner participation is forthcoming. The baseline assessment was conducted during the 2003/04 summer with the most recent assessment completed in 2009/10.

The reported data for each parameter represents a percentage of the total assessed riparian margin in the catchment. A table of the riparian assessment data is located in

Appendix 1. The following summary data was collected where riparian soil conservation has been recently implemented or is planned for the Matahuru catchment. Erosion, vegetation and fencing data summaries are presented in Figures 2, 3, 4 and 5. The number in brackets in each figure is the percentage change from the baseline data collected in the 2003/04 assessment.

Vegetation

Riparian vegetation improves stream bank stability and riparian margin biodiversity, as well as minimising increases in stream temperature due to shading. Riparian vegetation is split into grass and woody vegetation (native + willow + exotic other). Figure 2 shows 29% of the riparian margin is grass. The remaining 71% is woody vegetation, of which 45% is native, 8% is willow and 18% is other exotic species.

The length of the riparian margin in grass has decreased by 23% since the baseline assessment, associated with a corresponding 23% increase in riparian woody vegetation. The increase in woody vegetation is split, with the majority of the increase (17%) being exotic woody vegetation, while the increase in native vegetation accounted for the remaining 6%.

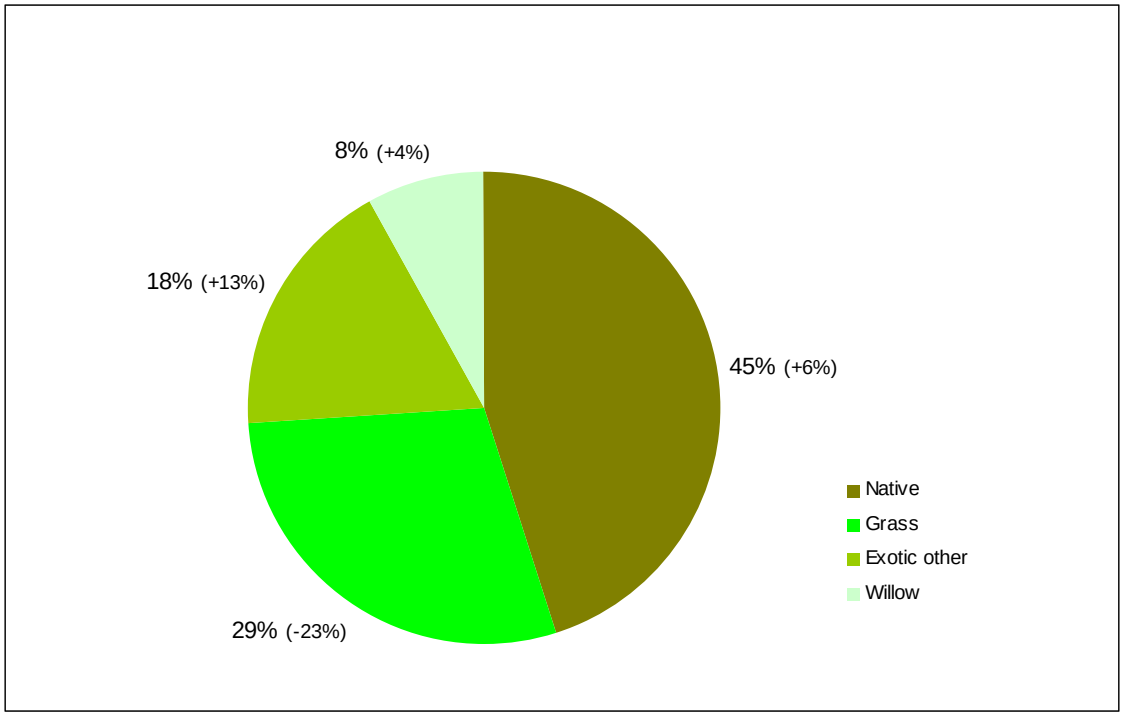

Figure 2: Matahuru riparian vegetation (value in brackets represents the percent change from baseline data)

Fencing

The amount of fencing on one side or both sides of the waterway is an indicator of likely stock exclusion from the waterway. Stock exclusion reduces direct contamination of water by pathogens, direct damage to the stream ecology by trampling of the stream bed and indirectly reduces sediment load from stock trampling the banks.

Stock is excluded from both sides for 77% of the waterway, from one side for 21% of the waterway and are not excluded from either side for 2% of the waterway (Figure 3). There has been an increase of 31% in the length of stream fenced on both sides since the 2003/04 assessment.

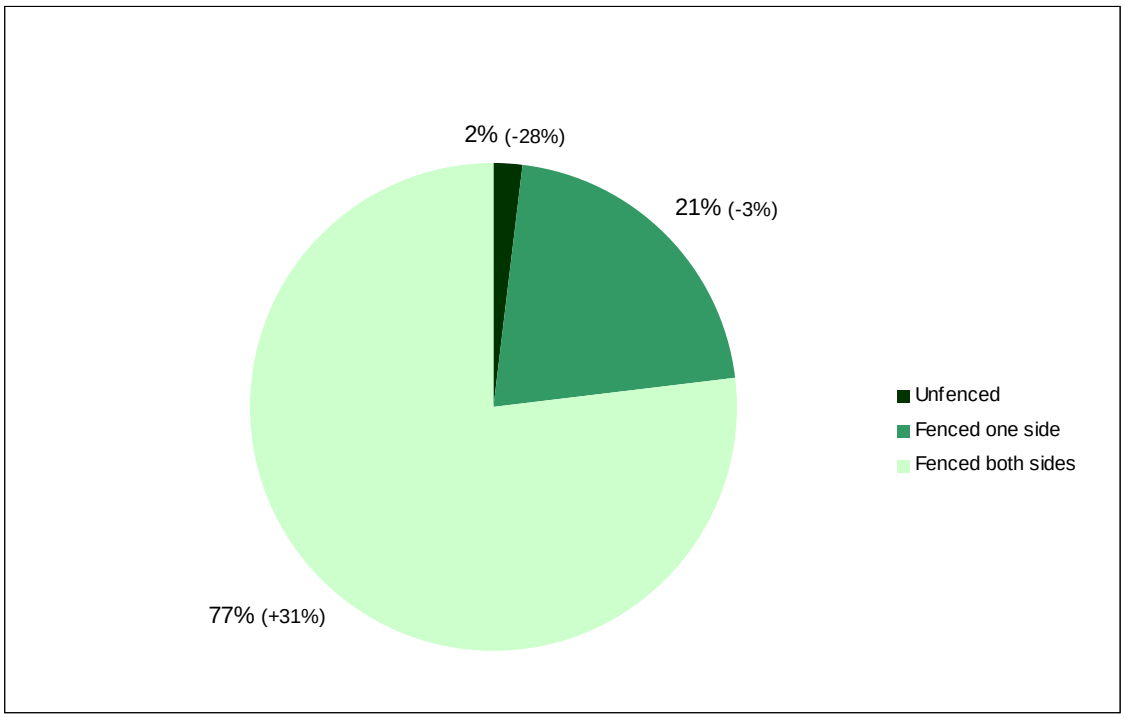

Figure 3: Matahuru stock exclusion by stream length (value in brackets represents the percent change from baseline data)

Riparian Enhancement

An estimated 87% of the banks are fenced while 13% are not fenced. The majority (76%) of the total fenced bank length (or 66% of the total bank length) has woody vegetation (Figure 4). The length of bank with fenced woody vegetation has increased by 25%.

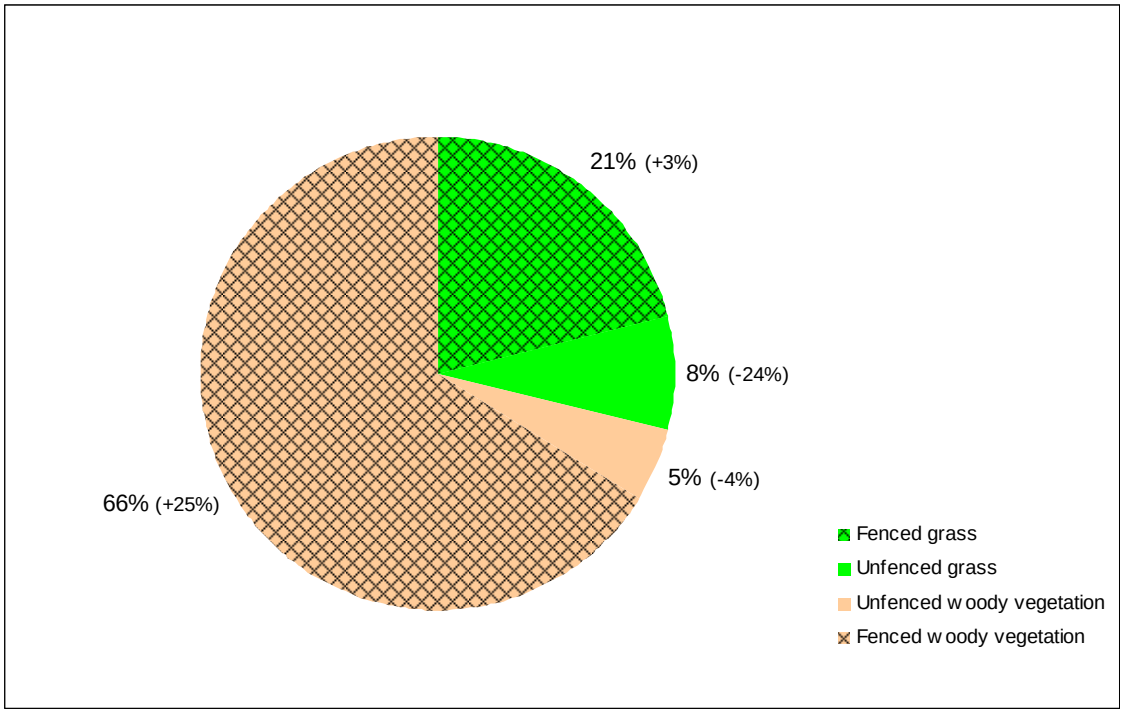

Figure 4: Matahuru riparian margin fencing and vegetation combinations (value in brackets represents the percent change from baseline data)

Stream bank stability

Stream bank stability is measured, as unstable stream banks are one of the main sources of sediment in waterways. Stream bank stability can be improved through the type of riparian vegetation used, and by fencing out stock.

An estimated 81% of the assessed riparian bank length is considered stable, an increase of 34% since the 2003/04 assessment (Figure 5). The remaining 19% is unstable. From the remaining 19% unstable bank, a greater portion is fenced (16%) than not fenced (3%). Grass vegetation is present on 32% of the total unstable bank length.

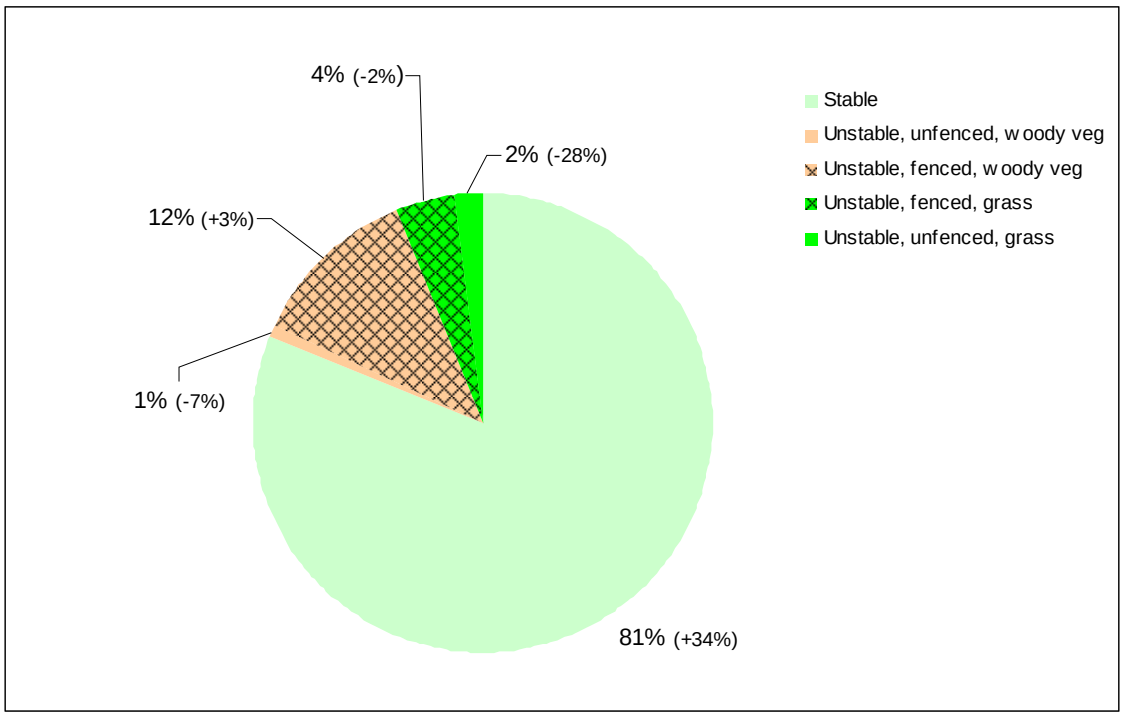

Figure 5: Matahuru stream bank instability for fencing and vegetation combinations (value in brackets represents the percent change from baseline data)

3.2.4 Water temperature

The water temperature loggers were deployed in the lower section of the Matahuru Stream; the upstream logger in the vicinity of the Mangapiko Valley Road Bridge and the downstream logger next to the Environment Waikato recorder station by Waiterimu Road. The distance between the two loggers is approximately 20km.

