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Catchment Environmental Monitoring Report 2012/13

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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 CEM programme allows the Waikato Regional Council 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 the Waikato Regional Council, 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 can often be misleading.

This report provides CEM programme results for the 2012/2013 year. Copies of reports as described in the list of references can be obtained by contacting the Waikato Regional Council (the Library) on 0800 800 401, or in electronic format from the publications page of the Waikato Regional Council website http://www.waikatoregion.govt.nz/publications/ or email: inforeq@waikatoregion.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 2012/13 monitoring period. Interpretations of the results, 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 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 et al., 2009a).

It is important to note that not all priority soil conservation catchments are monitored. However, the results for the monitored catchments should be applicable to other priority catchments in a given zone. A standard monitoring approach is recommended for all monitored catchments but the specific suite of monitoring will differ from catchment to catchment. This is dependent 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 the Waikato Regional Council.
- 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, the Waikato Regional Council implemented works consent monitoring, and the Waikato Regional Council 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 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 2011/2012.

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)

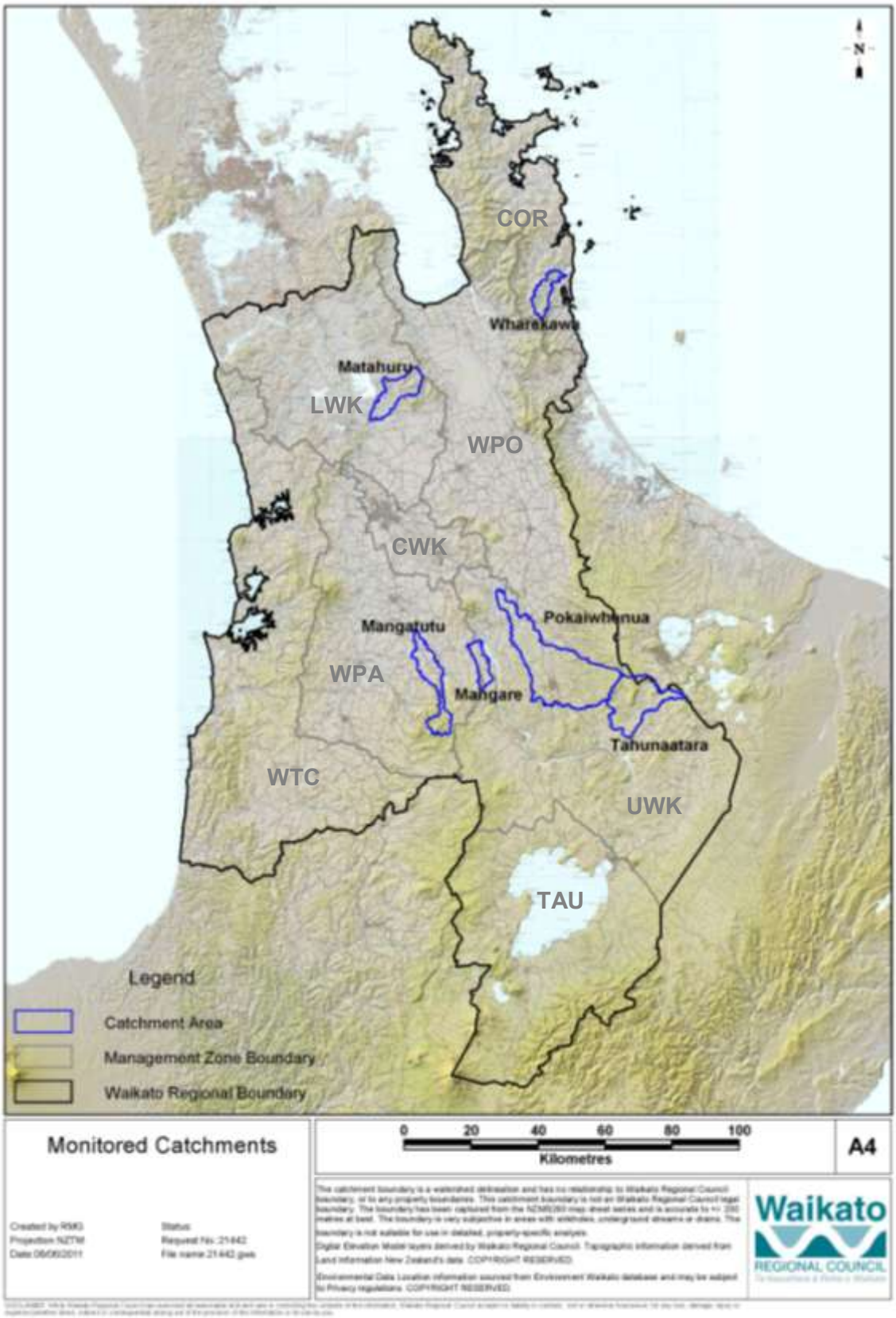

Figure 1: Monitored priority catchment locations, with management zone boundaries (labels explained in Table 1).

1.5 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. The changes in soil stability in the Waikato Region from 2002 to 2007 are discussed in Thompson & Hicks (2009b). For the most recent results of the Regional Soil Stability assessment conducted in 2007 refer to Thompson & Hicks (2009a).

Table 2: Waikato Regional Council's land and water monitoring programmes.

Programme	Main measures	Last assessment/ frequency
Regional soil stability assessment	Soil stability and soil conservation	2007; assessment 5-10 yearly
Regional riparian characteristics assessment	Riparian fencing, vegetation and erosion	2012/13; assessment 5-10 yearly
Permanent suspended sediment sites	Water quality including sediment and peak flows	7 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)

2 Lower Waikato zone

2.1 Introduction

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

2.2 Matahuru catchment

2.2.1 Monitoring progress

Monitoring is focused on the lower section of the Matahuru catchment; refer to Grant et al., (2009b) for survey locations. Table 3 presents monitoring completed by the end of the 2012/13 financial year.

Table 3: Lower Waikato zone monitoring completed by 2012/13.

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, 2011/12	2011/12
Photo points	Complete assessment along the lower section of the Matahuru Stream	2003/04, 2004/05, 2005/06, 2007/08, 2009/10, 2011/12	2011/12
Permanent suspended sediment sampling site	Event driven sampling	Installed in 2003 and ongoing	✓
Suspended sediment snapshots	• Low flow snapshot • Medium flow snapshot	2003 2008	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, 2010/11, 2011/12, 2012/13	✓

2.2.2 Soil stability

Refer to Hicks (2005a) for the most recent soil stability assessment report for this catchment.

2.2.3 Riparian characteristics

No riparian characteristics data were collected in the 2012/13 monitoring period in the Matahuru catchment. Refer to Littler et al., (2013) for the most recent results.

2.2.4 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 Waikato Regional Council recorder station by Waiterimu Road. The distance between the two loggers is approximately 20 km. To date ten deployments have been made with data collected, for 10 weeks from 1 January during each summer between 2003/04 and 2012/13.

The average of the daily maximum water temperature is derived to produce a single temperature for each site. The upstream temperature is then subtracted from the downstream temperature to provide a temperature difference for the monitored section of the river.

The daily average upstream and downstream maxima for 2012/2013 were 22.19°C and 21.58°C respectively. Refer to Table 12 in Appendix 1 for annual upstream and downstream temperatures. Figure 2 indicates that downstream temperature has been cooler than the upstream temperature for all years of assessment, because the temperature difference is always negative. The difference between upstream and downstream temperature is variable but linear regression indicates the difference has decreased since the start of the assessment period (Figure 2) due to the downstream site becoming warmer.

Observations during field visits suggest that shading of the Matahuru Stream is sporadic between the two sites, with a variety of vegetation types present. However, the percentage of woody vegetation has increased over the assessment period (Figure 2). As existing vegetation combined with any new plantings established and grew, it was expected that shading would increase and result in a larger temperature difference between the upstream and downstream monitoring sites (i.e. a net decrease in water temperature downstream). To date this does not appear to have happened and is perhaps related to the high stream order, making complete shading of the stream difficult.

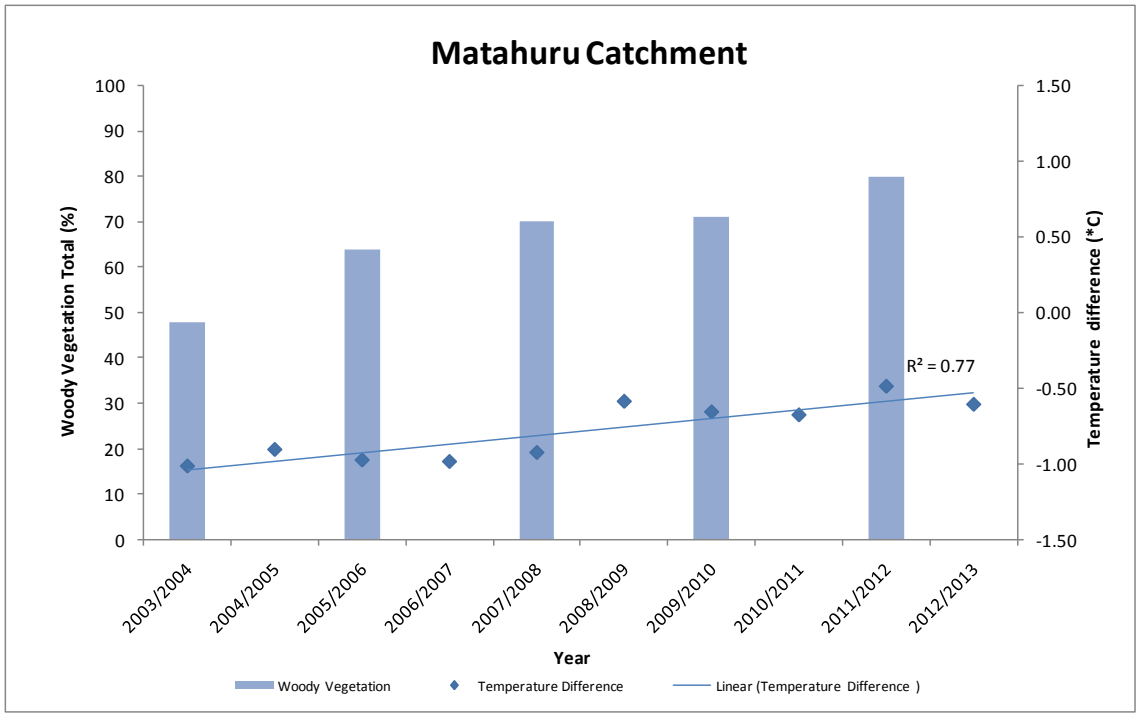

Figure 2: Annual changes in woody vegetation total (%) and temperature difference (°C) for the Matahuru Catchment.

2.2.5 Photo points

No photos were collected in the 2012/13 monitoring period in the Matahuru catchment. Refer to Littler et al., (2013) for the most recent results and comparisons.

2.2.6 Suspended sediment

A permanent suspended sediment sampling site has been in place at the Myjers farm bridge since July 2006. During this time 29 events have been sampled using an automatic sediment sampler. The data set is analysed to estimate sediment variables (Table 4). Data includes all results up until 31/12/2012. 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) and *Sampled Suspended Sediment Yields from the Waikato Region* (Hoyle et al., 2011).

Table 4: 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 – 31/12/2012	N/A
Sediment Samples		19/07/2006 – 31/07/2012	558
ISCO Period of Record		19/07/2006 – 31/07/2012	29 events

Specific yield ($t/km^2/yr$)	Average sediment yield (kt/yr)	% of sediment yield in gauged range of flow	% Error in Yield Estimate
201	16.7	64.7	5.3

The Matahuru River has an estimated specific yield of 201 $t/km^2/yr$ and an average sediment yield of 16.7 kt/yr (Table 4). Relative to other sampling sites in the Waikato Region the Matahuru River has a high specific sediment yield (Figure 3). This high specific yield is likely a result of pastoral farming being the dominant land use and a catchment which is formed in erodible tertiary sediments (Hoyle et al., 2011).

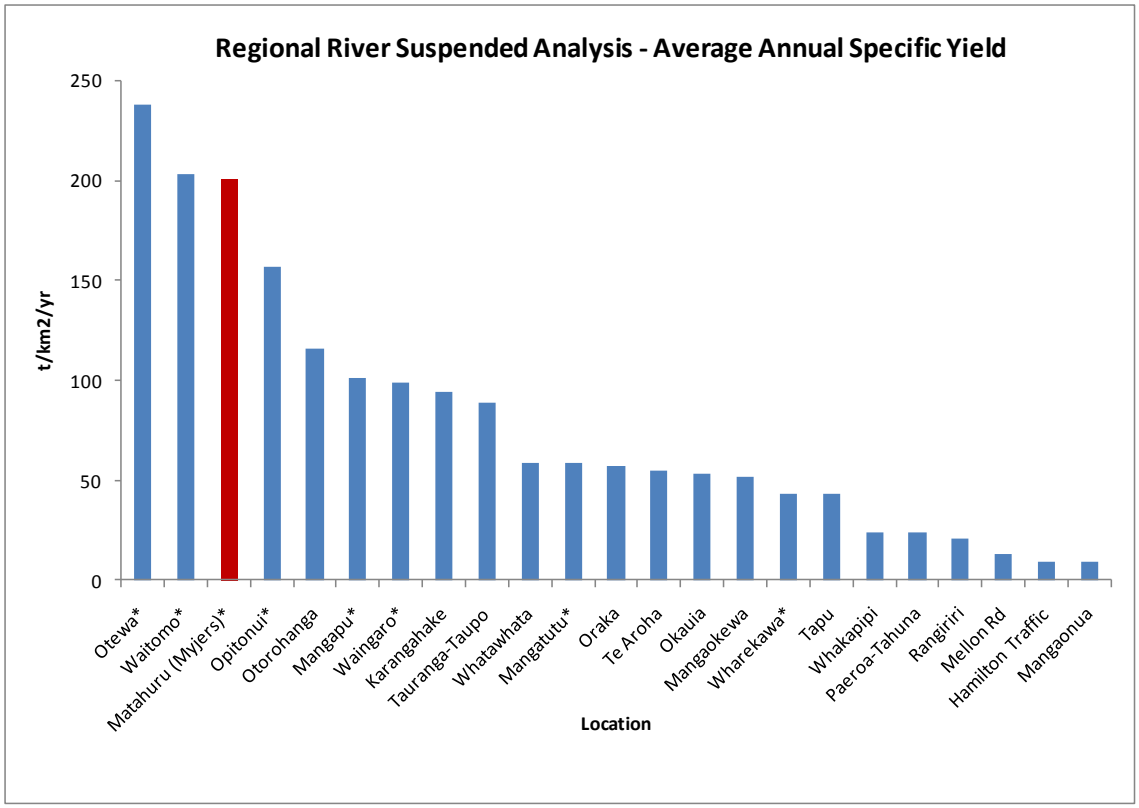

Figure 3: Average specific suspended sediment yield ($t/km^2/yr$) for monitored rivers in the Waikato Region, the Matahuru Stream site is highlighted in red.

2.2.7 Main points

Soil Stability

- No soil stability assessment completed this year.

Riparian Characteristics

- No riparian characteristics data were collected in the 2012/13 monitoring period.

