HAWKE'S BAY
REGIONAL COUNCIL

Tukituki Catchment
Riparian Assessment

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Environmental Science - Land Science

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Executive summary

Riparian assessment of the Tukituki Catchment provides baseline information on riparian conditions to inform the Hawke's Bay Regional Council's review of the water quality limit setting and secondly to examine the applicability of the methodology developed for the Council (Sarrazin & Zimmermann, 2003).

The Tukituki Catchment has 17 sub-catchments. The River Environment Classification and Freshwater Ecosystems of New Zealand database were used to locate streams and rivers from which the second to fourth order streams were extracted for assessment. First order streams were excluded due to the large number of such streams in the region. Fifth and larger order streams were excluded as most of them were braided rivers, with river beds often well over 60 m in width, which is a threshold when assessments of their riparian conditions become irrelevant. The riparian zone was taken to be the area inside a buffer zone reaching 30 m from each side of a centre line drawn on the river channel. The condition of the riparian zone was measured based on potential stock disturbance (the level of stock access to a stream) and riparian vegetation (composition and structure of the vegetation). This was a desktop assessment, using a geographical information system (GIS). Sub-catchments with a higher proportion under public conservation (e.g. Makaroro) showed lower level of stock disturbance and better riparian vegetation condition (both composition and structure). Sub-catchments where plantation forestry and steep gully systems act as barrier to stock access (e.g. Makaretu and Mangaonuku) also have low stock disturbance and good riparian vegetation conditions. Some of the sub-catchments such as Porangahau had a high level of stock disturbance and poor riparian vegetation. These findings suggest the level of stock disturbance and quality of riparian vegetation (vegetation structure and level of shading provided from the vegetation) are important for riparian condition.

The main technical limitation of this methodology is adequately assessing aerial imagery to describe the riparian environment. An investigation to ground truth the aerial images would reduce this limitation. A review of riparian monitoring protocols would help establish a robust State of the Environment monitoring of riparian zone.

1 Introduction

Hawke's Bay Regional Council (HBRC) reviewed the rules and limits for freshwater water quality and quantity in the Tukituki Catchment as part of the Plan Change 5 process. The National Institute of Water and Atmospheric Research (NIWA) was contracted to develop a water quality model incorporating land use and groundwater to use in testing land use change scenarios for the plan change. This model included elements which affect the riparian zone. .

The riparian zone is generally described as the vegetated strip of land along streams and rivers where interactions between land and waterways occur. Landform on which such vegetated land occur includes hill slope and flood plains.

The riparian zone is an important transition between terrestrial and freshwater ecosystems. It has a diverse range of ecological, sedimentological and hydrological functions, which are broadly categorised as a buffering function and intrinsic values.

The riparian zone buffers sediment, nutrient and water inputs from the land to the freshwater ecosystem by its above-ground (canopy, foliage, stem, litterfall) and below-ground (root) biomass. For example root system of vegetation provides bank stability, reducing the risk of erosion and resulting sediment inputs. Where roots intercept groundwater flow, plant uptakes dissolved nutrient, reducing nutrient input to waterways. Surface roughness provided by grass or litter reduces the velocity of overland flow, resulting particulate filtering and nutrient uptake by plants and microbes. In an event of heavy rainfall, tree canopy intercepts the rainfall, which is transported via foliage and stem flow to the ground, thus mitigates the risk of landslide associated with intensive rainfall.

The riparian zone also provides intrinsic values such as a range of habitats that encourage biological diversity in both terrestrial and freshwater ecosystems. Heterogeneity created from hanging vegetation, roots, and fallen logs provide ideal habitats for native fish such as inanga and long-fin eels. A range of native birds can benefit from such vegetation, including ducks, shags, pigeons, and passerines.

These two issues are related since lower nutrient, sediment, or pollutant inputs from land to water improve water quality and reduce nuisance sediment levels in the stream. Larger plants such as shrubs and trees also provide diverse habitat, and stream-side shading, which has water quality and ecological benefits.

1.1 Purpose of the assessment

This assessment serves two purposes:

1) To benchmark the aspects of riparian condition including stock disturbance and vegetation condition, (Section 2). This assessment forms part of the implementation of the Tukituki Catchment plan change. This will provide data on catchment riparian condition to help model water quality response to different levels of nutrient and sediment inputs.
2) To examine the applicability of the riparian assessment method developed by Sarrazin & Zimmermann (2003) to a catchment scale. This report details the methodology used and the results of the assessment, and identifies limitations, and recommends how these may be resolved.