Results

To date seven deployments have been made with data collected during each summer between 2003/04 and 2009/10. The average of the daily maximum water temperature is derived to produce a single temperature for each site. The downstream temperature is then subtracted from the upstream temperature to provide a single number for the monitored section of river (Table 4).

Table 4: Matahuru Stream average daily maximum water temperatures for the 10 week period commencing 1st January

Year	Upstream average daily maximum (°C)	Downstream average daily maximum (°C)	Temperature difference between d/s and u/s locations (°C)
2003/04	21.86	20.84	-1.02
2004/05	22.78	21.87	-0.91
2005/06	22.20	21.22	-0.98
2006/07	22.61	21.62	-0.99
2007/08	22.60*	22.41	-0.18*
2008/09	22.34	21.76	-0.59
2009/10	22.37	21.59	-0.78

*The upstream logger was out of the water during January 2008, so the daily maximum average temperature is unlikely to be representative.

The downstream temperature has been cooler than the upstream temperature by about 1°C for most years of assessment. There is no obvious trend in the data at this stage.

Shading of the Matahuru Stream is sporadic between the two sites with a variety of vegetation types present. As existing vegetation combined with any new plantings establish and grow, shading will increase and result in a larger temperature difference between the upstream and downstream monitoring sites (i.e. a net decrease in water temperature downstream). As can be seen in Figure 6, the woody vegetation has increased from the 2003/04 survey to the 2009/10 survey. However this does not appear to be reflected in the temperature difference, with the difference decreasing between 2006/07 and 2008/09, before increasing again in 2009/10. A longer monitoring period is required to establish a trend at this site. A mid-point temperature has been used for 2007/08 for the purposes of graphing the results as the actual result is not representative due to the logger being out of the water during January 2008.

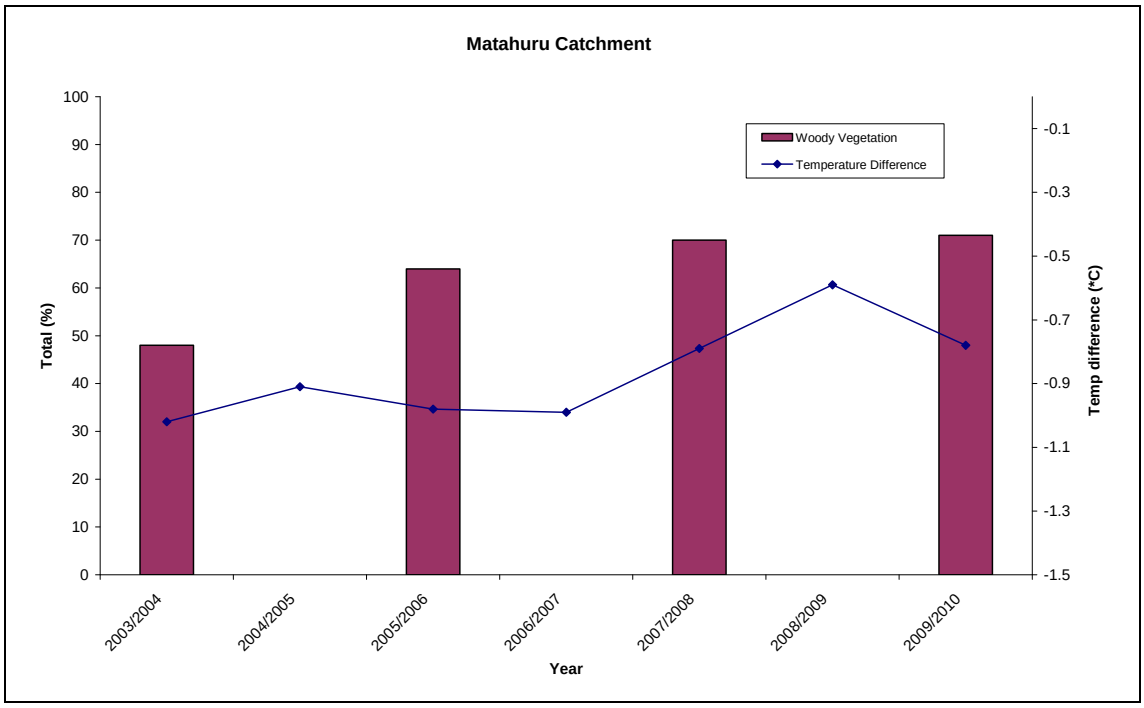

Figure 6: Woody vegetation total versus temperature difference in the Matahuru Catchment.

3.2.5 Photo points

The initial year of assessment was 2003/04 with subsequent assessments completed in 2004/05, 2005/06, 2007/08 and 2009/2010.

Results

Eleven 1km samples of stream were assessed giving a total of 55 photos for the Matahuru catchment. In general terms the photos indicate little change in riparian characteristics during the period documented by the photo points as minimal fencing and planting has taken place. However, small areas of soil conservation plantings have grown noticeably (Figures 7a & b).

	2003/04	2009/10
Assessment 2 at 750m		

Figure 7: Matahuru Stream photo point examples of visual change.

3.2.6 Suspended sediment

Permanent sampling site

A permanent suspended sediment sampling site has been in place at the Myjer farm bridge since July 2006. During this time 24 events have been sampled using an automatic sediment sampler. The data set is analysed to estimate sediment variables (Table 5). Data includes all results up until 31/12/2009. A continuing focus is to carry out manual depth-integrated suspended sediment gaugings while the automatic sampler is activated. The collection of these concurrent samples will allow for the automatic series to be calibrated to the whole river cross-section. For more detailed information refer to the Suspended Sediment Monitoring Report (Kotze et al., 2008).

Table 5: Matahuru permanent suspended sediment sampling site description and estimated sediment variables

Site name:	**Myjers**	**Map Ref (NZMS260):**	**S13:116-095**
River:	**Matahuru**		
		Start – End Date	**No of samples**
Flow Time Series		17/07/2006 – 31/12/2009	N/A
Sediment Samples		19/07/2006 – 04/12/2009	410
ISCO Period of Record		19/07/2006 – 04/12/2009	24 events

Specific yield ($t/km^2/yr$)	Average sediment yield (kt/yr)	% of sediment yield in gauged range of flow	% Error in Yield Estimate
124	10.3	72.7	4.1

The Matahuru Stream estimated specific yield of 124 t/km^2/yr and an average sediment yield of 10.3 kt/yr. Figure 8 shows the specific sediment yield for the Matahuru River relative to other monitored sites in the Region.

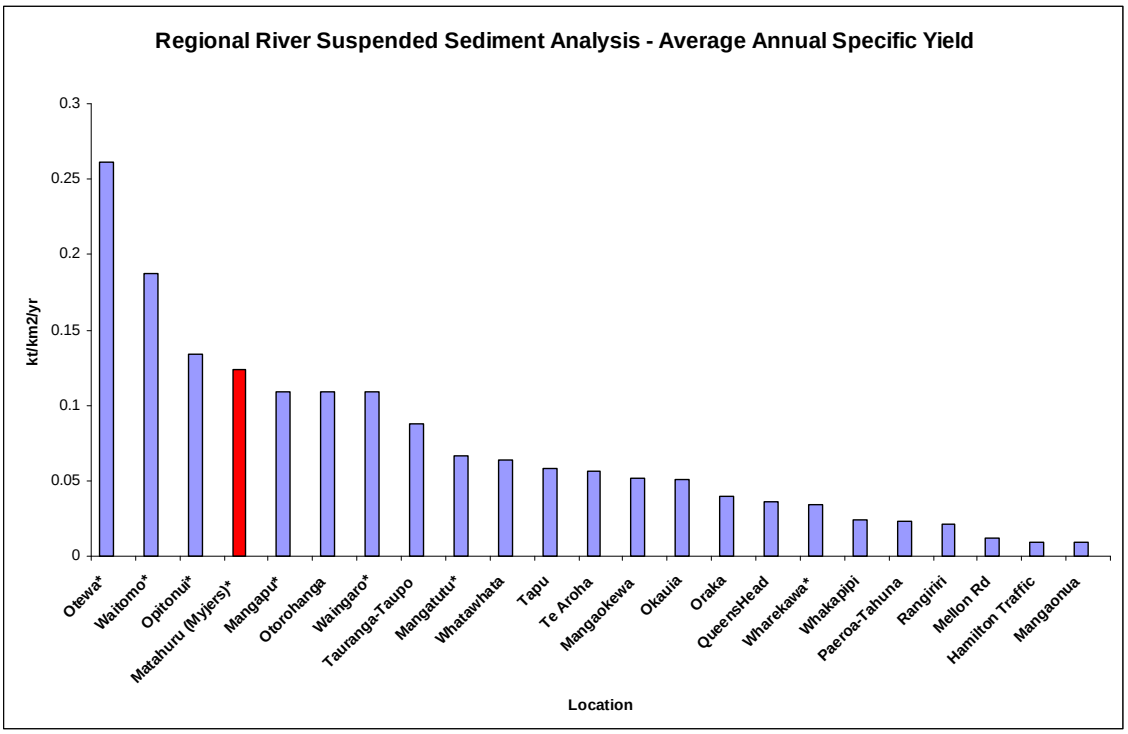

Figure 8: Average specific suspended sediment yield for monitored rivers in the Waikato Region (Matahuru site is highlighted).

The specific yield for the Matahuru is considered high relative to many sites in the region. The geology, high proportion of steep slopes and dominance of pasture in the catchment are likely reasons for the high specific yield value.

Sediment snapshot sampling

No sediment snapshots were undertaken in the Matahuru catchment during 2008. Please refer to Grant et al. (2009b) and Hill et al. (2006) for previously completed sediment snapshot results.

3.2.7 Main points

Soil Stability

- No soil stability assessment completed this year.

Riparian Characteristics

- The length of riparian margin with woody vegetation has increased from 48% of the total stream bank length in 2003/04, to 71% in the most recent assessment.

- Seventy seven per cent of Matahuru Stream is fenced on both sides, up from 46% in the baseline assessment, and 21% is fenced on one side. The length of stream with no fencing on either side has decreased from 30% in the baseline assessment to 2%.

- The total length of riparian margin which is fenced and contains woody vegetation has increased from 41% in the baseline assessment to 66% in the most recent assessment. The length of unfenced grass has decreased from 32% to 8% of the total Matahuru riparian length.

- An estimated 81% of the assessed riparian bank length was considered stable (up from 47% in 2003/04) and 19% unstable.

- A greater proportion of unstable stream bank length are fenced than not fenced.

- There has been a measurable increase in stream bank stability since riparian soil conservation works began.

Water Temperature

- The downstream temperature has been cooler on average than the upstream temperature for all monitored years. There is no clear trend in the data at this stage.

- Since 2003/04 river management and soil conservation works have occurred but in general shading of the Matahuru Stream remains sporadic.

- Measurable improvements in aquatic habitat are likely to be evident after about 10 years of monitoring.

Photo Points

- Photo points have shown some improvements to areas where soil conservation plantings have occurred.

Suspended Sediment

- A specific yield of 124 t/km^2/yr has been estimated based on results from the permanent suspended sediment monitoring site. A longer time period is required to produce a more accurate result.

4 Upper Waikato zone

4.1 Introduction

Monitoring is present in three catchments in the Upper Waikato zone; Pokaiwhenua, Mangare and Tahunaatara catchments. Monitoring progress and results are presented for each catchment individually.

4.2 Pokaiwhenua catchment

Monitoring progress
The monitoring locations in the Pokaiwhenua catchment are detailed in Grant et al. (2009b). Table 6 presents monitoring completed by the end of the 2009/10 financial year.

Table 6: Pokaiwhenua catchment monitoring completed by 2009/10

Monitoring	Activity	Completion	Included in this report (or year last reported)
Soil stability	Soil stability and soil conservation assessment	2005	(2005/06)
Riparian characteristic assessment	Complete assessment along the middle section of the Pokaiwhenua River	2003/04, 2005/06 2007/08, 2009/10	✓
Photo points	Complete assessment along the mid section of the Pokaiwhenua River	2003/04, 2004/05 2005/06, 2007/08 2009/10	✓
Permanent suspended sediment sampling site	None planned	N/A	N/A
Suspended sediment snapshots	• Low flow snapshot • High flow snapshot at next sufficient rainfall event	2003 Not completed	(2005/06)
Water temperature	Install loggers and record stream temperatures along the middle section of the Pokaiwhenua River	2003/04, 2004/05 2005/06, 2006/07 2007/08, 2008/09 2009/10	✓
Stream ecological health	Assess stream ecological health along the middle section of the Pokaiwhenua River	2003/04, 2004/05 2005/06, 2006/07 2007/08, 2008/09 2009/10	✓

N/A = not applicable

4.2.1 Soil stability

Refer to Hill, Blair and Hopkins (2006) for the most recent assessment report for this catchment.

4.2.2 Riparian characteristics

Introduction

For the 2009/10 assessment, six 1km samples were selected for assessment through the mid section of the Pokaiwhenua River. These locations are where funded works have been completed or are scheduled, where stream riparian margin access is possible, and where landowner participation is forthcoming. The samples are the same as used in previous assessments. The baseline assessment was conducted during the

summer of 2003/04 with further assessments undertaken in 2005/06 and 2007/08 and 2009/10. The reported data for each parameter represents a percentage of the total assessed riparian margin in the catchment. Tabled summary data is presented in Appendix 1. Vegetation, fencing and stream bank stability data summaries are presented in Figures 9, 10, 11, and 12. The number in brackets in each figure is the percentage change from the baseline data collected in the 2003/04 assessment.