Water Temperature

- The downstream temperature has been cooler on average than the upstream temperature for all monitored years. However, the temperature difference, whilst sporadic, appears to have become less since the start of the assessment period.
- Since 2003/04 river management and soil conservation works have occurred, but in general, shading of the Matahuru Stream remains sporadic.

Suspended sediment monitoring

- A specific yield of 201 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. The specific sediment yield from the Matahuru site is high relative to other monitoring sites in the Waikato Region.

3 Upper Waikato zone

3.1 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.

3.2 Pokaiwhenua catchment

3.2.1 Monitoring progress

The monitoring locations in the Pokaiwhenua catchment are detailed in Grant et al., (2009b). This report presents monitoring completed by the end of the 2012/13 financial year.

Table 5: Pokaiwhenua catchment monitoring completed by 2012/13.

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, 2011/12	2011/12
Photo points	Complete assessment along the mid section of the Pokaiwhenua River	2003/04, 2004/05, 2005/06, 2007/08, 2009/10, 2011/12	2011/12
Permanent suspended sediment sampling site	None planned	N/A	N/A
Suspended sediment snapshots	Low flow snapshot	2003	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, 2010/11, 2011/12, 2012/13	✓
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, 2010/11, 2011/12, 2012/13	✓

N/A = not applicable.

3.2.2 Soil stability

Refer to Hicks et al., (2005b), for the most recent assessment report for this catchment.

3.2.3 Riparian characteristics

No riparian characteristics data were collected in the 2012/13 monitoring period in the Pokaiwhenua catchment. Refer to Littler et al., (2013) for the most recent results.

3.2.4 Water temperature

The water temperature loggers are deployed in the middle section of the Pokaiwhenua River. The distance between the two loggers is approximately 1 km. To date nine

deployments have been made with data collected for 10 weeks from 1 January for each summer between 2003/2004 and 2012/2013 inclusive. The average of the daily maximum water temperature is derived to produce a single temperature for each site. The upstream temperature is then subtracted from the downstream temperature to provide a temperature difference for the monitored section of the river.

The daily average upstream and downstream maximums were 17.71 °C and 17.97 °C respectively. Refer to Table 13 in Appendix 1 for annual upstream and downstream temperatures. Figure 4 indicates that the downstream temperature was cooler than upstream between 2003/2004 and 2011/2012 because the results are negative. The opposite was true for the 2012/2013 period. Between the 2007/2008 and 2009/2010 reporting period the temperature difference increased, due to the downstream site becoming increasingly cooler than the upstream site. However, from 2009/2010 the temperature difference decreased, with the downstream temperature eventually being warmer than the upstream site (Figure 4). This change may be attributable to an increase in fencing and riparian planting in the upper reaches of the monitored stream section. Dense vegetation in the upper reaches and a narrower stream width may improve the shading in the upper section, compared to a wider stream width (5-7 m) and slower growing vegetation in the lower reaches.

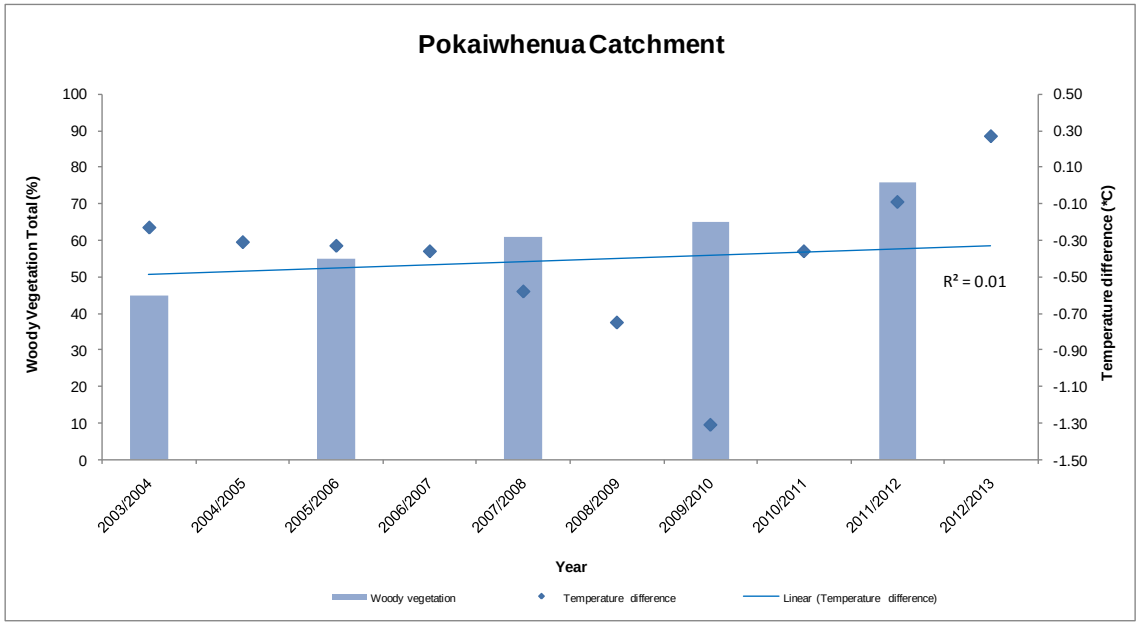

Figure 4: Woody vegetation total (%) and temperature difference (°C) in the Pokaiwhenua Catchment.

3.2.5 Photo points

No photos were collected in the 2012/13 monitoring period in the Pokaiwhenua catchment. Refer to Littler et al., (2013) for the most recent results and comparisons.

3.2.6 Stream Ecological Health

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. From this invertebrate sampling macroinvertebrate community index (MCI) is calculated. The initial year of assessment was completed in 2003/04 with subsequent assessments completed annually between January and March.

The dominant land use in the vicinity of both of the sampling sites in the Pokaiwhenua River is pastoral / horticultural. The river ranges between 5 - 11.6 m in width with the substrate predominantly consisting of a combination of cobbles and large gravel. The canopy cover is open. Figure 5 illustrates the MCI values as calculated for the upstream and downstream sampling sites in the Pokaiwhenua River.

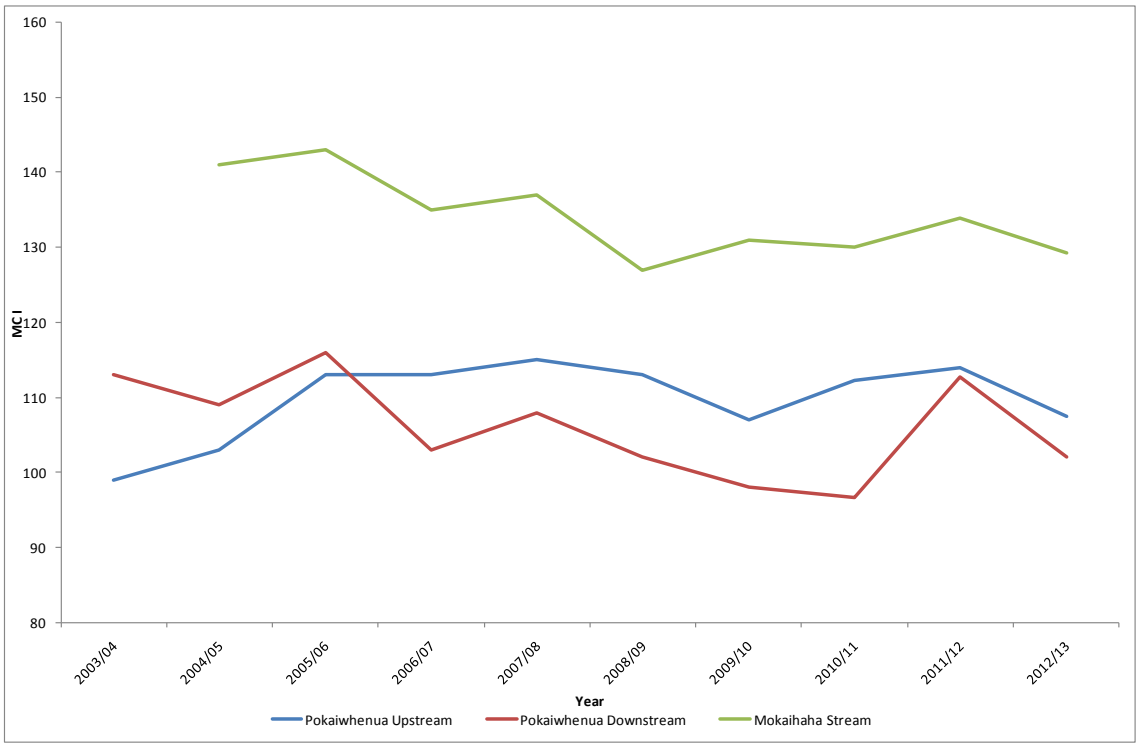

Figure 5: MCI values for the upstream and downstream sites in the Pokaiwhenua River and the nearby reference site in the Mokaihaha Stream.

In the vicinity of the two sampling sites, the presence and abundance of identified invertebrate species and the associated MCI scores indicate that the stream has a moderate to mild degradation in ecological health (Wright-Stow & Winterbourn, 2003) (Figure 5). There have been occasions when the river has been too high to wade, which have restricted sampling. The Mokaihaha Stream (site number 555.2) has been included, in Figure 5, as a pristine reference site to compare the MCI values from the Pokaiwhenua Stream. The Mokaihaha Stream has always had higher MCI values than those recorded in the Pokaiwhenua River. For more information on the monitored streams see Appendix 3.

3.2.7 Main Points

Soil Stability

- No soil stability assessment completed during this assessment period.

Riparian Characteristics

- No riparian characteristics data were collected in the 2012/13 monitoring period.

Water Temperature

- The downstream temperature was cooler on average than the upstream temperature until the summer of 2012/13.
- 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.

Stream Ecological Health

- Assessments of the invertebrates in Pokaiwhenua Stream indicate that there is a moderate to mild degradation in ecological health at both upstream and downstream sites.

3.3 Mangare Catchment

3.3.1 Monitoring progress

For survey locations in the Mangare catchment, refer to Grant et al., (2009b). This report contains monitoring completed by the end of the 2012/13 financial year.

Table 6: Mangare catchment monitoring completed by 2012/13.

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, 2011/12	2011/12
Photo points	Complete assessment along the middle section of the Mangare Stream	2003/04, 2004/05, 2005/06, 2007/08, 2009/10, 2011/12.	2011/12
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, 2010/11, 2011/12, 2012/13	✓
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, 2010/11, 2011/12, 2012/13	✓

N/A = not applicable.

3.3.2 Riparian characteristics

No riparian characteristics data were collected in the 2012/13 monitoring period in the Mangare catchment. Refer to Littler et al., (2013) for the most recent results.

3.3.3 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 1 km. The loggers have collected annual summer data for 10 weeks from 1 January, between 2006/07 and 2012/13 inclusive. The average of the daily maximum water temperature is derived to produce a single temperature for each site. The upstream temperature is then subtracted from the downstream temperature to provide a temperature difference for the monitored section of the river.

The daily average upstream and downstream maxima were 21.07 and 19.88°C respectively. Refer to Table 14 in Appendix 1 for annual upstream and downstream temperatures.

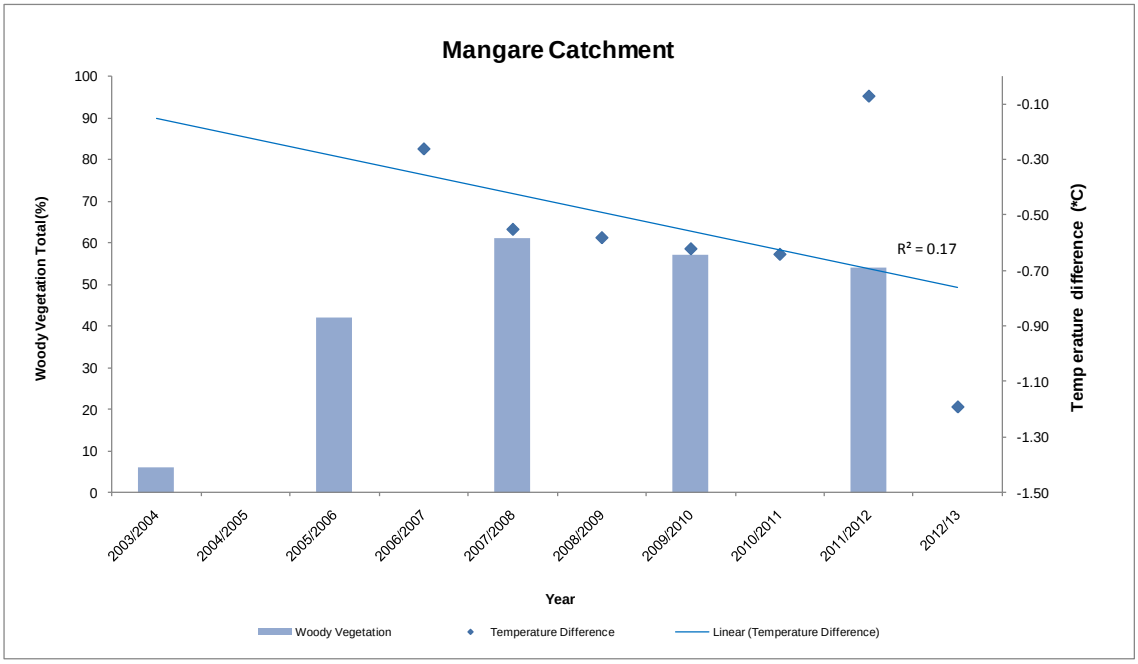

Figure 6: Woody vegetation total (%) and temperature difference (°C) in the Mangare Catchment.

Figure 6 indicates that downstream temperature has been cooler than the upstream temperature for all years of assessment, because the temperature difference is always negative. In 2011/2012 the temperature difference was small (Figure 6), this occurred during an exceptionally cool summer. It is anticipated that the low overall water temperature has resulted in less cooling from vegetative shading, resulting in a departure from the overall trend. A longer data set may provide us with more insight into ongoing trends.

3.3.4 Photo points

No photos were collected in the 2012/13 monitoring period in the Mangare catchment. Refer to Littler et al., (2013) for the most recent results and comparisons.

3.3.5 Stream ecological health

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.

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 - 5.3 m in width with the substrate predominantly consisting of large gravel. The stream between the upstream and downstream site is now significantly shaded by willows, however further upstream the canopy is still open.

