Environment Waikato Technical Report 2002/07

Regional Riparian Characteristics – 2002 Survey Manual

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1 Introduction

1.1 General

The Waikato region includes more than 20 rivers and 1420 streams. Fresh water resources are used for hydroelectricity, water supply, waste treatment, flood control and for recreational pursuits. They also provide important habitat for aquatic plants and animals (Environment Waikato, 1998). The demands on the region's rivers and streams continue to increase as the result of land use intensification. The long-term management of these resources is a high priority to ensure fresh water quality and aquatic biodiversity within the Waikato region are preserved for future generations. Riparian management techniques such as fencing and planting of riparian zones are an effective way of improving water quality and increasing aquatic and terrestrial biodiversity.

An absence of detailed riparian information for the region was identified, specifically, quantitative estimates of the amount of fencing, vegetation and erosion along rivers, streams and drains through pastoral land. Both Clean Streams and Project Watershed will require long-term monitoring (about 20 years) to demonstrate the effects of these initiatives.

The riparian characteristics survey has been designed to quantify the amount of fencing, vegetation and erosion present in streams, rivers and drains through pastoral land in the region. In addition to supporting Clean Streams and Project Watershed, the survey information could potentially support other Environment Waikato initiatives including the Biodiversity Strategy and environmental education on terrestrial ecology issues such as forest fragmentation. If the survey were repeated in 5-10 years time the initial information would provide a benchmark on which to gauge the effectiveness of Environment Waikato riparian policies.

This report describes the method developed and used for the 2002 Regional Riparian Characteristics Survey for the Waikato Region.

1.2 The importance of riparian zones

A riparian area is "an area of land directly influenced by permanent water" which exhibits vegetative and/or physical characteristics that reflect the presence of this permanent water (BLM, 1991). Riparian areas are receiving increased attention due to concern over changing land use and its impact on watercourses, and the potential for managing these areas of the land/water interface to manage the effects of land use change. Approximately 50 per cent of New Zealand's land has been converted to grazing over the past 150 years. The clearance of native forest for agricultural development has affected both water quality and biological communities in watercourses (Collier et. al. 1995).

Agriculture is essential to the New Zealand economy and contributes greatly to its export earnings (60 per cent of total export earning in 1991). It is necessary to try to reduce the impacts of agriculture on waterways while still trying to maintain efficient and viable farm practices (Quinn et. al. 1993).

Riparian zones have both biological and physical effects on watercourses. Benefits can be obtained by careful management of these areas, which can help reduce the effects of development on waterways while still maintaining production (Collier, 1995).
The functions and benefits of riparian zone management are in Table 1.

Table 1: Summary of riparian zone functions that can potentially buffer streams from various land use effects (Collier, 1995)

Riparian zone function	Potential in-stream effects
Buffers banks from erosion	Reduces fine sediment levels
Buffers channels from localised changes in morphology	Maintains water clarity
Buffers input of nutrients, soil, microbes and pesticides in overland flow	Reduces contaminant loads
Denitrifies groundwater	Prevents nuisance plant growths
Buffers energy inputs	Encourages growth of bryophytes and periphyton films
Provides in-stream food supplies and habitat	Maintains lower summer maximum temperatures
Buffers flood flows	Increases in-stream habitat features and terrestrial carbon inputs
Maintains microclimate	Maintains food webs
Provides habitats for terrestrial species	Reduces flood flow effects
Maintains dispersal corridors	Increases biodiversity

Other benefits to farmers and the wider community include improved waterway recreational and amenity values, productivity increases through planting of trees for timber in riparian zones, and improved milk quality where stock are drinking water that comes from a non-contaminated stream (Northland Regional Council, Information Series).

1.3 Riparian characteristics survey

1.3.1 Background

Environment Waikato is currently undertaking two major projects focusing on riparian zones – Project Watershed and Clean Streams. An absence of detailed riparian information for these projects, specifically quantitative estimates of the amount of fencing, vegetation and erosion of rivers, streams and drains initiated the riparian characteristics survey method development.

The data provided by the survey can initially be used to benchmark the state of riparian fencing, vegetation and erosion and from this establish state of the environment indicators. Interpreted information will feed into ongoing corporate initiatives such as Clean Streams and Project Watershed and also national and industry initiatives such as Fonterra's Clean Streams Accord.

1.3.2 Approach

In this manual the discussion of the riparian characteristics survey is separated into three sections.

Data capture methods – discusses the reasoning for selecting the data collection approach and the iterative process to determine the attributes to be measured.

Survey sampling design – a detailed description of the survey objectives, attributes, monitoring area, sample units and their selection, stratification and trend monitoring.

Coding and data collection – detailed description of attributes, tools used, field sheet design data input and storage.

In this survey ‘riparian’ is defined as including the margins of rivers, streams and drains within pastoral land. Included are margins with established soil conservation work.

1.3.3 Aim

The aim of the survey is to provide a repeatable and quantitative assessment of the characteristics of riparian fencing, vegetation and erosion through pastoral land in the Waikato region.

1.4 Data capture method

Numerous methodologies to capture riparian information have been tested and a strategy developed to put in place a survey to collect detailed riparian information (Hill, 2001). The main limitations of existing methodologies were that they did not provide the level of detail required for Clean Streams and Project Watershed. Method limitations and development are summarised and discussed in the following section and in more detail in Hill (2001).

Development of the riparian characteristics survey methodology began in 1999, with several methods of data collection explored. These included aerial photograph interpretation, satellite imagery interpretation, use of an aeroplane with still and video photography (from an aeroplane at 1000-1500 m) combined with ground truthing, and intensive field observation.

Aerial photographs, satellite imagery and aeroplane photography all proved to be limited in their ability to record type of vegetation, type of fencing and erosion (Table 2).