Vegetation

Natural biodiversity along the riparian margin can be increased through the planting of native vegetation. Riparian vegetation contributes to stream bank stability and the shading of the stream to help minimise increases in stream temperatures. Riparian vegetation is split in to grass and woody vegetation (native + willow + exotic other). Figure 9 shows 35% of the riparian margin is grass. The remaining 65% is woody vegetation, of which 15% is native, 13% is willow and 37% is exotic other.

The length of the riparian margin in grass has decreased by 20%. There has been a 34% increase in exotic woody vegetation, and a 14% decrease in native woody vegetation since the baseline assessment. This equates to an overall increase in riparian woody vegetation of 20%.

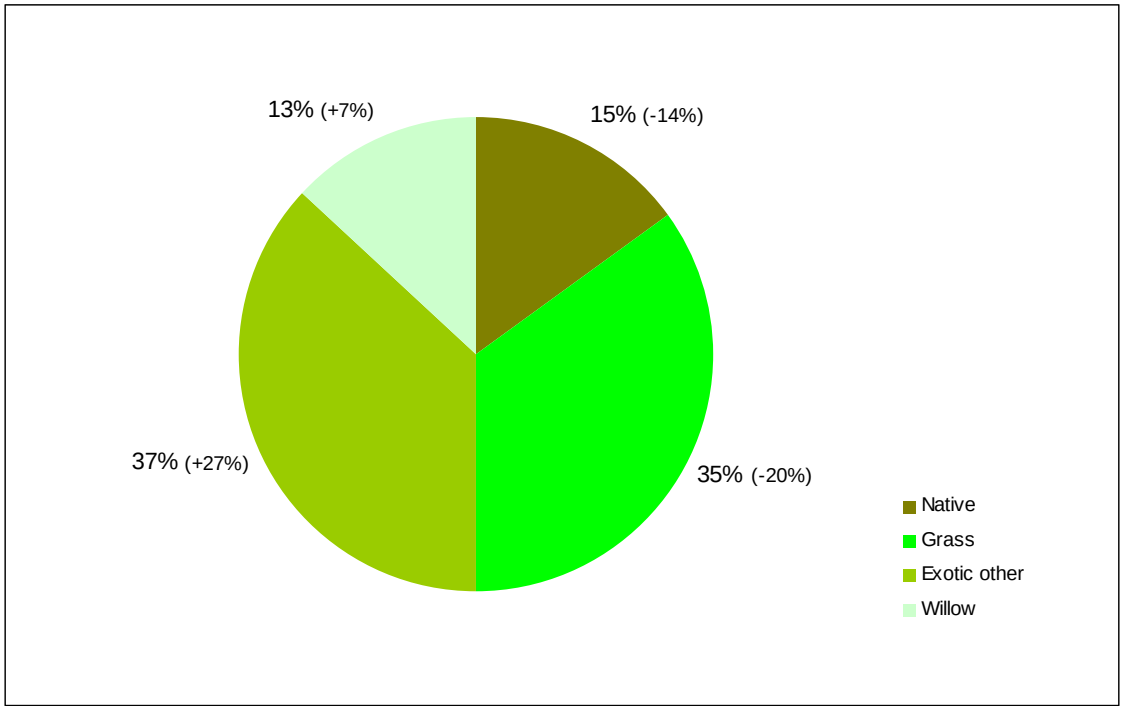

Figure 9: Pokaiwhenua riparian vegetation (value in brackets represents the percent change from baseline data).

Fencing

The amount of fencing on one side or both sides of the waterway is an indicator of likely stock exclusion from the waterway. Stock exclusion reduces direct contamination of water by pathogens, direct damage to the stream ecology by trampling of the stream bed and indirectly reduces sediment load from stock trampling the banks.

Stock is excluded from both sides for 99% of the waterway, from one side for 1% of the waterway and are not excluded either side for 0% of the waterway (Figure 10). There has been a dramatic increase in the length of stream fenced on both sides since the 2003/04 assessment (72%).

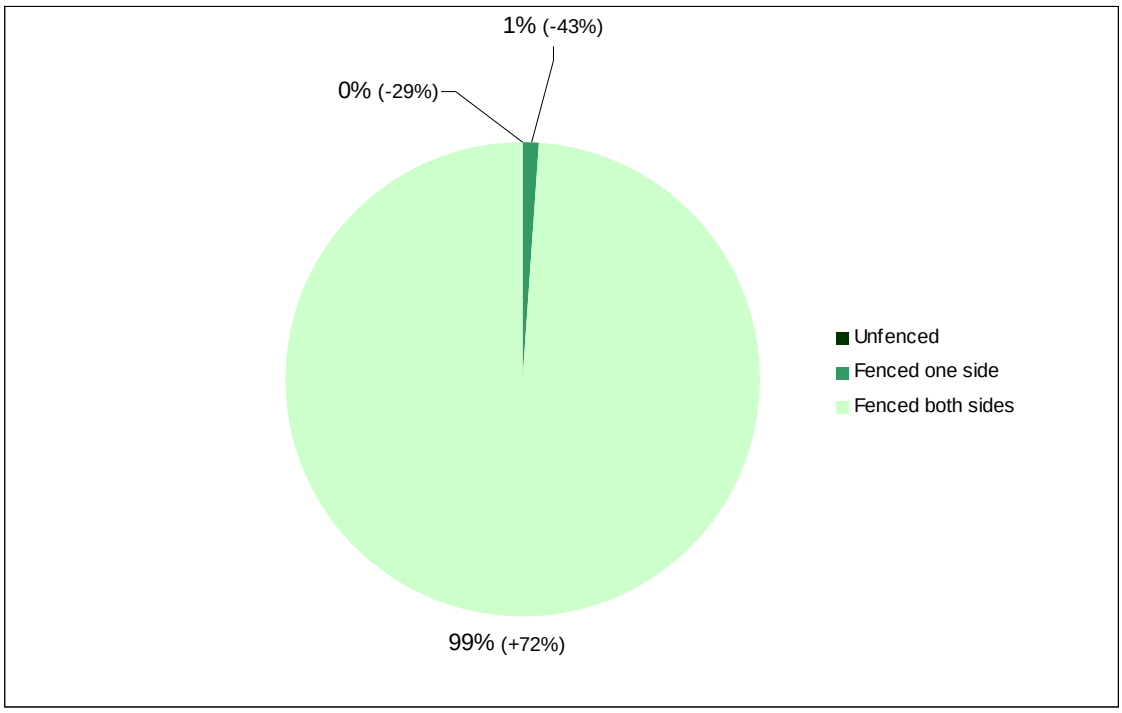

Figure 10: Pokaiwhenua stock exclusion by bank length (value in brackets represents the percent change from baseline data)

Riparian Enhancement

An estimated 65% of the banks are fenced while 35% are not fenced. The majority (66%) of the fenced banks (or 65% of the total bank length) have woody vegetation (Figure 11). The length of bank with fenced woody vegetation has increased by 47%.

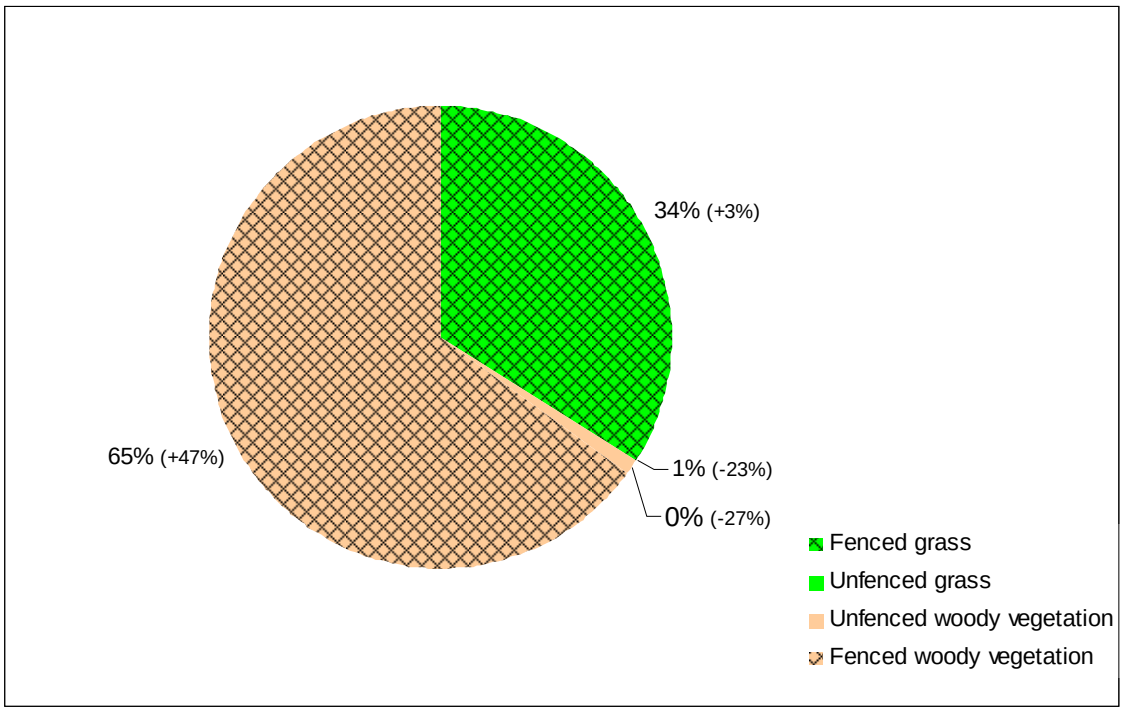

Figure 11: Pokaiwhenua bank length fencing and vegetation combinations (value in brackets represents the percent change from baseline data)

Stream bank stability

Stream bank stability is measured, as unstable stream banks are one of the main sources of sediment in waterways. Stream bank stability can be improved through type of riparian vegetation, and through fencing out stock.

An estimated 98% of the assessed riparian bank length is considered stable, an increase of 10% since the 2003/04 assessment (Figure 12). The remaining 2% is unstable. The remaining portion of unstable stream bank is fenced. Grass vegetation is present on 50% of the total unstable bank length.

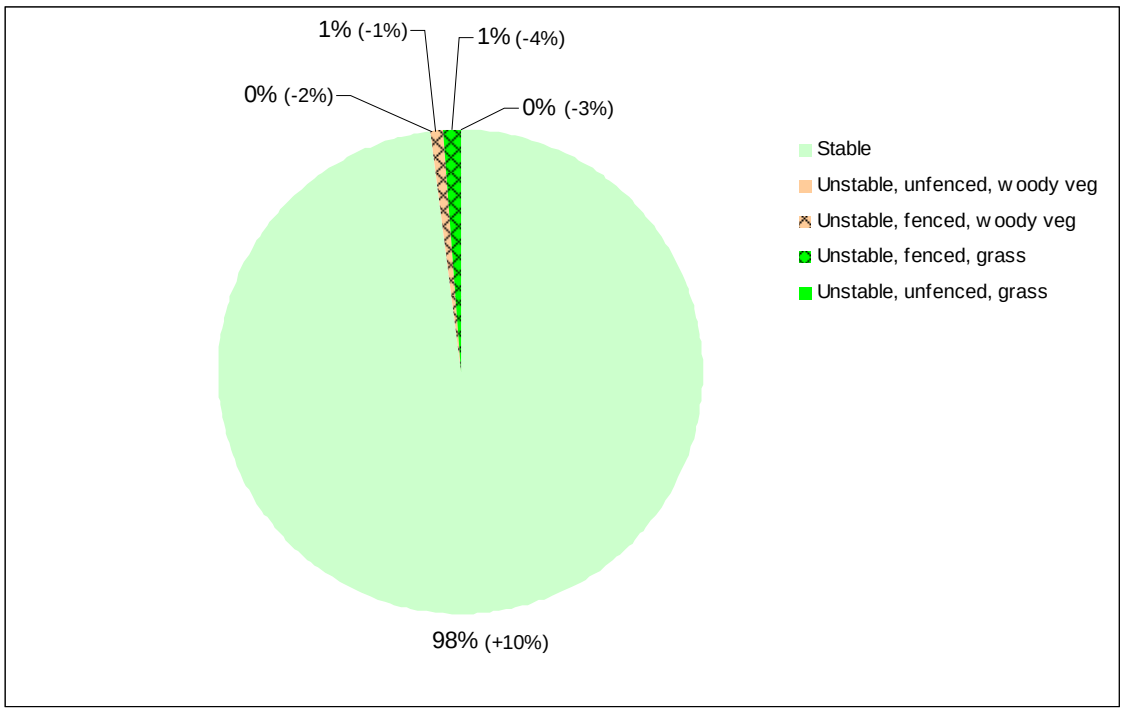

Figure 12: Pokaiwhenua erosion (value in brackets represents the percent change from baseline data)

Water temperature

The water temperature loggers are deployed in the middle section of the Pokaiwhenua River. The distance between the two loggers is approximately 1km. To date six deployments have been made with data collected each summer between 2003/2004 and 2009/2010 inclusive. The average of the daily maximum water temperature is derived to produce a single temperature for each site. The downstream temperature is then subtracted from the upstream temperature to provide a single number for the monitored section of river (Table 7).