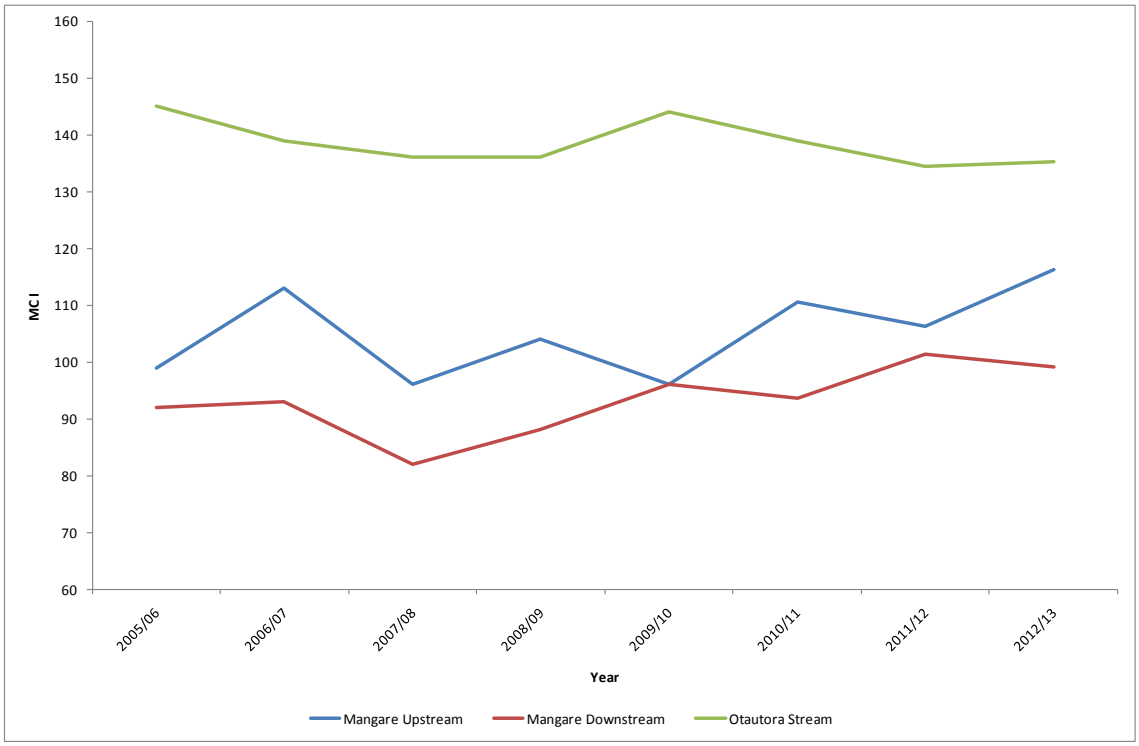

Figure 7 displays the MCI values as calculated for the upstream and downstream sampling sites in the Mangare Stream. Samples are taken between January and March every year. The upstream site is hard bottom and the downstream site is soft bottom. Refer to Table 24 in Appendix 3 for more detail.

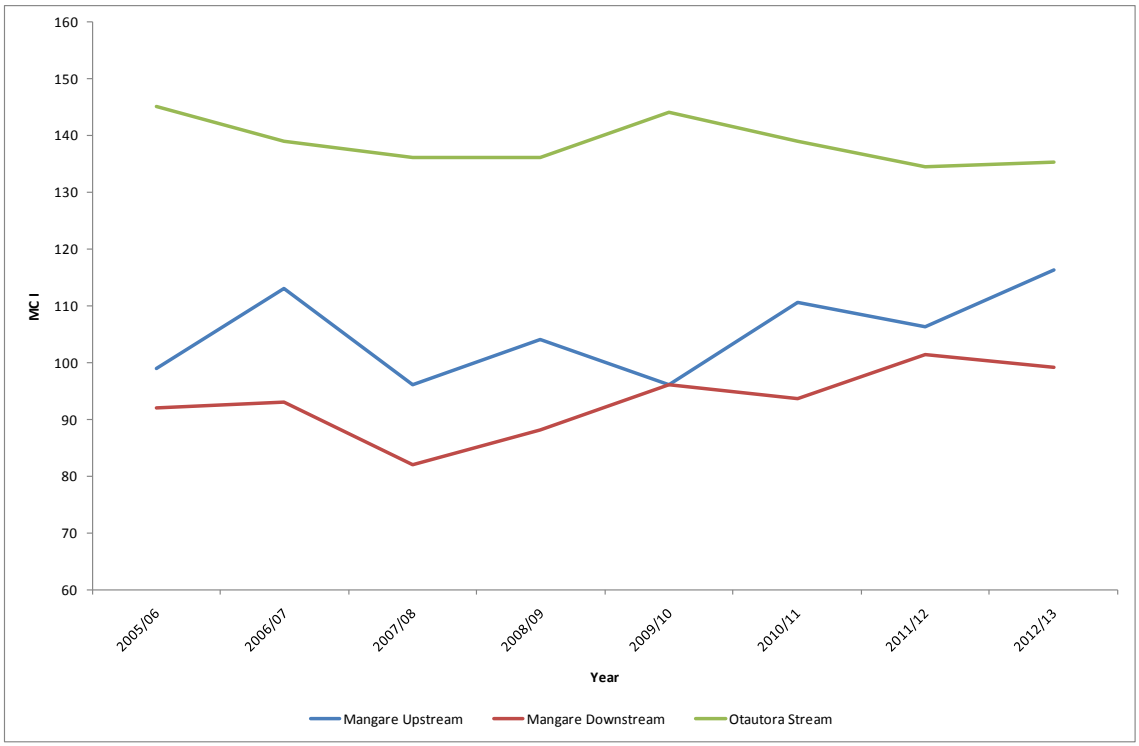

Figure 7: MCI values for the upstream and downstream sites on the Mangare Stream and nearby reference site on the Otautora Stream.

In the vicinity of the two sampling sites in the Mangare Stream, the presence and abundance of identified invertebrate species and associated MCI scores at the upstream site indicate that this stream has a moderate to mild degradation in ecological health (Wright-Stow & Winterbourn, 2003) (Figure 7). The downstream MCI is lower than the upstream MCI value (Figure 7). The Otautora Stream (site number 1888.4) has been included, in Figure 7, as a pristine reference site to compare the MCI values

from the Mangare Stream. The Otautora stream always has a higher MCI index than the Mangare Stream. For more information on the monitored streams see Appendix 3.

3.3.6 Main points

Riparian Characteristics

- No riparian characteristics data were collected in the 2012/13 monitoring period.

Water Temperature

- The downstream temperature has been slightly cooler on average than the upstream temperature.
- Shading has increased for the assessed stream reach, but the water temperature is unlikely to reflect this improvement for a number of years. There is still limited shading upstream of the monitored reach.

Stream Ecological Health

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

3.4 Tahunaatara catchment

3.4.1 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). This report contains monitoring completed by the end of the 2012/13 financial year.

Table 7: Upper Waikato zone monitoring completed by 2012/13.

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, 2010/11, 2011/12, 2012/13	✓
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, 2010/11, 2011/12, 2012/13	✓

N/A = not applicable.

3.4.2 Water temperature

Water temperature loggers are deployed in the middle section of the Pokaitu Stream, with a distance between them of approximately 5 km. To date, the temperature data for 10 weeks from 1 January, have been recorded between 2003/2004 and 2012/13 inclusive. The average of the daily maximum water temperatures is derived to produce a single temperature for each site. The upstream temperature is then subtracted from the downstream temperature to provide a temperature difference for the monitored section of the river.

The daily average upstream and downstream maxima were 16.17°C and 16.87°C respectively. Refer to Table 15 in Appendix 1 for annual upstream and downstream temperatures.

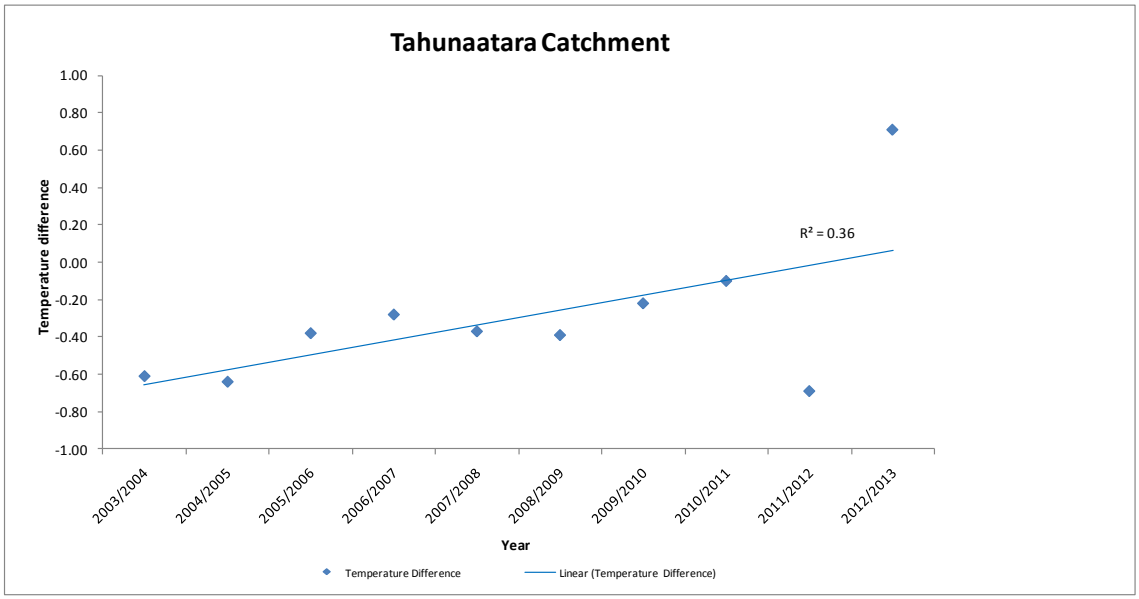

Figure 8: Temperature difference (downstream-upstream temperature) observed in the Tahunaatara Catchment (2003-2013).

Prior to 2012/2013 the downstream section was cooler than the upstream section, with a trend towards decreasing temperature difference. However, for the 2012/2013 reporting period the upstream section was cooler than the downstream section (Figure 8). Historically, visual observations suggest that shading of the stream has been sparse and sporadic. The decreasing temperature difference until 2010/2011 was attributed to the clearance of pines reducing the shading along the monitored stretch of the stream. The increased temperature difference evident in 2011/2012 may be attributable to regeneration of the vegetative cover, post clearance. However, the 2012/13 assessment period showed more changes occurring, and the upstream temperature is now lower than the downstream temperature (Figure 8). This could be due to clearance of trees along a 5 km stretch of the stream.

3.4.3 Photo points

No photos were collected in the 2012/13 monitoring period in the Tahunaatara catchment. Refer to Grant et al., (2009b) for the most recent results and comparisons.

3.4.4 Stream ecological health

Invertebrate sampling is conducted at one location in the Pokaitu Stream under the southern Apirana Road Bridge (where the downstream temperature probe is deployed). From this invertebrate sampling macroinvertebrate community index (MCI) is calculated. The initial year of assessment was in 2003/04, with subsequent assessments completed annually between January and March.

The dominant surrounding land use in the vicinity of the sampling site is pastoral. The stream is 3 - 6.6 m in width with the substrate predominantly consisting of large gravel.

The canopy cover is open. Figure 9 illustrates the MCI values as calculated for the Pokaitu Stream sampling site. Refer to Table 23 in Appendix 3 for more detail.

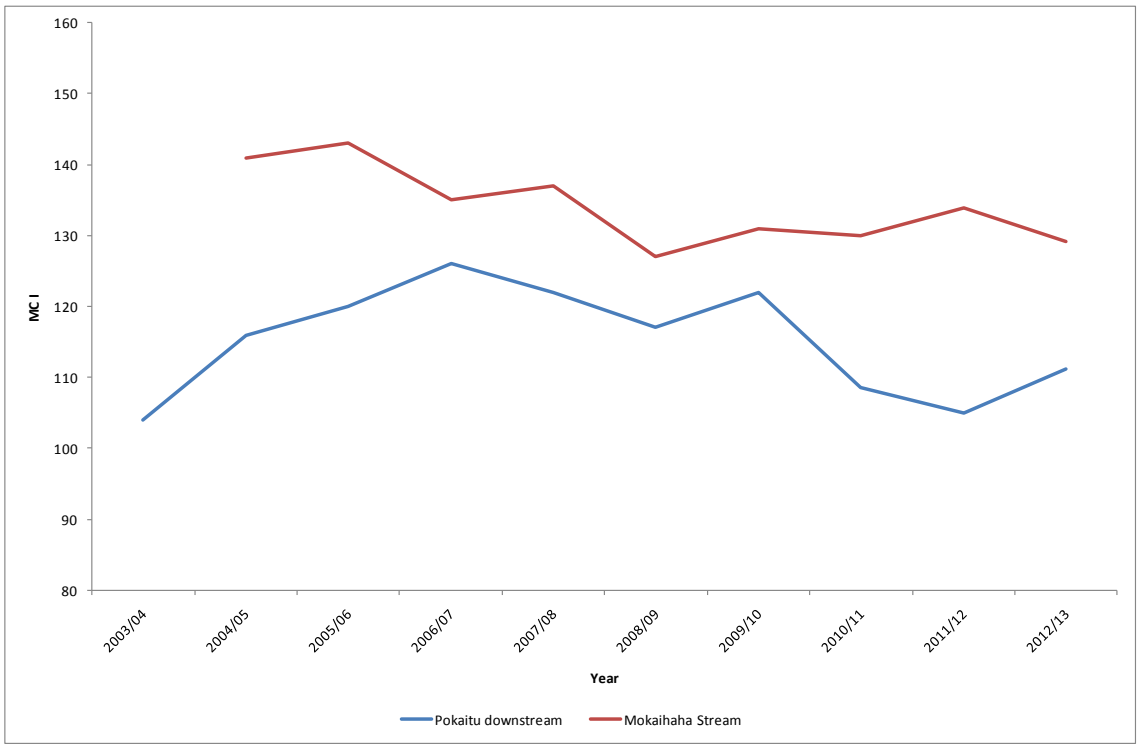

Figure 9: MCI values at the downstream site in the Pokaitu Stream (Tahunataara catchment) and nearby reference site in the Mokaihaha Stream.

The presence and abundance of identified invertebrate species in the vicinity of the sampling site and associated MCI scores, indicate that the stream has mild degradation of ecological health (Wright-Stow & Winterbourn, 2003). The Mokaihaha Stream (site number 555.2) has been included, in Figure 9, as a pristine reference site to compare the MCI values from the Pokaitu Stream. The reference site always has a higher MCI than the Poakaitu Stream (Figure 9). For more information on the monitored streams see Appendix 3.

3.4.5 Main points

Water Temperature

- The downstream temperature has been cooler on average than the upstream temperature for all assessed summers until 2012/13. During the 2012/13 assessment period the upstream temperature was cooler than the upstream temperature.

Photo points

- A decrease in the temperature difference may indicate a decrease in the vegetative cover along the stream.

Stream Ecological Health

- Assessments of the invertebrates in Pokaitu Stream indicate that the stream has mild degradation in terms of ecological health.

4 Waipā zone

4.1 Introduction

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

4.2 Mangatutu catchment

4.2.1 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). This report contains monitoring completed by the end of the 2012/13 financial year.

Table 8: Waipā zone monitoring completed by 2012/13.

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, 2010/11, 2012/13	✓
Photo points	Complete assessment along the lower section of the Mangatutu sub-catchment	2004/05, 2006/07, 2008/09, 2010/11, 2012/13	✓
Permanent suspended sediment sampling site	Event driven sampling	Ongoing since June 2004	✓
Suspended sediment snapshots	Low flow snapshot	2004	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, 2010/11, 2011/12, 2012/13	✓
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, 2010/11, 2011/12, 2012/13	✓

N/A = not applicable.