Table 2: A comparison of the effectiveness and limitations of riparian characteristic assessment methods

Method	Effectiveness	Limitations and advantages
Aerial photographs (1:27500 scale)	Capture of vegetation length, partial capture of fencing and erosion.	• Supports census or sampling approach on a regional basis. Fencing and erosion either masked by vegetation or lack of angle. • Practical interpolation of image information to data.
Satellite imagery (20 m resolution)	Capture of vegetation length, ineffectual capture of fencing and erosion.	• Supports census or sampling approach on a regional basis. Fencing and erosion either masked by vegetation or lack of angle. Resolution is not suitable for clear parameter identification. • Practical interpolation of image information to data.
Oblique still photography and video	Capture of vegetation length, partial capture of fencing and erosion.	• Impractical for census and sampling approach on a regional basis. • Time consuming and difficult interpolation of image information to data.
Field observation	Capture of vegetation length, fencing and erosion.	• Impractical for census but suitable for sampling approach on a regional

		basis. • Time consuming and high cost. • Detailed data collected for all parameters. • Practical interpolation of field information to data.

1.5 Rationale for selected method

Intensive field observation was selected as the way to collect data for the riparian characteristics survey. The method is time consuming but provides an effective and accurate way of measuring fencing, vegetation and erosion characteristics.

In December 1999 Environment Waikato undertook a field survey in Upper Waipa as part of a Local Area Management Strategy. The character of fencing, vegetation and erosion was recorded at 13 sites (2 km sections of rivers or streams) at a range of sites within the Upper Waipa catchment.

Sample numbers from the Upper Waipa survey were insufficient for statistical analysis but some trends were evident. This initial survey provided the direction for establishing the design and initial outline for the riparian survey.

After consultation with various groups in Environment Waikato (Resource Use, Resource Information and Asset Management) an outline for the survey was developed.

2 Survey sampling design

Rationale and guidelines for determining survey design follow that described in Frampton (2002). The methods presented in this manual have been specifically set up to provide a regional scale methodology and therefore are geared more towards using samples as opposed to completing a census. However, the scale of the survey or whether a census or sample design is used should not alter the riparian characteristics data collected. An example of a sample design and the rationale is provided in Appendix 1.

3 Coding and data collected

A series of codes have been formulated for use in data collection. The most detailed codes are associated for fencing, vegetation and erosion because these are characteristics identified within the survey objectives. Additional codes have been derived to record the presence of accessways and obstructions and describe general sample site characteristics. The presence of accessways and obstructions was deemed to be useful following staff consultation.

A copy of the field coding sheets can be found in Appendix 2. Each section of coding is discussed and illustrated with examples.

3.1 Fencing

A four-part code was used to describe the fencing characteristics (Table 3). Examples of fencing are provided in Figures 2-4.

Table 3: Coding criteria for fencing

Criteria	Description
Part 1: Type of fence present	
Electric (E)	Fence present is predominantly electric.
Wire (W)	Fence present is predominantly wire.
Wood (O)	Fence present is predominantly wood.
Mesh (M)	Fence present is of mesh construction.
Deer (D)	Fence present is designed for deer (mesh and >2 m in height.
No fence (N)	There is no fencing structure present.
Part 2: Number of cross wires present	[Number].
Part 3: Temporary (t) or permanent (p)	Indicative whether fence is temporary or permanent in structure.
Part 4: Effective (Ef) or ineffective (I)	Effective means fence is robust and will stop stock movement. Ineffective means that although a structure exists it is not robust and stock will move through/across structure.

Figure 1: An example of fencing; coding and description. 6 W P Ef: 6 wire, permanent, effective fence.

Figure 2: **An example of fencing; coding and description. 2 E P Ef: 2 wire electric permanent effective.**

Figure 3: **An example of fencing; coding and description. Left bank; 1 E T Ef : 1 wire electric temporary effective. Right bank; 4 W P Ef: 4 wire permanent effective.**

3.2 Vegetation

A five-part code is used to describe the vegetation characteristics (Table 4). Examples of vegetation are provided in Figures 5-12.

Table 4: Coding criteria for vegetation

Criteria	Description
Part 1: Vegetation character	
Native (N)	Predominance of native trees/shrubs.
Exotic (E)	Predominance of exotic (non-native) tree and shrub species.
Mixed (M)	Approximately 50% native and 50% exotic species.
Grass (G)	Consisting of low (<1 m) grass and/or weed species.
Part 2: Vegetation structure	
Forest (F)	Tall dense vegetation, trees close together.
Treeland (T)	>3 m high, widely spaced, grass in between.
Scrub (S)	Low stature vegetation, <3 m high and close together.
Shrubland (Sh)	Low stature, widely spaced, grass in between.
Grass (G)	Grass including small low lying weeds up to 1 m in height.
Wetland (W)	Raupo/sedges.
Part 3: Dominant species	
Dominant species types are recorded	Common exotic and native species have been given two letter codes (see Appendix 2).
Part 4: Vegetation height	Average height is recorded.
Part 5: Width of vegetation	Average width is recorded.
<2 m	Up to 2 m.
2-5 m	Between 2-5 m.
5-10 m	Between 5-10 m.
>10 m	Greater than 10 m.

Figure 4: An example of vegetation; coding and description. M F Ww Kn 5 m >10: Mixed, forest, willow, kanuka, 5 m average height, >10 m from streambank.

Figure 5: An example of vegetation; coding and description. E T Ww 8 m <2 m: Exotic, treeland, willow, 8 m average height, <2 m from streambank.

Figure 6: **An example of vegetation; coding and description. E S Ww 3 m 5-10 m: Exotic, scrub, willow, 3 m average height, 5-10 m from streambank.**

Figure 7: **An example of vegetation; coding and description. N Sh Fl 2 m >10 m: Native, shrubland, flax, 2 m average height, >10 m from streambank.**

Figure 8: **An example of vegetation; coding and description. N Sh Fl 2 m 5-10 m: Native, shrubland, flax, 2 m average height, 5-10 m from streambank.**

Figure 9: **An example of vegetation; coding and description. G G Gs <1 m >10 m: Grass, grass, grass, <1 m average height, >10 m from streambank.**

Figure 10: **An example of vegetation; coding and description. G G Gs <1 m >10 m: Grass, grass, grass, <1 m average height, >10 m from streambank.**

Figure 11: **An example of vegetation; coding and description. G W Rau 1.5 m 2-5 m: Grass, wetland, raupo, 1.5 m average height, 2-5 m from streambank.**

3.3 Erosion

A four-part coding system describes the criteria of the erosion data collection (Table 5). Examples of vegetation are provided in Figures 13-23.