Table 7: Pokaiwhenua Stream average daily maximum water temperatures for the 10 week period commencing 1st January

Year	Upstream average daily maximum (°C)	Downstream average daily maximum (°C)	Temperature difference between d/s and u/s locations (°C)
2003/04	18.44	18.21	-0.23
2004/05	18.78	18.47	-0.31
2005/06	18.32	17.98	-0.33
2006/07	18.51	18.15	-0.36
2007/08	19.21	18.63	-0.58
2008/09	19.07	18.32*	-0.75*
2009/10	18.33	17.14	-1.19

*The downstream logger was out of the water during March 2009, so the daily maximum average temperature is unlikely to be representative.

Table 7 illustrates the downstream temperature has been slightly cooler on average than the upstream temperature for all monitored summers. Although sections of the

stream have been fenced and planted, little shading occurs between the upstream and downstream monitoring sites. The data suggests there is a decrease in the temperature at the downstream site compared to the upstream site over time. Figure 13 shows a relationship between the temperature difference and the woody vegetation cover over the years. A mid-point temperature has been used for 2008/09 for the purposes of graphing the results as the actual result is not representative due to the logger being out of the water during March 2009.

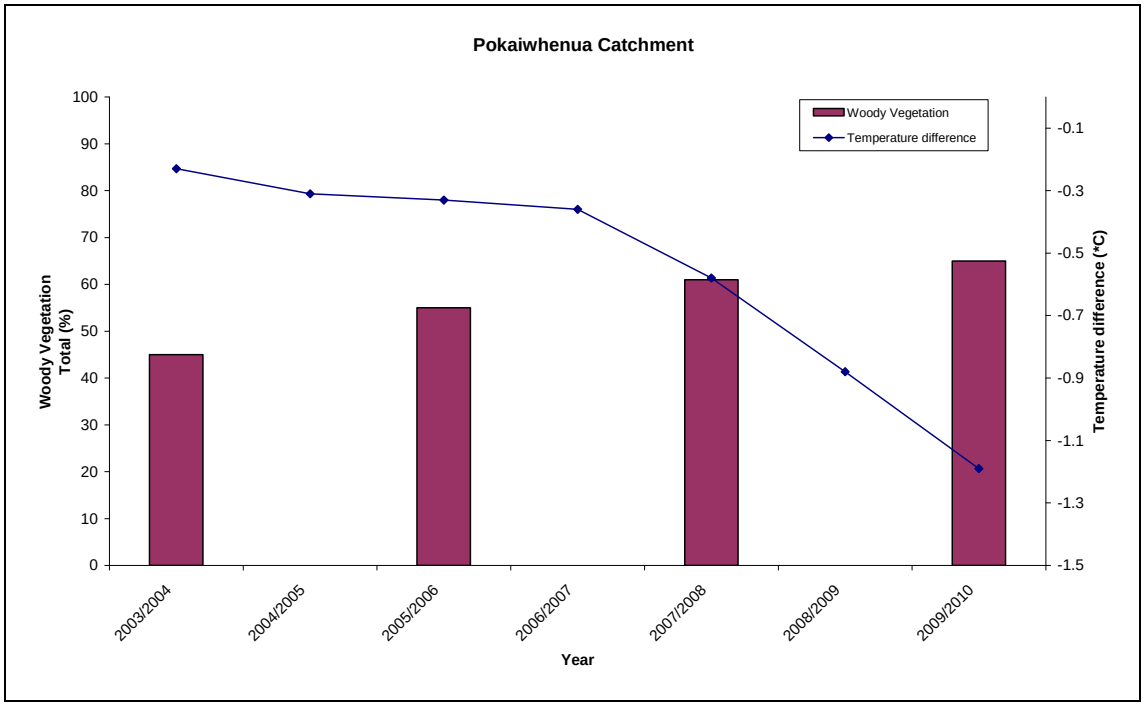

Figure 13: Woody vegetation total versus temperature difference in the Pokaiwhenua Catchment.

Photo points

The initial year of assessment was 2003/04 with subsequent assessments completed in 2005/06, 2007/08 and 2009/10.

Six 1km samples of stream were assessed giving a total of 30 photos for the Pokaiwhenua catchment. Large sections of stream have shown improvements due to soil conservation planting. Other sections which have been fenced are covered in rank grass (Figure 14a - b).

	2003/04	2009/10
Assessment 2 at 500m		

Figure 14: Pokaiwhenua River photo point examples of visual change, assessment 2 at 500m (a and b).

Stream ecological health

The dominant surrounding land use in the vicinity of both of the sampling sites in the Pokaiwhenua River is pastoral/horticultural. The stream ranges between 5-7m in width with the substrate predominantly consisting of a combination of cobble, gravel and sand. The canopy cover is open.

Invertebrate sampling is carried out in the same two locations where the water temperature probes are deployed in the middle section of the Pokaiwhenua River. The initial year of assessment was completed in 2003/04 with subsequent assessments completed annually.

Table 8 lists the MCI (Macroinvertebrate Community Index) values as calculated for the upstream and downstream sampling sites in the Pokaiwhenua River. Samples are taken between January and March every year.

Table 8: MCI values for the Pokaiwhenua River and nearby reference site (Mohaihaha Stream).

Site	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10
Pokaiwhenua upstream	99	103	113	113	115	113	107
Pokaiwhenua downstream	113	109	116	103	108	102	98
Reference site - Mohaihaha Stream	N/A	141	143	135	137	127	131

In the vicinity of the two sampling sites in the Pokaiwhenua River the presence and abundance of identified invertebrate species and the associated MCI scores indicate that the stream has a mild degradation in ecological health (Wright-Stow & Winterbourn 2003). A longer monitoring period is required to identify a trend in the MCI values. A reference site has been included to compare the MCI values from the Pokaiwhenua Stream. The reference site is the Mohaihaha Stream (site number 555.2). For more information on the monitored streams see Appendix 2.
Main Points

Soil Stability

- No soil stability assessment completed this year.

Riparian characteristics

- The amount of native vegetation had decreased from 29% to 10% in the 2007/08 riparian survey due to low survival of native plantings; however this has now increased to 15%.

- The length of stream bank fenced has increased. Of the increase fencing, on both banks increased from 27% to 99% and fencing on one bank decreased from 44% to 1%. 0% of the sampled stream length has no fencing.

- The length of bank with fenced, woody vegetation has increased from 18% when the first assessment was taken in 2003/04, to 65% in the most recent assessment.

- An estimated 98% of the assessed riparian bank length was considered stable and 2% unstable. This is an increase of 10% in stability since the baseline assessment was taken in 2003/04.

- Photo points show some changes in areas where soil conservation plantings have occurred.

Water Temperature

- The downstream temperature is consistently cooler on average than the upstream temperature for all monitored summers.

- There is an emerging trend in the data showing the downstream site recording increasing cooler temperatures than the upstream site.

- Soil conservation works have occurred along some stretches of bank, but due to the width of the river, the shading effect on the stream temperature may be limited.

- Measurable improvements in aquatic habitat are likely to be evident after about 10 years of monitoring.

Photo Points

- Photo points show some changes in areas where soil conservation plantings have occurred.

Stream Ecological Health

- Assessments of the invertebrates in Pokaiwhenua Stream indicate that there is a mild degradation in ecological health.

4.3 Mangare catchment

Monitoring progress

For survey locations in the Mangare catchment, refer to Grant et al. (2009b). Table 9 contains monitoring completed by the end of the 2009/10 financial year.

Table 9: Mangare catchment monitoring completed by 2009/10

Monitoring	Planned activity	Completion	Included in this report (or year last reported)
Soil stability	Not planned	N/A	N/A
Riparian characteristic assessment	Complete assessment along the middle section of the Mangare Stream	2003/04, 2005/06 2007/08, 2009/10	✓
Photo points	Complete assessment along the middle section of the Mangare Stream	2003/04, 2004/05 2005/06, 2007/08 2009/10	✓
Permanent suspended sediment sampling site	Not planned	N/A	N/A
Suspended sediment snapshot	Not planned	N/A	N/A
Water temperature	Install loggers and record stream temperatures along the middle section of the Mangare Stream	2006/07, 2007/08 2008/09, 2009/10	✓
Stream ecological health	Assess stream ecological health along the mid section of the Mangare Stream	2005/06, 2006/07 2007/08, 2008/09 2009/10	✓

N/A = not applicable

Riparian characteristics

Introduction

Two 1km samples were selected for assessment through the middle section of the Mangare Stream. These locations are where Project Watershed funded works have been completed and are scheduled, where stream riparian margin access is possible, and where landowner participation is forthcoming. The baseline assessment was conducted in the 2003/04 year with the most recent assessment conducted in 2009/10. The reported data for each parameter represents a percentage of the total assessed riparian margin in the catchment. Tabled summary riparian assessment data is located in Appendix 1.

Vegetation, fencing and stream bank stability data summaries are presented in Figures 15, 16, 17, and 18. The number in brackets in each figure is the percentage change from the baseline data collected in the 2003/04 assessment.

Vegetation

Riparian vegetation contributes to stream bank stability, and improves the shading of the stream to help minimise increases in stream temperatures. Natural biodiversity along the riparian margin can be increased through the planting of native vegetation. Riparian vegetation is split into grass and woody vegetation (native + willow + exotic other). Figure 15 shows 43% of the riparian margin is grass. The remaining 61% is woody vegetation, of which 0% is native, 42% is willow and 15% is exotic other.

The length of the riparian margin in grass has decreased by 51%; associated with a corresponding 51% increase in exotic woody vegetation.

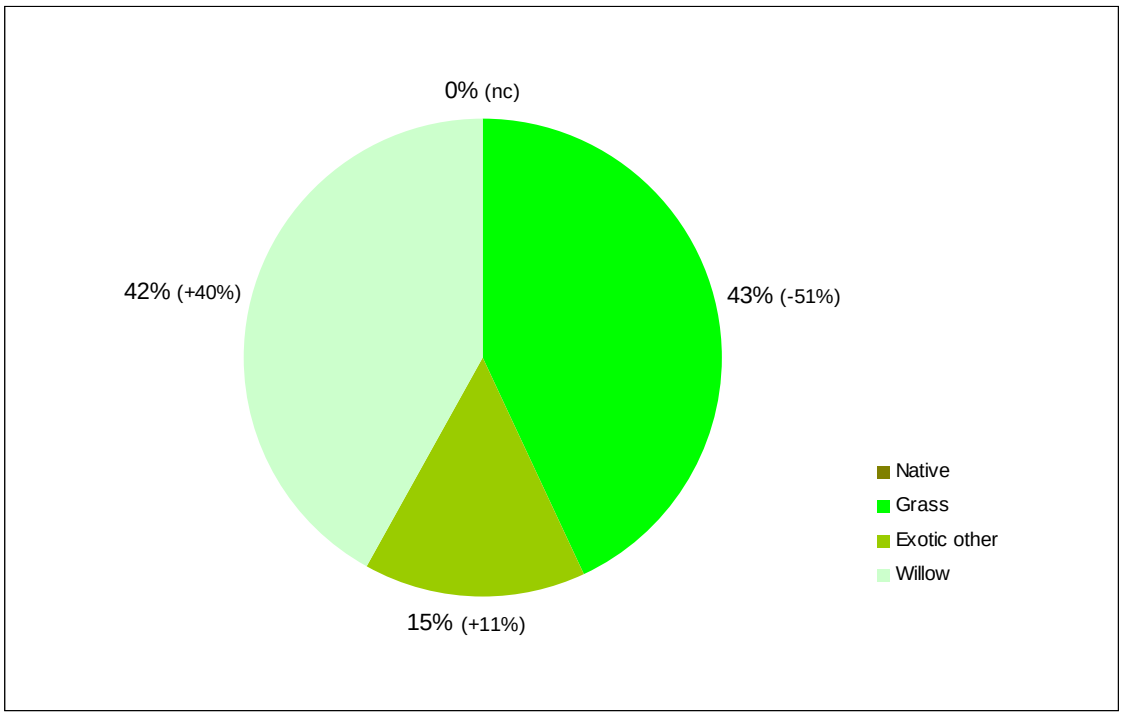

Figure 15: Mangare vegetation (value in brackets represents the percent change from baseline data).

Fencing

The amount of fencing on one side or both sides of the waterway is an indicator of likely stock exclusion from the waterway. Stock exclusion reduces direct contamination of water by pathogens, direct damage to the stream ecology by trampling of the stream bed and indirectly reduces sediment load from stock trampling the banks.

The farm animals are excluded from both sides for 50% of the waterway, from one side for 31% of the waterway and are not excluded either side for 19% of the waterway (Figure 16). There has been an increase in the length of stream fenced on both sides since the 2003/04 assessment.