4.2.2 Riparian characteristics

Introduction

Seven 1 km samples were selected for assessment through the lower section of the Mangatutu sub-catchment with four of the samples on the Mangatutu Stream and three on the tributaries (two on the Mangawhara Stream and one on an unnamed tributary of the Paraheka Stream). The assessments on the Mangatutu Stream are at locations where Waikato Regional Council funded river management and soil conservation works are scheduled, where stream riparian margin access is possible and where landowner participation is forthcoming. Those on tributaries of the Mangatutu Stream provide for greater geographic spread within the Mangatutu sub-catchment, therefore wider representation of riparian characteristics will be measured. The initial assessment was conducted during the 2004/05 summer with the most recent assessment completed in 2012/13.

The reported data for each parameter represent a percentage of the total assessed riparian margin in the catchment. Tabled summary riparian assessment data are located in Appendix 2.

The following summary data was collected where riparian soil conservation has been recently implemented, or is planned for the Mangatutu catchment. Erosion, vegetation and fencing data summaries are presented in Figures 10, 11, 12 and 13.

Vegetation

Riparian vegetation contributes to stream bank stability and 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 10 shows that during the current reporting period (2012/13) 47% of the riparian margin is grass. The remaining 53% is woody vegetation, of which 1% of the total length is native, 23% is willow and 28% is other exotic species. The length of riparian margin containing willows has increased from 6% of the total length in 2004/05 to 23% in the most recent survey; while other woody exotic vegetation and grass have decreased (Figure 10).

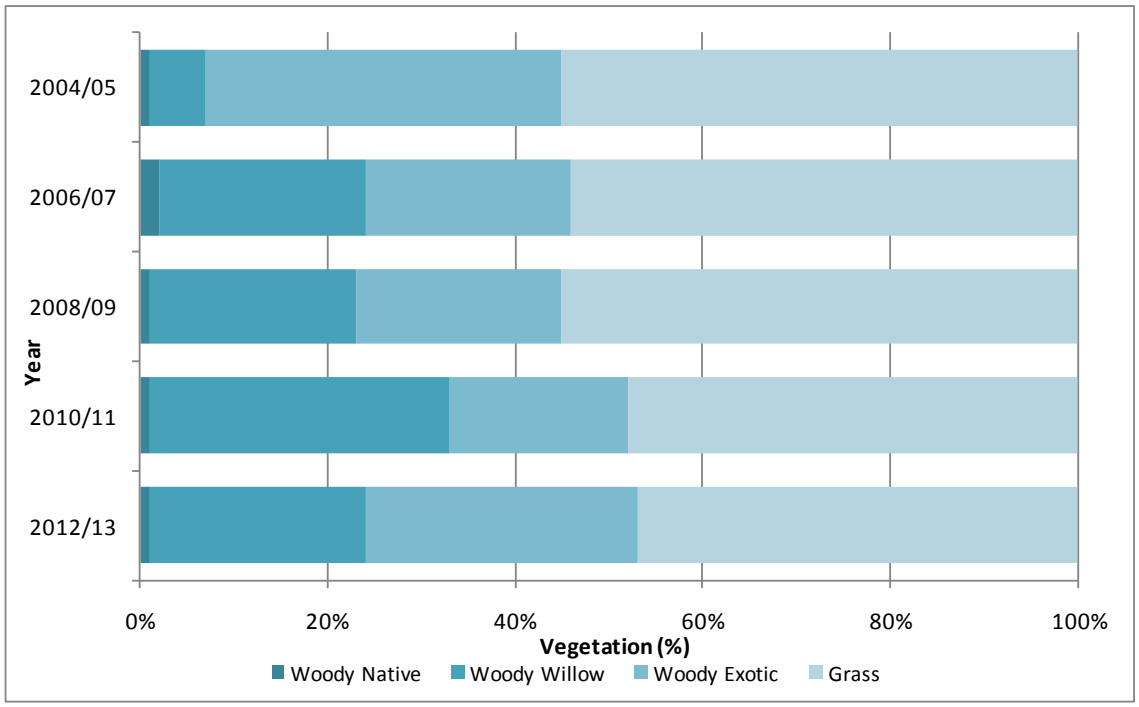

Figure 10: Mangatutu Catchment riparian vegetation by bank length (%).

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, damage to the stream ecology by trampling of the stream bed and indirectly reduces sediment load from stock trampling the banks.

Figure 11 indicates that for the 2012/13 reporting period stock is excluded from both sides for 75% of the waterway, from one side for 17% of the waterway and are not excluded either side for 8% of the waterway. The length of stream bank unfenced on both sides has decreased (from 32%) since the 2004/05 assessment (Figure 11).

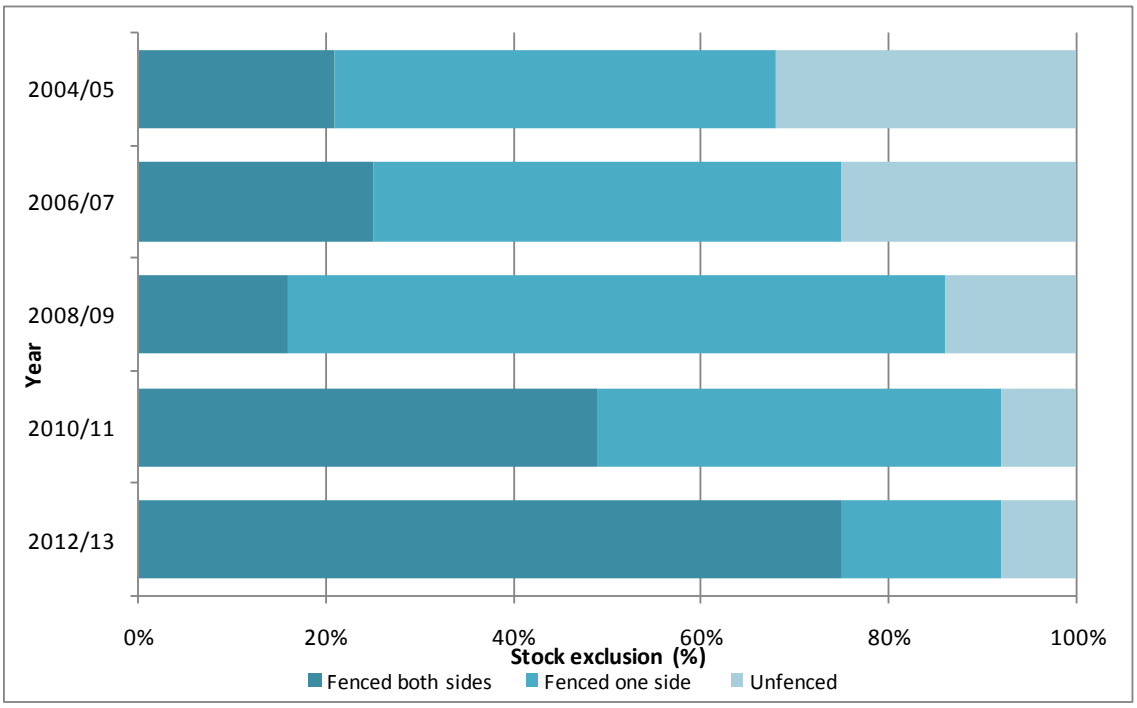

Figure 11: Mangatutu Catchment stock exclusion by bank length (%).

There has been an increase in fencing over the total stream bank length since the baseline assessment, from 45% to 83% (Figure 12). In 2012/13 The proportion of stream bank that is fenced off and has woody vegetation has increased from 24% to 49% of the total length since reporting began in 2004/05. Unfenced woody vegetation now occupies only 4% of the total stream bank length (Figure 12).

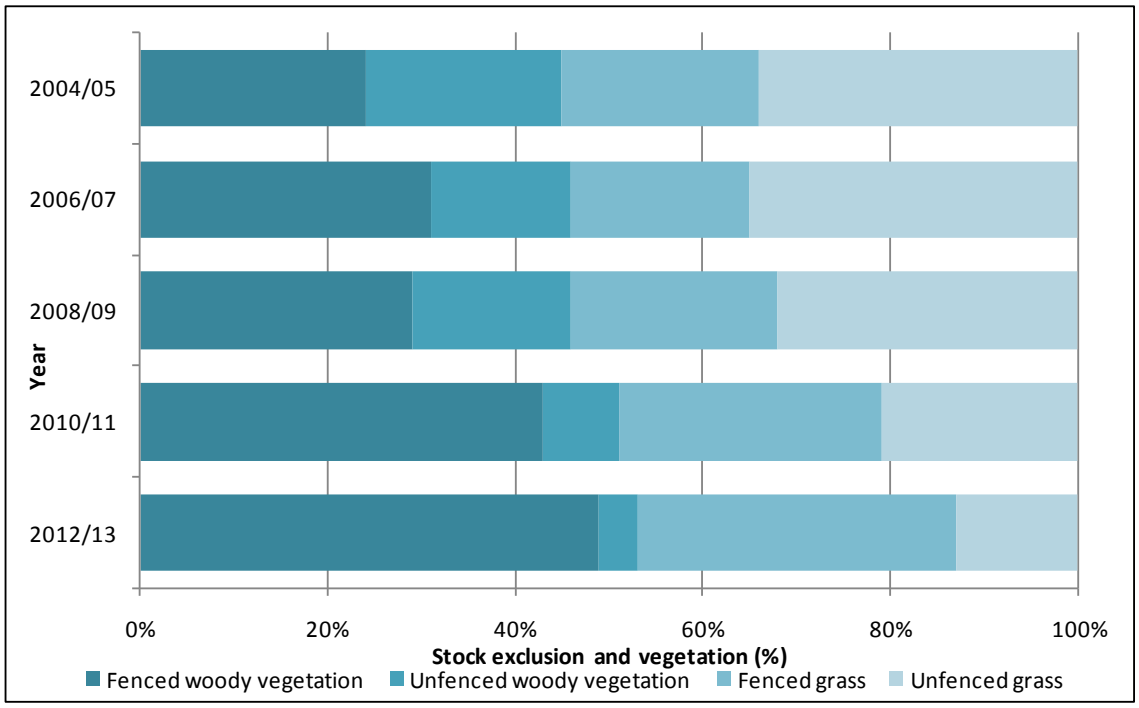

Figure 12: Mangatutu Catchment bank length fencing and vegetation combinations (%).

Stream bank stability

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

In the 2012/2013 survey an estimated 90% of the assessed riparian bank length is considered stable, up from the 57% measured in the 2004/05 assessment (Figure 13). The remaining 10% is unstable. Grass vegetation is present on 90% of the total unstable bank length (Figure 13).

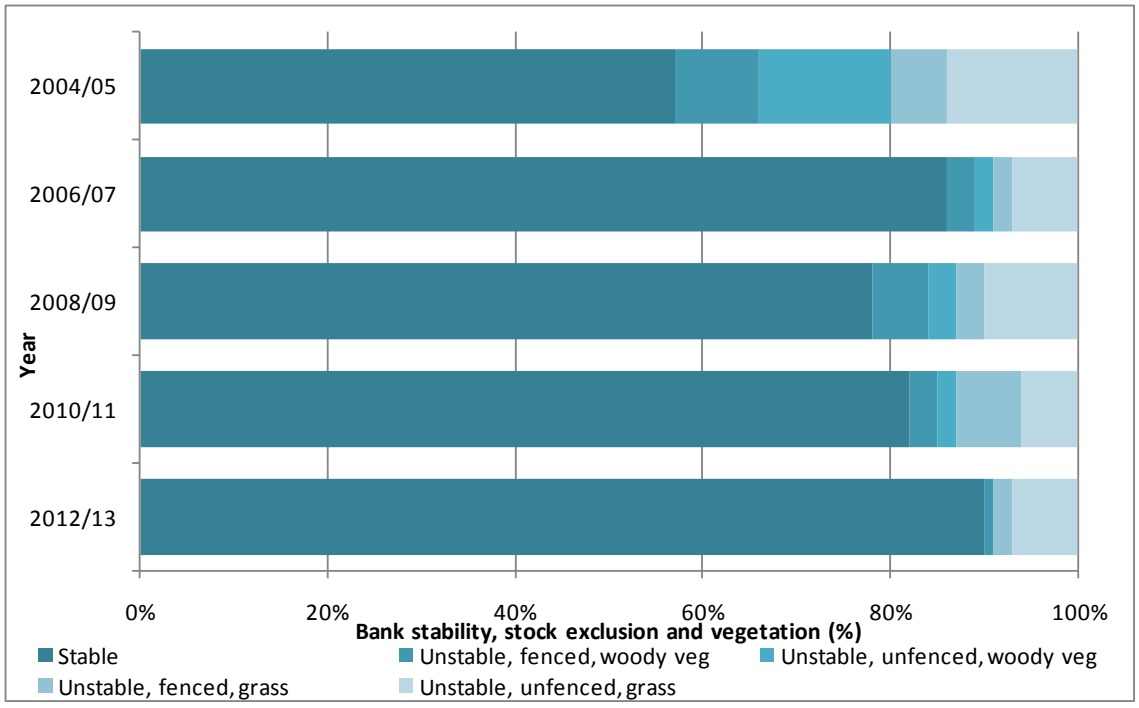

Figure 13: Mangatutu Catchment stream bank stability (%).

4.2.3 Water temperature

Due to its length (18km) and differences in character and management between the upper and lower sections of the stream three water temperature loggers are deployed along the monitored section of the Mangatutu 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 ten deployments have been made with data collected, for 10 weeks from 1 January, for the summers between 2003/04 and 2012/13. 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 summers' results.

The average of the daily maximum water temperature is derived to produce a single temperature for each site. The upstream temperature is then subtracted from the downstream temperature to provide a temperature difference for the monitored section of the river. The daily average upstream, midstream and downstream maximums were 20.51°C, 21.67°C, and 19.66°C respectively. Refer to table 16 in Appendix 1 for more detail.

Figures 14,15 and 16 show that shading of the Mangatutu Stream remains sporadic between the temperature monitoring sites however this level of shading is expected to increase over the long term as new plantings mature. For the entire reporting period the midstream sampling section has been warmer than the upstream section (Figure 14). However, with the exception of 2010/11 period the downstream section has always been cooler than the midstream section (Figure 15). Generally, in the monitored region of the stream there is a warming effect in the upper section compared with a cooling effect in the lower section. For the total monitored length (upstream versus downstream), stream temperature is typically lower upstream than downstream (Figure 16). Only the data from the 2007/08 and 2012/13 summers have shown the downstream temperature to be cooler than the upstream temperature. However more data would provide a better insight into ongoing trends. We expect that as existing vegetation combined with establishment and growth of any new plantings, shading will increase and result in a larger temperature difference between the upstream to downstream monitoring sites.