Table 5: Coding criteria for erosion

Criteria	Description
Part 1: Type	
Type of erosion:	
Scour (Sc)	Occurs when water undercuts the waterway bank. A scour consists of a concave bank.
Slip (Sl)	Movement of earth above a sharply defined shear plane. Often results in a planar slide (Selby, 1985).
Slump (Sm)	Characteristically a shearing and rotational movement of a mass of earth along a curved failure plane (Selby, 1985).
Part 2: Position	
Location of area of erosion on the waterway:	
Outside bend (o)	Occurs on outside bend of channel.
Inside bend (I)	Occurs on inside bend of channel.
Straight (s)	Occurs along straight channel either side.
Part 3: Stability	
If erosion is active or unstable:	
Unstable (U)	Likely to add sediment to the waterway when in flood.
Active (A)	Adding sediment to the waterway at the present time.
Part 4: Protection	
If area of erosion is fenced, vegetated or both:	
Vegetated (V)	Has vegetation along the majority of the area of erosion.
Fenced (F)	Is fenced along the area of erosion.
Protected (P)	Is vegetated and fenced along the area of erosion.
Not protected (N)	Is not vegetated nor fenced along the area of erosion.

Figure 12: **An example of scour erosion; coding and description. Sc (A) s 15 x 1.5 m N: Scour, (active), straight, 15 m long, 1.5 m high, not protected.**

Figure 13: **An example of scour erosion; coding and description. Sc (A) o 8 x 1.5 m N: Scour, (active) outside, 8 m long, 1.5 m high, not protected.**

Figure 14: **An example of active and unstable scour erosion; coding and description. Sc (U) o 5 x 1.5 m N and Sc (A) o 5 x 1.5 m N: Scour, (unstable), outside, 5 m long, 1.5 m high, not protected and scour, (active), outside, 5 m long, 1.5 m high, not protected.**

Figure 15: **An example of slip erosion; coding and description. Sl (A) o 15 x 3.5 m N: Slip, (active), outside, 15 m long, 3.5 m high, not protected.**

Figure 16: **An example of slip erosion; coding and description. Sl (A) o ~25 x 15 m V: Slip (active), outside, approximately 25 m long, 15 m high, vegetated.**

Figure 17: **An example of slip erosion; coding and description. Sl (U) s 5 x 5 m N: Slip (unstable), straight, 5 m long, 5 m high, not protected.**

Figure 18: **An example of slump erosion; coding and description. Sm (A) o 10 x 2 m N: Slump, (active), outside bend, 10 m long/2 m high, not protected.**

Figure 19: **An example of slump erosion; coding and description. Sm (A) o 5 x 2 N: Slump, (active), outside, 5 m long, 2 m high, not protected. Note that the active section of erosion recorded separate to unstable section of erosion.**

Figure 20: **An example of slump erosion; coding and description. Sl (A) o 6 x 1.5 m N: Slump, (active), outside, 6 m long, 1.5 m high, not protected.**

Figure 21: **An example of slump erosion; coding and description. Sm (U) o 20 x 2 m N: Slump (unstable) outside, 20 m long, 2 m high, not protected.**

Figure 22: **An example of slump erosion; coding and description. Sm (U) o 15 x 2.5 m N: Slump (unstable) outside 15 m long, 2.5 m high, not protected.**

3.4 Accessways and obstructions

3.4.1 Accessway

Table 6: Coding criteria for accessways

Type	Explanation
Part 1: Type	
Ford (F)	Ford with or without water running over.
Bridge without culvert	Bridge spanning waterway.
Bridge with culvert	Bridge – solid with culverts.
Part 2: Length	
Length	For example, 10 m length of streambank.
Part 3: Location	
Location	Mark location of the obstruction with a waypoint (GPS).

An accessway is defined as a structure or track that provides a means of moving across the waterway. Accessways are potential sites where stock may come into contact with water, fish passage may be disrupted or debris and sediment may accumulate. A single-part coding system describes the criteria of the accessway data collection. Examples of accessways are provided in Figures 24-26.

Figure 23: **An example of an accessway; coding and description. Ford: F.**

Figure 24: **An example of an accessway; coding and description. Bridge: B.**

Figure 25: **An example of an accessway; coding and description. Bridge with culvert: Bc.**

3.4.2 Obstructions

An obstruction is defined as an object that blocks the waterway by 50 per cent or more and would impede water flow or act as a trap for debris. A three-part code is used (Table 7).

Table 7: **Coding criteria for obstructions**

Criteria	Description
Part 1: Type	
Non-living debris (X)	For example, dead wood, metal.
Vegetation (V)	This includes living vegetation only.
Dams (D)	Dam restricting waterway.
Part 2: Length	
Length	For example, 10 m length of streambank.
Part 3: Location	
Location	Mark location of the obstruction with a waypoint (GPS).

Figure 26: **An example of an obstruction; coding and description. X (metal), 5 m WP*: The obstruction is non-living debris, consists of metal, is 5 m long and occurs at WP*.**

Figure 27: **An example of an obstruction; coding and description. V(Ww) 5 m WP*: The obstruction is living debris, consists of willow, is 5 m long and occurs at WP*.**

3.5 General site

General site codes provide a record of land and waterway characteristics representative of the whole sample site. Some of these characteristics are used for stratifying the samples during data analysis. For instance, the land use recorded in the field is more accurate than the estimate using existing land use or land cover GIS databases.

The general site information should be completed after the sample observations have been made (that is, when the entire sample site has been observed).

3.5.1 Weather condition

The main weather event during the sampling of the site is recorded. Codes used are:

- fine
- overcast
- rain
- showers.