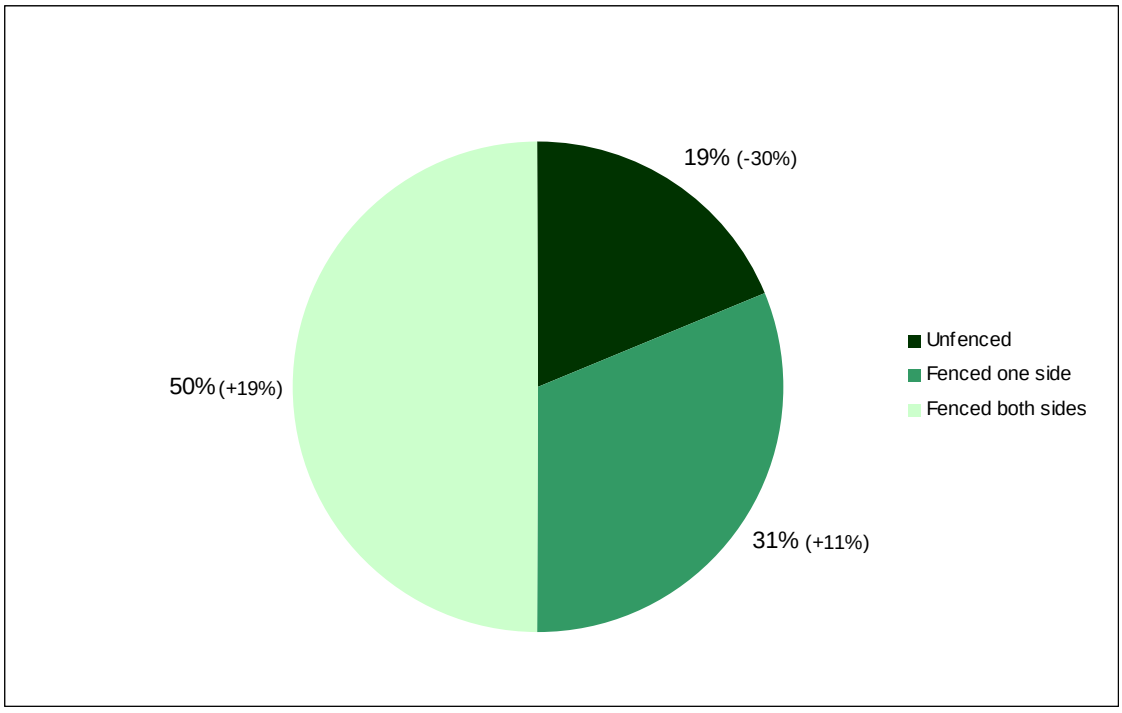

Figure 16: Mangare stock exclusion by bank length (value in brackets represents the percent change from baseline data).

Riparian Enhancement

An estimated 66% of the banks are fenced while 34% are not fenced (Figure 17). The majority (70%) of the fenced banks (or 46% of the total bank length) have woody vegetation. The length of bank with fenced woody vegetation has increased dramatically from 3% of the total length, to 46%.

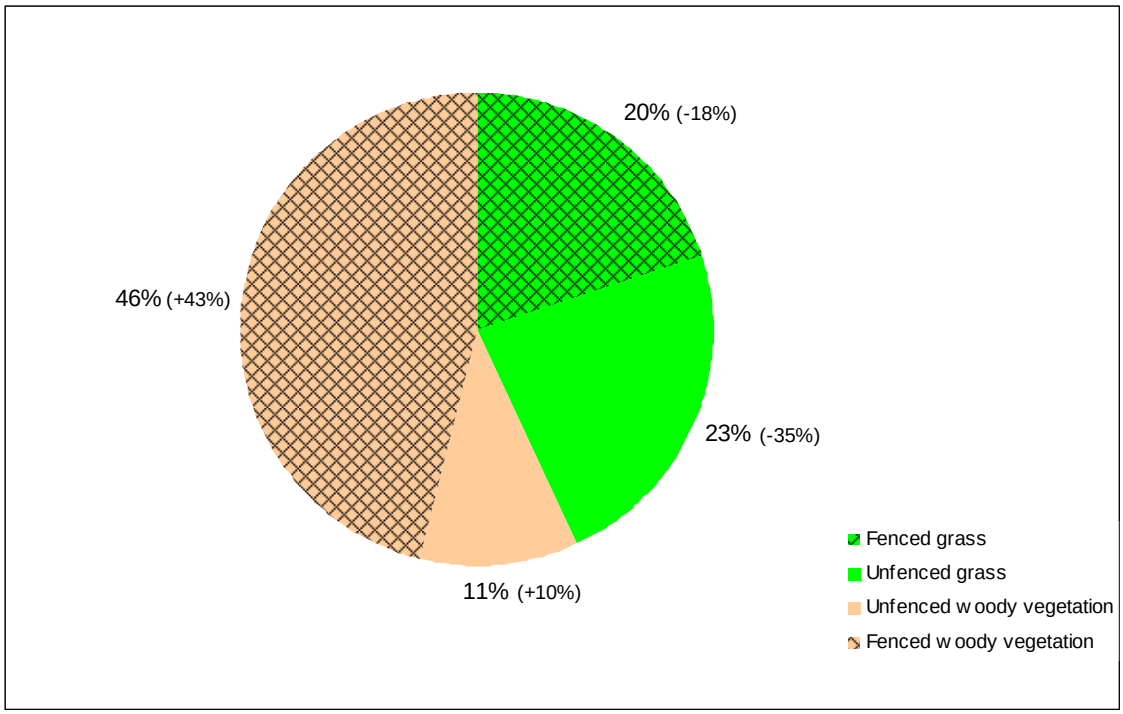

Figure 17: Mangare bank length fencing and vegetation combinations (value in brackets represents the percent change from baseline data).

Stream bank stability

Stream bank stability is measured, as unstable stream banks are one of the main sources of sediment in waterways. Stream bank stability can be improved through type of riparian vegetation, and through fencing out stock.

An estimated 86% of the assessed riparian bank length is considered stable (figure 18). From the remaining 14% unstable bank, a greater portion is fenced (8%) than not fenced (6%). Grass vegetation is present on 29% of the total unstable bank length.

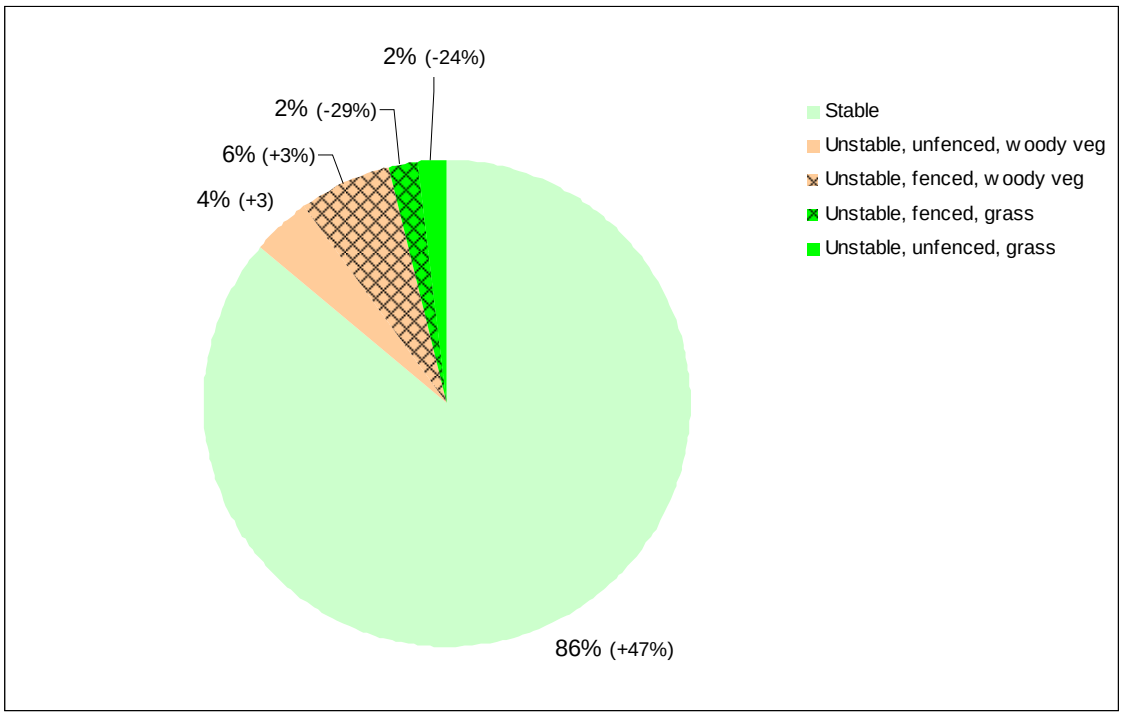

Figure 18: Mangare erosion (value in brackets represents the percent change from baseline data).

Water temperature

The water temperature loggers are deployed in the middle section of the Mangare Stream, with a distance between the two loggers of approximately 1km. The loggers have collected summer data annually between 2006/07 and 2008/09 inclusive. The average of the daily maximum water temperature is derived to produce a single temperature for each site. The downstream temperature is then subtracted from the upstream temperature to provide a single number for the monitored section of river (Table 10).

Table 10: Mangare Stream average daily maximum water temperatures for the 10 week period commencing 1st January

Year	Upstream average daily maximum (°C)	Downstream average daily maximum (°C)	Temperature difference between d/s and u/s locations (°C)
2006/07	21.53	21.27	-0.26
2007/08	22.82	22.28	-0.55
2008/09	22.03	21.44	-0.59
2009/10	20.90	20.31	-0.59

Table 10 illustrates the downstream temperature has been slightly cooler on average than the upstream temperature for all monitored summers. The shading of Mangare Stream has greatly improved for one section of the stream during the years of assessment; however a longer time period is required for the water temperature to reflect these changes. Figure 19 does show an increase in the temperature difference between 2006/07 and 2008/09. This coincides with the increase in woody vegetation from the surveys done in 2005/06 and 2007/08.

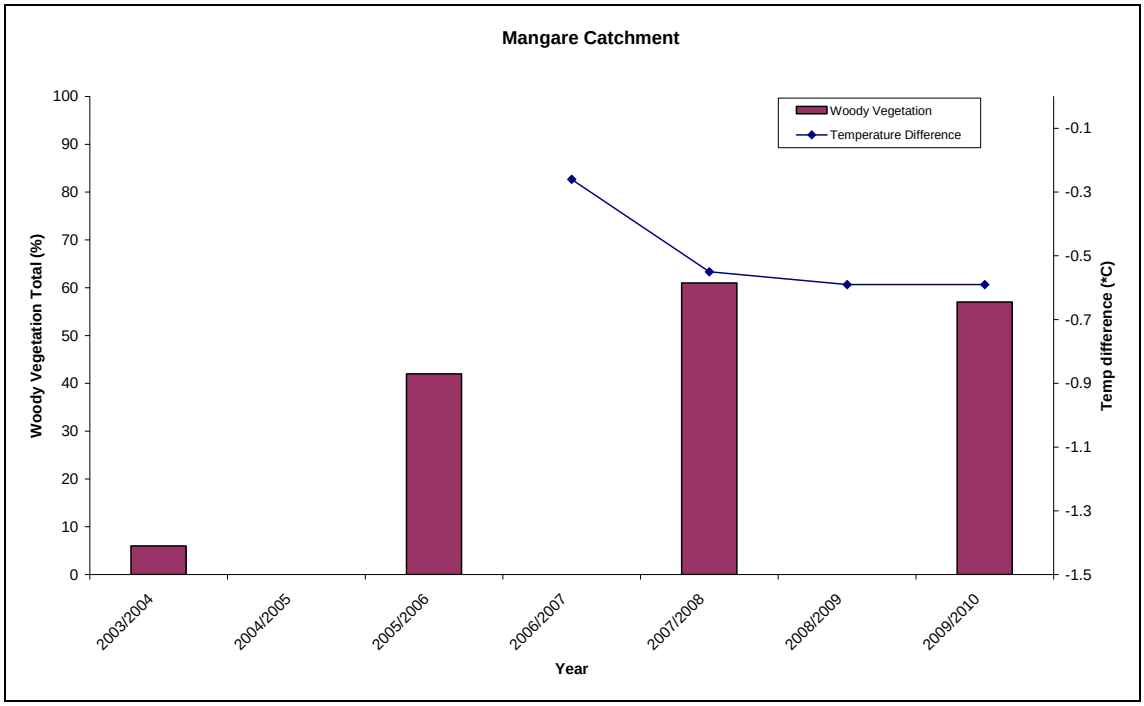

Figure 19: Woody vegetation total versus temperature difference in the Mangare Catchment. Temperature data only begins from 2006/2007 onwards.

Photo points

The initial year of assessment was 2003/04 with subsequent assessments completed in 2004/05, 2005/06, 2007/08 and 2009/2010. Two 1km samples of stream were assessed giving a total of 10 photos for the Mangare Catchment. The initial baseline photos from 2003/04 are in the left column with the most recent photos from 2007/08 in the column on the right. The photos in one section of the stream indicate little change in riparian characteristics during the monitored period due to little to no riparian fencing or planting. However, the other section of stream showed significant change where the assessed reach has been fenced and planted with willow poles on both banks (Figure 20 a & b).

2003/04	2009/10
	

Figure 20: Mangare Stream photo point examples of visual change, assessment 1 at 750m (a and b).

4.3.1 Stream ecological health

The dominant surrounding land use in the vicinity of both of the sampling sites in the Mangare Stream is pastoral. The stream ranges between 1.5-3m in width with the substrate predominantly consisting of a combination of cobble, gravel, and sand with some bedrock in places. The canopy cover is open however partial shading of the stream is beginning to occur from willow poles planted in 2005.

Invertebrate sampling is carried out in the same two locations where the water temperature probes are deployed in the middle section of the Mangare Stream. The initial year of assessment was completed in 2006, with subsequent assessments conducted annually.