2 Methodology

In this study the Tukituki Catchment is divided into sub-catchments of 17 major tributaries (Appendix A). The sub-catchments were coded as T1 to T17[1]. ArcGIS version 10 was used for the entire assessment except the data analysis, which was carried out using Microsoft Excel. More detail is shown below.

2.1 Rationale for the selection of width of the riparian zone and order of streams to be assessed

Key findings from the Ministry of Agriculture and Forestry (now part of the Ministry for Primary Industries) review of riparian buffer zone effectiveness (Parkyn, 2004) were:

- A buffer 20-30 m wide can remove nearly all nitrate from the land before it reaches surface water, on low gradient slopes.
- If a buffer is forested, a 10 m wide buffer can remove 70 % of the nitrate
- Where a self-sustaining buffer of native vegetation is present, a buffer width of 10-20 m is recommended as a minimum.

Given this exercise aimed to contribute to a nutrient model, a width of 30 m was used to examine riparian condition.

Stock disturbance (measured by level of stock access) and riparian vegetation was visually assessed in streams of 2nd to 4th order as classified by the River Environment Classification (see section 2.2). 5th and higher order streams were excluded, since most had braided beds often over 60 m wide. These rivers were wider than the area being examined, so the riparian margin could not be considered. There were too many 1st order streams to consider in the time available, so these smaller streams were also excluded.

2.2 Data and data processes

River-related data[2] were extracted from FENZ (Freshwater Ecosystems of New Zealand) and used as a platform for this assessment. FENZ is a spatial database in which freshwater ecosystems (rivers, lakes, and wetlands) are classified according to biological and abiological attributes (Leathwick, 2010). As the FENZ datasets are of national scale, it was clipped to the Tukituki Catchment boundary. A buffer of 30 m on each side of a centre line was created for each reach[3] of the river. The 30 m buffer is considered to be the riparian zone.

The River Environment Classification (REC) is another national database for rivers that classifies and groups rivers that have similar physical characteristics (Snelder, 2004). The REC was developed before FENZ, and is integrated in the FENZ, although the stream order data is not included in the FENZ database. The 30 m buffer (polygon) was joined with the REC, which resulted in a dataset that contains the order of each stream. As mentioned above, only 2nd to 4th order streams were extracted for visual assessment.

2.3 Visual Assessment

The 30 m buffer (riparian zone) along all of the 2nd to 4th order streams was layered onto *Kiwi Image Aerial* (2010). The aerial image within the buffer was visually examined and classified by riparian vegetation condition and stock disturbance following criteria adopted from Sarrazin & Zimmermann (2003) (Table 1 & Table 2).

[1] HawkesBay_WaterManagementCatchments layer was used for extracting sub-catchments in the Tukituki Catchment.

[2] River-related data is polyline data. Level IV dataset was used (see FENZ).

[3] Within FENZ river dataset, each river reach is assigned with unique ID (NZ Reach ID)

Table 1. Riparian vegetation class (adopted from Sarrazin & Zimmermann, 2003)

Riparian Vegetation Class	Riparian Vegetation Class Characteristics
Excellent	Predominantly indigenous vegetation with dense groundcover which provides sufficient shading along the streambanks, is mainly intact and the riparian vegetation width is larger than 5 m*
Good	The riparian vegetation is dominated by exotic species. The completeness of the bank or the streamside vegetative buffer is generally reduced, although the lateral extent is still sufficient to provide benefits in terms of shading to the stream.
Fair	The riparian vegetation is full of gaps and does not provide sufficient shading or other benefits for the stream environment. Vegetation consists predominantly of exotic species and the width of the bankside vegetation is small.
Poor	The stream/river is nearly void of any trees and suffers from insufficient shading. Predominantly pasture grasses and weeds make up the vegetative cover along the waterway.

*'5 m' was measured visually during the assessment, e.g. where there are 1 or more rows of tree canopy present, vegetation width was considered to be 5 m or more.

Table 2. Stock disturbance class (adopted from Sarrazin & Zimmermann, 2003)

Stock Disturbance Class	Stock Disturbance Class Characteristics
Excellent	Stock has no access to the waterway and no stock damage is visible.
Good	Stock has access to a small part of the stream/river and stock damage is low
Fair	Stock has access to most of the stream/river and stock damage is evident.
Poor	Stock has access to the entire stream/river and stock damage presents a strong impairment.