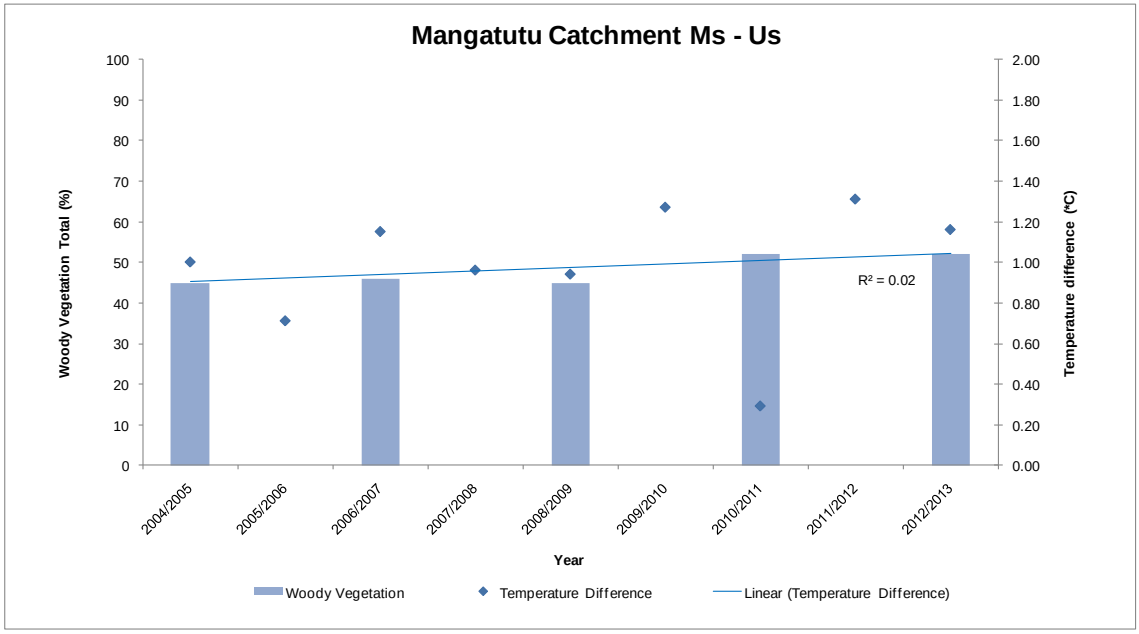

Figure 14: Woody vegetation total (%) and temperature difference (°C) in the Mangatutu Catchment midstream minus upstream temperature.

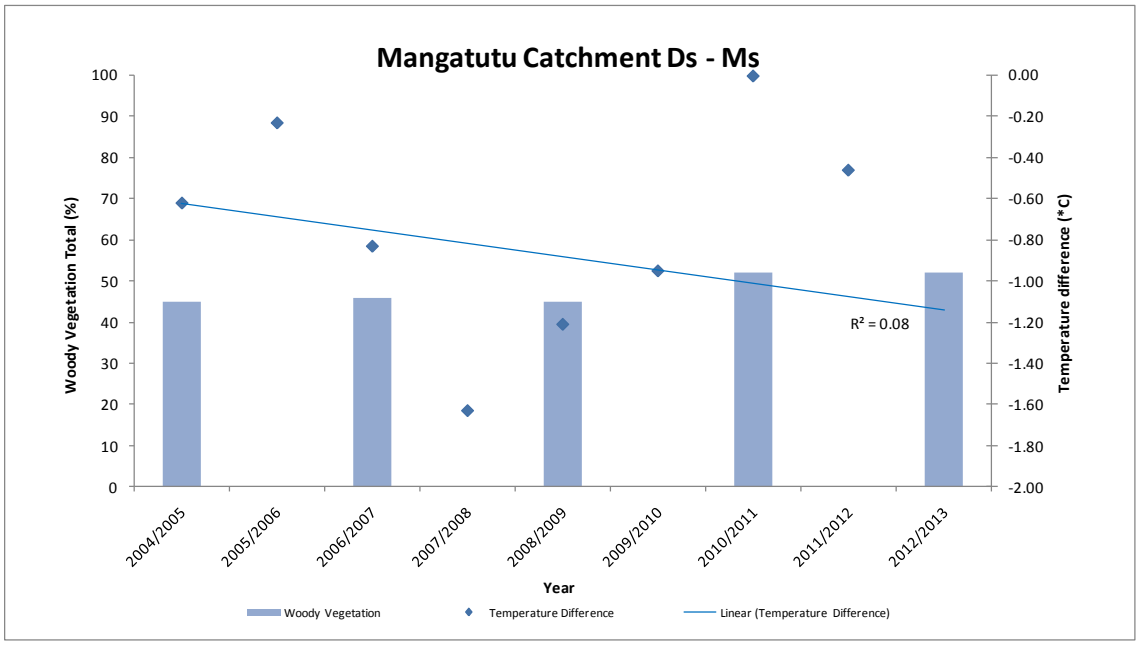

Figure 15: Woody vegetation total (%) and temperature difference (°C) in the Mangatutu Catchment downstream minus midstream temperature.

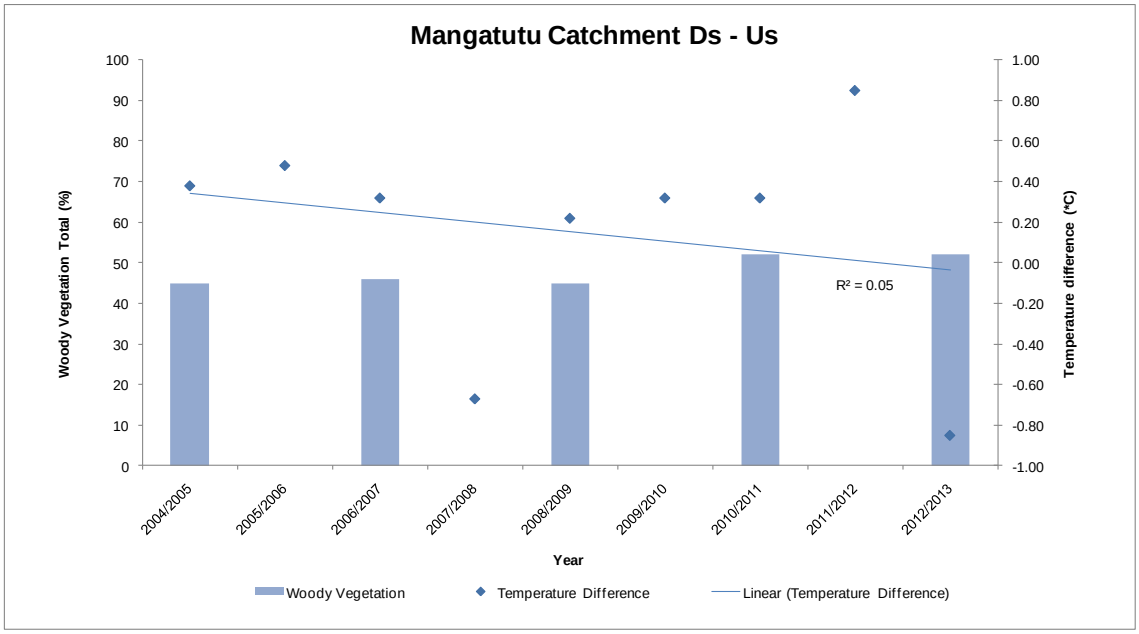

Figure 16: Woody vegetation total (%) and temperature difference (°C) in the Mangatutu Catchment downstream minus upstream temperature.

4.2.4 Photo points

Photo assessments have been completed along the Mangatutu Stream in 2004/05, 2006/07, 2008/09, 2010/11 and 2012/13. Seven 1000 m samples were assessed along the stream totalling 35 photos, at 250 m intervals, for the Mangatutu catchment over a total distance of 7000 m. Sections of the stream have shown improvements due to soil conservation planting. Other sections which have been fenced are covered in rank grass (Figure 17).

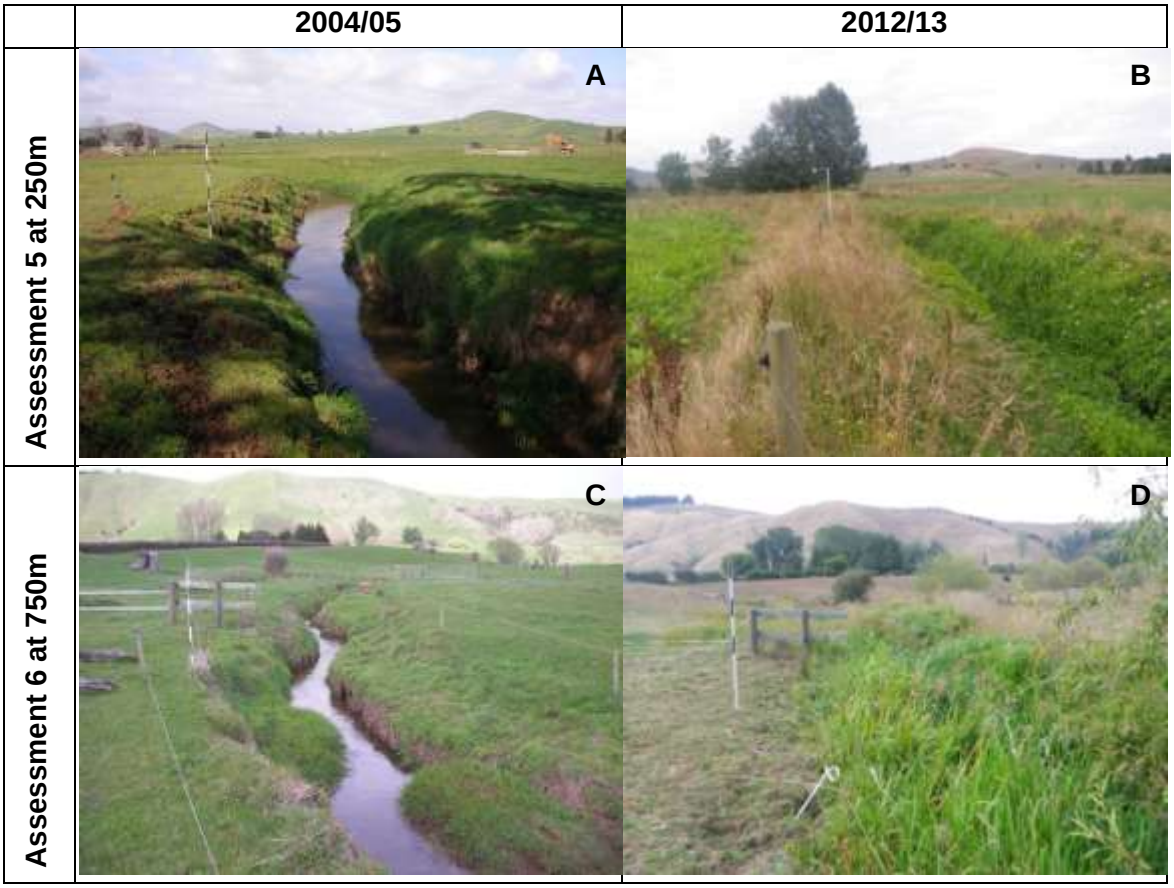

Figure 17: Mangatutu Stream photo point examples of visual change between 2004/05 and 2012/13, for assessment 5 at 250 m (A and B) and assessment 6 at 750 m (C and D).

4.2.5 Suspended sediment

A permanent suspended sediment sampling site has been in place at Walker Road Bridge on the Mangatutu Stream since June 2004. During this time 47 events have been sampled using an automatic sediment sampler. The data set is analysed to estimate sediment variables (Table 9). Data includes all results up until 31/12/2012. 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) and *Sampled Suspended Sediment Yields from the Waikato Region* (Hoyle et al., 2011). A low flow snapshot was taken in 2004, with results described in Hill et al., (2006).

Table 9: 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 – 31/12/2012	N/A
Sediment Samples		22/06/2004 – 8/06/2010	959
ISCO Period of Record		22/06/2004 – 8/06/2010	47 events

Specific yield ($t/km^2/yr$)	Average sediment yield (kt/yr)	% of sediment yield in gauged range of flow	% Error in Yield Estimate
43	5.3	42.1	3.4

The Mangatutu Stream has an estimated specific yield of 43 $t/km^2/yr$ and an average total sediment yield of 5.3 kt/yr (Table 9). Figure 18 shows the specific sediment yield for the Mangatutu Stream relative to other monitored sites in the Region. The specific yield for the Mangatutu Stream can be considered moderate relative to other sites in the region. The dominant geology (comprising welded ignimbrite and overlying tephras) is the likely reason for this moderate specific sediment yield value (Figure 18).

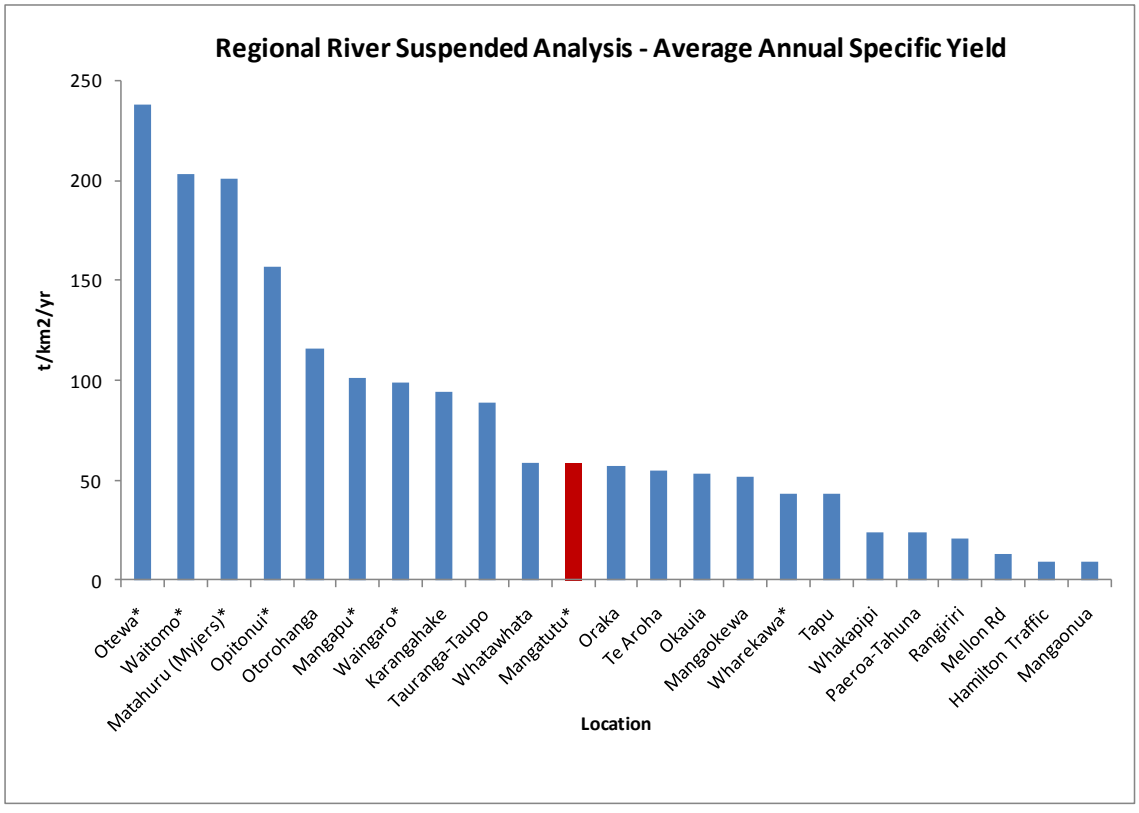

Figure 18: Average specific suspended sediment yield (t/km^2) for monitored rivers in the Waikato Region, the Mangatutu Stream site is highlighted in red.

4.2.6 Stream ecological health

Invertebrate sampling is conducted in the Mangatutu Stream immediately upstream of the Walker Road Bridge, near the downstream temperature logger. From this invertebrate sampling macroinvertebrate community index (MCI) is calculated. The initial year of assessment using these methods was in 2004/2005 with subsequent assessments completed annually between January and March.

