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MAKATOTE-KOPUAROA STREAM MEAN BED LEVEL TRENDS; 1958 TO 2017.

1.0 Introduction:

This is one of a series of reports on river/stream bed level trends in the Waiapu catchment, Ruatoria, commissioned by the Environmental section and the (former) Roading section of the Gisborne District Council.

The Makatote and Kopuaroa are the same stream; the Kopuaroa commencing upstream of the Totaranui stream tributary, some 6.3 kilometres from the confluence with the Mata River.

The following trends in mean bed levels have been derived from cross section surveys by the former East Cape Catchment Board and the Gisborne District Council, commencing in 1958. Trends have been assessed starting at the most upstream cross section, EC522, approximately 16 kilometres upstream of the confluence with the Mata River. "*Mean bed levels*" has a specific meaning in relation to braided rivers on the east coast, and a full definition is provided in the Addendum.

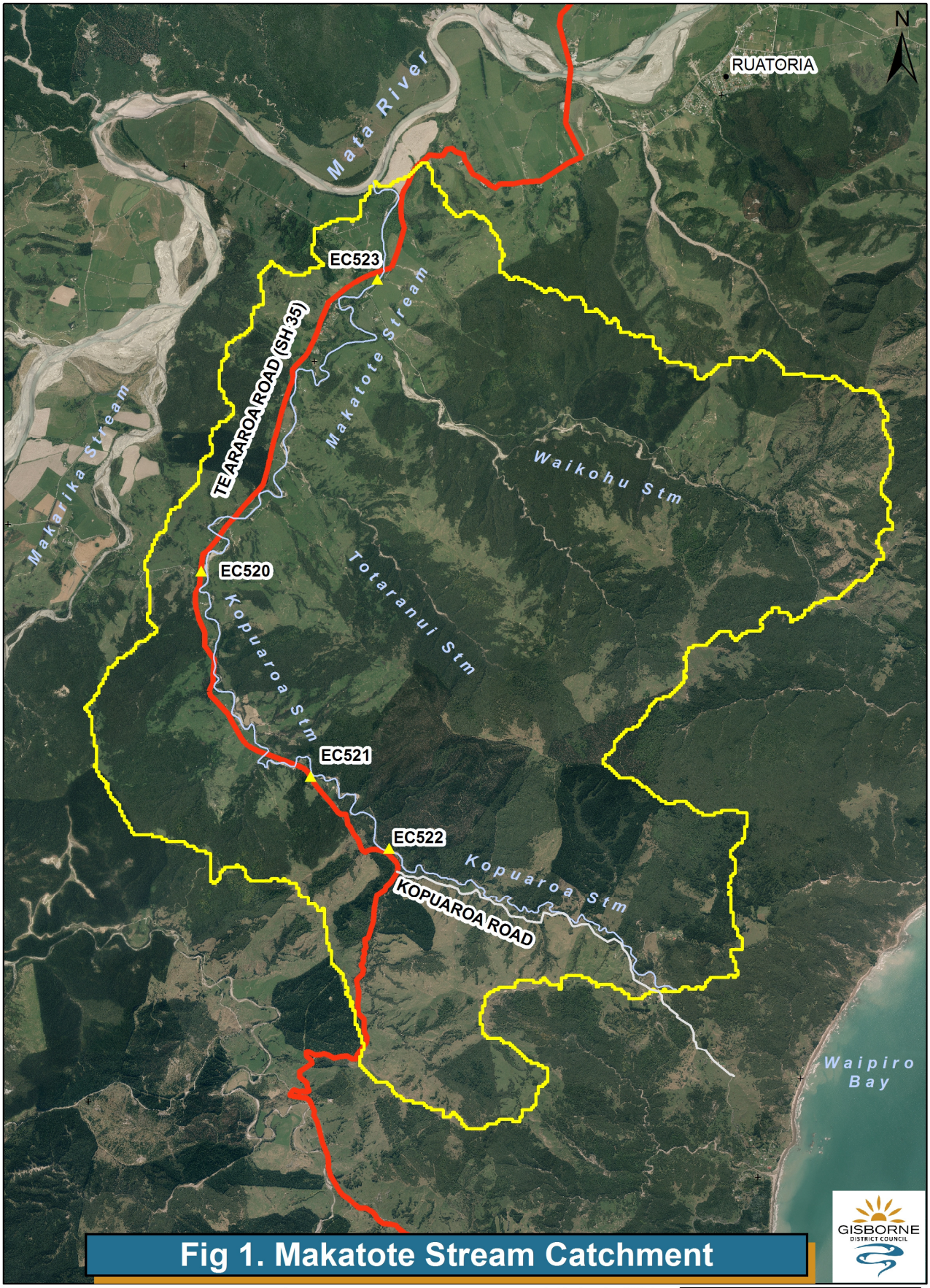
Cross section surveys are only a "snapshot" of the river bed levels at a specific location on a particular day. Because of the movement of bed load material in "waves" during floods and freshes, there are frequent naturally occurring fluctuations in mean bed levels. While long term trends in mean bed levels are reasonably reliable indicators of bed level change, shorter term trends (ie; from surveys over ten years or less) are not reliable and it would be unwise to rely on these surveys alone.