Riparian vegetation structure was also classified based on 'classname' of LCDB 3, or using the classification Atkinson (1985) where the latter is more relevant. Land Cover Database version 3 (LCDB 3), public conservation area (provided by Department of Conservation), QE II National Trust covenant area and New Zealand 10 m contour were used as supplemental information to help assess riparian condition and stock disturbance. Where the visual assessment had low confidence[4], it was recorded in the attribute table as ground-truthing required.

2.3.1 Assumptions developed during visual assessment

- Where terrain is steep and likely to be unsuitable for grazing, particularly where good or light vegetation was found, it was assumed that stock access to streams was relatively low risk.
- Where the river forms a gorge and/or a large landslide exist, it was assumed that there was lower risk of stock access to the stream.
- It was assumed that smaller streams were more susceptible to stock access/disturbance.
- 'Stock damage' and 'strong impairment' included soil erosion and visible changes in colour of waterways due to erosion, sediment input, and defecation from stock.

[4] Confidence level may be low due to various reasons such as insufficient quality of the aerial image. The fence line may be hidden under the canopy of vegetation, which also leads to low confidence in the assessment.

- Where rivers were braided and the riparian zone (ie, within the 30 m buffer) was primarily river gravels, the riparian condition was assessed immediately outside of this buffer to a width of approximately 30 m.
- Areas of forestry were assumed to have minimum level of stock access, i.e. excellent stock exclusion

2.4 Final data processing in ArcGIS

The assessed 30 m buffer was converted from polygon to polyline format. This involved firstly cleaning the polygons, and secondly splitting REC data (polyline) within the cleaned polygon. The resulting data was 17 sets of polyline data that had all the attributes from the polygon, including stock disturbance and riparian vegetation. All 17 sets of data were then merged into a single polyline shapefile. This shapefile is available from HBRC on request.

2.5 Data Analysis

The attributes of the polyline shapefile were exported to Microsoft Excel for further calculation. The proportion of stock disturbance and riparian vegetation classes were calculated from the total length of all the streams assessed. For example, a figure of 17% in the 'poor' stock disturbance class in sub-catchment 'T1 – Waipawa' means that 17% of the total length of 2^{nd}, 3^{rd} and 4^{th} order streams has a high level of disturbance due to stock access (Figure 3-1 & Table 2).

3 Results

3.1 Stock Disturbance Class

The Makaroro (T17) sub-catchment has the lowest level of riparian disturbance (Figure 3-1). This is because a large part of this sub-catchment is at high altitude. It also falls within the public conservation area managed by Department of Conservation (DoC), from which stock are excluded (Appendix B). The Makaretu sub-catchment (T7) has low disturbance levels, which is attributed to a combination of the upper area being protected (by DoC) and the steep gully systems along the main channel.

Waipawa (T1), Mangaonuku (T2), and Upper Tukituki (T4) sub-catchments have relatively low disturbance. All of these sub-catchments are located in the upper area of the Tukituki Catchment, falling partly within the public conservation area managed by DoC. Hawea sub-catchment (T14) has a relatively low stock disturbance level despite being located in the lower part of the Tukituki Catchment. This is due to the high proportion of land cover under plantation forestry through which the streams flow, and also due to the steep gully systems along many of the streams, which inhibit stock access to the streams.

Sub-catchments such as Maharakeke (T8), Mangatarata (T10) and Upper Tukituki Corridor (T15) in the middle to lower Tukituki Catchment tend to have higher disturbance to their streams. By contrast, the Porangahau sub-catchment (T7), though located in the upper part of the Tukituki Catchment, has the highest stock disturbance in any of the sub-catchments in the Tukituki Catchment.

