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Tauranga Harbour

Sediment Source Survey

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Cover Photo: Erosion site with young and old willows, both with potential for causing further problems.

Executive Summary

Environment B·O·P has undertaken a field survey of 23 of the major streams flowing into Tauranga Harbour. The work was undertaken as a component of general investigations of the natural environment of Tauranga Harbour. The work was done predominantly during the university vacations of 1995/6, 1996/7 and 1997/8.

The report provides an order of magnitude estimate of sediment transported from stream bank erosion into Tauranga Harbour from the harbour catchments. The report describes and costs possible stream improvement works and estimates the reduction of sediment yields such works may achieve.

Contents

Chapter 1: Introduction

This report investigates stream bank erosion as a factor in sediment input into the Tauranga Harbour. Some areas of the Tauranga Harbour are perceived to be silting up rapidly, with loss of habitat and amenity values. Tauranga Harbour has and will continue to naturally aggrade and infill over the long term, however certain land use practices can reduce elevated levels of sediment input. This report investigates the major streams and rivers to determine if works such as bank erosion protection, riparian strip fencing, clearing of obstructions and the like will have a significant effect on the sediment input to the harbour. In the process, a description of the condition of each of the streams has been made along with comments on flood protection and stream channel improvements.

The report concentrates on describing and illustrating the current condition of each stream individually. Where known, a brief history in note form, including Catchment Commission or Regional Council involvement is provided.

The final section compares the condition of each stream in a summary format, allowing prioritisation of works to reduce sediment input into Tauranga Harbour, with comments on the benefits that can be gained from reductions in sediment supply.

The site survey work was undertaken by university students over the Christmas vacations of 1996/7 and 1997/8. The report begins with the easternmost stream (Waitao) and works through to the Tuapiro Stream in the west.

Chapter 2: Background

Excess sediment in waterways and harbours can degrade habitats by restricting breathing of fish and smothering of biota that in turn restricts feeding of larger species. It can also change the balance of habitat types, e.g. turn open water into mangrove-suitable habitat. In addition, the presence of high levels of sediment from other than bank erosion may also indicate that other contaminants can easily enter waterways. A proportion of some contaminants, (Pb, Cu, Zn etc), adhere to sediments and may be released slowly into the environment at their resting place. Bacterial and nutrient contamination of waterways is not dependant on sediment supply, but some soil conservation measures such as riparian retirement can significantly reduce levels of bacterial, nutrient and sediment contamination (Cooper, 1990). Bacterial and nutrient contamination of some streams in the Tauranga Harbour catchment are of concern, as several streams do not meet bathing water quality guidelines (McIntosh, 1994).

Soil conservation efforts in the Bay of Plenty have traditionally concentrated on the upper and middle reaches of streams and on vulnerable slopes, where soils are prone to gully erosion, sheet erosion and slips. Many vulnerable parts of the Tauranga Harbour catchment are largely protected in this way, primarily by retirement from grazing and maintenance of vegetative cover. Other land uses with a high potential for sediment generation, such as large scale earthworks and quarrying, are controlled by consent. However there still exists considerable potential for sediment to enter waterways from these processes.

A particular source of sediment is from stream bank erosion. Many hundreds of kilometres of waterways exist in the Tauranga Harbour catchment; some 73 streams are named on 1:50,000 maps and 27 on a 1:250,000 map. This study focuses mostly on the floodplains and gentler topography of the larger streams and rivers. In general, stream bank erosion is more prevalent on floodplains than elsewhere, partly because the material there is relatively small and easily eroded, but partly also because stream banks within gorges are generally already clear of sediment from past erosive events. Where streams are very small, stream energy is low, so grasses are often sufficient to hold stream banks together (even if the particles are small), so bank erosion is less prevalent. Where the majority of the headwaters are in native bush, no attempt has been made to survey or measure sediment supply from these areas. It is noted that streams appeared relatively free of sediment at the top end of each survey, although most surveying was carried out in summer and with good weather. The survey covers some 133km of 23 streams and rivers. The streams are described from east to west, and in the direction of survey (generally downstream). The distances quoted are measured upstream from the stream mouths.

Advice for stream management has been given by soil conservation and engineering staff when requested, along with financial assistance when appropriate. At many sites, however, the focus is on production rather than stream management. In many areas, grazing right up to the waters edge is practised, leaving a weak or exposed bank, or with stock actively breaking

down the banks. In other places, stream areas are seen as unproductive or difficult to use and are neglected, to become overgrown often with plant pests and more difficult to use. Where vegetation or debris blocks a stream, bank erosion may be the result as the stream cuts a new path around the obstacle.

Monthly measurements of sediment concentration in the main streams and rivers entering Tauranga Harbour were undertaken under a separate study from 1990. While there is considerable variation due to various flow rates at the time of sampling, over time, a picture could be built up of the relative contribution of sediment each stream makes. The last part of this study analyses the correlation between bank erosion and those measurements of sediment concentration. There is, naturally, considerable subjectivity in the descriptions of bank erosion and the extent of the survey for each stream.

Each stream was photographed at various locations; note that it is difficult to take photographs that give the whole picture of congested streams – partly because of that congestion. The effects are, however, evident in several photographs.

Chapter 3: Waitao Stream

3.1 Description

The Waitao Stream catchment of 33km^2 is a predominantly bush-covered area, relatively steep in the upper reaches, joined on a floodplain (3-4km from Rangataua Bay) by the Arateka Stream and the Kaiate Stream, each with a larger proportion of farmed catchment than the main stream. A moderate amount of land is forested.

Figure 3.1 Upper Waitao catchment in a relatively steep valley

Figure 3.2 View down the middle catchment of the Waitao

3.2 History

Three isolated stopbanks built in lower reaches by BOPCC in 1975, 1981, 1986, protecting individual properties.

Minor willow clearing 1994. Major clearing 1978, 1968.

Many complaints of silting, accusations of quarry causing silting since 70s and continuing. Quarry contributed to cost of works in 1978.

There is a history of congestion of willows and bank erosion. There is a common belief Environment B·O·P is responsible for willow, bank maintenance.

A good set of photographs of the lower area was taken in December 1995. (Hewitt,1995)

3.3 Current Situation

Figure 3.3 Ground vegetation of banks is dominant in the last 600m to the estuary

Figure 3.4 A willow growing in the stream 900m from the estuary.

Figure 3.5 Overhanging may collapse into the stream in future

Figure 3.6 Potential for stream blockage on fence

The stopbanks are all in good condition with adequate berm width, with the exception of one location at the upstream end of the southernmost bank, which is eroding. There are no trees at this location, refer Figure 3.7.