The dominant surrounding land use in the vicinity of the sampling site is pastoral. The stream is 4 - 11.2 m in width with the substrate predominantly consisting of large to small gravel. The canopy cover is partly shaded although the removal of nuisance riparian willow will, in the short term, reduce canopy cover. Figure 19 displays the MCI values as calculated for the Mangatutu Stream sampling site. Refer to Table 22 in Appendix 3 for more detail.

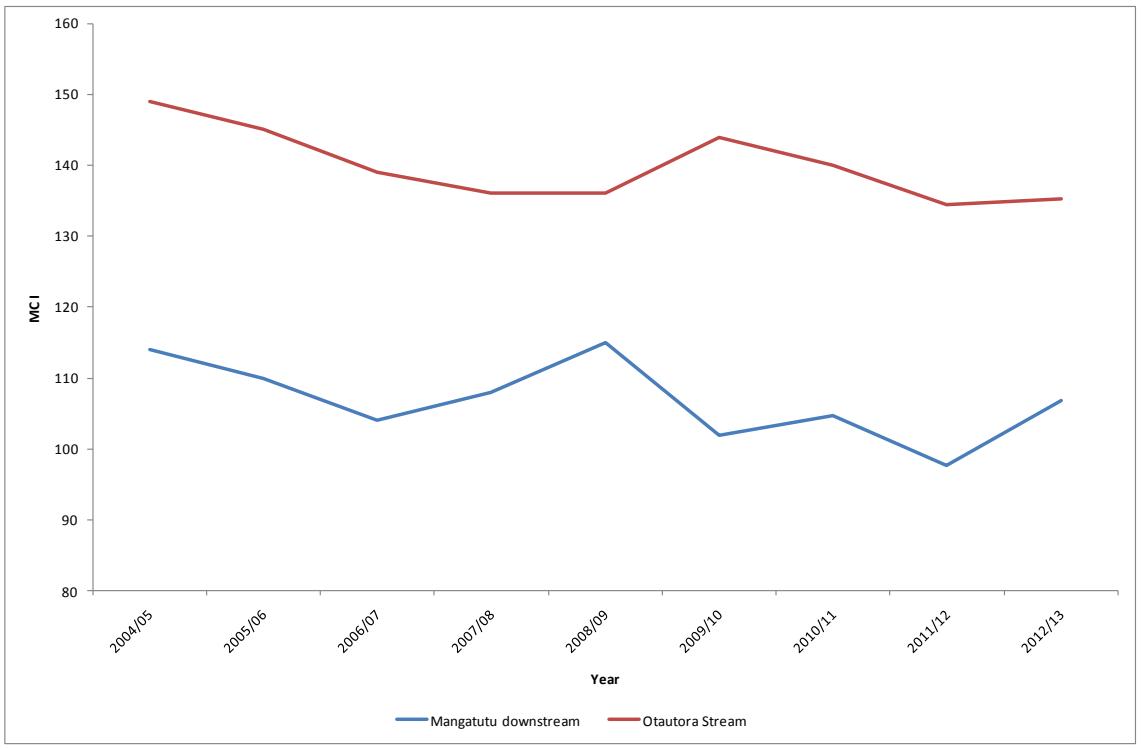

Figure 19: MCI values for the sampling site in the Mangatutu Stream and nearby reference site in the Otautora Stream.

The presence and abundance of identified invertebrate species in the vicinity of the sampling site in the Mangatutu Stream and associated MCI scores, indicate that the ecological health of the stream is considered to be mildly degraded. (Wright-Stow & Winterbourn, 2003) (Figure 19). The MCI values for the downstream site on the Mangatutu show a declining trend overall (Figure 19). The Otautora Stream (site number 1888.4) has been included, in Figure 19, as a pristine reference site to compare the MCI values from the Mangatutu Stream. The MCI for the reference site is always higher than the Mangatutu Stream (Figure 19). For more information on the monitored streams see Appendix 2.

4.2.7 Main points

Riparian Characteristics

- The proportion of grass and woody vegetation has remained relatively similar between the 2004/05 and 2012/13 assessments. Woody vegetation covers 53% of the riparian margin, of which 1% of the total length is native, and 52% is exotic (including willows).
- There has been an increase in fencing over the total stream bank length from 45% in 2004/05 to 83% in the most recent survey (2012/13).
- The proportion of stream bank that is fenced off with woody vegetation has increased from 24% to 49% of the total stream bank length over the eight years separating the assessments. The length of unfenced grass has decreased to 13% of the stream bank length.
- An estimated 90% of the assessed riparian bank length was considered stable during the current reporting period, up from 57% in 2004/05.
- Out of the total unstable length of stream bank, grass is currently the predominant vegetation covering 90%.
- Photo assessments have shown some changes since 2004/05 to areas where soil conservation plantings have occurred and where rank grass has grown.

Suspended sediment monitoring

- The specific yield for the Mangatutu catchment above Walker Road Bridge is 43 t/km^2/yr after five years of sampling.
- A low flow snapshot was taken in 2004, with results described in Hill et al., (2006).

Water Temperature

- Water temperature has been monitored annually since 2004/05. With the exception of the 2007/08 and 2012/13 monitoring periods, the downstream site has recorded warmer temperatures than the upstream site. This is expected to improve as soil conservation plantings grow and shade the water. A longer monitoring period is required before a trend can be identified.

Stream Ecological Health

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

4.2.8 Other monitoring

Automatic sediment samplers are installed on the Upper Waipa River (at Otewa) and the Waitomo Stream to monitor suspended sediment in the Waipa zone. The Mangapu Stream has had an automatic sampler in the past. For more detailed information refer to the *Suspended Sediment Monitoring Report* (Kotze et al., 2008) and *Sampled Suspended Sediment Yields from the Waikato Region* (Hoyle et al., 2011). *Mangatutu Stream Ecological Monitoring Results – 2004 to 2007* has been completed by Gibbs (2008) as a Waikato Regional Council Internal Series report, and can be accessed internally on DOC #1212429 or by contacting Waikato Regional Council. This report describes the changes in ecological health in the Mangatutu Stream resulting from the soil conservation work which has occurred since 2004.

5 Coromandel zone

5.1 Introduction

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

5.2 Wharekawa catchment

5.2.1 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). This report contains monitoring completed by the end of the 2012/13 financial year.

Table 10: Coromandel zone monitoring completed by 2012/13.

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, 2010/11, 2012/13	2012/13
Photo points	Complete assessment along the monitored section of the Wharekawa River	2006/07, 2008/09, 2010/11, 2012/13	2012/13
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, 2010/11, 2011/12, 2012/13	✓
Stream ecological health	Assess stream ecological health along the Wharekawa River	2004/05, 2006/07, 2007/08, 2008/09, 2009/10, 2010/11, 2011/12, 2012/13	✓

N/A = not applicable.

5.2.2 Riparian characteristics

Introduction

Four 1 km and one 500 m samples were selected through the lower section of the Wharekawa River. The assessments on the Wharekawa River are at locations where Peninsula Project funded river management and soil conservation 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 2006/07 summer with the most recent assessment completed in 2012/13. Just prior to the 2008/09 assessment willow removal took place at some sections of the river, decreasing the length of stream bank with woody vegetation, and increasing the level of erosion.

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 2.

The following summary data was collected where riparian soil conservation has been recently implemented, or is planned for the Wharekawa catchment. Erosion, vegetation and fencing data summaries are presented in Figures 20, 21, 22 and 23.

Vegetation

Riparian vegetation contributes to stream bank stability and 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 19 shows that during the current assessment year 9% of the riparian margin is grass, the remaining 91% is woody vegetation, of which 67% of the total length is native, 8% is willow and 16% is exotic other. The length of the riparian margin in grass has increased by 7%; associated with a corresponding 7% decrease in riparian woody vegetation since data was first collection in the 2006/07 reporting period (Figure 20).

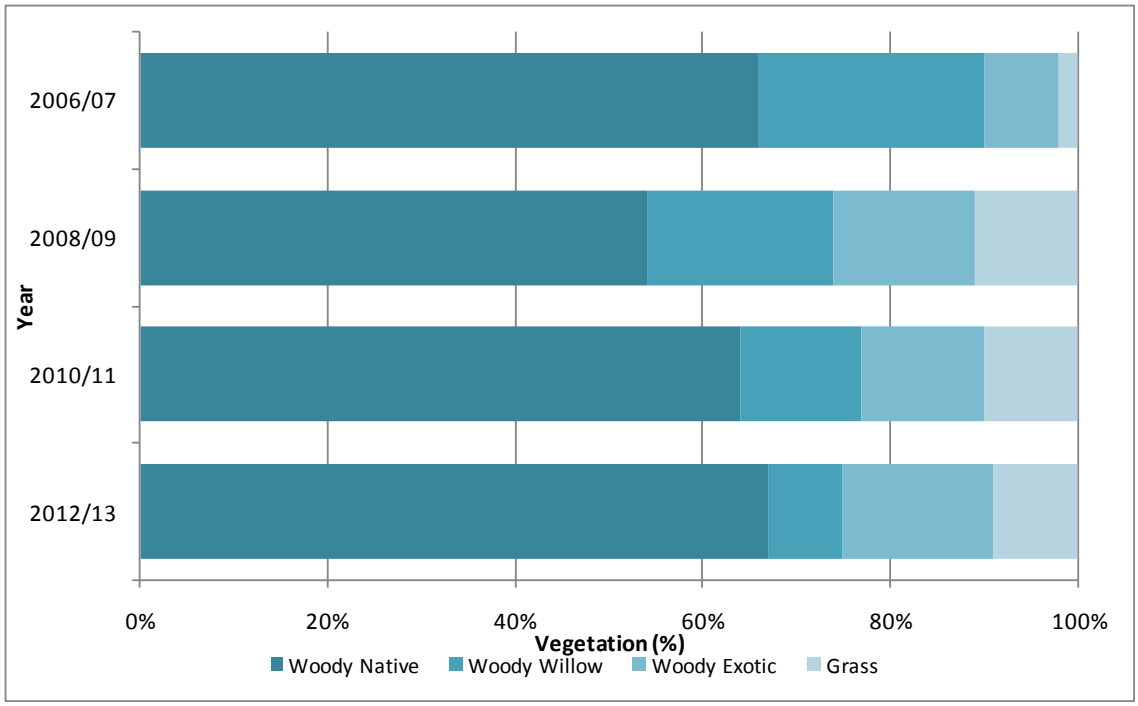

Figure 20: Wharekawa Catchment riparian vegetation by bank length (%).

Fencing

The amount of fencing on one 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.

Currently, stock is excluded from both sides for 96% of the waterway, leaving 4% of the waterway only fenced on one side (Figure 21). There has been a considerable increase in the length of stream fenced on both sides since the 2006/07 assessment (Figure 21).

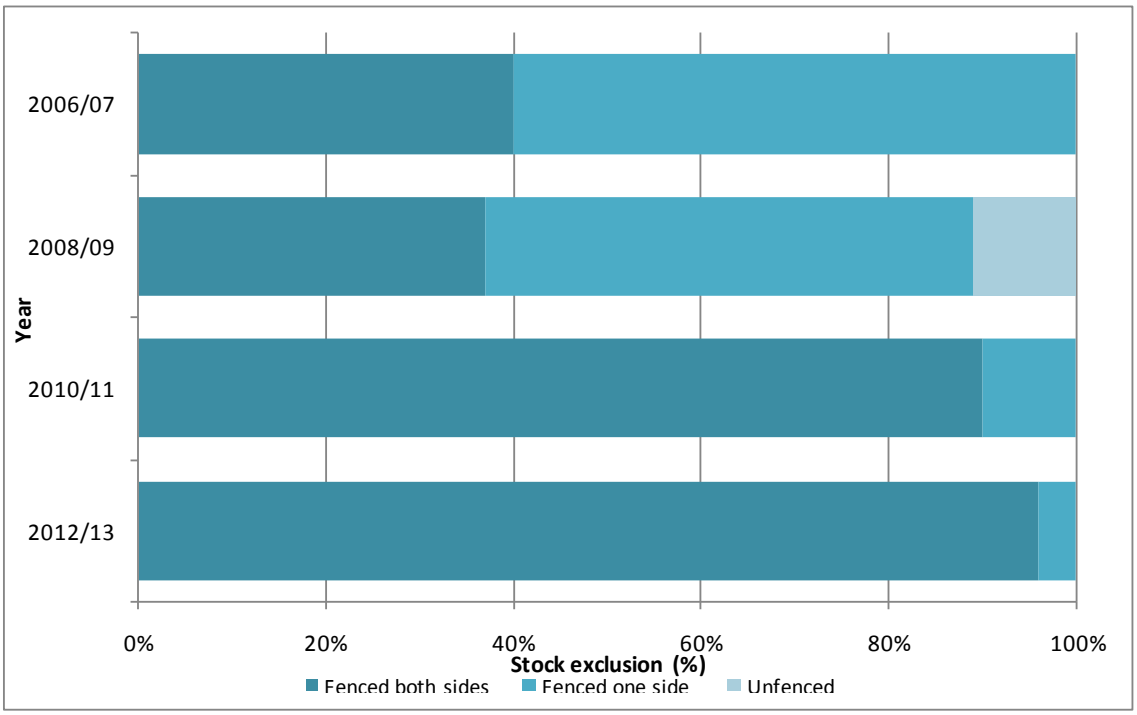

Figure 21: Wharekawa Catchment stock exclusion by bank length (%).

There has been an increase in fencing over the total stream bank length since the baseline assessment in 2006/07, from 70% to 98% (Figure 22). 91% of the total fenced bank length is comprised of woody vegetation (Figure 22). The proportion of stream bank that is fenced off and has woody vegetation has increased from 70% to 89% of the total length since the 2006/07 assessment (Figure 22).

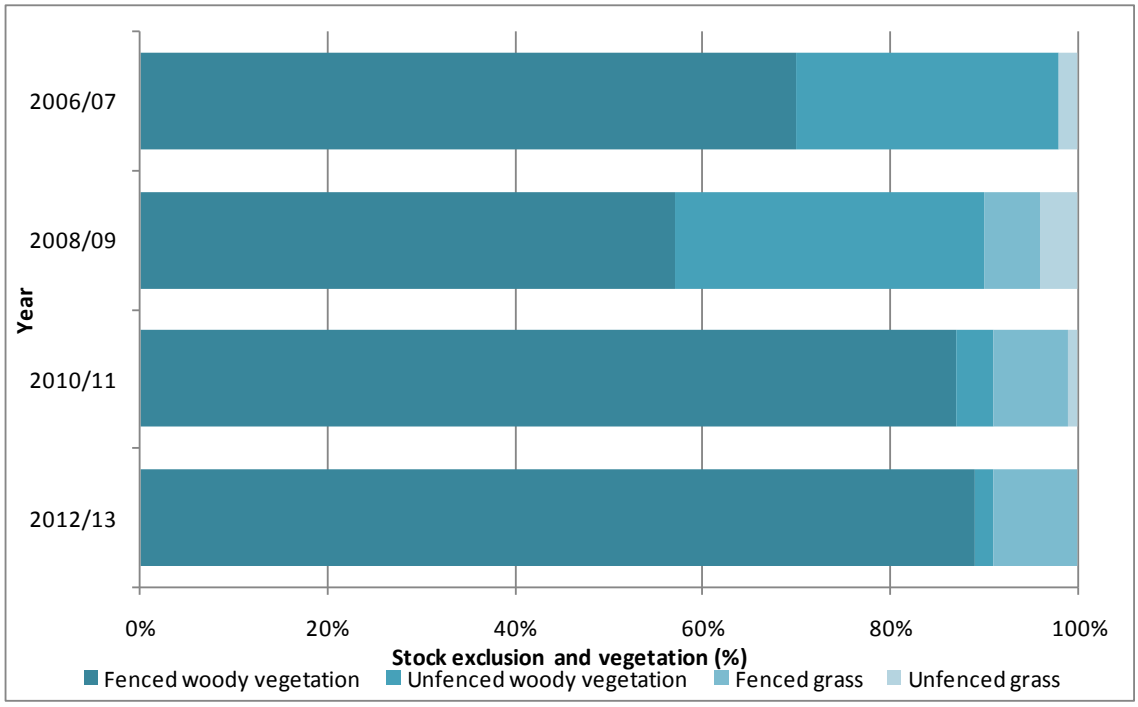

Figure 22: Wharekawa Catchment bank length fencing and vegetation combinations (%).