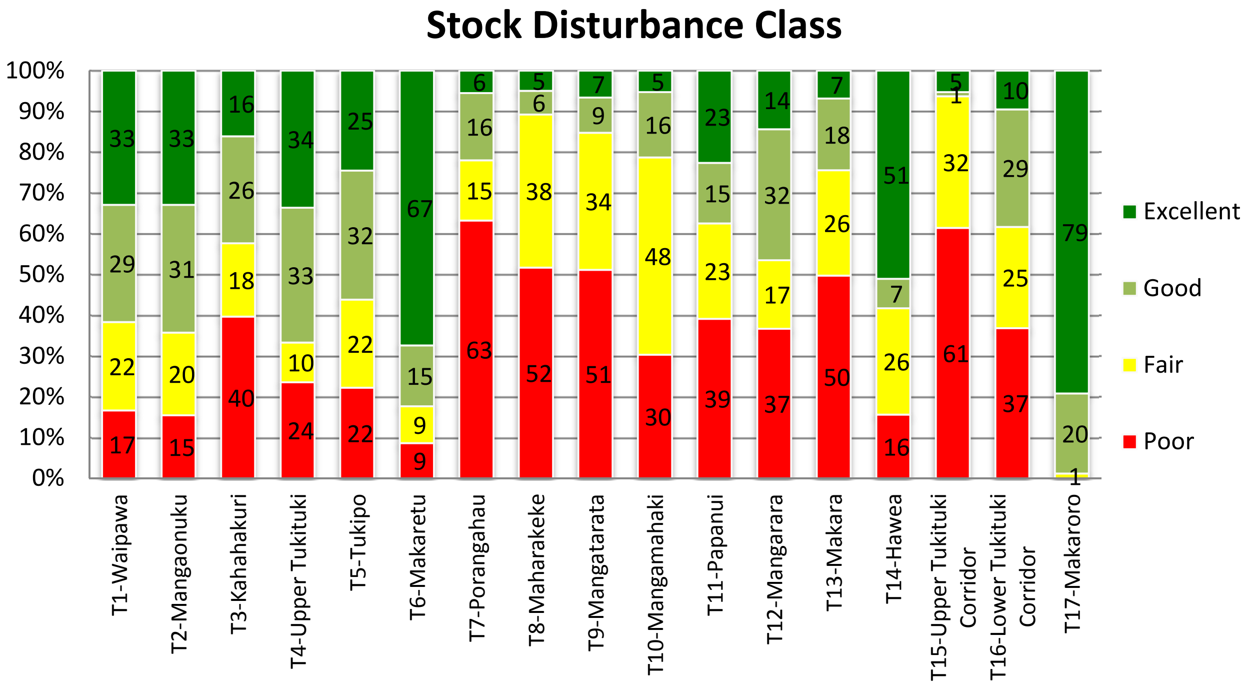

Figure 3-1: Stock disturbance classes of Tukituki sub-catchments. Any totals that do not sum to 100% in the diagram are caused by rounding.

3.2 Riparian Vegetation Class

The pattern of vegetation conditions shown in Figure 3-2 is similar to the pattern of stock disturbance shown in Figure 3-1.

The Makaroro sub-catchment (T17) has the best riparian vegetation – predominantly indigenous (Figure 3-2). This is probably because a lot of the Makaroro sub-catchment is conservation land (Appendix C). The next best sub-catchment is Waipawa (T1), in which most of the 'excellent' indigenous dominant riparian vegetation tends to be confined to higher altitude or stream escarpments.

Riparian vegetation dominated by exotics is more prevalent in Mangaonuku (T2), Upper Tukituki (T4) and Makaretu (T6) sub-catchments. The Hawea sub-catchment (T14) has 'Good' riparian vegetation, predominantly plantation forestry.

Porangahau (T7), Maharakeke (T8), Mangatarata (T10) and Upper Tukituki Corridor (T15) sub-catchments have a high proportion of poor riparian vegetation.