2.0 The Makatote-Kopuaroa River catchment:

The Makatote-Kopuaroa Stream, is known as the Makatote Stream up to the Totaranui tributary, a distance of some 6.3 kilometres from the confluence of the Makatote with the Mata River. Upstream of the Totaranui tributary it is known as the Kopuaroa Stream; see Figure 1.

The Kopuaroa reaches a further 15.7 kilometres running approximately parallel to and to the west of SH35; and then adjacent to Kopuaroa Road, almost as far as Te Puia. The literal translation of the name "Kopuaroa" is "*long river/stream with deep pools*". The stream is certainly long but it is likely that most of, if not all, the deep pools have long since been infilled with sediment following the clearing of the indigenous bush in the late 19th and early 20th centuries.

The Makatote-Kopuaroa Stream is a total 22 kilometres in length, and has a catchment area of 71.5 square kilometres; see Figure 1.


N
RUATORIA
Mata River
EC523
TE ARAROA ROAD (SH 35)
Makatote Stream
Makarika Stream
Waikohu Stm
EC520
Totaranui Stm
Kopuaroa Stm
EC521
EC522
Kopuaroa Stm
KOPUAROA ROAD
Waipiro Bay
GISBORNE DISTRICT COUNCIL
Fig 1. Makatote Stream Catchment
Land Information
Name: makatote
Path: X:\Projects\makatote.mxd
Date: 23/06/2017
User: mdc
Contains Crown Copyright Data - Sourced from Land Information NZ. Orthophotography - NZAM,Terralink & Aerial Surveys
Scale 1:60,000

3.0 Executive Summary:

At the most upstream cross section at EC522, since 1967 mean bed levels have degraded at a rate of 58 to 69mm/year, except for a sudden increase in mean bed levels circa 1988, thought to be the result of sediment input from the Cylone Bola storm. It would appear that forestry has been very successful in shutting down erosion sources in the upper catchment, ie; upstream of EC522.

Further downstream, between EC 520 and EC521, the stream appears to be in a state of equilibrium with respect to its sediment input, while at EC523 (just upstream of the SH35 bridge), the MBL plot shows a gradual degrading trend with little variation from survey to survey.

Because of the fine-grained texture of the bedload (pebble, sand and silt-sized particles) and poor quality of this material, no shingle has been extracted here for commercial purposes in the past (according to GDC records since 2001), and it is most unlikely that shingle will be extracted from this stream in the future;

Whilst the long term mean bed level trends are reasonably accurate, shorter term trends ie; over 10 years or less, are not considered as reliable. It is recommended that cross section surveys are carried out in the future at the same sites at two yearly intervals**.**

4.0 Stream Distances:

As for the Makarika Stream, it has been noted that Makatote-Kopuaroa Stream distances (measured along the centre of the alluvial surface from January 2015 Google Earth aerial photography), are quite different from the original distances between bench marks. The following table compares the original stream distances with the 2015 stream distances:

Survey Bench Mark	**Original Distance (m)**	**2015 Distance (m)**	**Difference (m)**
Mata confluence:	0m	0m	
EC523	1,580	1,650	70
EC519	4,740	BM now missing	n/a
EC520	8,390	9,085	695
EC521	12,210	13,855	1,655
EC522	14,200	15,885	1,685

This discrepancy of up to 1,685 metres between the two measurements in the above table may be due in part to increasing sinuosity of the stream course, particularly between EC520 and EC521, or may be an error in the early channel length measurements, or both. In the author's opinion, errors in the original measurements (scaling from 1:10,000 photography) are likely to be the main source of the discrepancies.
For consistency throughout this report the 2015 stream distances have been used.

5.0 River bed load material grading:

The Makatote-Kopuaroa has a relatively fine-grained bed load; pebbles, sand and silt sized particles similar to that in the Makarika, which is in the adjacent catchment to the west. The reason for this lies in the similar lithologies of the two catchments, as described by Dr M Marden in item 5 of the Addendum.

Figure 2 shows the Kopuaroa stream bed at Kopuaroa No. 1 bridge, which is approximately 14 kilometres from the confluence with the Mata River, and a short distance downstream of EC521. At the SH35 bridge (figure 3) some 12.5 kilometres downstream, the bed material appears to be very fine grained indeed.

Fig. 2: *Kopuaroa Stream at No. 1 bridge; Photo: D Peacock, 7th Nov. 2011.*

Fig. 3: *Makatote Stream at SH35 bridge; Whareponga Road turnoff. Photo: D Peacock, 7th Nov. 2011.*

6.0 Kopuaroa Stream Mean Bed Levels:

Figure 4 below, shows mean bed levels for the two cross sections plotted together. The plot for EC522 is at the correct elevation, but the plot at EC521 has been adjusted upwards 15 metres, so that the two curves can be conveniently compared.

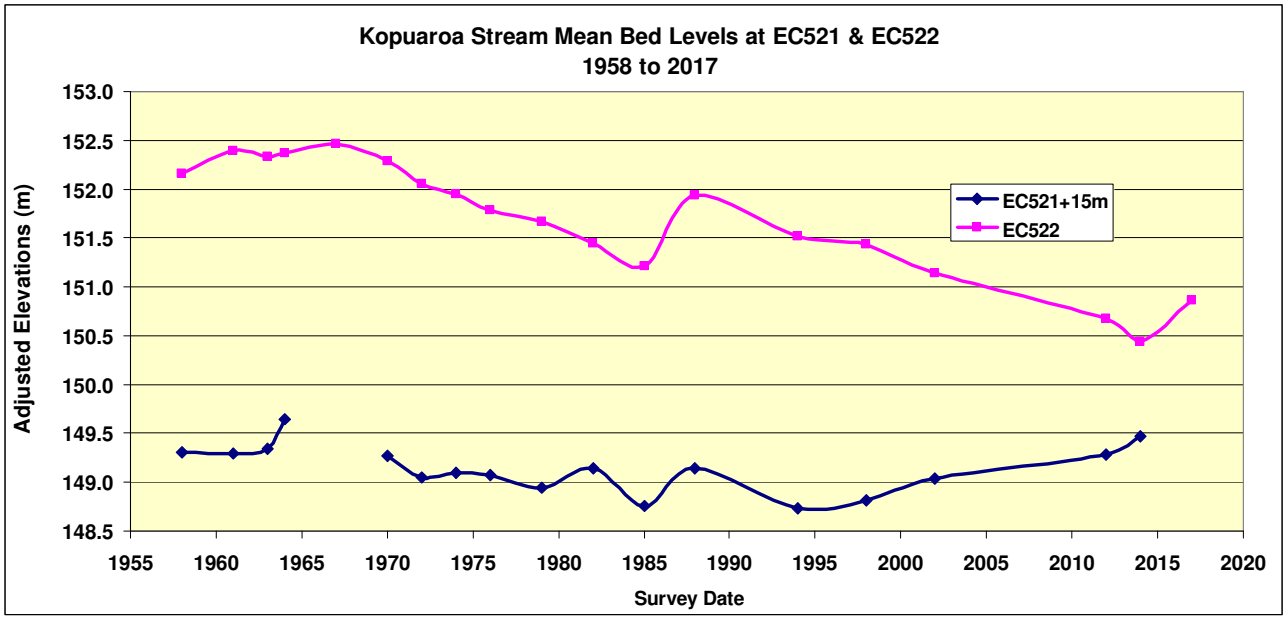


Fig. 4.