Table 11 lists the MCI (Macroinvertebrate Community Index) values as calculated for the upstream and downstream sampling sites in the Mangare Stream. Samples are taken between January and March every year.

Table 11: MCI values for the Mangare Stream and nearby reference site (Otautora Stream).

Site	2005/06	2006/07	2007/08	2008/09	2009/10
Mangare upstream	99	113	96	104	96
Mangare downstream	92	93	82	88	96
Reference site – Otautora Stream	145	139	136	136	144

In the vicinity of the two sampling sites in the Mangare Stream the presence and abundance of identified invertebrate species and the associated MCI scores for the assessment of the upstream site indicate that this stream has a moderate degradation in ecological health (Wright-Stow & Winterbourn 2003). The downstream MCI score in the most recent monitoring period has arisen slightly for causes unknown. A longer monitoring period is required to identify a trend in the MCI values. A reference site has been included to compare the MCI values from the Mangare Stream. The reference site is the Otautora Stream (site number 1888.4). For more information on the monitored streams see Appendix 2.

4.3.2 Main points

Riparian characteristics

- Fifty seven per cent of the Mangare Stream riparian margin is woody vegetation; an increase from 6% in the first assessment in 2003/04, and 43% is grass.

- The amount of unfenced stream has decreased from 49% in the baseline assessment to 19%. Half of the monitored section of Mangare stream has fences along both sides of the stream, an increase since the first assessment was taken. The remaining 31% of the stream bank is fenced on one side.

- The length of bank with fenced woody vegetation has increased from 3% in the baseline assessment, to 46% in the 2009/10 assessment. Unfenced grass has decreased from 58% of the stream bank to 23%.

- An estimated 86% of the assessed riparian bank length was found to be stable, up from 39% in 2003/04.

Water Temperature

- The downstream temperature has been slightly cooler on average than the upstream temperature, but a longer time period is needed before trends emerge.

- Shading has increased for half of the assessed stream reach, but the water temperature is unlikely to reflect this improvement for a number of years.

Photo Points

- Photo points have shown some large improvements to areas where soil conservation plantings have occurred, however little vegetation growth is evident for the sections of monitored stream which haven't been fenced off.

Stream Ecological Health

- Assessments of the invertebrates in Mangare Stream over the previous monitoring periods indicate that this stream has a moderate degradation in overall ecological health in recent years.

4.4 Tahunaatara catchment

4.4.1 Monitoring progress

Monitoring focuses on the middle section of the Pokaitu Stream, a sub-catchment of the Tahunaatara Stream, which feeds into Lake Atiamuri. For survey locations in the Pokaitu catchment, refer to Grant et al. (2009b). Table 12 contains monitoring completed by the end of the 2009/10 financial year.

Table 12: Upper Waikato zone monitoring completed by 2009/10

Monitoring	Planned activity	Completion	Included in this report (or year last reported)
Soil stability	Not planned	N/A	N/A
Riparian characteristic assessment	Not planned	N/A	**N/A**
Photo points	5km photo survey along the Pokaitu Stream	2003/04, 2008/09	(2008/09)
Permanent suspended sediment sampling site	Not planned	N/A	N/A
Suspended Sediment snapshot	Not planned	N/A	**N/A**
Water temperature	Install loggers and record stream temperatures along the middle section of the Pokaitu Stream	2003/04, 2004/05 2005/06, 2006/07 2007/08, 2008/09 2009/10	✓
Stream ecological health	Assess stream ecological health along the middle section of the Pokaitu Stream	2003/04, 2004/05 2005/06, 2006/07 2007/08, 2008/09 2009/10	✓

N/A = not applicable

4.4.2 Water temperature

Water temperature loggers are deployed in the middle section of the Pokaitu Stream, with a distance between them of approximately 5km. To date, the temperature data for six summers have been recorded, between 2003/2004 and 2008/2009 inclusive. The average of the daily maximum water temperatures is derived to produce a single temperature for each site. The downstream temperature is then subtracted from the upstream temperature to provide a single number for the monitored section of river (see Table 13).

Table 13: Pokaitu Stream average daily maximum water temperatures for the 10 week period commencing 1st January

Year	Upstream average daily maximum (°C)	Downstream average daily maximum (°C)	Temperature difference between d/s and u/s locations (°C)
2003/04	17.52	16.91	-0.61
2004/05	17.87	17.23	-0.64
2005/06	17.01	16.63	-0.38
2006/07	17.13	16.85	-0.28
2007/08	17.53	17.16	-0.37
2008/09	17.39	17.00	-0.39
2009/10	16.70	16.54	-0.16

As Table 13 illustrates, the downstream temperature has been slightly cooler on average than the upstream temperature for all years of assessment. At present sparse and sporadic shading of the stream occurs between the two temperature probes. A longer time period is required before any trends can be determined; particularly as clearance of pine trees along the stream have affected the shading of the water.

4.4.3 Photo points

No photos were collected in the 2009/10 monitoring period in the Tahunaatara catchment. Refer to Grant et al. (2009b) for the most recent results and comparisons.

4.4.4 Stream ecological health

The dominant surrounding land use in the vicinity of the sampling site is pastoral. The stream is 3-4m in width with the substrate predominantly consisting of gravel with some cobble and sand. The canopy cover is open.

Invertebrate sampling is conducted in the Pokaitu Stream under the southern Apirana Road Bridge (where the downstream temperature probe is deployed). The initial year of assessment was in 2003/04 with subsequent assessments completed annually.

Table 14 lists the MCI (Macroinveterbrate Community Index) values as calculated for the Pokaitu Stream sampling site. Samples are taken between January and March every year.

Table 14: MCI values for the Pokaitu Stream and nearby reference site (Mohaihaha Stream).

Site	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10
Pokaitu downstream	104	116	120	126	122	117	122
Mohaihaha Stream	N/A	141	143	135	137	127	131

In the vicinity of the sampling site in the Pokaitu Stream the presence and abundance of identified invertebrate species and the associated MCI scores indicate that the stream has mild to clean water quality in terms of ecological health (Wright-Stow & Winterbourn 2003). A longer monitoring period is required to identify a trend in the MCI values. A reference site has been included to compare the MCI values from the Pokaitu Stream. The reference site is the Mohaihaha Stream (site number 555.2). For more information on the monitored streams see Appendix 2.

4.4.5 Main points

Water Temperature

- The downstream temperature has been slightly cooler on average than the upstream temperature for all assessed summers.

- A longer time period is required before water temperature trends will emerge.

- Measurable improvements in aquatic habitat are likely to be evident after about 10 years of monitoring.

Riparian characteristics

- In general, shading of the Pokaitu Stream remains sparse and sporadic, affected by tree clearance along the stream.

Photo Points

- A comparison of visual change was made using a photo survey between 2003/04 and 2008/09. No major improvements in riparian vegetation and water shading have been made during this time as very little vegetation has been planted.

Stream Ecological Monitoring

- Assessments of the invertebrates in Pokaitu Stream indicate that the stream has mild to clean water quality in terms of ecological health.

5 Waipa zone

5.1 Introduction

Monitoring is present in one catchment in the Waipa zone; Mangatutu catchment.

5.2 Mangatutu catchment

5.2.1 Monitoring progress

Monitoring focuses on the Mangatutu Stream catchment where river management and soil conservation initiatives are being implemented. For survey locations in the Mangatutu catchment, refer to Grant et al. (2009b). Table 15 contains monitoring completed by the end of the 2009/10 financial year.

Table 15: Waipa zone monitoring completed by 2009/10

Monitoring	Activity	Completion	Included in this report (or year last reported)
Soil stability	Not planned	N/A	N/A
Riparian characteristic assessment	Complete assessment along the lower section of the Mangatutu sub-catchment	2004/05, 2006/07 2008/09	(2008/09)
Photo points	Complete assessment along the lower section of the Mangatutu sub-catchment	2004/05, 2006/07 2008/09	(2008/09)
Permanent suspended sediment sampling site	Event driven sampling	Ongoing since June 2004	✓
Suspended sediment snapshots	• Low flow snapshot • High flow snapshot at next sufficient rainfall event	2004 Not completed	(2005/06)
Water temperature	Install loggers and record stream temperatures along the lower section of the Mangatutu River.	2003/04, 2004/05 2005/06, 2006/07 2007/08, 2008/09 2009/10	✓
Stream ecological health	Assess stream ecological health along the middle and lower section of the Mangatutu River.	2004/05, 2005/06 2006/07, 2007/08 2008/09, 2009/10	✓

N/A = not applicable

5.2.2 Riparian characteristics

No riparian characteristics data was collected in the 2009/10 monitoring period in the Mangatutu catchment. Refer to Grant et al. (2009b) for the most recent results.

5.2.3 Water temperature

Three water temperature loggers are deployed along the monitored section of the Mangatutu Stream, due to its length (18km) and differences in character and management between the upper and lower sections of the stream. The downstream logger is under the Walker Road Bridge, the midstream logger is beneath the Lethbridge Road Bridge and the upstream logger is near the Wharepuhunga Road Bridge. To date seven deployments have been made with data collected for the summers between 2003/04 and 2009/2010. The 2003/2004 temperature data collected

was only for the period of February to March; therefore the daily maximum average for this summer is not representative and cannot be compared to the other summer's results.

The average of the daily maximum water temperature is derived to produce a single temperature for each site. The downstream temperature is then subtracted from the upstream temperature to provide a single number for the monitored section of river (see Table 16).

Table 16: Mangatutu Stream average daily maximum water temperatures for the 10 week period commencing 1st January.

Year	Upstream average daily max (°C)	Temp diff btwn u/s and m/s locations (°C)	Midstream average daily max (°C)	Temp diff btwn d/s and m/s locations (°C)	Downstream average daily maximum (°C)	Temp diff btwn d/s and u/s locations (°C)
2004/05	19.85	-1.00	20.85	-0.63	20.22	+0.38
2005/06	19.41	-0.71	20.12	-0.23	19.89	+0.48
2006/07	20.01	-1.14	21.15	-0.82	20.33	+0.32
2007/08	21.74	-0.96	22.70	-1.63	21.07	-0.67
2008/09	20.07	-2.13	22.20*	-1.91	20.29	+0.22
2009/10	19.99	-1.25	21.24	-0.94	20.30	+0.31
*The midstream logger was out of the water during most of February and March 2009, so the daily maximum average temperature is unlikely to be representative.						

As Table 16 illustrates, the downstream temperature has mostly been cooler than the upstream temperature, for the upper and lower sections. For the total monitored length, stream temperature increases downstream. Generally, the cooling effect is diminished in the lower section compared with the upper monitored section of the stream. Only the data from the 2007/08 summer has shown the downstream temperature to be cooler than the upstream temperature. No temperature difference trends have emerged, a longer monitoring period is required. Shading of the Mangatutu Stream remains sporadic between the temperature monitoring sites however this level of shading should increase over the long term as new plantings mature. Figure 21 shows that the temperature difference has remained relatively stable, as has the amount of woody vegetation in the catchment, apart from the temperature in 2007/08.

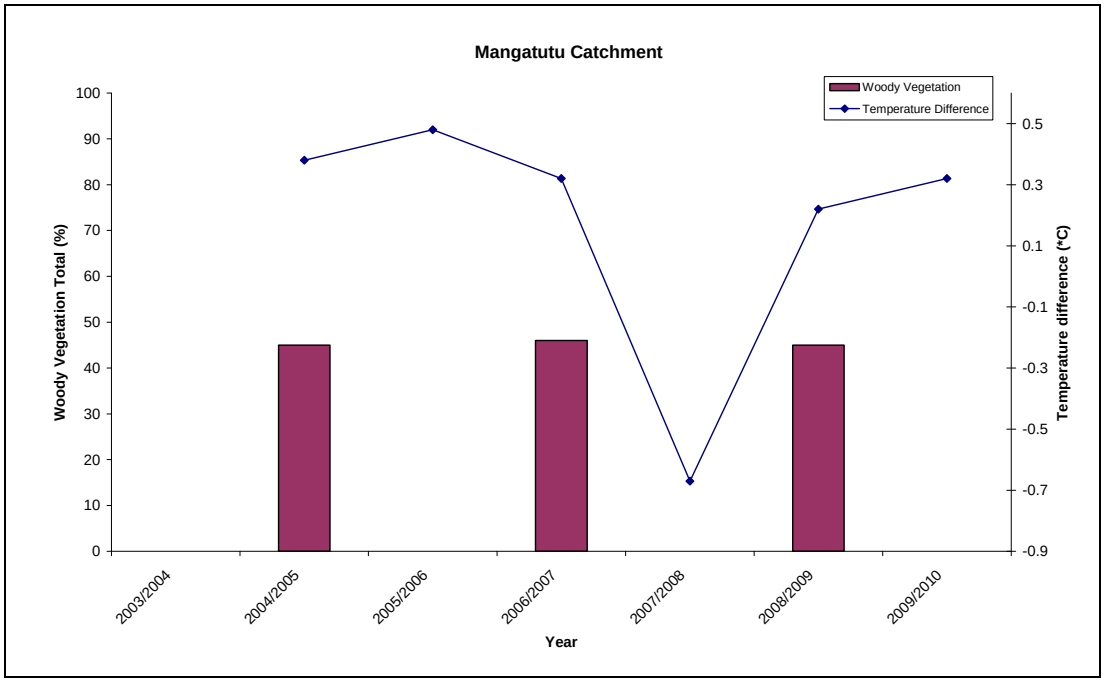

Figure 21: Woody vegetation total versus temperature difference in the Mangatutu Catchment. Temperature and woody vegetation data only begins from 2004/05 onwards.