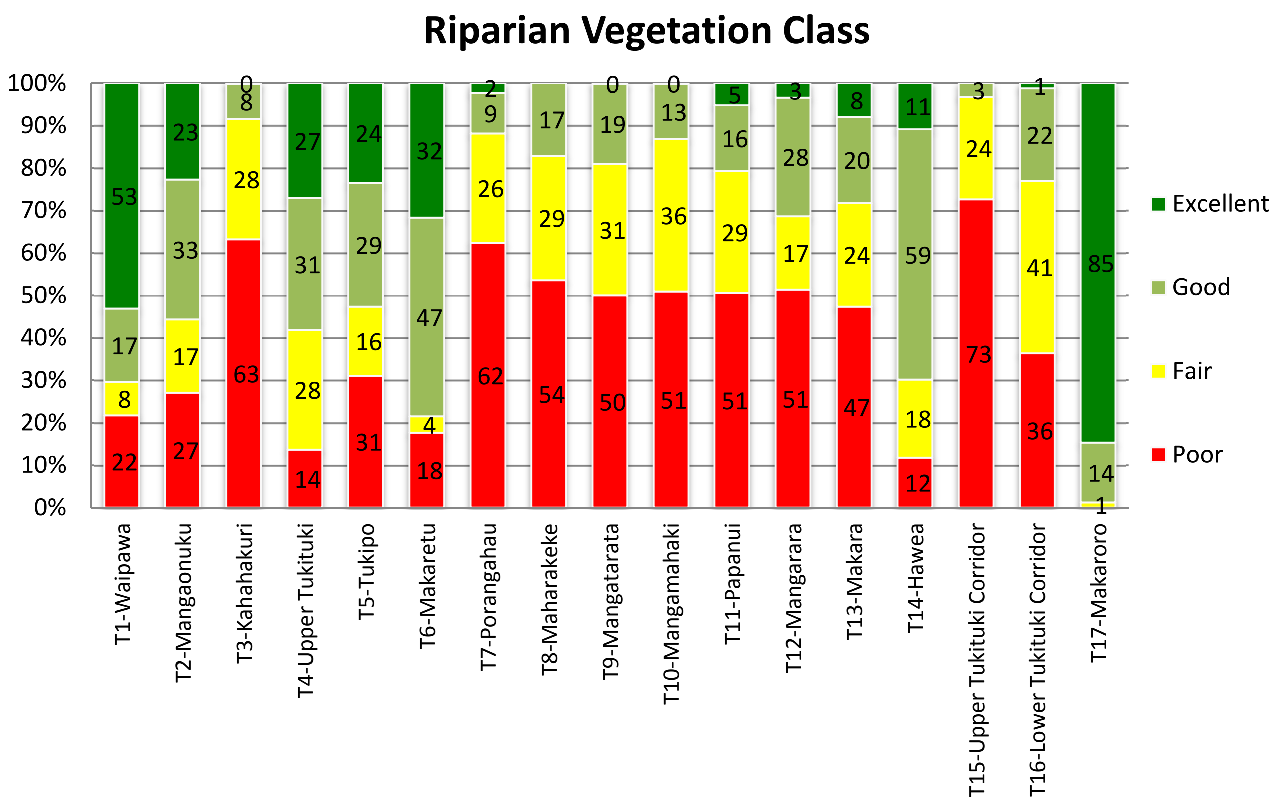

Figure 3-2: Riparian vegetation class of Tukituki sub-catchments. Any totals that do not sum to 100% in the diagram are caused by rounding.

4 Technical Limitations of Method

Technical limitations were identified during this study. These technical limitations may restrict the data presented above to a preliminary and indicative analysis only. The specific technical limitations include the following:

- This exercise was undertaken using 2010 aerial imagery. This is therefore a snapshot of a particular state in time. No trends can be accounted for in this analysis.
- Some of the aerial imagery was of inadequate quality to assess stock access and riparian vegetation.
- Fence lines were often discontinuous and/or placed to stop grazing animals from accessing streams. This affected the visual assessment of stock disturbance.
- The 30 m buffer around some of the higher order streams of lower than 5th order are within braided river systems, which makes assessment problematic.

Many of these issues may be dealt with through ground-truthing. Indicative proportions of the stream/river reaches where ground-truthing may be required are shown in Table 3. Higher percentages indicate lower confidence in the results. Ground-truthing may also capture changes in the riparian conditions that have occurred since the aerial imagery was captured in 2010.

Table 3. Proportion of modelled stream length within the sub-catchment that may require ground truthing for stock disturbance and/or riparian vegetation class.

	%
T1-Waipawa	22
T2-Mangaonuku	24
T3-Kahahakuri	35
T4-Upper Tukituki	12
T5-Tukipo	25
T6-Makaretu	24
T7-Porangahau	0
T8-Maharakeke	0
T9-Mangatarata	18
T10-Mangamahaki	18
T11-Papanui	0
T12-Mangarara	13
T13-Makara	11
T15-Upper Tukituki Corridor	4
T16-Lower Tukituki Corridor	17
T17-Makaroro	4

First order streams were omitted because insufficient time and resource was available during the assessment. To fully assess the impacts of land use activities on water quality and ecology, these smaller, upstream reaches may need to be included.

5 Conclusions

This broad-level assessment of the state of the riparian condition in the Tukituki catchment provides baseline data and examines the applicability of the methodology.