Stream bank stability

Stream bank stability is measured because 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 91% of the assessed riparian bank length is considered stable, which is the same as that measured in the 2006/07 assessment (Figure 23). The remaining 10% is unstable. The unstable portion of the stream bank is fenced (Figure 23).

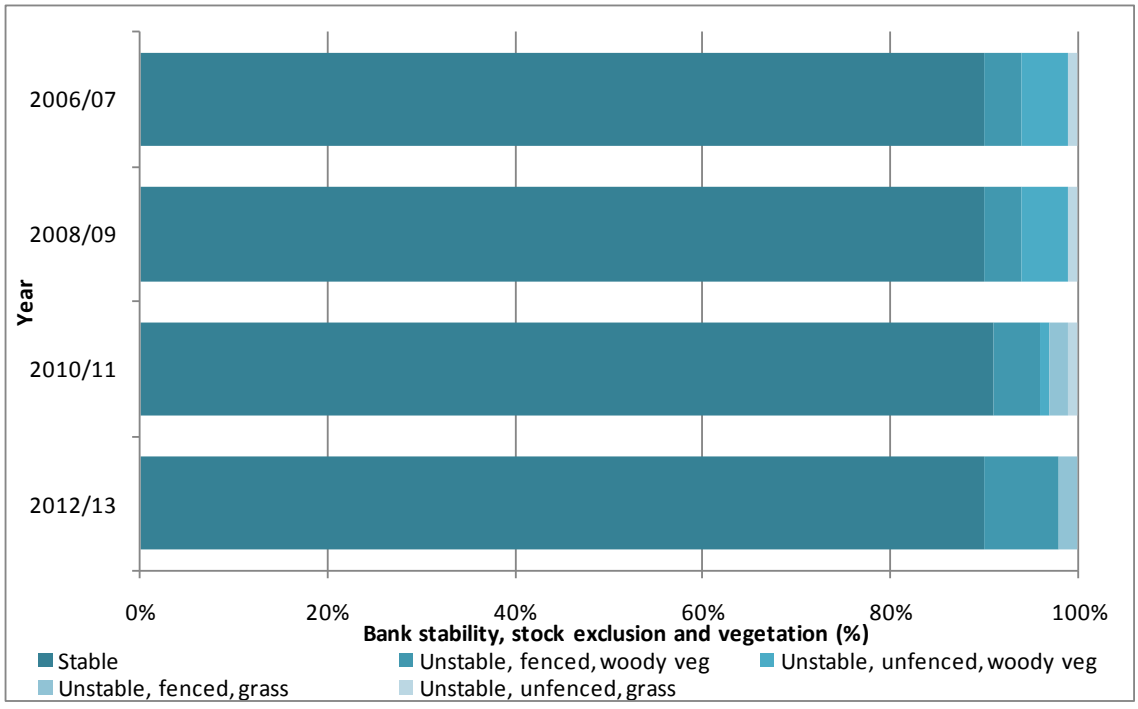

Figure 23: Wharekawa Catchment stream bank stability (%).

5.2.3 Water temperature

Three 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 3.5 km further upstream, near where the river emerges from the forest. The midstream logger is approximately 1 km downstream of the upstream logger. Seven deployments have been made with data collected for 10 weeks from 1 January for all summers from 2006/07, until 2012/13 inclusive.

During the summers of 2009/10 and 2011/12 the logger deployed at the upstream site was swept away, therefore there is no data during this period. The temperatures recorded at the Waikato Regional Council hydrology site (midstream logger) downstream from the upstream site have been used to compensate for this missing data. The average of the daily maximum water temperatures is derived to produce a single temperature for each site. The upstream temperature is then subtracted from the downstream temperature to provide a temperature difference for the monitored section of the river. The 2012/13 daily average upstream, midstream and downstream maximums were 22.46ºC, 21.61 ºC and 22.27 ºC respectively. Refer to Table 17 in Appendix 1 for more detail.

Figures 24 to 26 show the relationship between the temperature difference and the woody vegetation cover over the entire measurement period between the upstream to midstream, midstream to downstream and upstream to downstream temperature loggers. It can be noted that in general the water temperature cools between the upstream and midstream loggers (Figure 24), and warms again between the midstream and downstream loggers (Figure 25). The exception is the 2010/11 assessment period where the midstream site is warmer than upstream site and the downstream site is cooler than the midstream site (Figures 24 and 25). Figure 26 indicates that overall the water temperature for all assessment years is lower downstream than upstream. Changes in the woody vegetation in the lower monitored stretch due to the removal of old Willows may account for the variation in temperature differences.

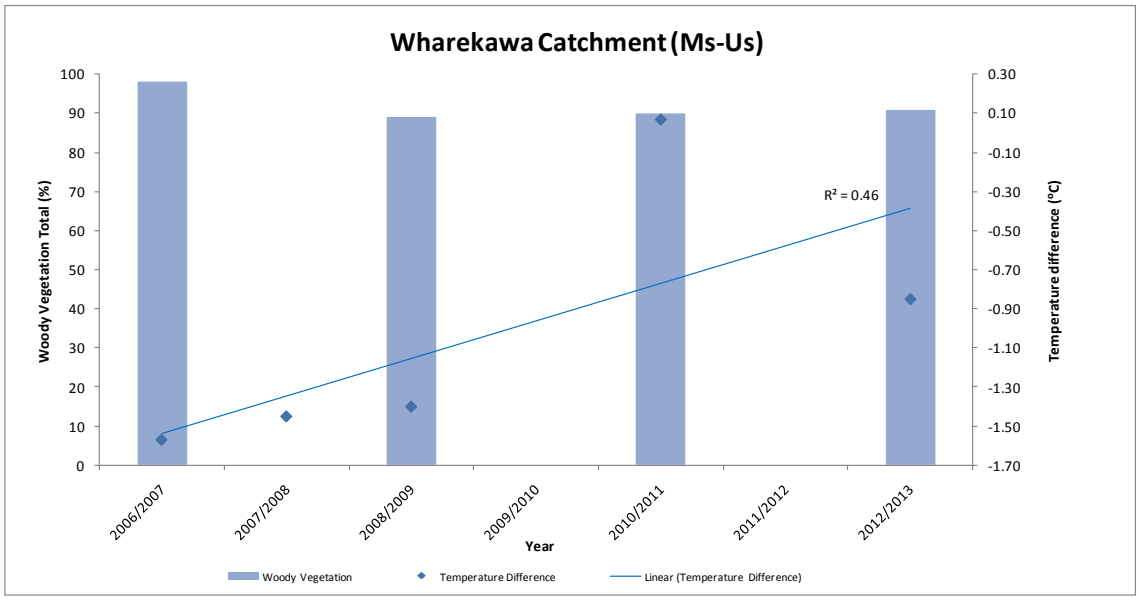

Figure 24: Woody vegetation total (%) and temperature difference (°C) in the Wharekawa Catchment midstream minus upstream temperature. Temperature and woody vegetation data only begins from 2006/2007 onwards.

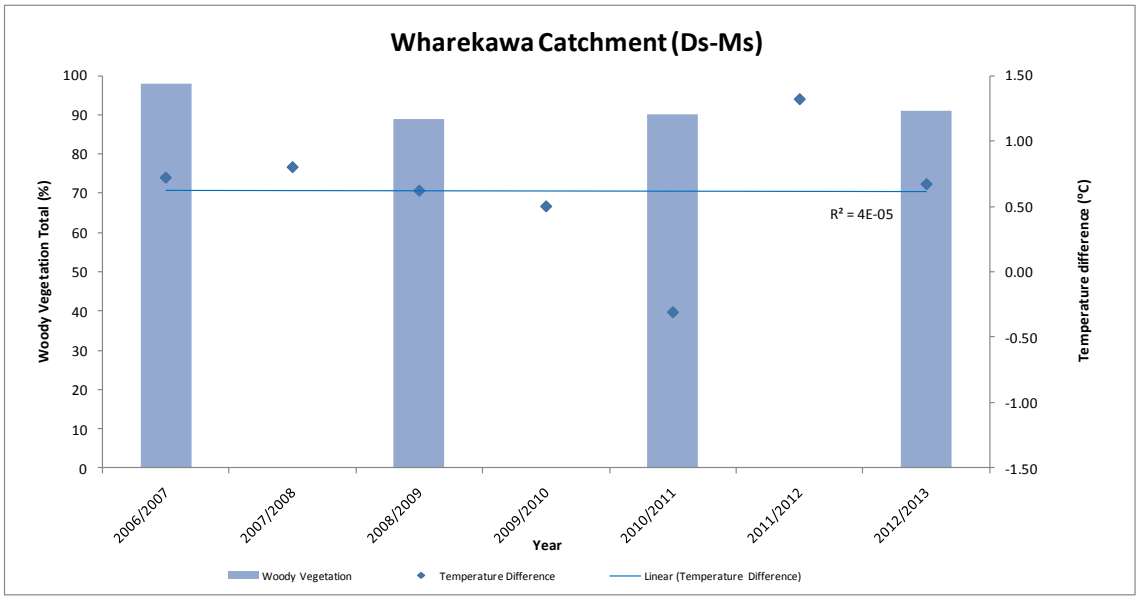

Figure 25: Woody vegetation total (%) and temperature difference (°C) in the Wharekawa Catchment downstream minus midstream temperature. Temperature and woody vegetation data only begins from 2006/2007 onwards.

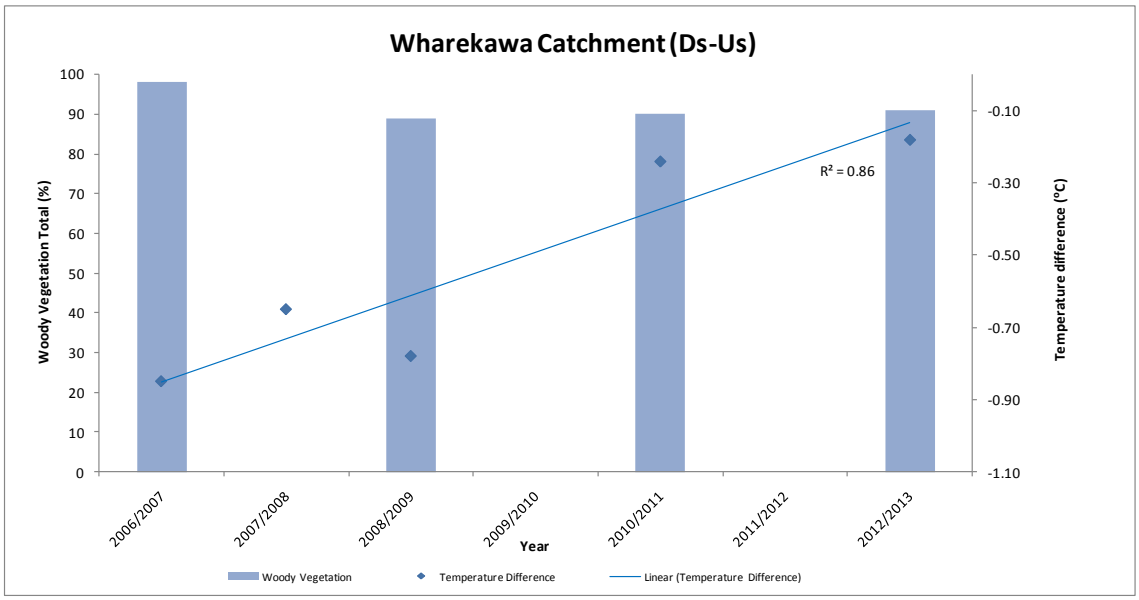

Figure 26: Woody vegetation total (%) and temperature difference (°C) in the Wharekawa Catchment Downstream minus upstream temperature. Temperature and woody vegetation data only begins from 2006/2007 onwards.

5.2.4 Photo points

Photo assessments have been completed along the Wharekawa River in 2006/07, 2008/09, 2010/11 and 2012/13. One 500 m and four 1000 m samples were assessed along the river totalling 26 photos, at 250 m intervals, over a total distance of 4500 m. As willow removal was done just before the 2008/2009 assessment, some of the samples (in particular samples 3 and 5) showed a decrease in riparian vegetation and increase in erosion. However some samples showed a decrease in erosion, such as that shown in Figure 27. Samples which have had soil conservation plantings in the riparian margin are expected to show positive visual changes in future assessments.

	2004/05	2012/13
Assessment 2 at 750m		

Figure 27: Wharekawa River photo point examples of visual change between 2004/05 (A) and 2012/13 (B) for assessment 2 at 750 m.

5.2.5 Suspended sediment

A permanent sediment sampling site has been in place at Adams Farm Bridge on the Wharekawa River since June 1991. During this time 21 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 11). Data includes all results up until 31/12/2012. 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 11: Wharekawa River 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 – 31/12/2012	N/A
Sediment Samples		25/09/1991 – 04/07/2012	622
ISCO Period of Record		20/04/2000 – 04/07/2012	29 events

Specific yield ($t/km^2/yr$)	Average sediment yield (kt/yr)	% of sediment yield in gauged range of flow	% Error in Yield Estimate
57	2.68	97.1	5.0

The Wharekawa River has an estimated specific yield of 57 $t/km^2/yr$ and an average sediment yield of 2.68 kt/yr (Table 11). Figure 28 shows the specific sediment yield for the Wharekawa River relative to other monitored sites in the Region. The specific yield for the Wharekawa can be considered low relative to many sites in the region (Figure 28). The influencing factors are likely to be the dominance of woody vegetation cover and geology.