Figure 3.7 An eroding stopbank at 3.45km

There is a grassed spillway in good condition near the Kaiate confluence, which cuts out a bend which has several willows and an old, low bridge partially blocking it. Another spillway just downstream of this was contracted to be built (but was not observed).

In total, there were eight locations where logs had fallen right across the stream, twenty-three locations where there were partial blockages, six places where willows were growing out of the middle of the stream bed and seventeen trees identified as posing potential problems as they grow bigger. There were eleven locations where recent minor bank erosion was identified, all in the absence of tree growth on the banks (refer Figure 3.8). There is one staff gauge located alongside the middle stopbank, WL on survey day was 0.73m on the gauge.

Figure 3.8 Sediments from erosion may be deposited and stored until larger flows transport them further.

Figure 3.9 *The upper reaches may have obstructions, but little damage is caused here as flood waters have plenty of room to spread and the banks are vegetated.*

Figure 3.10 *Valley in the middle part of the catchment, 4.6km from the estuary, has a flood plain of 50 to 100m.*

Figure 3.11 Waitao Stream near Kaitemako Quarry

The most congested areas are:

- between 1050 and 1400m upstream of the mouth:
  three full and at least five partial blockages,
  one in-stream willow.

- between 2200 and 2400m:
  three in-stream willows,
  several partial blockages.

- between 2700 and 2900m:
  one full and six partial blockages.

There is minor bank erosion at the following distances from the mouth: 1780m, 1820m, 2250m, 2400m, 2800m, 3450m, 3550m, 3800-3900m. The only current concerns would be with the stopbank at 3450m and where a blockage is worsening erosion at 2800m.

The stopbank locations are as follows:

- Right bank 1700-2000m
- Right bank 2300-2800m
- Left bank 2800-3450m

3.4 Conclusion

There is considerable blocking of the waterway in several locations along the lower reach of the Waitao stream. In areas where the banks are grassed (rather than treed), minor bank erosion is evident. The stopbanks present appear to be doing their job, although one spot requires maintenance. In general, the immediate stream banks are not high (1-2m). Some areas are grassed, some covered with blackberry and some planted with willows. From 1978 photos, the stream bed level appears to be similar (if anything, a little lower now).

Maintenance of the waterway, in particular the clearing of willows likely to cause blockages, is vital in reducing the flood risk and erosion of banks of the lower stream area. To reduce future problems associated with overgrown willows, alternative plantings could be investigated. In particular, an area of manuka appeared to hold the bank together sufficiently without creating significant debris problems. A preferred cross-section probably includes a fenced area that may include willows and shrubs, but not with the willows right on the bank edge or in the stream. Because of their easily reproduced nature, willows may not be particularly appropriate for this catchment.

Individual landowners have obviously benefited from past stopbank works. Further stopbanking is quite possible along much of the lower reach, although the floodplain is fairly narrow in some places so would be of limited benefit there. Stopbanking has been proposed in the past on the right bank just above the Arateka confluence - this is probably the most viable area. Any proposal would need careful assessment - a full reach scheme may not be justified.

Chapter 4: Kaiate Stream (Tributary of Waitao)

4.1 Current Situation

1.5km above its confluence with the Waitao, the Kaiate Stream cuts through flood plains with average bank height around 2m. Within the lower reaches, frequent willows are rooted in and beside the water and partially block the 1.5m wide channel.

Moderate erosion is present at some locations. The plains are mostly grass covered. A quarry is as close as 30m from the stream near Waitao road; a pond beside the quarry reveals the potential for high sediment input to the stream with rainfall. Further upstream are more blockages that, while small, fully dam the stream. Little water is held behind them at normal flows, but during high flow would cause significant restrictions to flow.

Figure 4.1 Partial blocking of the Kaiate Stream

Figure 4.2 *Near the top of the flood plains, large willows span the river, partially blocking it (seen to the right). Flooding is evident to 2m above the water level and some minor erosion is noted.*

Chapter 5: Kaitemako

5.1 Description

The Kaitemako catchment of 11km^2 is mostly rolling farmland and runs into Welcome Bay.

5.2 History

There have been no major problems or works undertaken in this catchment in the recent past.

5.3 Current Situation

Below the bridge, the stream is tidal, widens to 4m, and deepens (to about 1.2m). The floodway narrows to 25m and is heavily vegetated with trees and wetland plants, however, the channel itself remains mostly clear (1 or 2 partial blockages).

Above the bridge, trees are uncommon, the floodway mostly being covered in reed sweetgrass *(Glyceria Maxima).*

Figure 5.1 The floodplains of the lower reaches are currently mostly vegetated in Glyceria Maxima with a few dispersed willows.

The floodway generally varies between 50 and 100m wide, narrowing to 30m in a housing area where fill has reduced the floodway width The stream channel itself is about 2m wide for a considerable length, varying from 0.4m to 0.7m deep. Banks are generally 0.5m high, although this increases to 2m near the road bridge. There are thick growths of *Glyceria Maxima* in the channel all along this reach. The channel has been straightened and follows the right edge of the floodway, with a bank (used as a walking track) formed along the right bank (over a stormwater pipe).

There is one willow growing in the channel and one large pine tree has fallen across (above) the stream. Debris was observed about 1.2m above the ground level in some willow trees in the floodway. Some gorse, blackberry, shrubs on right bank.

Figure 5.2 Debris draped on a willow tree above the normal flow does not presently choke the stream at 1km.

Figure 5.3 Fallen pine tree at 1.2km lies above the stream.

Figure 5.4 2 km above the streams mouth, the Kaitemako flood plains are still covered in glyceria maxima.

5.4 Conclusion

The lower reach of the Kaitemako stream is generally clear of large obstructions, but is reduced in capacity by thick *Glyceria Maxima* growths. The continued use of the floodway as a wetland area means no problems are created by this. The stream appears to have a significant gradient, which means that if some areas are desired to be grazed, say, it may be possible to achieve this by reducing downstream obstructions. However, the current situation is probably desired aesthetically for this relatively urban stream.

Chapter 6: Waiorahi/Waimapu

6.1 Description

The Waiorahi catchment comprises 40% of the Waimapu Stream catchment (101km^2) and enters the Waimapu Stream 2km from the Waimapu Estuary.

The Waiorahi is a particularly long (15km), narrow (2km) catchment starting in the Mamaku Plateau, following an incised, bush-lined gorge for most of its length and only emerging onto floodplains 3km from its confluence with the Waimapu stream.

The Waimapu catchment is slightly shorter and wider (up to 7km wide) away from the mouth; it is more pear-shaped. It is not particularly incised and flows through rolling farmland through most of its length.

Figure 6.1 The upper Waimapu Stream catchment characterises the rest of the stream.