The assessment has provided an overview of the riparian conditions of the Tukituki Catchment. It has identified sub-catchments with relatively poor riparian conditions. Results has shown a clear correlation between the level of stock access and riparian vegetation, in other words the riparian vegetation of good structure and quality is generally associated with less stock access and less erosion.

Such information would help the other sections of the council to prioritise the area where management actions are most needed. For example the information would help the Land Management section to implement the Tukituki Plan Change 6, prioritising sub-catchments where management actions such as stock exclusion and revegetation is necessary. The baseline information also would help the policy and planning section with regard to reviewing the rules and guidelines around vegetation protection in relation to soil conservation and water quality.

The information presented in this report will also form integral part of the sediment production and transport model (SedNetNZ) which predicts sediment loss and movement at a farm scale.

Methodology used poses some technical limitations. This has been addressed in this report for future improvements of the method.

6 Acknowledgements

I would like to acknowledge the contribution made by Fiona Cameron for her work in the initial pilot study of the Papanui and Porangahau sub-catchments.

I would also like to acknowledge Dr. Barry Lynch (HBRC) who instigated this project and proposed the use of visual examination of high resolution aerial imagery to examine riparian condition. I would also like to thank Dr Lynch for his peer review and valuable feedback, which are reflected in this report.

7 References

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Appendix A Sub-catchments of Tukituki Catchment