5.2.4 Photo points

No photos were collected in the 2009/10 monitoring period in the Mangatutu catchment. Refer to Grant et al. (2009b) for the most recent results and comparisons.

5.2.5 Suspended sediment

Permanent sampling site

A permanent suspended sediment sampling site has been in place at Walker Road Bridge on the Mangatutu River since June 2004. During this time 43 events have been sampled using an automatic sediment sampler. The data set is analysed to estimate sediment variables (Table 17). Data includes all results up until 31/12/2009. A continuing focus is to carry out manual depth-integrated suspended sediment gaugings while the automatic sampler is activated. The collection of these concurrent samples will allow for the automatic series to be calibrated to the whole river cross-section. For more detailed information refer to the Suspended Sediment Monitoring Report (Kotze et al., 2008).

Table 17: Mangatutu permanent suspended sediment sampling site description and estimated sediment variables.

Site name:	**Walker Road**	**Map Ref (NZMS260):**	**S15:203-423**
River:	**Mangatutu**		
		Start – End Date	**No of samples**
Flow Time Series		08/06/2004 – 31/12/2009	N/A
Sediment Samples		22/06/2004 – 16/10/2009	935
ISCO Period of Record		22/06/2004 – 16/10/2009	43 events

Specific yield ($t/km^2/yr$)	Average sediment yield (kt/yr)	% of sediment yield in gauged range of flow	% Error in Yield Estimate
66	8.0	19.1	4.9

The Mangatutu River has an estimated specific yield of 66t/km^2/yr and an average sediment yield of 8.0kt/yr. Figure 22 shows the specific sediment yield for the Mangatutu River relative to other monitored sites in the Region.

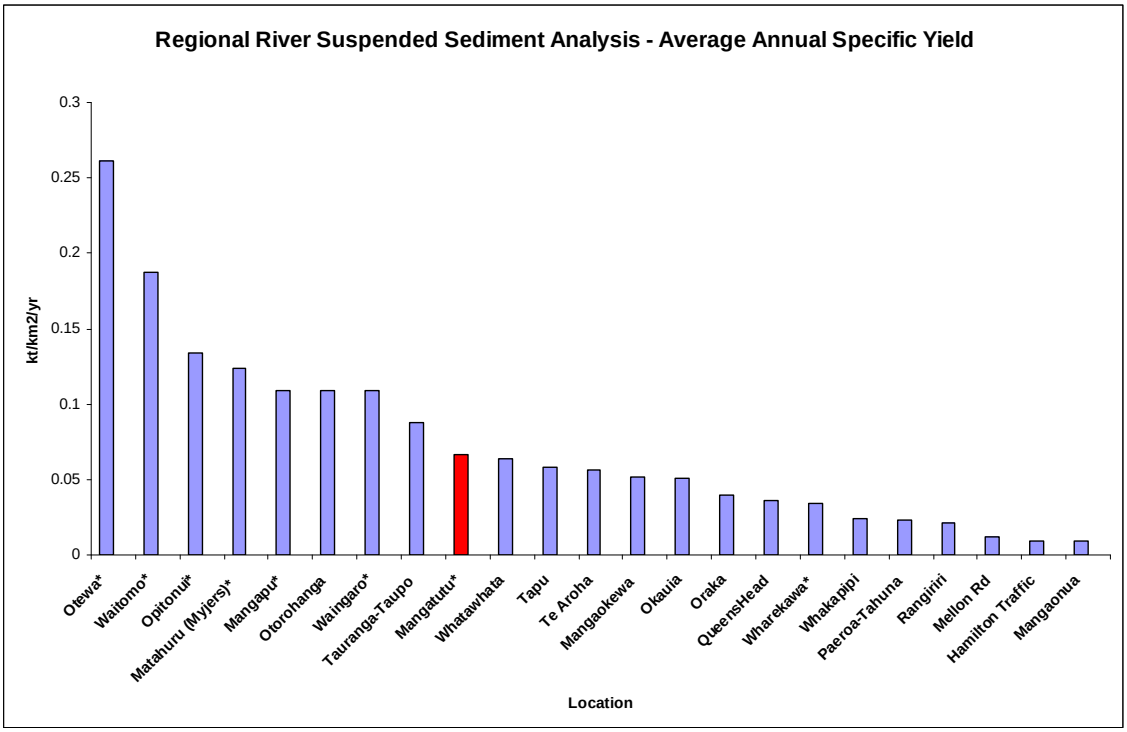

Figure 22: Average specific suspended sediment yield for monitored rivers in the Waikato Region (Mangatutu site is highlighted).

The specific yield for the Mangatutu can be considered moderate to low relative to many sites in the region. The dominant geology (comprising welded ignimbrite and overlying tephras) is likely reasons for the low specific sediment yield value.

Snapshot sampling

Refer to Hill et al. (2006) for the low flow snapshot results taken in April 2004. A high flow sediment snapshot will be undertaken at the next opportunity.

5.2.6 Stream ecological health

The dominant surrounding land use in the vicinity of the sampling site is pastoral. The stream is 4-5m in width with the substrate predominantly consisting of gravel and sand with some silt. The canopy cover is partly shaded although the removal of nuisance riparian willow will in the short term reduce canopy cover.

Invertebrate sampling is conducted in the Mangatutu River immediately upstream of the Walker Road Bridge, near the downstream temperature logger. The initial year of assessment using these methods was in 2005 with subsequent assessments completed annually.

Table 18 lists the MCI (Macroinvertebrate Community Index) values as calculated for the Mangatutu River sampling site. Samples are taken between January and March every year.

Table 18: MCI values for the sampling site in the Mangatutu River and nearby reference site (Otautora Stream).

Site	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10
Mangatutu downstream	114	110	104	108	115	102
Otautora Stream	149	145	139	136	136	144

In the vicinity of the sampling site in the Mangatutu River the presence and abundance of identified invertebrate species and the associated MCI scores indicate that the ecological health of the stream is considered to be moderate to mildly degraded (Wright-Stow & Winterbourn 2003). A longer monitoring period is required to identify trends in the MCI values. A reference site has been included to compare the MCI values from the Mangatutu Stream. The reference site is the Otautora Stream (site number 1888.4). For more information on the monitored streams see Appendix 2.

5.2.7 Main points

Riparian Characteristics

- No riparian characteristics data was collected in the 2009/10 monitoring period.

Water Temperature

- Assessments of the invertebrates in Mangatutu Stream indicate that there is a moderate to mild degradation in ecological health.

Suspended Sediment

- The specific yield for the Mangatutu catchment above Walker Road Bridge is 66t/km^2/yr after five years of sampling. However a longer monitoring period is required (at least 10 years) in order to produce a more accurate result.

Stream Ecological Health

- Water temperature has been monitored annually since 2004/05. With the exception of the 2007/08 monitoring period, the downstream site has recorded warmer temperatures than the upstream site. This is likely to improve as soil conservation plantings grow and shade the water. A longer monitoring period is required before a trend can be identified.

5.2.8 Other monitoring

Automatic sediment samplers are installed on the Upper Waipa River (at Otewa) and the Mangapu Stream to monitor suspended sediment in the Waipa zone. For more details, refer to the Suspended Sediment monitoring report (Kotze et al., 2008). *Mangatutu Stream Ecological Monitoring Results – 2004 to 2007* has been completed by Gibbs (2008) as an Environment Waikato Internal Series report, and can be accessed internally on DOC #1212429 or by contacting Environment Waika to. This report describes the changes in ecological health in the Mangatutu Stream resulting from the soil conservation work which has occurred since 2004.

6 Coromandel zone

6.1 Introduction

Monitoring is present in one catchment in the Coromandel zone; Wharekawa catchment.

6.2 Wharekawa catchment

6.2.1 Monitoring progress

Monitoring will focus on the Wharekawa River catchment where river management and soil conservation initiatives are being implemented. For survey locations in the Wharekawa catchment, refer to Grant et al. (2009b). Table 19 contains monitoring completed by the end of the 2009/10 financial year.

Table 19: Coromandel zone monitoring completed by 2009/10.

Monitoring	Activity	Completion	Included in this report (or year last reported)
Soil stability	Not planned	N/A	N/A
Riparian characteristic assessment	Complete assessment along the monitored section of Wharekawa River.	2006/07, 2008/09	(2008/09)
Photo points	Complete assessment along the monitored section of the Wharekawa River	2006/07, 2008/09	(2008/09)
Permanent suspended sediment sampling site	Event driven sampling, concluded in 2003. Site reinstalled.	April 2000 until Feb 2003. Reinstalled Dec 2009.	✓
Suspended sediment snapshots	Not planned	N/A	N/A
Water temperature	Install loggers and record stream temperatures along the Wharekawa River	2006/07, 2007/08 2008/09, 2009/10	✓
Stream ecological health	Assess stream ecological health along the Wharekawa River	2004/05, 2006/07 2007/08, 2008/09 2009/10	✓

N/A = not applicable

6.2.2 Riparian characteristics

No riparian characteristics data was collected in the 2009/10 monitoring period in the Mangatutu catchment. Refer to Grant et al. (2009b) for the most recent results.

6.2.3 Water temperature

Water temperature loggers are deployed in the lower section of the Wharekawa River. The downstream logger is near the SH25 Bridge, and the upstream logger is approximately 3km further upstream, near where the river emerges from the forest. Four deployments have been made with data collected for the summers of 2006/07, 2007/08, 2008/09 and 2009/10.

The average of the daily maximum water temperature is derived to produce a single temperature for each site. The downstream temperature is then subtracted from the

upstream temperature to provide a single number for the monitored section of river (Table 20). There is no upstream data for 2009/10 due to the logger being washed away during a flood event in early 2010.

Table 20: Wharekawa River average daily maximum water temperatures for the 10 week period commencing 1st January

Year	Upstream average daily maximum (°C)	Downstream average daily maximum (°C)	Temperature difference between d/s and u/s locations (°C)
2006/07	21.78	21.07	-0.71
2007/08	22.13	21.54	-0.59
2008/09	22.16	21.47	-0.69
2009/10	No data	21.15	No data

As Table 20 illustrates, in previous years the downstream temperature has been slightly cooler on average than the upstream temperature. The woody vegetation has decreased due to willow being cleared to make way for planting. A longer monitoring period is required before a trend can be identified. Figure 23 shows a relationship between the temperature difference and the woody vegetation cover over the years.

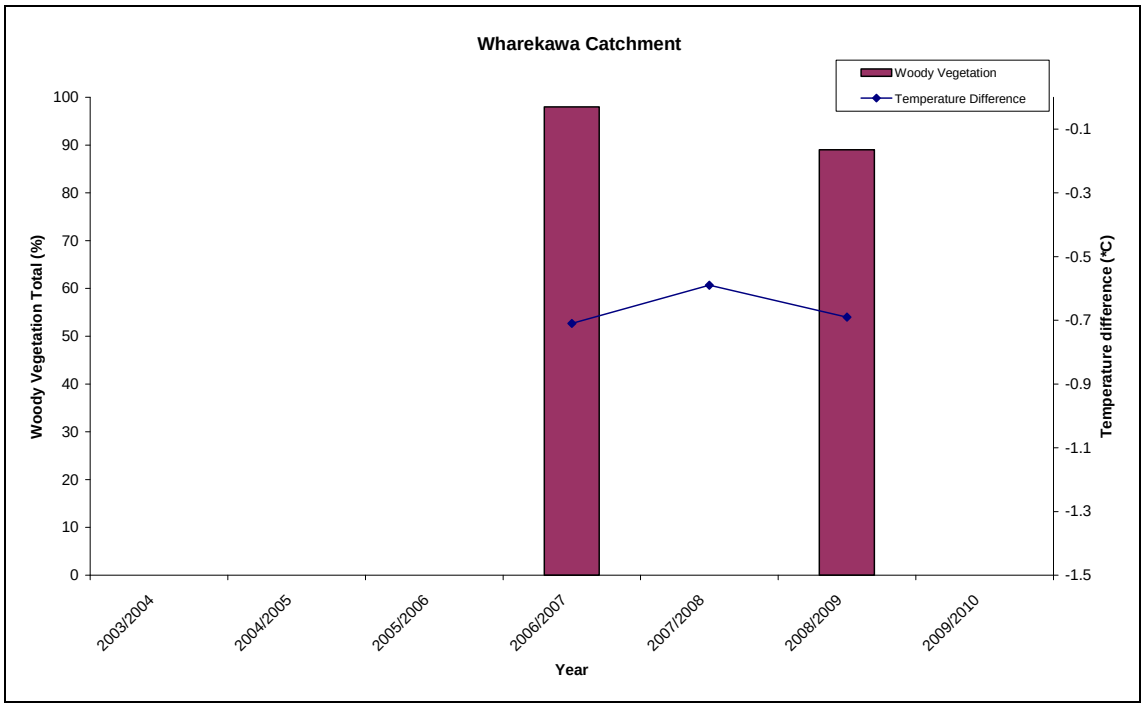

Figure 23: Woody vegetation total versus temperature difference in the Wharekawa Catchment. Temperature and woody vegetation data only begins from 2006/2007 onwards.

6.2.4 Photo points

No photos were collected in the 2009/10 monitoring period in the Mangatutu catchment. Refer to Grant et al. (2009b) for the most recent results and comparisons.