EC522:
At the most upstream cross section in the Kopuaroa stream, EC522, mean bed levels have been relatively steady between 1958 and 1967, after which there has been a rapid degrade over the next 18 to 20 years; averaging 69 mm/year. The survey in 1988 was carried out in September of that year, so it is likely that the sudden increase in mean bed level (shown on the graph between 1985 and 1988) was due to the input of sediment into the stream channel from erosion caused by the Cyclone Bola storm in March 1988.

For the next 28 years from 1988 the stream bed at EC 522 continued to degrade at a slightly slower average rate of 58 mm/year until 2014. It would appear that forestry has been very successful in shutting down erosion sources in the upper catchment.

EC521:
Mean bed levels at this cross section have been steady over time, with a slight degrade from 1964 to 1972, and a small rise in mean bed level between 1985 and 1988, no doubt attributable to sediment input from the Cyclone Bola storm. Contrary to the mean bed level trend at EC522, mean bed levels then gradually rise until the last survey in 2014.

Given the differences between the mean bed level plot at EC522 and the plot at EC 521, a distance of only two kilometres apart, it would appear that there has been significant sediment input into the Kopuaroa stream between the two cross sections. Dr M Marden comments as follows: *"The forestry block in the vicinity of these 2 cross sections was likely planted to slow down earthflow activity and prevent the small linear gullies from deepening so I suspect the influx of sediment post Bola was because these earthflows showed signs of reactivation in response to Bola".* Alternatively, or in addition, the sediment input may have come from the reworking of channel material from upstream of EC521.

There has been substantial reforestation since circa 2002 on the right bank between the two cross sections, but the effects of this (if any), are yet to show in the mean bed level plots.