3.5.2 Land use

The predominant land use for the land immediately surrounding the sample site is recorded. A limited number of categories are used to simplify the data in line with land use classes used for regional indicators.

- Beef/drystock farming (Beef/Drystock).
- Dairy farming (Dairy).
- Horticulture (for example, orchard, vegetable, flower growing) (Horticulture).
- Deer farming (Deer).
- Cropping (for example, corn, maize) (Cropping).
- Hay production (Hay).

3.5.3 Topography/soil order/geology

Environment Waikato's Geographic Information System (GIS) is used to provide general topography, soil and geology site information via the NZLRI database. The data relates to the start point of the sample and includes slope class, New Zealand Soil Classification Soil Order (Hewitt, 1998) and Toprock geology.

3.5.4 Channel width

The minimum and maximum width of channel is estimated over the length of stream surveyed.

3.5.5 Channel type

The channel type is classified according to Quinn (1999) and is presented in Figure 28.

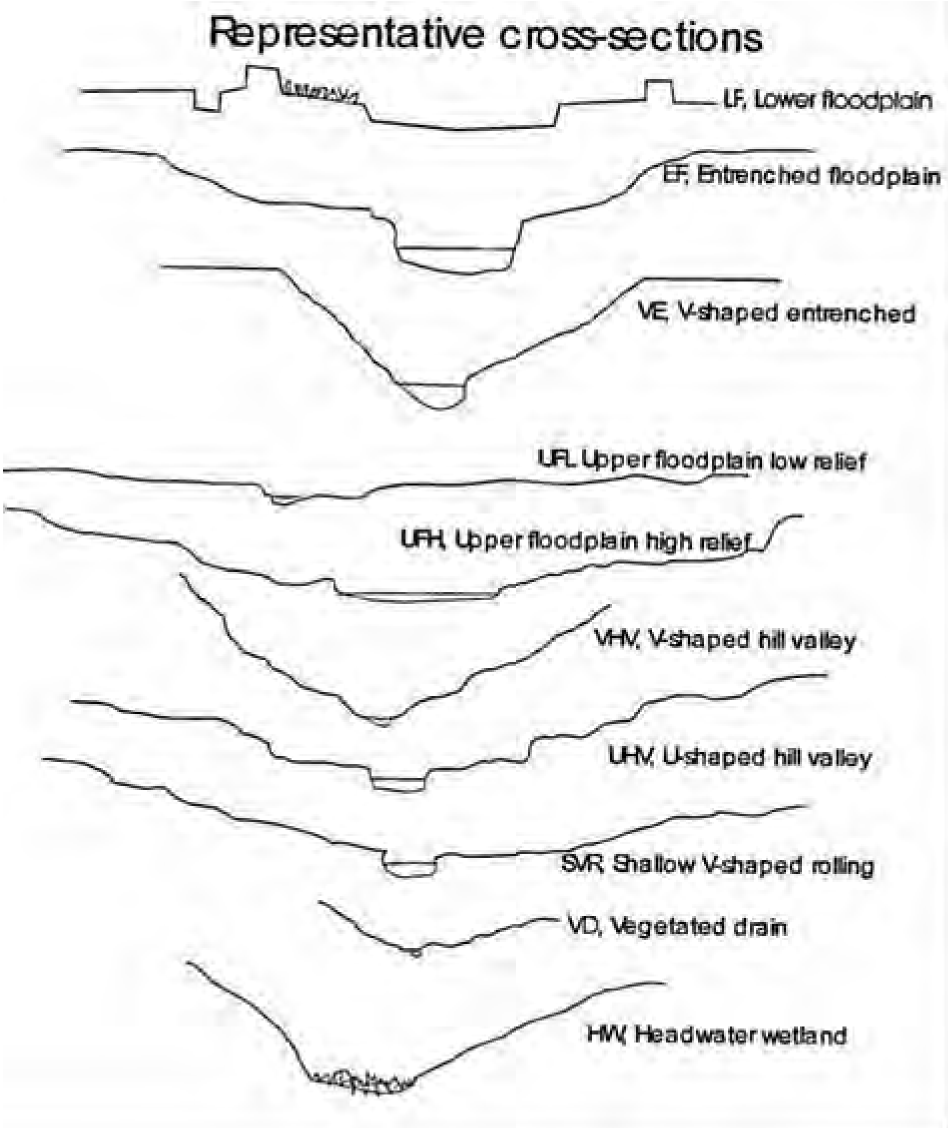


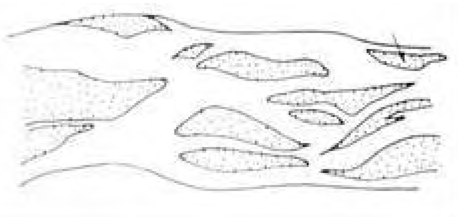
Figure 28: Channel type classes used in this survey (after Quinn, 1999).

3.5.6 Valley width

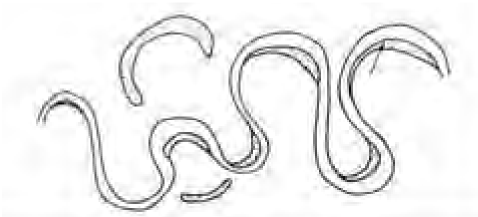
To assist with placing the given waterway in context with the surrounding landscape the width of the land between both sides of the valley for the given waterway is estimated. For valleys greater than 500 m width ">500 m" is recorded.

3.5.7 Channel shape

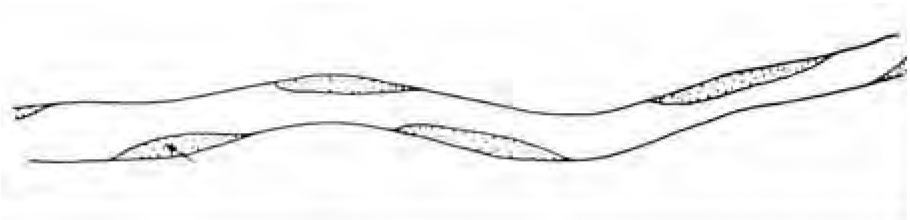
The channel shape is classified according to Selby (1985) into four classes: channelised, meandering, straight and sinuous (Figure 30a, b, c and d). Channel shape can assist with understanding the energy of the waterway and the surrounding landscape. For instance, a channelised channel usually reflects a high-energy environment with highly variable discharges and high sediment availability. Conversely, a straight channel reflects a low energy environment, lower gradient and lower sediment input (Richards, 1982).