Waimapu Stream has many minor tributaries all along its length, including Pukekonu, Kirikiri, Mangarewa, and Toropeke streams.

6.2 History

There appear to have been no major stream-related problems in these catchments in recent council records and no major works carried out.

6.3 Current Situation – Waiorahi

The lower reach of the Waiorahi Stream meanders through floodplains 100-200m wide, with banks generally less than 1m high (often 0.5m).

Figure 6.2 Meanders minimise stream gradient, consequently flood waters are retained longer but are less erosive due to lower velocities.

Just below the Oropi Rd bridge, there are four willows growing in the stream. The stream is clear of willows for the first 400m upstream of the road bridge, but from there to 2km above the bridge, there are many tens of willows growing in the stream itself, several partial blockages and a few logs right across the stream. The first 400m has thick *Glyceria Maxima* in the stream, restricting the 4m wide, 1.5m deep stream to a channel about 1m wide in several places. Twenty-two willows are growing in the stream and causing minor partial blockages. About a further ten are causing significant blockages.

The water level is very near the top of the bank at normal flow, so the stream will easily flood. This may reduce the erosion that would otherwise be caused by the willows.

Figure 6.3 *Here, 700m above its confluence with the Waimapu, willows strain the Waiorahi Stream. There is potential for increased blocking.*

Figure 6.4 *Erosion at 2.2km*

Figure 6.5 Downstream view at 2.4km, open flood plain with grasses to waters edge, some slumping of banks.

6.4 Conclusion – Waiorahi

The floodplains are probably frequently inundated and will continue to be more so if the willows are left to choke the stream further. The water level could be lowered by realigning the stream (which would allow some congestion to be bypassed), however, this would tend to increase velocities. Stopbanking would be of benefit to landowners, but would probably also require removal of all congestion to allow gravity drainage from paddocks. A first estimate indicates some 20ha could be protected to a 5yr level with 4km (24,000m^3) of stopbanks. Stopbanks would significantly reduce the floodplain area, so would tend to increase the amount of sediment transported downstream, unless reductions in sediment supply by limiting bank erosion were sufficient to offset the reduction in floodplain deposition.

6.5 Current Situation – Waimapu

Figure 6.6 Waimapu Stream mouth to the estuary.

The lower 2.2km reach to the rugby grounds is clear of any obstructions, although about ten willows alongside the grounds have the potential to cause problems in the future.

Figure 6.7 Stopbanking around the playing fields appears to be in excellent condition. Here, the stream is very wide (35m at the footbridge by the grounds) and slow-flowing.

There are two partial blockages and two overhanging willows just downstream of the SH29 bridge (2.3km). Between the SH29 bridge and the Pukemapu Rd bridge, there are many large willows overhanging and/or partially blocking the stream (especially 2.4km to 2.8km, refer Figure 6.8), six full blockages and eight partial blockages (mostly from 3.2 to 3.6km, refer Figure 6.9). The stream is about 10m wide here.

Figure 6.8 Overhanging willows are potential blockages.

Figure 6.9 Vegetation debris can thoroughly dam the channel.

Figure 6.10 Sediment at 4.1km resulting from bank erosion and fill dumping as seen in the background.

Between Pukemapu Rd (3.8km) and the start of a short gorge (4.5km), there is one willow growing in the stream which appears to be exacerbating erosion at that spot, but is otherwise generally clear. Logs are visible at the start of the gorge.

Figure 6.11 A mid-stream willow collects small debris making an effective barrier at the mouth of the gorge.

The gorge (4.5 to 5.3km) was not surveyed, but probably contains a moderate amount of debris, judging from the downstream condition. The upstream end of the gorge is clear, with water flowing in an 8m (estimated) wide, bouldery channel with a moderate gradient (some white water).

Figure 6.12 Downstream view from 5.6km towards gorge.

No problems are apparent in the stretch from 5.3 to 7.5km except for bank erosion on a sharp bend at the outlet of a quarry sediment pond (refer Figure 6.13).

Figure 6.13 High suspended sediment levels in pond at 6.1km, due to quarry activities.

Where there are berms, the stream banks are 2-3m high. Stock grazing was evident down to the waters edge along with indications of past erosion.

Figure 6.14 Some very steep banks have been fenced off, but most of the banks are grazed.

6.6 Conclusion – Waimapu

With no wide floodplain, the effect of blockages in the Waimapu is not severe. However, there are several large blockages, especially between 2.3km and 3.6km, which will only get worse as willows grow around them. There are also many large willows overhanging the stream and threatening further blockages. There would be only very minor benefit from stopbanking since only small areas would benefit.

Chapter 7: Kopurererua

7.1 Description

The Kopurererua Stream catchment is elongated in a northerly direction, covers 74km^2 and has a maximum elevation of 450m. It rises gently in the bush and farmland of the Mamaku Plateau, then follows a steeply incised gorge for 4km before meandering through a long series of floodplains, including the lower reach which passes through the Judea industrial area of Tauranga. It then enters the Waikareao Estuary of Tauranga harbour. A major tributary is the Tautau stream, which joins the Kopurererua 5km above SH29 (11km above mouth).

7.2 History

Extensive study of lower reach (below SH29 bridge) was conducted in 1985. It suggested leaving bulk of basin as storage area for floods; limited stopbanking, a catchment management plan, improved stormwater system, and continued monitoring.

Flood risk to Historic Village and Industrial area.

Extensive willow clearing in the lower reaches was carried out in ‘72 – ‘74, and again in ’85.

7.3 Current Situation – Kopurererua Stream from Waikareao Estuary to SH29 Bridge (at 6km).

The Judea industrial area skirts the river for the first 1km above the estuary. Trees and toitoi are frequent in this section with good bank vegetation. The river is $\approx$ 15m wide with 3m banks.

Figure 7.1 River past the Judea industrial area.

At the end of the industrial area, banks continue at around 0.5m in height, increasing to 1m within a couple of hundreds of meters. *Glyceria maxima* then appears in the channel to about 3km (refer Figure 7.2), growing out from the banks between 1 and 3m, effectively narrowing the stream width to around 4m in places.

Figure 7.2 Glyceria Maxima reduces the effective width of the stream.

From 3 to 4km, it appears that dumped fill material constitutes the right bank over several lengths of up to 50m (refer Figure 7.3). There is steady erosion on the left bank, probably due to tidal variation. From approximately 3km to the SH29 bridge (6km), there were five localities in which a stock path to the water's edge existed. The banks in this area were often partially supported by old tree trunks embedded in them - it is possible this is a product of previous tree clearings works. Water clarity was improved compared to near the mouth. Between 4 and 6km, the banks are well vegetated with occasional erosion. Only a few trees are present, commonly draping up to 2m into the main flow. Logs in several places are jammed across the streambed, often 10 to 20cm of water flows over these, resulting in localised swift currents.