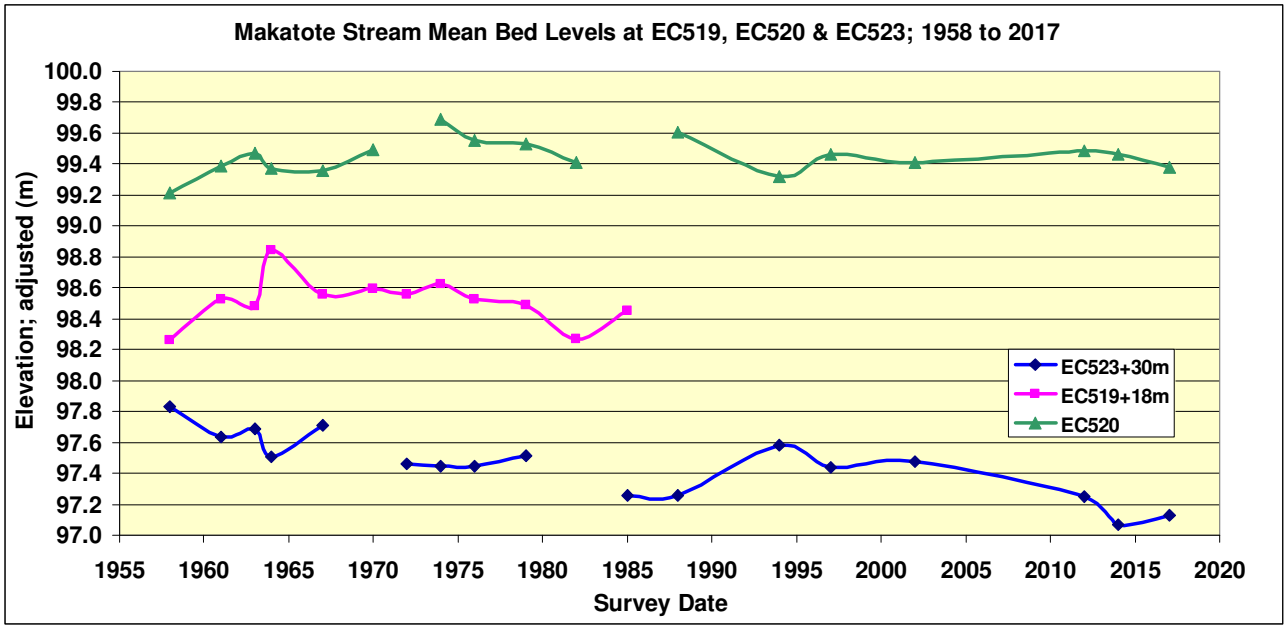


Fig. 5

7.0 Makatote Stream Mean Bed Levels:

Figure 5 shows mean bed levels for the three cross sections EC519, EC520 and EC523 plotted together. EC 520 is actually on the Kopuaroa Stream and has been incorrectly named as on the Makatote in the survey records.

The plot for EC520 is at the correct elevation, but the plots at EC519 and EC523 have been adjusted upwards 18 and 30 metres respectively, so that the three curves can be conveniently compared. The trend line for EC520 is virtually flat with not more than about 300mm deviation from this line.

Unfortunately the last survey at EC519 was in 1985. Given the relatively minor changes in mean bed level from the EC521 cross section to EC520, the stream over this 4.8km reach appears to be in a state of equilibrium with respect to its sediment input. The plot at EC523 (just upstream of the SH35 bridge), shows a gradual degrading trend with little variation from survey to survey.

8.0 Conclusions:

- At the most upstream cross section at EC522, since 1967 mean bed levels have degraded at a rate of 58 to 69mm/year, except for a sudden increase in mean bed levels circa 1988, thought to be the result of sediment input from the Cylone Bola storm;
- It would appear that forestry has been very successful in shutting down erosion sources in the upper catchment, ie; upstream of EC522;
- The stream over the 4.8km reach between EC 520 and EC521 appears to be in a state of equilibrium with respect to its sediment input;
- The plot at EC523 (just upstream of the SH35 bridge), shows a gradual degrading trend with little variation from survey to survey;
- Because of the fine grain size and poor quality of the bed load material, no shingle has been extracted here for commercial purposes in the past (according to GDC records since 2001);
- While it is most unlikely that shingle will be extracted from this stream in the future, the cross section surveys will provide a useful record of the impact of future storms or changes to the catchment land use;

- Whilst the long term mean bed level trends are reasonably accurate, shorter term trends ie; over 10 years or less, are not considered as reliable.

9.0 Recommendations:
It is recommended that:

1. Cross section surveys are carried out in the future at the same sites at two yearly intervals**;**

NB: *Recommendation 1 should be subject to further review when survey methods using the latest available technology; ie drone surveys and DEM's, have been appraised for use on all of the Waiapu catchment rivers*.

Acknowledgements:

- Ian Hughes and Brian Currie; for providing a continuous high quality survey record for the past 59 years;
- Mark Cockburn for the preparation of Figure 1;
- Dr. M Marden, for comments on the effect of reforestation, and for item 5 in the addendum.
- Paul Murphy for checking and commenting on the draft reports;
- Dr. J Tunnicliffe, Environmental Science Dept; University of Auckland; for preparation of items 1 to 3 in the addendum;