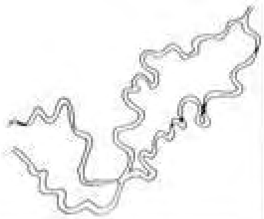
a) Channelised – stream has more than one channel which divide around coarse-grained sediment bars (except at high flood).



b) Meandering – stream has one channel, which winds and curves.



c) Straight – stream channel is straight but the main water body will often meander back and forth within the channel.



d) Sinuous – stream channels diverge and converge around large, stable, vegetated islands.

Figure 29: Channel shape a) channelised, b) meandering, c) straight, and d) sinuous (Selby, 1985).

3.5.8 Stream bed type

Stream bed type is visually classified according to the dominant sediment size. Sediment size classes are those defined by Milne et. al. (1995).

Table 8: Particle size class

Particle size class	Size range
Sand	Mineral particles ranging in diameter from 0.06 to 2.0 mm.
Silt	Mineral particles ranging in diameter from 0.06 to 0.002 mm.
Gravel	Pieces of material ranging in diameter from 2 to 20 mm.
Cobble	Pieces of material ranging in diameter from 20 to 60 mm.
Boulders	Pieces of material ranging in diameter from 60 to 200 mm.
Aquatic vegetation	Any type of aquatic plant present within the waterway. Present. Absent.

Stock access to water	Do stock have the ability to reach the waters edge or enter the water?	
	Yes or no.	

4 Methods

4.1 Pre data collection

Topographic maps (NZMS 260 series) are used to aid in the location of the sample sites. Sites generated by the GIS are transposed by hand onto topographic maps for use in the field.

Once the area has been identified it is necessary to seek permission from the land owners to gain access to the property. The nearest homes are approached and attempts made to locate the relevant person. When located, information is passed on outlining the project and addressing any questions. Permission is asked to access the stream and land. If a land owner cannot be located, a flyer is placed in a letterbox or on a doorstep outlining the project (Appendix 3). An approximate time of the visit and contact phone numbers (for staff in the field and at the office) are provided.

4.1.1 Equipment used

The following equipment was used for the field observations and data input. Although specific brands, models and specifications have been listed this does not imply that this equipment must be used for the survey. Alternative models with similar specifications should be suitable and the details in this section should assist with equipment comparison and selection.

Global Positioning System (GPS)

Global Positioning System (GPS) used to collect information was Garmin 12 XL.

Specifications of Garmin 12XL are:

- 12 parallel channel receiver
- 500 waypoint capacity
- accurate to +/- 7 m.

Data is downloaded by direct cable connection using Mapsource (Garmin software). This software provides the ability to manipulate waypoints and calculate distances between waypoints. A single file for each sample is stored and can be exported directly into Microsoft Excel if required.

Digital camera

A digital camera was a practical method of visually recording the start point of each sample and observations along the sample for future reference. A Fujifilm FinePix 2400 Zoom digital camera was used.

Specifications of the Fujifilm FinePix 2400 Zoom camera are:

- automatic focus
- storage media – SmartMedia card
- zoom lens of 38-114 mm
- file format – JPEG
- file size 1600x1200/1280x960/640x480.

Measuring wheel

A measuring wheel was a practical method of measuring and recording the distance between waypoints in the field. This alternative method was developed to reduce the amount of data manipulation. A Rotosure 1000 standard precision measuring wheel was used.

4.2 Data collection

Data collection begins when the start of the sample is located. The GPS is switched on and left for one minute to 'lock on to' satellites. A 'start' waypoint is created and stored in the GPS. A photo is also taken of the start waypoint for the purposes of relocating the sample site. The number of this waypoint is recorded on the data sheet. Recording of all data variables on both sides of the waterway begins at this time.

The sample length and shape is measured either using the GPS unit or using a combination of the GPS and a measuring wheel. Both methods measure the length and path of the waterway by marking waypoints along the sample as observations are made. The aim is to get a sample of 1000 m (1 km) and the recording occurs as close to the streambank as possible.

For the first method a waypoint is recorded every 10 metres until 100 waypoints collected. Because additional waypoints will be recorded to mark observation changes the final number of waypoints will be greater than 100. To estimate when 100 waypoints (1000 m) is reached, subtract the number of observation waypoints from the current waypoint number on the GPS. It is better to do a few extra waypoints than too few.

The second method uses the cumulative metres recorded for the waypoints. Additional waypoints are also marked when the waterway changes direction. When an observation changes a waypoint is made and the wheel is returned to zero. A running total of the observation lengths is kept until they total 1000 m.

All observations for right and left banks are measured concurrently. When an observation changes a waypoint is recorded. The distance between that waypoint and the previous waypoint is recorded and the measuring wheel set back to zero. If a measuring wheel is not being used (that is, a GPS only is being used) the distance between waypoints will be measured in the office from the route map in to Garmin software Mapsource (see section 5.4 Data input).

Two types of observation are collected: continuous and point observations. The continuous observations include fencing and vegetation. Erosion observations are essentially point data, with each section of erosion characterised separately. Similarly, for accessways, obstructions and some of the 'other' observations, a single waypoint is used to record their occurrence.

4.3 Post data collection

After the fieldwork for a sample site has been completed the data stored on the GPS and images stored on the digital camera are downloaded on return to the office.

Waypoints from the GPS are transferred by data cable to Garmin software Mapsource. Because the waypoints from the GPS are continuous (each unit capable of holding 500 points at a time), points are divided into the relevant sites and stored in site folders within Environment Waikato's computer system. Folders are organised by catchment and site number.