Figure 7.3 Dumped fill adjacent to stream has not yet been tested by flood flows.

7.4 Current Situation – Kopurererua Stream Above SH29 Road Bridge

Figure 7.4 For the first 1.4km of the Kopurererua stream upstream from the SH29 road bridge, vegetation of the 1m banks consists mainly of grasses.

Minor, intermittent erosion is evident with one notable eroded face observed 100m upstream of the SH29 bridge. No channel obstructions were found. From 1.4 to 2.9km above the bridge, bank vegetation increases in the upstream direction becoming a significant feature higher in this section. It appeared to be tightly interwoven, and in places overhanging the stream perhaps up to 0.5m. Where vegetation did not dominate so much, the bank appeared more susceptible to being exposed from erosion. At one site, a branch and trapped debris blocked around the bottom third of the flow and relatively large sediment particles were observed to be transported from this point as suspended load due to the increase in velocity.

Over 1km upstream to 3.9km above the SH29 bridge, the thick bank cover vanishes. About ten trees were noted as rooted within or dragging in the river (refer Figure 7.6), and erosion (more easily visible) of banks (from 1 to 2.5m height) was apparent particularly on the outside of a bend.

Figure 7.5
Thick vegetation cover stabilises the bank

Figure 7.6 *Lone tree rooted on the edge of the stream, erosion on a nearby downstream bank.*

The next part of the stream is an open section with farmed land to the river's edge. Banks here have been eroded over a continuous 400m length (to 4.3km from SH29), refer Figure 7.7; there are no obstructions in the river over this section. Although bank heights commonly impede access to the river, hoof prints are occasionally found at the water's edge. Downstream of this, fencing which borders the river begins.

Figure 7.7 The true right bank is significantly eroded at 4km from the mouth.

Figure 7.8 Vegetation can protect the banks but has potential to impede the flow. Tight meanders increase the length of the river, reducing flood capacity and putting pressure on the outside of bends.

Beyond this, a thick cover of bank vegetation (blackberry & gorse) appears. Within this, the river moves into a spectacular meander for a distance of approximately 300m (i.e. 4.5 to 4.8km). Only a few trees (every 50 to 100m) protrude into the water in this section partially blocking the flow. Further up, a 500m stretch contains many trees, (refer Figure 7.9), that are growing in the streambed, so that most normal flow

is strained through the vegetation. Other trees bridge the river, adding to the blockages. Erosion and slumping of the bank is periodically visible within this section.

Figure 7.9 Many trees choke the river, from both growing and falling in the water.

Between this heavily vegetated section and the confluence with the Tautau stream (5.6km above the SH29 bridge), the tree density is halved, refer Figure 7.10.

Figure 7.10 Below the Tautau confluence, in-stream trees do not significantly congest the channel, banks are in good state.

Above the confluence, trees again heavily congest the Kopurererua stream. The flood plain is reduced here to around 100m. In contrast, the Tautau stream flood plain (contributing $\approx 1/3$ the final Kopurererua Stream flow) is roughly 40 to 60m, with practically no tree influence on the stream. Water clarity here is good, in contrast to the murky flow in the lower reaches. No point of sudden change was identified.

7.5 Conclusion – Kopurererua Stream

In the section to 1km below its confluence with the Tautau Stream, willows and other trees heavily choke the Kopurererua; most of these are growing in the channel. This section is closely followed by tight meanders, which in combination with the blockages accentuates the lack of ability to clear floodwaters hence inundating the floodplains. The most extensive erosion closely follows the meanders; however as the banks are low, only a modest volume of sediment is involved.

The effect that the rubbish dump has on the lower reaches was not observed; however by the time the stream nears the Waikareao estuary, all factors are contributing and the water is quite murky.

Chapter 8: Wairoa River

8.1 History

Commercial gravel extraction took place in the upper Ngamuwahine catchment from 1969. Blockages of drains on land adjacent to the Wairoa were cleared from sedimentation and pumice deriving from an outcrop near Belk road, in 1967 and 1979. In 1981 the Ruahihi project was officially opened and failed catastrophically within a day. There was much concern about immense soil input to the river and harbour from various groups. Much of farmed land in the lower reaches was flooded, resulting in 0.5cm of very fine sediment deposition. Little erosive damage/slumping to banks occurred other than at the point of entry to the Wairoa. Only a small proportion of sediments was thought to be discharged to the harbour initially, with the remainder retained on the bed. Normal flow conditions are thought incapable of transporting sediments. Some reports state that opposite Belk road, at low tide, deposition has narrowed the river to half its normal width.

2.5km of stopbanks exist.

8.2 Description

Water from the upper catchment of the Wairoa River is diverted and retained in a network of hydro-scheme lakes, which tend to trap sediment. Sections of the Wairoa and Mangakarengorengo beds are almost dry under normal conditions due to diversions. Water re-enters the Wairoa river at the Ruahihi powerhouse (12.5km upstream of the railway bridge at the estuary) joining a clearer but minor flow from other lesser tributaries.

Figure 8.1 Mangapapa catchmen; Lloyd Mandeno penstocks to the left.

Figure 8.2 Further down viewing across the Wairoa catchment.

8.3 Current Situation – from Ruahihi to Harbour

Water appears tainted slightly orange/brown below the Ruahihi power house, yet this is also evident above the hydro-schemes, hence is suspected to be related to ground water and run off flows. A 0.5 to 1m deep rocky bed (refer Figure 8.3) is bounded by 10m high banks around 50m apart; previous flooding is evident to 4m. Grass grows down to the water's edge, with trees generally set back a little. The river is clear of trees and debris, and there is some tidal influence here. 12km upstream of the railway bridge, there is a stretch of erosion 20m long and over 4 to 5m high. The right bank is mainly grass to the water's edge; farmland extends for most of the river. At 10.4km, a distinct change to a sandy bed is apparent, which dominates the remainder of the river.