Prepared by:
D H Peacock;
23rd June 2017**.**

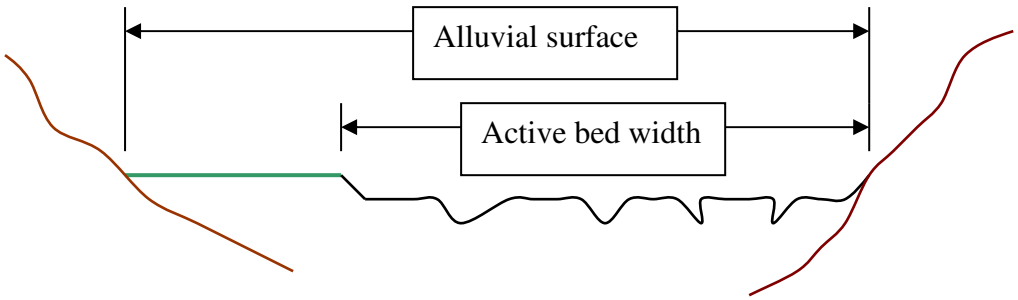
ADDENDUM

The following definitions and explanations have been provided to clarify the terms used in this report. Items 1 & 2 have been kindly provided by Dr Jon Tunicliffe; while item 5 has been prepared by Dr Mike Marden.

1. Mean river bed level:
"In the context of actively braiding or anabranching rivers found in the East Cape, ***mean river bed level*** refers to the average topographic elevation across multiple channels (including bed and banks) and the actively reworked (non-vegetated) alluvial surfaces, such as bars and braidplains. Changes to the mean bed elevation across this active transport corridor reflects adjustments to reach-wide sediment storage over time.

2. Reach:
A ***reach*** is length of river, typically constituting several meander wavelengths, with relatively homogenous governing conditions, e.g. discharge, channel geometry and floodplain extent."

3. Alluvial surface and active bed width:



The above diagram (not to scale), shows the ***alluvial surface*** for a braided river bed and the ***active bed width*** as measured by the cross section surveys. The green coloured terrace on the left of the diagram represents a terrace with vegetation at least one year old which is no longer considered to be part of the active river bed. ***Mean bed levels*** are computed for each cross section from the mean of all the levels taken within the active bed width.

4. Aggradation rates chart:

The following chart applies only to rivers/streams in the Waiapu catchment or the upper Waipaoa catchment.

Aggradation Rate mm/yr	**Descriptive term**
0 to 9	Negligible
10 to 29	Gradual
30 to 99	Moderate
100 to 199	Rapid
200 to 499	Very rapid
>500	Extreme

5. Makatote-Kopuaroa catchment lithologies:

The following explanation has been kindly prepared by Dr M Marden, Landcare Research, Gisborne:

The bedrock underlying the upper reaches of Kopuaroa Stream, a tributary of the Makatote Stream, is the Tapuwaeroa Formation. It consists of fossiliferous sandstone dominated alternating sandstone and mudstone with minor conglomerate, breccia and mudstone. Whangai Formation underlies the Waikohu and Totaranui Streams, also tributaries of the Makatote Stream, and consists of non-calcareous mudstone overlain by well-bedded calcareous mudstone.
In its upper catchment reach the Waikohu Stream is incised into bedrock comprising the Weber and Wanstead Formations. The Weber Formation consists of poorly-bedded, grey calcareous mudstone with thin beds of green glauconitic sandstone. The Wanstead Formation consists of pale, green-grey, calcareous and non-calcareous mudstone intercalated in places by red, brown and white smectitic mudstone, and thin glauconitic mudstones. As evidenced by the presence of thrust faults these formations, dominated by fine-grained mudstone were highly tectonised during the emplacement of the East Coast Allochthon (Mazengarb and Speden 2000). All these lithologies have been locally folded and faulted resulting in disrupted bedding and loss of coherence. This together with groundwater seepage permeating through these thrust fault zones accounts for the presence of springs and seeps at the surface hence the presence of extensive areas of earthflow incised by small,

shallow, linear gullies. Extensive reversion in Waikohu Stream, together with several small block of exotic forest likely established to slow the rate of earthflow activity, has undoubtedly prevented these linear gullies from deepening and generating more sediment.

The fine-grained texture of the bedload (pebble, sand and silt-sized particles) in these streams is in keeping with other rivers that drain a similar mix of fine-grained, disaggregated lithologies with similar high rates of attrition and downstream fining e.g., the Makarika Stream. This contrasts with the bedload of the Mata River which drains a significant area of thicker-bedded, younger-aged and therefore less tectonically disrupted lithologies, thus the bedload is coarser (cobble to boulder-sized). The coarser bed load is also less mobile and attrition rates are lower, thus downstream fining is less evident.