Photos from the digital cameras are also downloaded and renamed (for example, erosion, start waypoint, end waypoint, vegetation, fencing). These photos are also stored within the relevant site number within the computer system.

The result is a two-tier folder system:
- catchment – for example Taupo

- site number – contains Mapsource file and photos of that site.

Accurate recording of photo and waypoint numbers is essential in the field to enable ease of data naming and sorting when downloaded.

4.4 Data input

Mapsource is used to calculate distances between waypoints for measurement of vegetation and fencing.

By using the route building tool, waypoints can be connected and distances measured between points.

Completed field sheets are entered into Microsoft Excel. Within each spreadsheet file the following sheets are created.

- Site information.
- Erosion.
- Erosion summary.
- Vegetation.
- Vegetation summary.
- Fencing.
- Fencing summary.
- Obstruction.
- Accessway.

Separate summary sheets are created to ensure the raw data remains available for detailed analysis of individual characteristics (for example, fencing type, vegetation type and buffer width). Summary sheets are used to calculate a per site figure for:

- fenced and unfenced
- vegetated (woody vegetation) and non-vegetated (grass only)
- active and unstable erosion
- number and length of obstructions
- number and length of accessways.

5 Costs

Indicative costs are presented to assist with budgeting for a similar survey. The costs are derived for actual costs incurred during the 2002 Riparian Characteristics Survey for the Waikato Region. Costings are based on a sample size of 378 sites (Table 9).

Table 9: Estimated cost of site selection, field sampling, data input and reporting

Task	Hours	Cost
Site selection	1 day randomly selecting sites on GIS (8 hours @ $60/hr)	$480.00
Field sampling	14 days for 1 person (112 hours @ $60/hr)	$6,720.00
	14 days vehicle (1700km @ $0.50/km)	$850.00
Data input	5 days for 1 person (40 hours @ $60/hr)	$2,400.00
Report (results, analysis and interpretation)	2.5 days for 1 person (20 hours @ $60/hr)	$1,200.00
TOTAL	**Cost per site $277.38**	**$11,650.00**

Costs will depend on the amount of travelling required, the number of kilometres surveyed, whether one or two staff carry out the surveying and the reporting requirements.

Acknowledgements

The Resource Information Group, Environment Waikato, has developed the method for the riparian characteristics survey. Numerous staff have been involved with its development since November 1999.

The project was initiated within the Coasts, Land and Wetlands Programme, managed at that time by Tony Fenton. Subsequently, Peter Singleton provided guidance as the new Coasts, Land and Wetlands Programme Manager. Doug Stewart and Ross Jones assisted with the initial fieldwork in the Upper Waipa. Len Brown designed and performed the site selection procedures using the GIS. Karen Denyer assisted with the vegetation coding. Ralph Ostertag and Heather Windsor guided by Johlene Kelly carried out the fieldwork for the survey and in doing so continually refined the methods presented in this manual. Rochelle Price carried out the data input for the survey and in doing so contributed to developing the data storage methods.

References

Collier, K.J.; Cooper, A.B.; Davies-Colley, R.J.; Rutherford, J.C.; Smith, C.M. and Williamson, R.B. 1995: *Managing riparian zones: A contribution to protecting New Zealand's rivers and streams*. (2 volumes). Department of Conservation, Wellington, 39.

Environment Waikato. 1998: Waikato State of the Environment Report, Environment Waikato, Hamilton. 244.

Gibbs, J.P. 1995: *MONITOR Users Manual – Software for Estimating the Power of Population Monitoring Programs to Detect Trends in Plant and Animal Abundance.*

Hill, R.B. 2001: A Strategy for Assessing the Character of Riparian Margins in the Waikato Region. *Internal Report 2001/07*, Environment Waikato, Hamilton.

Milne, J.D.G.; Clayden, B.; Singleton, P.L. and Wilson, A.D. 1995: *Soil Description Handbook*. Manaaki Whenua Press, Lincoln, New Zealand. 157.

Northland Regional Council: *Land Beside Water – Streamside Management No 1*; Information Series.

Quinn, J.M.; Cooper, A.B. and Williamson, R.B. 1993: *Riparian Zones as Buffer Strips: A New Zealand Perspective.* NIWA, New Zealand. 88.

Quinn, J.M. 1999: Towards a riparian zone classification for the Piako and Waihou River catchments. *Environment Waikato Technical Report TR99/16*, NIWA Client Report: EVW00214.

Selby, M.J. 1985: *Earth's Changing Surface – An introduction to Geomorphology.* Clarendon Press, Oxford. 605.

Appendix 1: Survey design rationale for the 2002 regional survey

Attributes

Attributes to be measured include riparian fencing, vegetation and erosion characteristics. Specific components for all attributes are described in Section 4 (Attributes and coding).

Monitoring area

The monitoring area was restricted to the pastoral land within the Waikato region as defined by the Land Cover Data Base (LCDB) on the GIS. However, to fulfil the information requirements of Project Watershed and Clean Streams the region was also partitioned into nine management zones. A management zone is defined as an area loosely based on a catchment boundary adjusted to meet political and logistical requirements (for example, management zone boundaries align with individual land parcel boundaries). Six management zones related specifically to Project Watershed and three additional management zones to encompass the remainder of the region for Clean Streams (Table 1). For the purpose of presenting data at a regional level, data for each management zone will be weighted according to the regional proportion of river, stream and drain length in the management zone.

Table 1: Management zones in the Waikato region

Management zone	Code	Weighting by length
Project Watershed		
Middle Waipa	MWP	**0.09**
Upper Waipa	UWP	**0.04**
Lower Waikato	LWK	**0.13**
Middle Waikato	MWK	**0.06**
Upper Waikato	UWK	**0.10**
Lake Taupo	TAU	**0.12**
Additional		
Coromandel	COR	**0.11**
Hauraki	HAU	**0.13**
West Coast	WSC	**0.21**

Sampling units and stratification

Two approaches were considered for a sampling framework. The first approach involved measuring all riparian margins within the region – census collection. This would provide a large amount of information and provide an accurate, precise and complete view of riparian characteristics in the region. It would also incur large costs and be logistically impractical.