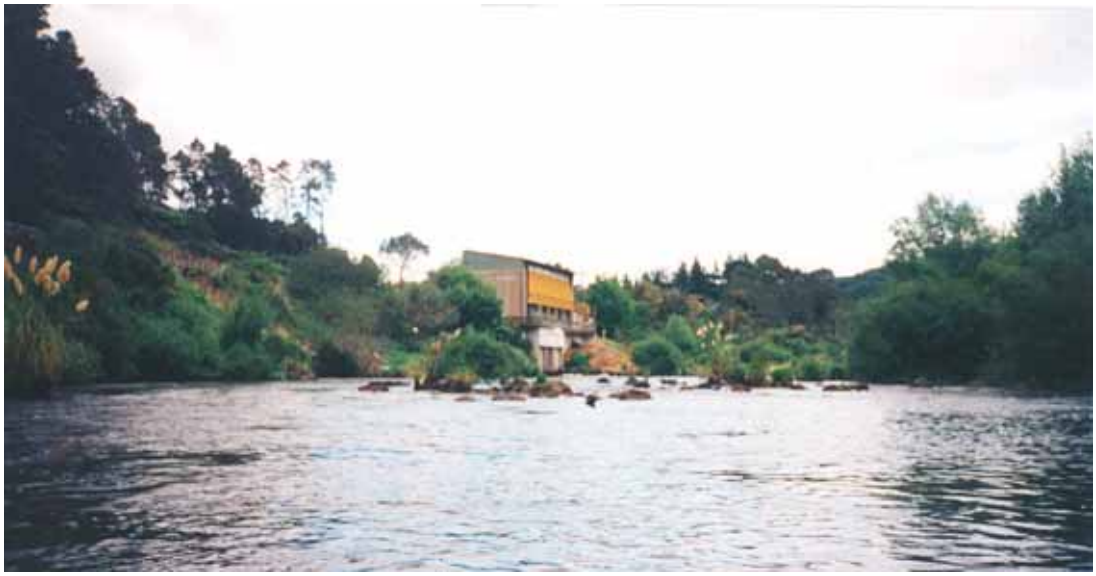

Figure 8.3 Shallow rocky bed at the Ruahihi power house.

At 9.5km Omanawa River joins the Wairoa; the Omanawa was observed as cloudy and takes some distance downstream of the confluence to mix laterally. Waireia stream (at 8km) while also considered murky, has a small flow rate; fallen trees lie across this stream. Forestry lines the left bank of the Wairoa until the Ohourere

stream (at 6.6km); some sections of bank are rocky. Periodic erosion has occurred, however revegetation is also apparent.

Figure 8.4 Confluence of the Wairoa and the Omanawa rivers.

Lower banks (2m ± 1m) start from around 6km on both sides. At 4km, several trees overhang the river (refer Figure 8.5) and two dead trees lie in the water, however the width of the river has increased to 80m so that the proportion remains small. The banks within the normal tidal range are unvegetated (at least 0.6m in some places).

Figure 8.5 Downstream view, recontoured right bank, and cattle to waters edge.

Figure 8.6 Large trees in the river, (living or dead), have only a small impact once the river widens.

Downstream of the railway bridge to SH2 bridge (a distance of 1.5km) the river widens slightly; on the edge of the channel, reeds grow in a soft mud. Past the railway bridge, the river develops into an estuary.

8.4 Conclusion – Wairoa River

Because the Wairoa is almost completely diverted through the Ruahihi power scheme under normal flow conditions, sediments in the water are low at the Ruahihi site because of settling in the hydro lakes. From Ruahihi to the Harbour the Wairoa has a small gradient and is relatively wide, hence little erosion is caused on this section of river by the slow flow, and floods don't generally significantly increase the water level. The bulk of sediments in the river are thought to originate through some of the main tributaries. Trees that protrude into the river have little impact, due to the small proportion of flow they affect.

Chapter 9: Omanawa River

9.1 History

Meander straightened in 1960, extensive eroding.

Mid 60's - willow cuttings planted for bank stability. Silting, erosion and willow blockages noted in later years.

Active erosion in places but "only where it can be controlled by plantings", i.e. the lower end.

Early 1989, large discoloration noticed in the river, source located and now known as Jensen's gully. Steep gully that had been reactivated, 15m face, 70m across, with additional drops downstream. Large volumes of sediment added to river as the gully was cutting deeper and heading upstream.

Large detention dam built 1996 to reduce peak flows down the gully face.

9.2 Current Situation

Preceded by the bush covered gorge of around 100m height shown in Figure 9.1, the Omanawa river first contacts farmland on one bank, 6km above its confluence with the Wairoa River. Here the channel is 15m wide while only 0.3 - 0.4m deep (refer Figure 9.2). The sandy bed is rippled and sediment of up to 1.5cm diameter is seen moving as bed-load between ripples. Scattered erosion, approximately 0.3m in height, is evident.

Figure 9.1 Omanawa gorge high in the catchment (approximately 7km above the beginning of the survey). Rocky bed and cliffs contain the river flow.

Figure 9.2 Clear and shallow water - easily visible bed ripples.

At 5.4km, erosion 1 to 2m high by 20m long exists between the bends of a large meander; the river is slightly narrower and deeper.

A grassed flood plain up to 100m wide occurs inside the 4 to 5km section. Tighter meanders within the plain are well bounded by a bush covered gorge (refer Figure 9.3). Outside banks are commonly eroded over entire height (i.e. ≈4m) whereas the inside banks (lower) are covered in sand deposits.

Figure 9.3 Grasses cover the flood plains 5km above the Wairoa confluence.

Figure 9.4 Erosion and deposition on the outer and inner banks respectively.

A more random channel course follows between 3 and 4km. Banks increase to around 10m and are eroded, with sand deposits prevalent on the inside, the water was noticed as more murky. From the Wairoa to 3km, the true left is employed in agriculture. Sheep have access to the waters edge. Between 2 and 3km, the river ceases to have the same gorge confinement. Typical bank height is around 2m.

Figure 9.5 Trees have been flattened into the stream by floodwaters.

The first trees *in* the channel were noticed 2km above the Wairoa confluence (refer Figure 9.6), and bank erosion was evident. From 0.8 to 1.5km, the left bank land is planted in crops and agricultural use of the right bank begins; trees follow the river's path, some blockages are encountered. Drainage works were being carried out at the time of the survey; a small quantity of very muddy water entered the river here.

Figure 9.6 Discoloured stream (around 0.4m width) enters.

From 0.4 to 0.8km, there are frequent blockages due to dead trees being caught on the bed.

Figure 9.7 Within the final 200m willows straddle almost the entire river so that at one point only 0.5m can freely flow past.

Trees then line a sand-covered terrace at the water's edge to the road bridge.

9.3 Conclusion – Omanawa River

Significant erosion was found in the main stream. The most severe and frequent was seen between 3 and 5km upstream of the confluence with the Wairoa River. The extent of erosion and the height at which sand is deposited indicate the magnitude of flood flows and the presence of significant sediment transport during floods. The detention dam recently built at the head of one gully reduces the flow rate from that area and will reduce erosion from that site, but other stream bank erosion needs planting and retirement to control it effectively.