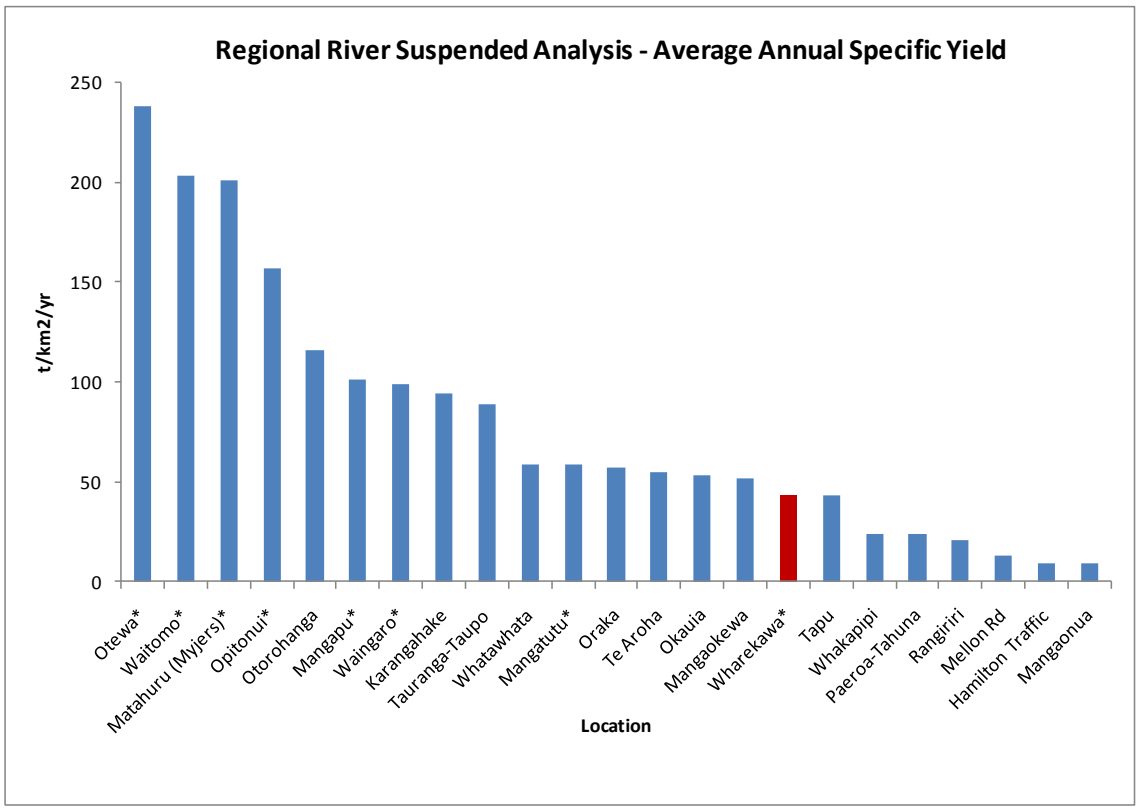

Figure 28: Average specific suspended sediment yield (t/km^2) for monitored rivers in the Waikato Region, the Wharekawa River site is highlighted in red.

5.2.6 Stream ecological health

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. From this invertebrate sampling macroinvertebrate community index (MCI) is calculated. 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.

The dominant surrounding land use in the vicinity of the sampling site is pastoral but the riparian zone is generally planted. The canopy cover is partly shaded. The stream is up to 14 m wide with the substrate predominantly consisting of large gravel and cobbles.

Figure 29 illustrates the MCI values as calculated for the Wharekawa River sampling site. Samples are taken between January and March every year. Refer to Table 25 in Appendix 3 for more detail.

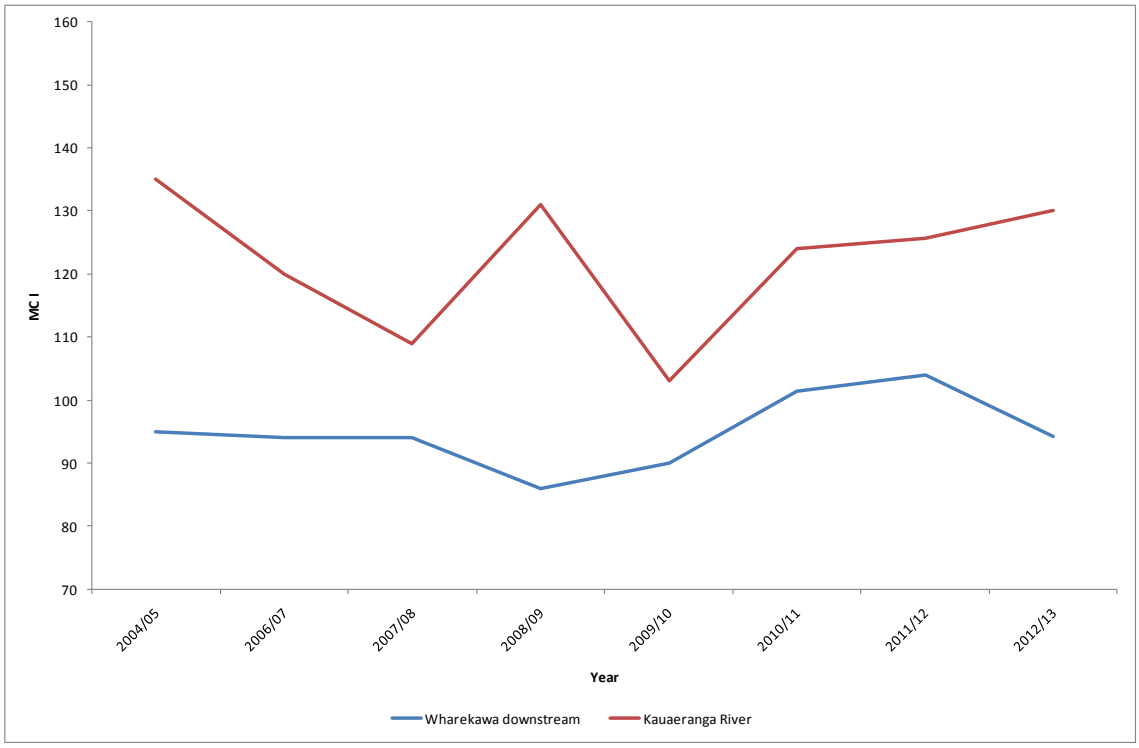

Figure 29: MCI values for the sampling site in the Wharekawa River and nearby reference site in the Kauaeranga River.

In the vicinity of the sampling site 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) (Figure 29). The Kauaeranga River (site number 234.28) has been included, in figure 29, as a pristine reference site to compare the MCI values from the Wharekawa River. The Reference site on the Kauaeranga River always has higher MCI values than the Wharekawa River. For more information on the monitored streams see Appendix 3.

5.2.7 Main points

Riparian characteristics

- Ninety one per cent of the riparian margin is woody vegetation, 67% of which are native species.
- Of the entire length of stream bank, 98% is fenced, and 89% is both fenced and has woody vegetation.
- The riparian margin is stable for 90% of the total length.
- Photo assessments have shown improvements in erosion and vegetation growth in areas of the Wharekawa River riparian margin.

Suspended sediment

- The specific yield for the Wharekawa catchment is estimated to be 57 t/km^2/yr, based on samples taken both manually and from an automatic sediment sampler since 1991.

Temperature

- There are no upstream data for 2009/10 and 2011/12. In other years the downstream temperature has been cooler on average than the upstream logger. A longer monitoring period is required to identify a trend.

Stream Ecological Health

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

5.2.8 Other monitoring

An automatic sediment sampler is installed on the Opitonui River to monitor suspended sediment. For more detailed information refer to the Suspended Sediment Monitoring Report (Kotze et al., 2008) and sampled suspended sediment yields from the Waikato Region (Hoyle et al., 2012).

6 References

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Appendix 1: Temperature results

The downstream temperature is then subtracted from the upstream temperature to provide a single number for the monitored section of each river within a catchment (Table 1 to 6).

Matahuru catchment – Lower Waikato zone 2003-2013

Table 12: 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	-0.90
2005/06	22.20	21.22	-0.98
2006/07	22.61	21.62	-0.99
2007/08	23.34*	22.41	-0.93*
2008/09	22.34	21.76	-0.59
2009/10	22.62	21.96	-0.66
2010/11	22.93	22.25	-0.68
2011/12	20.77	20.28	-0.49
2012/13	22.19	21.58	-0.61

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

Pokaiwhenua catchment – Upper Waikato zone 2003-2013

Table 13: 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	18.75	17.45	-1.31
2010/11	18.69	18.33	-0.35
2011/12	17.11	17.01	-0.09
2012/13	17.71	17.97	0.27

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

Mangare catchment – Upper Waikato zone 2006-2013

Table 14: 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	21.85	21.27	-0.58
2009/10	21.45	20.82	-0.62
2010/11	21.64	21.00	-0.64
2011/12	18.54	18.47	-0.07
2012/13	21.07	19.88	-1.19

Tahunaatara catchment – Upper Waikato zone 2003-2013

Table 15: 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	17.18	-0.35
2008/09	17.39	17.00	-0.39
2009/10	17.06	16.84	-0.22
2010/11	17.47	17.37	-0.10
2011/12	15.97	15.28	-0.69
2012/13	16.17	16.87	0.71

Mangatutu catchment – Waipa zone 2004-2013

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 m/s and u/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	-0.62	20.22	0.38
2005/06	19.41	0.71	20.12	-0.23	19.89	0.48
2006/07	20.01	1.15	21.15	-0.83	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	20.12	1.27	21.39	-0.95	20.44	0.32
2010/11	19.43	0.29	19.73	0.02	19.75	0.32
2011/12	17.24	1.31	18.55	-0.46	18.09	0.85
2012/13	20.51	1.16	21.67	-2.01	19.66	-0.85

*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.

Wharekawa catchment – Coromandel zone 2006-2013

Table 17: Wharekawa River average daily maximum water temperatures for the 10 week period commencing 1st January.

Year	Upstream average daily max (°C)	Temp diff btwn m/s and u/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)
2006/07	22.06	-1.57	20.48	0.72	21.21	-0.85
2007/08	22.51	-1.45	21.06	0.80	21.86	-0.65
2008/09	22.62	-1.40	21.22	0.62	21.84	-0.78
2009/10	*	*	21.06	0.50	21.56	*
2010/11	21.65	0.07	21.72	-0.31	21.41	-0.24
2011/12	*	*	19.75	1.32	21.07	*
2012/13	22.46	-0.85	21.61	0.67	22.27	-0.18

*The upstream logger was lost for the period of 2009/10 and 2011/12 due to substantial flood events.

Appendix 2: Riparian characteristics summary

Mangatutu catchment – Waipa zone 2012/13

For each table the number in brackets is the change from the 2004/05 assessment, which was the first year the assessment was done.

Mangatutu erosion.

Riparian **erosion** characteristics – Mangatutu (% of total bank length)									
Erosion	stable 90(+33)	unstable 10(-33)							
Fencing	nd	fenced 3(-12)				unfenced 7(-21)			
Vegetation		grass 2(-4)	willow woody veg. 1(+1)	other exotic woody veg. 0(-8)	native woody veg. 0(-1)	grass 7(-7)	willow woody veg. 0(-2)	other exotic woody veg. 0(-12)	native woody veg. 0(nc)

nd = not detailed, nc = no change

Mangatutu vegetation.

Riparian **vegetation** characteristics –Mangatutu (% of total bank length)			
Grass 47(-8)	Woody vegetation 53(+8)		
	Exotic 52(+8)		Native 1(nc)
	Willow 23(+17)	Non-willow 29(-9)	

Mangatutu fencing.

Riparian **fencing** characteristics - Mangatutu								
Fencing: % of stream length	**no fence on both sides** 8(-24)				**fenced on one side** 17(-30)		**fenced on both sides** 75(+54)	
Fencing: % of total bank length	**not fenced** 17(-38)				**fenced** 83(+38)			
Breakdown by vegetation	grass 13(-21)	willow woody veg. 1(-2)	other exotic woody veg. 3(-15)	native woody veg 0(nc)	grass 34(+13)	willow woody veg. 23(+19)	other exotic woody veg. 25(+6)	native woody veg. 1(nc)

Wharekawa catchment – Coromandel zone 2012/13

For each table the number in brackets is the change from the 2006/07 assessment, which was the first year the assessment was done.

Wharekawa erosion.

Riparian **erosion** characteristics – Wharekawa (% of total bank length)									
Erosion	stable 90(nc)	unstable 10(nc)							
Fencing	nd	fenced 10(+6)				unfenced 0(-6)			
Vegetation	nd	grass 2(+2)	willow woody veg. 1(+1)	other exotic woody veg. 2(+2)	native woody veg. 5(+1)	grass 0(-1)	willow woody veg. 0(-1)	other exotic woody veg. 0(nc)	native woody veg. 0(-4)

nd = not detailed, nc = no change

Wharekawa vegetation.

Riparian **vegetation** characteristics – Wharekawa (% of total bank length)			
Grass 9(+7)	Woody vegetation 91(-7)		
	Exotic 24(-8)		Native 67(+1)
	Willow 8(-16)	Non-willow 19(+8)	

Wharekawa fencing.

Riparian **fencing** characteristics - Wharekawa								
Fencing: % of stream length	**no fence on both sides** 0(nc)				**fenced on one side** 4(-56)		**fenced on both sides** 90 (+56)	
Fencing: % of total bank length	**not fenced** 2(-28)				**fenced** 98(+28)			
Breakdown by vegetation	grass 0(-2)	willow woody veg. 0(-4)	other exotic woody veg. 1(-1)	native woody veg. 1(-21)	grass 9(+9)	willow woody veg. 9(-11)	other exotic woody veg. 15(+9)	native woody veg. 65(+21)

Appendix 3: Macroinvertebrate Community Index (MCI)

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).

Macro invertebrate Community Index (MCI):

IBI Score range	Integrity Class	MCI Range	QMCI range	Degradation Category
58–60	Excellent	125-200	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	-	-	-

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.

MCI values for the Pokaiwhenua River and nearby reference site (Mokaihaha Stream)

Site	2003/ 04	2004/ 05	2005/ 06	2006/ 07	2007/ 08	2008/ 09	2009/ 10	2010/ 11	2011/ 12	2012/ 13
Pokaiwhenua upstream	99	103	113	113	115	113	107	112.2	114	107.5
Pokaiwhenua downstream	113	109	116	103	108	102	98	96.6	112.7	102.1
Reference site - Mokaihaha Stream	N/A	141	143	135	137	127	131	130	133.9	129.2

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	2010/11	2011/12	2012/13
Mangatutu downstream	114	110	104	108	115	102	104.7	97.6	106.9
Otautora Stream	149	145	139	136	136	144	140	134.4	135.3

MCI values for the Pokaitu Stream and nearby reference site (Mokaihaha Stream)

Site	2003/ 04	2004/ 05	2005/ 06	2006/ 07	2007/ 08	2008/ 09	2009/ 10	2010/ 11	2011/ 12	2012/ 13
Pokaitu downstream	104	116	120	126	122	117	122	108.6	105	111.2 (H)
Mokaihaha Stream	N/A	141	143	135	137	127	131	130	133.9	129.2

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

Site	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13
Mangare upstream	99	113	96	104	96	110.5	106.3	116.2
Mangare downstream	92	93	82	88	96	93.7	101.3	99.1
Reference site – Otautora Stream*	145	139	136	136	144	140	134.4	135.3

*Mangare upstream site is hard-bottom and Mangare downstream site is soft-bottom. The reference site is hard-bottom

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	2010/11	2011/12	2012/13
Wharekawa	95	94	94	86	90	101.4	104	94.3
Kauaeranga River	135	120	109	131	103	124	125.6	130