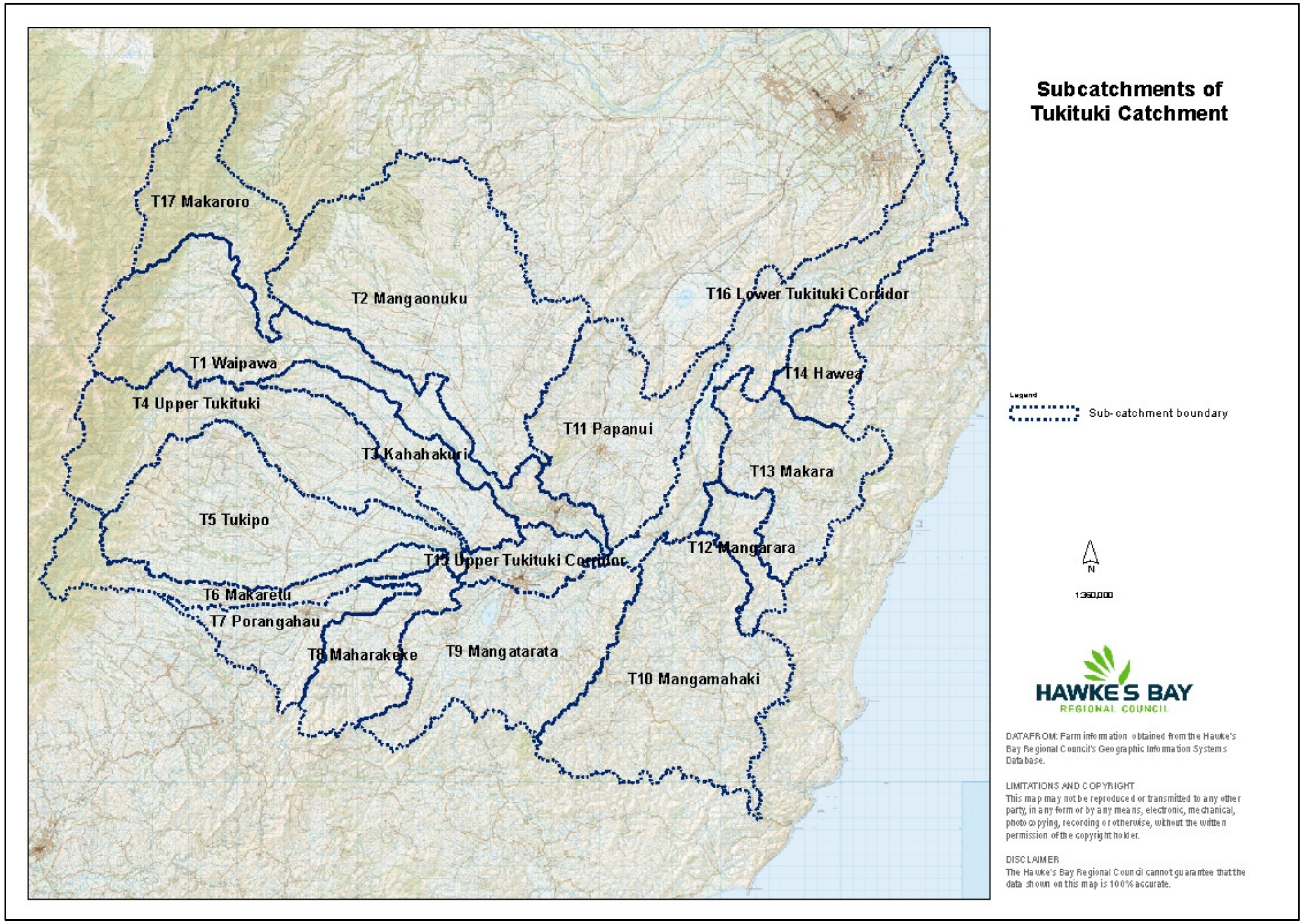

Figure A-1: Sub-catchments of the Tukituki Catchment.

Appendix B Stock Disturbance Class

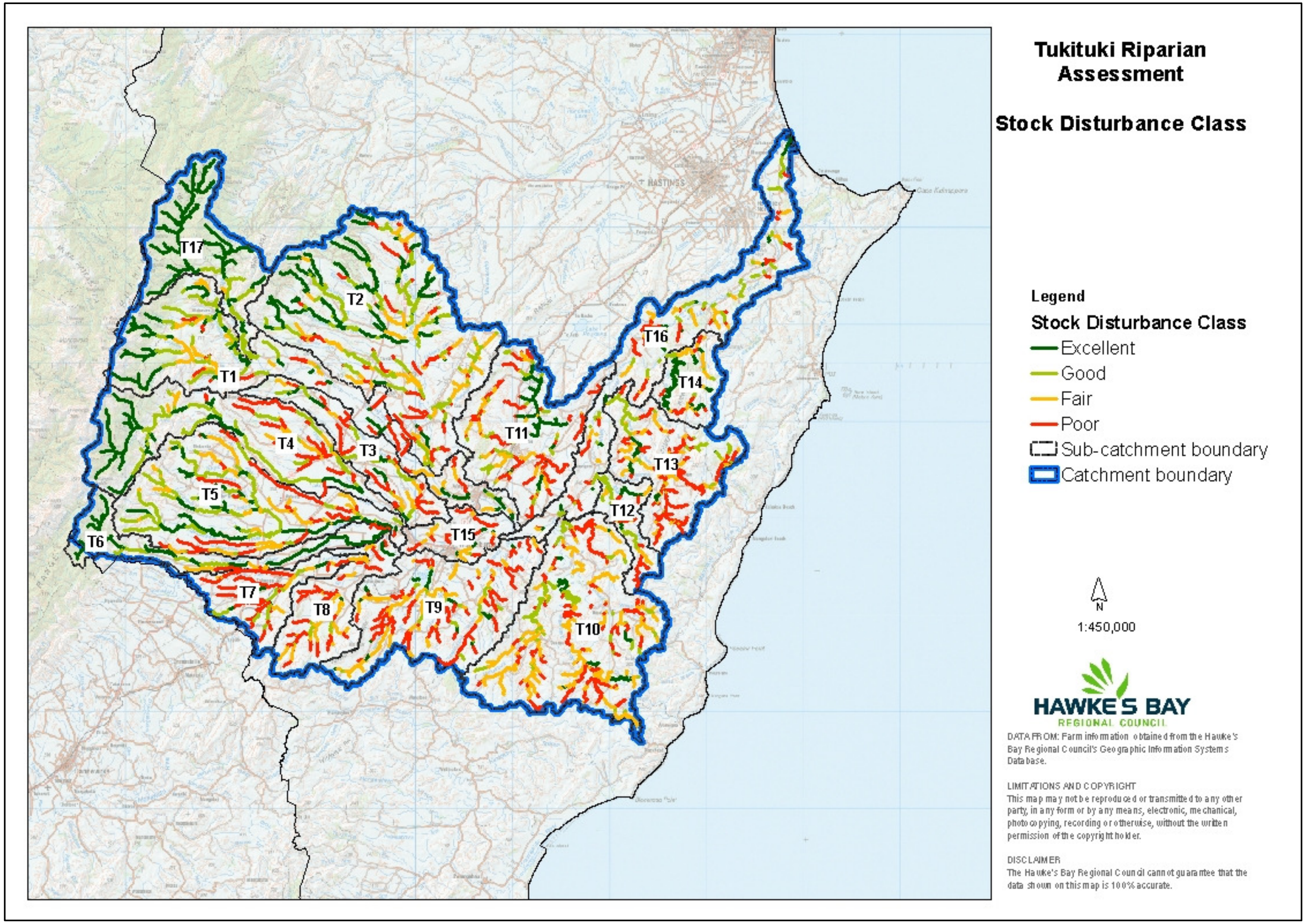

Figure B-1: Stock Disturbance Class.