Above 6km, access is difficult and the stream margins are largely undisturbed. The steep bush-covered gorge higher in the catchment will continue to contribute sediment, especially where gully erosion exists. Above the hydro intake, a proportion of this sediment will be retained. In the lower reaches, banks are lower with wider flood plains to disperse the flood flows.

Chapter 10: Ohourere Stream

10.1 History

There appear to have been no significant stream-related problems in this catchment and no major works carried out.

10.2 Current Situation – Crawford Road

This section is a little over 2km. The river has a small flow rate and is initially clear. There is heavy bush on the left bank, while initially (i.e. almost first 1km) the right bank is farmed. The stream is within a steep gorge; the rock bed has a steep gradient with a few large drops (i.e. 3m). The lower half of this section is bordered by forestry. The river gradually goes to a gentler gradient; some fallen trees partially lie in the river. Rock banks had mud deposits on them, in turn growing vegetation. The water appeared *at least* as discoloured as the Wairoa at their confluence.

10.3 Conclusion – Ohourere Stream

Because much of the bed and therefore banks is rock, erosion is not a substantial feature. Higher upstream, blockages are from trees growing in the stream, where lower blockages are more due to trees which have fallen in. The small flow rate and catchment, along with access difficulty, discourage any clearing.

Chapter 11: Te Puna Stream

11.1 History

Reclamation and stopbanking for farming near the mouth occurred in the mid 70s. A major flood occurred in 1972 causing damage from silting of flood plains. Many tree blockages have been reported over the years. Stopbanks were built below SH2 in 1971 and 1972.

11.2 Current Situation – From Odey Road to SH2

Initially a small flow is bordered by around 5 to 10m of bush, consequently there is much dead wood on the bed. The water is very clear; the rock bed is covered by sands in pooling areas. There are some grasses growing on the streambed. Within this stretch there is a ford and weir.

Figure 11.1
As the bush decreases, it is replaced by blackberry (that has been killed off by spraying), with some dragging in the stream. Grass patches line the 1.5m high bank, generally farmed hills rise on either side of a 50 to 100m of floodplain.

The first substantial drop sees water falling around 7m over a rock shelf. The land level does not follow these dramatic changes in bed level and a gorge develops with bush extending to farmed land making access to water level more difficult. At each visible section of water it appears there is a substantial drop, from a topographical map it is estimated that the stream gradient in the top portion (i.e. down to around 2.5km above SH2) has at least 30m per 1km. There is little erosion because the rock base (Waiteariki ignimbrite) extends up the banks; the very steep and high banks are stable. Vegetation is on ledges and lower gradient banks where possible. A small moss covered area 2m either side of the 3 to 4m wide channel is available as a flood plain through some of the flatter sections (refer Figure 11.2).

Figure 11.2 Within the gorge there is a few metres floodable area to either side of the channel.

At 4.8km above SH2, the stream leaves its gorge setting. The next kilometre is bordered by farmed land. Just prior to leaving the bush surroundings, a small point of bank erosion was noted where trees were being undermined.

At 3.55km, there is a partial dam consisting of apparently planted trees (10cm diameter); there is a steady flow of water through the dam. Only 20m downstream of this there is another dam, however this is more significant (refer Figure 11.3). Stream banks are low and there is barely any evidence of erosion. A large rock shelf waterfall signals the end of this more open section.

Figure 11.3 The second debris dam, low flows pass through the blockage.

In the next gorge a series of large drops run on from one another, cascading into small pools. The rock banks again have some vegetation and are very stable. Gradually the gorge becomes deeper with access down the channel difficult because of steep banks.

At the conclusion of this gorge (2.6km above SH2), there is approximately a 200m wide floodplain. The banks are generally less than 1m high with good grass cover. The water is not as crystalline as earlier yet is still clear.

The bed now contains many loose rocks which form short bouldery rapids (refer Figure 11.4) each 50 – 100m in length over the following 1km. In this section, the stream meanders within the plains. Animals are generally fenced off from the river.

Figure 11.4
At 1.8km above SH2, the steep gradient decreases.

Figure 11.5 From 200m above SH2, viewing upstream, adjacent land is swampy. The water is noticeably discoloured as it mixes with tidal harbour waters.

Around 1.4km above SH2, the river becomes very still for the first time, the surface appearing to be hardly moving. There are substantial amounts of tree debris on the bed.

In the final 800m above the bridge, the floodplain decreases as high hillsides confine the stream. A few tributaries enter the Te Puna on the right bank; these are within their own deep gullies. In one of these gullies (0.9km above SH2), water has been retained in ponds which step down to the Te Puna. Each pond appears to be high in suspended solids and heavily discoloured. The Te Puna has many trees along its banks in this section, some of which drape into the water. The land immediately next to the stream is fully saturated in places.

At the SH2 road bridge the water appeared to be noticeably discoloured for the first time. This occurred over a short distance however the point of transformation was not identified because of lack of access to the water. One possible cause is thought to be tidal mixing from the harbour, which may have higher suspended sediments due to wind-induced suspension of sediments in shallow areas. The tide on the date of the survey was close to mid tide on an outgoing cycle. The other possible cause is that water of high sediment concentration is entering the stream on the right from one of the ponds mentioned above. This was not investigated further.

Again, the stream becomes part of an estuary of the harbour.

11.3 Conclusion – Te Puna Stream.

The foundations of this stream are dominated by layered ignimbrite rock; all large drops are over rock shelves. The banks are very stable despite their steepness; therefore erosion is not an issue for the bulk of this stream.

The stream is very clear until the final kilometre above SH2; the reason the stream becomes slightly turbid is unknown as access to the water was difficult in this region. If the sediment load in the water proved significant, identifying the source is recommended.

There is farmland adjacent to the stream only on three relatively short lengths, these were in the lower, middle and upper reaches surveyed and were of approximate lengths 1.6km, 1km, and 1km respectively. There is substantial tree debris on the bed both in the upper and lower reaches. The stretches within the gorge are generally clear of debris.

Chapter 12: Waipapa River

12.1 History

River clearance works were done 1968-69, namely willow removal, especially around the Old Highway.

1980 – Dumped logs were cleared as they posed a potential hazard to downstream bridges and were suspected of damaging aquatic life in the reserve between the old and new highways.

Willows severely blocked the stream in 1980 causing floods to spread more than normal. Damage caused to nurseries.

Unauthorised straightening of a tributary in 1982 was discovered and stopped. Downstream of this water intake filters were blocking up.

12.2 Current Situation

Beginning 3.1km above SH2 and just below a large waterfall the river has many boulders forming the bed. The channel width is between 1.5 and 4m with around 7m area adjacent for floodwaters. The hills rise on either side from this point.