The second approach involved sampling a proportion of the region's riparian population. This would not provide a complete profile of the region but would be more cost and time effective. If a proportion of the population is to be sampled then the sampling method needs to be well designed, so that the survey is effective and representative of the region.

A **stratified random sampling method** (approach two above) was chosen to provide an overall view of the riparian characteristics in the region.

The **sample unit** consisted of a randomly selected 1000 m length of riparian margin. Both banks are assessed to provide a sample of 2000 m length of riparian margin. Additional information for separate banks can also be extracted also (for example, proportion of riparian margin with fencing on both banks).

The **stratification** used in the riparian characteristics survey was derived based on information requests and prior knowledge gained from preliminary methodology development in the Upper Waipa (Hill, 2001). The stratification provides a meaningful way of grouping data to reduce variability. A stratified random sample method is the most efficient way of sampling when an unbiased representation of a multiple population is required (Hill, 2001). Table 2 outlines the rationale used to select stratification criteria. There is a maximum of 14 possible strata.

Table 2: Rationale for stratification criteria (Hill, 2001)

	Number of stratum	**Rationale for strata**	
		Affect on variability	**Anticipated outcome**
Catchment /management boundary	1	Geographic/management boundary – more likely to have similar catchment characteristics.	Percentage of catchment waterways with(out) fencing, vegetation or streambank erosion.
LUC group (1-4, 5-8)	2	Approximates drystock and dairy farming division – farm types require different management.	Percentage of drystock or dairy waterways with(out) fencing, vegetation or streambank erosion.
Strahler order and drains (Drains, 1-6+)	7	Approximates catchment classification – waterways managed differently depending on size and landscape position.	Percentage of different strahler orders with(out) fencing, vegetation or streambank erosion.

Land use capability and strahler order criteria

For the riparian characteristics survey two classifications have been used based on land use (**LUC grouping**) and river size (**strahler order**). The ability of an area of land to be developed and used in a certain way is its land use capability (LUC). LUC consists of a scale of classes from 1-8. Each class provides an indication of the capability of the land for particular uses. LUC classes 1-4 have been combined to identify flat to rolling land while LUC classes 5-8 identify rolling to steep land. Groupings of the LUC are designed to represent dairy (LUC 1-4) and drystock (LUC 5-8) farming. This approach is based on Upper Waipa sample observations and approximates farm type in the absence of spatial farm type data at the time of survey.

Strahler order is a system of ordering channels within river systems. The higher the strahler order the larger the waterway (Selby, 1985). Figure 1 shows the way in which strahler order is applied to a river system. For the purposes of this survey drains have been identified separately (irrespective of strahler order). This is because specific riparian characteristics data is required on drains.

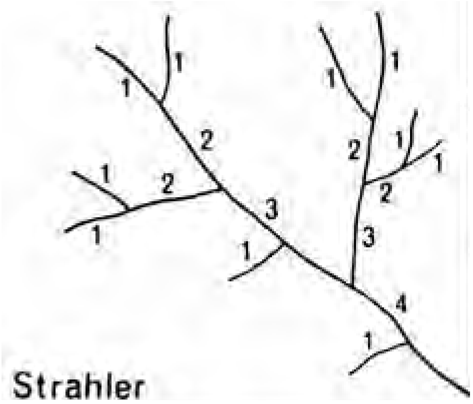


Figure1: Strahler order (Selby, 1985)

Sample size

Sample size was determined based on ensuring the survey had sufficient 'power' to detect at least a 30 per cent change from the mean over a 10-year interval. Power analysis (Gibbs, 1995) completed for preliminary riparian characteristics data (Hill, 2001) indicated that for a 5-year repeat survey, that between 40 and 70 samples were required to detect a 20-30 per cent change from the mean. Sampling was set at the lower 40-sample limit in this survey because of time, resource and budget constraints. An assumption was made that stratification would only be used should it reduce variability within the data. Therefore the 'power' of the sampling would only improve. Likewise, increasing the survey interval from 5 to 10 year would improve the 'power' of the survey, hence a sample size of ~40 was acceptable based on the preliminary data analysis in (Hill, 2001).

A minimum of three replicates for each stratum per management zone were selected and measured, providing a total of 42 samples for each management zone (Table 3), 378 sample sites for the Waikato region.

Table 3: Sample size and stratification of riparian characteristics

Stratification	Number of strata	Sample size	Effect tested
Management zone (MZ)	1	42	Between management zones.
LUC group (LUC)	2	21	Between LUC groups irrespective of strahler order.
Strahler order (SO)	7	6	Between strahler orders irrespective of LUC group.
Strahler order by LUC group (LUC*SO)	14	3	Between strahler orders of different LUC groups.

In practice not all strata occur. In this situation the sample size is increased for the most common strata, weighted by the potential number of possible sampling sites.

Trend monitoring

Riparian information is required at a sub-region level for the purposes of capturing state and for measuring temporal changes for Project Watershed and Clean Streams. It is likely that temporal changes will be monitored following the implementation of riparian management practices. Implementation will be staggered spatially and temporally, and envisaged changes in riparian characteristics are unlikely to be clearly detectable within the first 5 years. A tentative interval of 10 years has been set for repeating the survey (2011).

Sample locations

The sample is generated using GIS technology. A GIS warehouse has been designed to contain waterways that are greater than 1000 m and are on pasture. Management zone boundary, land use capability and strahler order then stratify these waterways. Each waterway site is given a site number.

These site numbers are in random order and listed by management zone, land use capability and strahler. The sites are selected by stratum. The sites are in random order so their selection is by moving sequentially down the list of each strata division.

Each stratum will contain a sample of 3 once 42 sites are complete.

If a site happens to be inaccessible or does not meet survey criteria then the next random site for that particular stratum is used.