Appendix C Riparian Vegetation Class

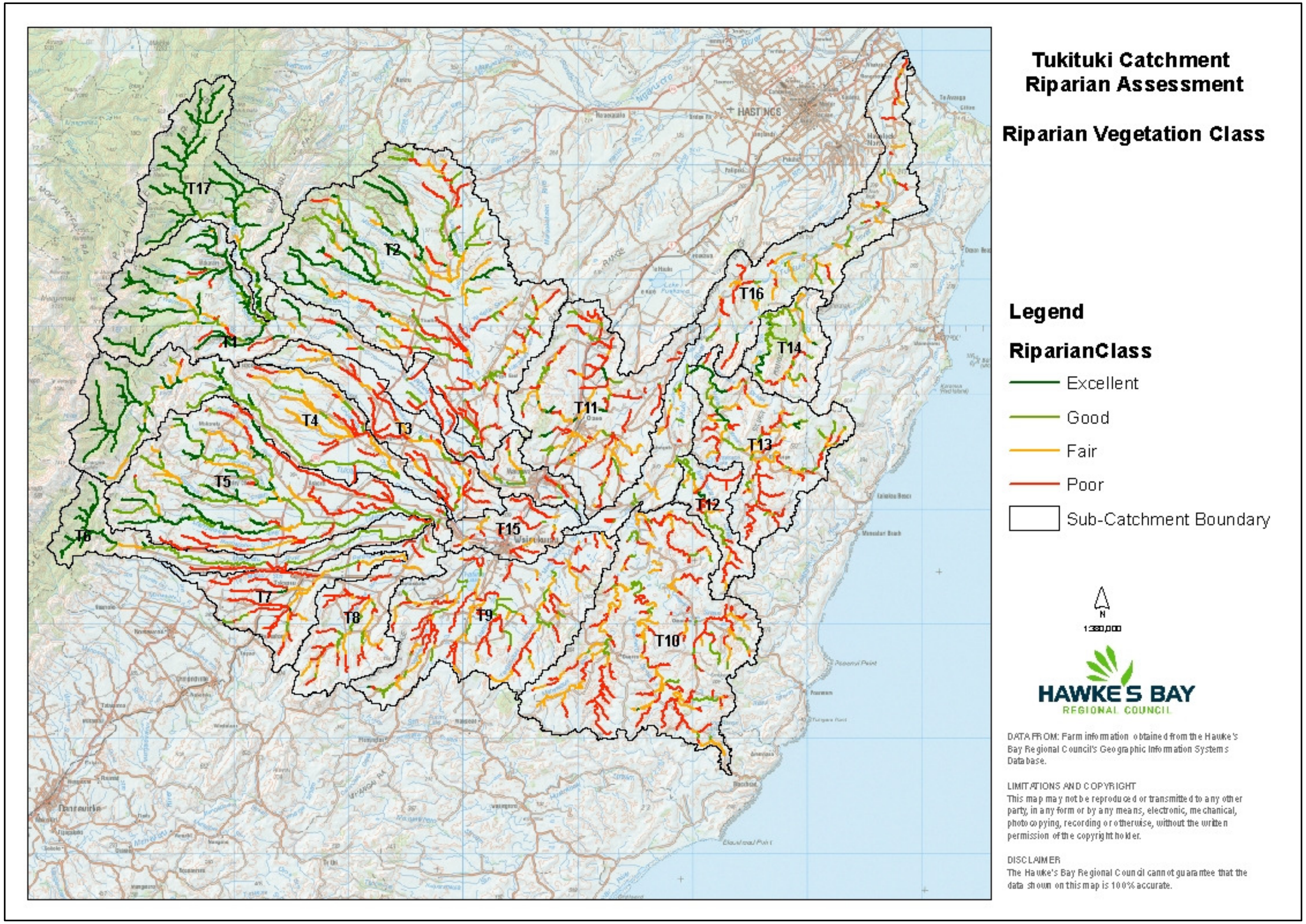

Figure C-1: Riparian vegetation class.