Figure 12.1 Here the water is clear, the banks are well vegetated 0.3m above the water line, below which is a thick covering of moss.

The river becomes generally flat from soon after this point with a more consistent width around 5m. A reasonable amount of tree debris can be seen on the bed. Vegetation cover is still good, with forestry on the left; banks are around 2 to 3m high. Deer are farmed on the right bank which is well fenced off from the river.

Figure 12.2 From 2.8 till 2.2km above SH2 the river is flat, erosion is minimal; some tree debris is evident in patches.

The first significant obstruction occurs at 1.9km above SH2 where a willow restricts the stream (refer Figure 12.3). Erosion (10m by 1.5m) follows shortly after. The surrounding land starts to open out.

Figure 12.3 The river drops over a 1m shelf and is restricted by a willow that is rooted on the left bank.

Figure 12.4 At approximately 1.4km above SH2 the river has previously been fully blocked by debris. A new route has eroded its path sharply to the true right leaving a 3m bare bank (shown on the left of this upstream view).

Further downstream (until 1km) is a series of similar blockages, but which are not so advanced. Islands within the river divide the flow and can trap sediments behind them creating an obstruction (refer Figure 12.5).

Figure 12.5 At 1.2km, growth of in-stream willows encourages sediment deposition. The consequential islands redirect flow, causing erosion.

There are several overhanging willows which are potential contributors to blockages (refer Figure 12.6). Erosion on the left bank at 1.3km is of substantial length and is also very close to an unsealed farm road, with the possibility of undermining it if the erosion continues. At 1km there is a 100m section of erosion.

Figure 12.6 Typical potential tree blockage at 1km above SH2, while extensive erosion is evident in the background.

Between the Old Highway and SH2, banks are 1 to 2m high and are well vegetated in the river loops. There is a 15m wide flooding area adjacent. Three willows overhang the water in the first half of the loop with more in the latter half.

At SH2, there is a final drop in the river, which on the day of the survey the tide did not over top. The water lost much of its clarity at this point indicating the harbour's influence. Around 2km of river exist before transition to the harbour via the Waipapa estuary. Some low-lying land adjacent to the river is being cleared for grazing of stock; much of the land has little freeboard above the river level (refer Figure 12.7).

Figure 12.7 Flats beside river at 400m below SH2 are cleared for grazing of stock. For the first 800m below SH2 the left bank is lined with willows.

Estuarine vegetation dominates this lower region with marshland plants throughout grazing fields, indicating a groundwater level close to the surface.

12.3 Conclusion – Waipapa River

The survey began at the point at which farmland and bush interface; (the assumption is that the more significant effects occur in this stretch, with works not generally carried out amongst the bush).

The most notable problems were found to be concentrated between 1 and 2km above SH2. These were erosion, tree blockages, and deposition. It was noted that in some places the deposition contributed to further erosion.

Chapter 13: Apata Stream

13.1 History

Drainage works in the lower reaches occurred in 1981 including installation of a floodgated culvert to limit tidal inflow. No financial assistance (Catchment Commission or Government) was received for these works

13.2 Current Situation

Initially a small flow is bordered by trees with a moderate amount of debris on the bed. The 1 – 2m high banks are mainly well vegetated with grasses extending up to farmed hills. The banks are generally fenced but stock access at 5.0km has resulted in minor bank erosion and slumping (refer Figure 13.1). Fencing is absent on the left bank, only occasional sign of stock being visible at the waters edge.

Figure 13.1 Slumping of the right bank at 5.0km.

Downstream of this small intermittent patches of erosion are evident in the more open, grassy areas.

At 4.6km above SH2 the banks steepen slightly with little erosion as the rock base extends up the banks. The banks are well vegetated and consequently there is much dead wood on the bed often collecting on rocks and branches in the stream. 300m downstream the surrounding area opens out as the stream flows down a small rock shelf into a pool. The left bank becomes exposed. The stream then flows down into a well vegetated area.

Figure 13.2 The water is clear, the banks are well vegetated, with debris collecting on rocks and branches.

At 3.9km, a debris dam has formed which partially blocks the flow. Only 5m downstream of this, a table with little erosion.

Figure 13.3 This second, larger dam catches much debris and fully blocks the stream flow.

2.4km above SH2, the surrounding area opens out, with farmed land to the streams edge. A floodplain of 10m is available for floodable waters. The banks have a vegetation cover of grass and appear more prone to erosion. Approximately 12 isolated patches of erosion were noted.

Figure 13.4 Grass banks are prone to erosion and slumping.

Between 2.1km and 1.7km above SH2 the adjacent area to the stream becomes swampy, and hoof prints are frequently found at the waters edge. Bank height decreases and the stream width varies. There are three areas (50-100m apart) where willows congest the channel, each extending for 5-10m (refer Figure 13.4). Between these congested areas, the surrounding area is open, with no major obstructions present, although some dead wood lies across the channel and on the banks.

Figure 13.5 At 1.9km above SH2, willows congest the stream, with potential for increased blockages.

Downstream of the railway line minor erosion and slumping of the grass banks occurs due to stock access.

1.3km above SH2 the stream becomes surrounded with vegetation for 100m, and as a result, dead wood lies on the streambed at several sites. In this stretch a large tree lies across the stream collecting debris and blocking the flow (refer Figure 13.6). Downstream smaller branches are found overhanging the stream.

Figure 13.6 Gyceria Maxima grows in the channel, reducing the width. The banks are well vegetated.

Figure 13.7 A large tree blockage dams the channel at 1.24km above SH2.

The surrounding dense vegetation then declines. The stream in this open area appears to have been modified and diverted quite recently. The 2m high banks are well vegetated with grasses, except for an area 10m long where the bank is exposed; this appears quite stable. Dead branches and trees are common on the banks which may be due to recent clearing of vegetation. No major obstructions were found.

The stream then becomes surrounded by vegetation. A few small branches overhang the stream with the occasional small patch of erosion evident. 850m above SH2 a small tributary flows into the stream which appears to be bringing in sediment. Several metres downstream vegetation on both banks has been flattened; debris was observed 2m above the present water level in overhanging branches and in vegetation on the banks. The banks continue to have good vegetation cover.

Figure 13.8 A lone tree overhangs the stream at 700m above SH2, banks have good vegetation cover.

550m above SH2 a floodgated culvert is present. Below this the water loses much of its clarity, and the stream widens to 5m. 250m downstream (refer Figure 13.9) a debris blocked culvert crossing consisting of four pipes diverts flow either side. The culverts do not appear to be serving a purpose, though they once may have acted as a bridge or a walkway.