6.2.5 Suspended sediment monitoring

A permanent sediment sampling site has been in place at Adams Farm Bridge on the Wharekawa River since June 1991. During this time 19 events have been sampled using an automatic sediment sampler, which was on site between April 2000 and February 2003, and was redeployed in December 2009. The data set is analysed to estimate sediment variables (Table 21). Data includes all results up until 31/12/2009. A continuing focus is to carry out manual depth-integrated suspended sediment gaugings

while the automatic sampler is activated. The collection of these concurrent samples will allow for the automatic series to be calibrated to the whole river cross-section. For more detailed information refer to the Suspended Sediment Monitoring Report (Kotze et al., 2008).

Table 21: Wharekawa permanent suspended sediment sampling site description and estimated sediment variables.

Site name:	**Adams Farm Bridge**	**Map Ref (NZMS260):**	**T12:623-468**
River:	**Wharekawa**		
		Start – End Date	**No of samples**
Flow Time Series		10/06/1991 – 31/12/2008	N/A
Sediment Samples		25/09/1991 – 27/02/2003	478
ISCO Period of Record		20/04/2000 – 27/02/2003	19 events

Specific yield ($t/km^2/yr$)	Average sediment yield (kt/yr)	% of sediment yield in gauged range of flow	% Error in Yield Estimate
34	1.6	56.5	3.6

The Wharekawa River has an estimated specific yield of $34t/km^2/yr$ and an average sediment yield of 1.6kt/yr. Figure 24 shows the specific sediment yield for the Wharekawa River relative to other monitored sites in the Region.

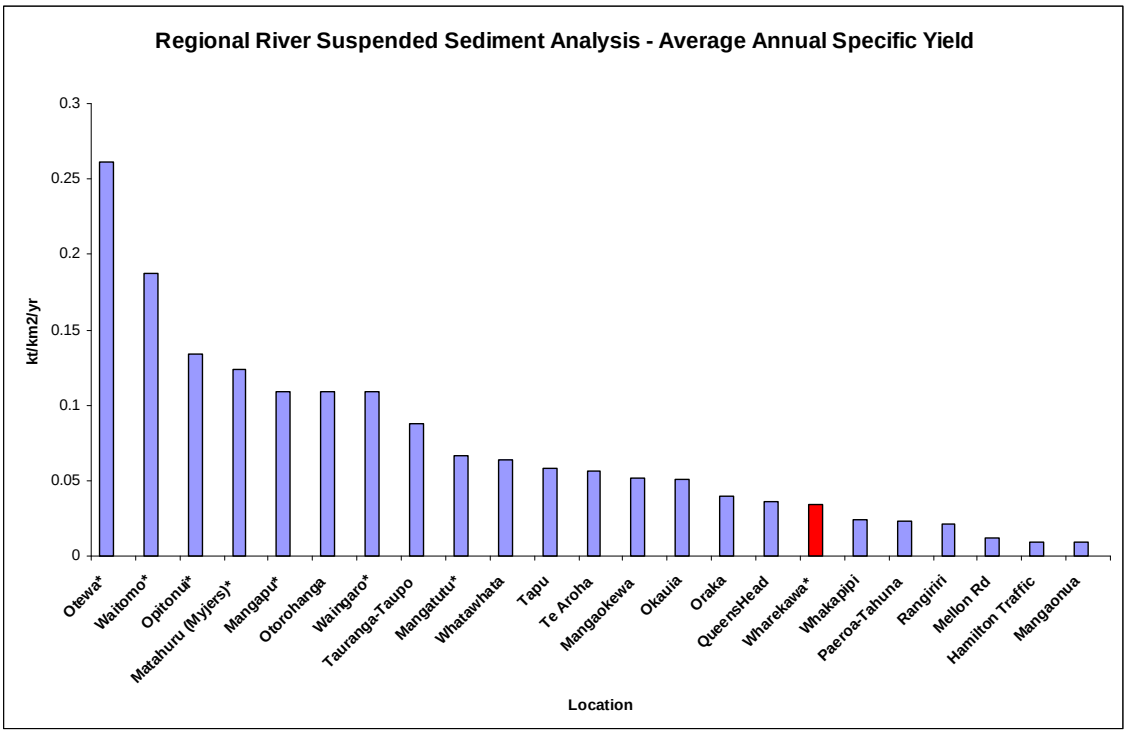

Figure 24: Average specific suspended sediment yield for monitored rivers in the Waikato Region (Wharekawa site is highlighted).

The specific yield for the Wharekawa can be considered low relative to many sites in the region. The influencing factors are likely to be the dominance of woody vegetation cover and geology.

6.2.6 Stream ecological health

The dominant surrounding land use in the vicinity of the sampling site is pastoral but the riparian zone is generally planted. The stream is up to 14m wide with the substrate

predominantly consisting of gravel and sand with some cobbles. The canopy cover is partly shaded.

Invertebrate sampling is conducted in the Wharekawa River in the vicinity of the Adam's Farm Bridge, midway between the upstream and downstream temperature loggers. The initial year of assessment using these methods was in 2004/05 with sampling undertaken annually since then, except for in 2005/06 when no samples were taken.

Table 22 lists the MCI (Macroinvertebrate Community Index) values as calculated for the Wharekawa River sampling site. Samples are taken between January and March every year.

Table 22: MCI values for the sampling site in the Wharekawa River and nearby reference site (Kauaeranga River).

Site	2004/05	2006/07	2007/08	2008/09	2009/10
Wharekawa	95	94	94	86	90
Kauaeranga River	135	120	109	131	103

In the vicinity of the sampling site in the Wharekawa River the presence and abundance of identified invertebrate species and the associated MCI scores indicate that there is a moderate degradation in ecological health (Wright-Stow & Winterbourn 2003). A longer monitoring period is required before trends in the MCI values can be identified. A reference site has been included to compare the MCI values from the Pokaiwhenua Stream. The reference site is the Kauaeranga River (site number 234.28). For more information on the monitored streams see Appendix 2.

6.2.7 Main points

Riparian characteristics

- No riparian characteristics data was collected in the 2009/10 monitoring period

Water Temperature

- As there is no upstream data for 2009/10 we cannot make any inference on the difference between the upstream and downstream temperature loggers. In previous years the downstream temperature has been cooler on average than the upstream logger. A longer monitoring period is required to identify a trend.

Suspended sediment monitoring

- The specific yield for the Wharekawa catchment is estimated to be 34t/km^2/yr, based on samples taken both manually and from an automatic sediment sampler since 1991.

- Continued manual sediment sampling adds to the existing dataset.

Stream Ecological Health

- Assessments of the invertebrates in Wharekawa River indicate that there is a moderate degradation in ecological health.

6.2.8 Other monitoring

An automatic sediment sampler is installed on the Opitonui River to monitor suspended sediment. Further details are in the Suspended Sediment Monitoring Report (Kotze et al., 2008).

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Appendix 1: Riparian characteristics summary

Matahuru catchment – Lower Waikato zone 2009/10

For each table the number in brackets is the percent change from the 2003/04 assessment, which was the first year the assessment was done.

Matahuru erosion

Riparian **erosion** characteristics – Matahuru (% of total bank length)									
Erosion	stable 81(+34)	unstable 19(-34)							
Fencing	nd	fenced 16(+1)				unfenced 3(-35)			
Vegetation		grass 4(-2)	willow woody veg. 2(+1)	other exotic woody veg. 3(nc)	native woody veg. 7(+2)	grass 2(-28)	willow woody veg. 0(-1)	other exotic woody veg. 0(-2)	native woody veg. 1(-4)

nd = not detailed, nc = no change

Matahuru vegetation

Riparian **vegetation** characteristics –Matahuru (% of total bank length)			
Grass 29(-23)	Woody vegetation 71(+23)		
	Exotic 26(+17)		Native 45(+6)
	Willow 8(+4)	Non-willow 18(+13)	

Matahuru fencing

Riparian **fencing** characteristics - Matahuru								
Fencing: % of stream length	**no fence on both sides** 2(-28)				**fenced on one side** 21(-3)		**fenced on both sides** 77(+31)	
Fencing: % of total bank length	**not fenced** 13(-29)				**fenced** 87(+29)			
Breakdown by vegetation	grass 8(-24)	willow woody veg. 0(-2)	other exotic woody veg. 1(-1)	native woody veg 4(-2)	grass 21(+3)	willow woody veg. 8(+5)	other exotic woody veg. 17(+14)	native woody veg. 41(+7)

For each table the number in brackets is the percent change from the 2003/04 assessment, which was the first year the assessment was done.

Pokaiwhenua erosion

Riparian **erosion** characteristics – Pokaiwhenua (% of total bank length)									
Erosion	stable 98(+10)	unstable 2(-10)							
Fencing	nd	fenced 2(-5)				unfenced 0(-5)			
Vegetation	nd	grass 1(-4)	willow woody veg. 1(+1)	other exotic woody veg. 0(nc)	native woody veg. 0(-2)	grass 0(-3)	willow woody veg. 0(nc)	other exotic woody veg. 0(-2)	native woody veg. 0(nc)

nd = not detailed, nc = no change

Pokaiwhenua vegetation

Riparian **vegetation** characteristics – Pokaiwhenua (% of total bank length)			
Grass 35(-20)	Woody vegetation 65(+20)		
	Exotic 50(+34)		Native 15(-14)
	Willow 13(+7)	Non-willow 37(+27)	

Pokaiwhenua fencing

Riparian **fencing** characteristics - Pokaiwhenua								
Fencing: % of stream length	**no fence on both sides** 0(-29)				**fenced on one side** 1(-43)		**fenced on both sides** 99(+72)	
Fencing: % of total bank length	**not fenced** 1(-50)				**fenced** 99(+50)			
Breakdown by vegetation	grass 1(-23)	willow woody veg. 0(-3)	other exotic woody veg. 0(-8)	native woody veg 0(-16)	grass 34(+3)	willow woody veg. 13(+9)	other exotic woody veg. 37(+35)	native woody veg. 15(+3)

Mangare catchment – Upper Waikato Zone 2009/10

For each table the number in brackets is the percent change from the 2003/04 assessment, which was the first year the assessment was done.

Mangare erosion

Riparian **erosion** characteristics – Mangare (% of total bank length)									
Erosion	stable 86(+47)	unstable 14(-47)							
Fencing	nd	fenced 8(-26)				unfenced 6(-21)			
Vegetation		grass 2(-29)	willow woody veg. 6(+5)	other exotic woody veg. 0(-2)	native woody veg. 0(nc)	grass 2(-24)	willow woody veg. 0(-1)	other exotic woody veg. 4(+4)	native woody veg. 0(nc)

nd = not detailed, nc = no change

Mangare vegetation

Riparian **vegetation** characteristics – Mangare (% of total bank length)			
Grass 43(-51)	Woody vegetation 57(+51)		
	Exotic 57(+53)		Native 0(nc)
	Willow 42(+41)	Non-willow 15(+12)	

nc = no change

Mangare fencing

Riparian **fencing** characteristics – Mangare								
Fencing: % of stream length	**no fence on both sides** 19(-30)				**fenced on one side** 31(+11)		**fenced on both sides** 50(+19)	
Fencing: % of total bank length	**not fenced** 34(-25)				**fenced** 66(+25)			
Breakdown by vegetation	grass 23(-35)	willow woody veg. 1(nc)	other exotic woody veg. 10(+10)	native woody veg 0(nc)	grass 20(-18)	willow woody veg. 41(+40)	other exotic woody veg. 5(+3)	native woody veg. 0(nc)

nc = no change

Appendix 2: Macroinvertebrate Community Index (MCI)

Macro invertebrate Community Index (MCI):

IBI Score range	Integrity Class	MCI Range	QMCI range	Degradation Category
58–60	Excellent	125-100	6.2-10	Clean
48-52	Good	105-115	5.2-5.7	Mild
40-44	Fair	85-95	4.2-4.7	Moderate
28-34	Poor	<75	0-3.7	Severe
12-22	Very poor	-	-	-

Appendix 2 Integrity Score (IBI), Integrity classes, Macroinvertebrate Community Index (MCI) and Quantitative Macroinvertebrate Community Index (QMCI) ranges defined for invertebrate communities (Wright-Stow and Winterbourn, 2003).

Additional information on monitored streams:

Stream name	Stream Depth	Stream Width	Main Substrate Type	Distance between u/s and d/s loggers
Pokaiwhenua	0.6m	11.6m	Large Gravel/cobble	1.2km
Mangare	0.5m	5.3m	Large gravel	1.3km
Tahunaatara	0.5m	6.6m	Large gravel	4.5km
Mangatutu	0.5m	11.2m	Large/small gravel	18km
Wharekawa	0.3m	13.6m	Cobble/Large gravel	3.4km

Stream depth, width and substrate type are gathered while conducting REMS surveys and are only indicative of the 100m stretch that is sampled. It does however give an idea of the size and substrate type of the streams.

Additional information on reference streams for REMS:

Stream name	Stream Depth	Stream Width	Main Substrate Type
Mokaihaha	0.2m	7.4m	Bedrock/Sand
Otautora	0.2m	3.6m	Cobble/Sand/Gravel
Kauaeranga	0.3m	20m	Boulder/Cobble
Pohomihi	0.3m	9.8m	Large Gravel

Stream depth, width and substrate type are gathered while conducting REMS surveys and are only indicative of the 100m stretch that is sampled. It does however give an idea of the size and substrate type of the streams.