Appendix 2: Field observation codes

Fencing (four-part code)

Part	Code
Part 1: Type of fence present	E Electric W Wire O Wood D Deer M Mesh N No fence present
Part 2: Number of cross wires present	[Number]
Part 3: Temporary or permanent	T Temporary P Permanent
Part 4: Effectiveness	I Ineffective Ef Effective

Erosion (four-part code)

Part	Code
Part 1: Type	Sc Scour Sp Slip Sm Slump
Part 2: Position	O Outside bend I Inside bend S Straight
Part 3: Stability	U Unstable A Active
Part 4: Protection	V Vegetated F Fenced P Protected (vegetated and fenced) N Not vegetated or fenced

Vegetation (five-part code)

Part	Code	
Part 1: Type	N Native E Exotic G Grass M Mixed native and exotic	
Part 2: Structure	F Forest (tall dense veg/trees close) T Treeland (>3 m high/widely spaced/grass between) S Scrub (low stature/<3 m high/close together) Sh Shrubland (low stature/widely spaced/grass in between) G Grass (including small low lying weeds up to 1 m in height) W Wetland (raupo/sedges)	
Part 3: Dominant species	Native	Exotic
	Mn Manuka Kn Kanuka Kh Kahikatea Tt Totara Bh Beech Fn Fern Fl Flax Pt Pittosporum	Gr Gorse Ww Willow Gs Grass Or Orchard Pr Privet Bb Blackberry Tb Tobacco weed Eu Eucalyptus Pp Poplar Ba Barberry Mc Macrocarpa Cr Crop (for example, corn) Pn Pine
Part 4: Vegetation height	Average height of vegetation (in metres)	
Part 5: Width of vegetation	Width of vegetation from water <2 m, 2-5 m, 5-10 m, >10 m	

Other

Criteria	Code
Accessway	F Ford B Bridge

	Bc	Bridge with culvert
Obstruction	X V( ) D	Non-living debris Vegetation (type code) Dam

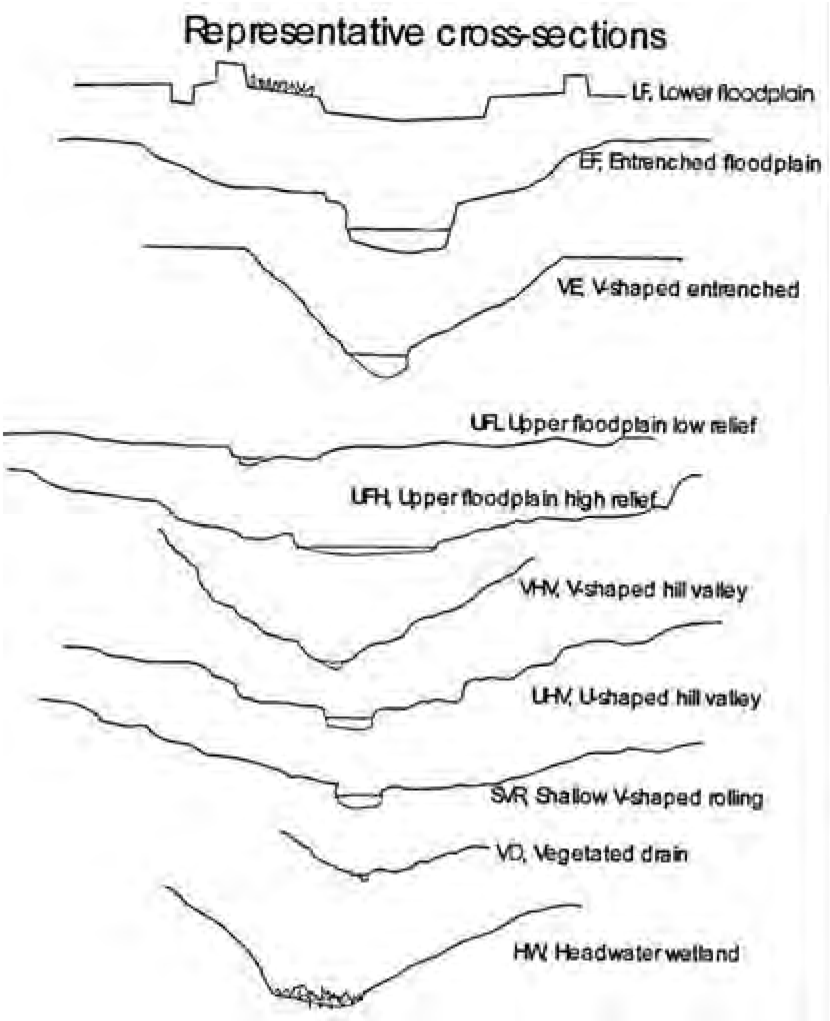
Additional codes

Criteria	Description
Weather condition	Fine/overcast/dry/rain
Land use	Beef/dairy/deer/horticulture/hay
Topography/soil order/geology	To come from GIS
Channel width	Estimate minimum and maximum width of channel, for example 5-7
Channel type	See channel type classes (next page).
Valley width	Estimate width
Channel shape	Channelised/meandering/straight/sinuous
Stream bed type	Silt/sand/gravel
Aquatic vegetation	Present/absent
Stock access to water	Yes/No

Photo description

- Erosion.
- Obstruction.
- Accessway.
- Vegetation.
- Fencing.
- Other (explain).
- Character.

Channel type classes (after Quinn, 1999)



Appendix 3: Letter to land owners

Flyer left at homes close to sample site when land owner cannot be located (printed on Environment Waikato letterhead).

Staff members from Environment Waikato are currently in your area undertaking a waterway survey.

The survey is being carried out over the entire Environment Waikato region. Waterways to be surveyed are chosen entirely at random by computer.

The main aim of the survey is to measure the type of vegetation, fencing and erosion that is present on each waterway.

Environment Waikato staff will be in the area for 1-2 hours. The staff conducting the survey can be contacted on:
025-

Or alternatively, if you require any further information please call Reece Hill in the Hamilton office on:
0800-800401.

Thank you