Figure 13.9 Culverts collect debris, and partially block the flow.

Chapter 14: Wainui River

14.1 History

There appears to have been no recent major stream related problems in this catchment and no major works carried out.

14.2 Current Situation

Beginning 7km above SH2, the river flows within an 8-10m wide bouldery channel (some white water). The banks are well vegetated and the river is bordered by bush, except for a small stretch (100m) of relatively open land. Deer are farmed on the right and are well fenced off the river. 100m downstream, the river flows down a large waterfall, from which a gorge develops making access difficult. A series of small drops follows and the river becomes surrounded by bush.

Figure 14.1 Looking downstream at 4.5km, the river is bordered by bush, the banks are stable and well vegetated.

3.6km above SH2 a small tributary flows into the river. The tributary prior to entering the river is stagnant and discoloured with weed forming a mat on the surface. 300m downstream of this, the adjacent area to the right opens out partially, the banks become vegetated with grasses. Sands form the channel bed and the river becomes brownish in colour and slow flowing. Dead wood and debris is frequently found situated on the riverbed.

Figure 14.2 At 3.7km above SH2, the steep gradient decreases. Minor amounts of debris lie on the streambed.

Between 3.1km and 1.9km above SH2 the banks are 0.5-1.5m high and well vegetated, small patches of minor erosion occur occasionally in the more open, grassy areas. Where the river is bordered by bush, a few trees overhang slightly in the river, though do not block the river flow. Dead wood continues to be frequent on the riverbed. No obstructions are present in this stretch.

Figure 14.3 Viewing downstream areas of adjacent land are swampy and the river is noticeably discoloured.

Below the Railway Bridge (1.9km), the surrounding area opens out and a flat swampy area extends up to farmed hills. Stock have access to the river with signs found frequently at the rivers edge. At 1.8km above SH2, a tree lies partially in the river due to the collapse of the left bank. Downstream of this, the banks become increasingly bare with slight undercutting and slumping. There is also a decrease in water clarity, which may be due to the harbours influence.

700m above SH2, several large trees have been uprooted and lie in the channel, though not blocking the flow.

Figure 14.4 Slumping occurs in the tidal areas of the river, with some dead wood in the channels.

The river then develops into an estuary environment and concludes becoming part of the Tauranga Harbour.

14.3 Conclusion – Wainui River

The bulk of the river is surrounded by bush with erosion not an issue in these areas.

Farmland surrounds the river on two occasions; these were in the upper and lower reaches. In the lower reaches the river appears to lose much of its water clarity and substantial amounts of debris was seen on the channel bed. Only very minor erosion was seen, (where banks were grassed rather than bordered with trees). No major obstructions were apparent along the river.

Chapter 15: Aongatete River

15.1 History

Silt removed near the SH2 Bridge by Ministry of Works in 1965. Many complaints of silting, accusations of the quarry causing silting since the mid 60s. Quarry contributed to cost of river improvements in the lower reaches of the river.

Survey carried out in 1967 and again in 1975, proposals prepared for river channel improvements in the lower reaches.

Heavy rainfall in 1974, caused extensive flooding of the SH2 Bridge and damage to pasture. Clearing of waterway and banks followed.

Five stopbanks built in the lower reaches by BOPCC in 1980 and 1981 protecting individual properties.

Bank erosion control in 1987.

Minor willow clearing and associated debris removal in 1987.

700m of coastal erosion protection in 1995, including protective plantings and the reconstruction of stopbank.

50-60m of realignment, tree removal and bank protection in 1995.

Minor willow clearing and bank erosion repairs downstream of the SH2 bridge in 1996.

15.2 Current Situation

From Upland Road Bridge to the Tauranga Harbour.

The 3-5m wide channel has many boulders forming the bed and is shallow and clear. The river is bordered by trees, the 2-3m high banks are well vegetated with little erosion. Small branches overhang the river, though the channel is generally obstruction free (refer Figure 15.1).

Figure 15.1 Looking downstream from Upland Road bridge. Banks have a thick vegetation cover, and erosion is minimal.

The banks continue to be well vegetated, with trees bordering the stream. Minor bank erosion on a bend at 3.3km (at quarry).

Figure 15.2 Young willows growing on rock beds have been flattened by high flows.

Figure 15.3 Looking upstream, banks are well vegetated, except for minor erosion on the bend.

2.3km above SH2 the banks have good vegetation cover, except for small areas of minor erosion, exposing the roots of trees. This occurs several times along the Aongatete River and has caused several small trees to fall into the stream. Willow trees occasionally overhang the river.

Figure 15.4 Looking downstream at 1.9km, large rocks cover the banks.

300m downstream, clearing of bank vegetation has resulted in dead wood on the banks and the occasional small branch overhangs the stream. Willows commonly drape in the river and collect debris; the river is relatively wide and at present has little effect on the river flow. The banks are well vegetated with trees, sweetgrass and blackberries so that access is often difficult; little erosion occurs.

700m above SH2, the river becomes deeper and slow flowing. Willows are present, commonly with overhang 3m into the main flow, effectively narrowing the channel width (refer Figure 15.5).

Figure 15.5 Willows overhang up to 3m across the main flow.

As the river bends around, the area adjacent to the right bank opens out, with some small minor bank erosion. The right bank remains bordered by trees. Between 500m and the SH2 bridge, the banks are 1 – 2m high, and mostly well vegetated with grasses. Intermittent willows continue to overhang the river and often partially block the flow. Logs and branches have collected in the river on several occasions, only one place do they partially block the flow. These logs have the potential to dam the river. A stopbank on the left is in good condition.

Figure 15.6 Willows continue to overhang the stream in this open area, some debris on the channel bed at 300m above SH2.

At the SH2 bridge, willows grow on the bank. 50m downstream of SH2 a large tree has fallen across the river and partially blocks the flow (refer Figure 15.7). Several metres downstream, more trees lean over the river and may be potential contributors to the blockage.

Figure 15.7 Partial blockage 50m below SH2.

The river then becomes surrounded by dense vegetation (some willow clearing has occurred), till 300m downstream, where the surrounding area opens out and the banks become well vegetated with an established riparian strip. Six hundred metres below SH2 the left bank has recently been cleared of vegetation for a stretch of 100m

(refer Figure 15.8). The right bank is well vegetated, except for two small areas of erosion 20m apart. The river is still and loses much of its water clarity at this point.

Figure 15.8 Recent clearing of vegetation leaves the bank exposed. Downstream of this, a stopbank situated 10m from the left bank follows the river to the estuary.

Figure 15.9 Looking upstream the true right bank is well vegetated, while frequent slumping of the left bank is evident.

The river then enters Tauranga Harbour.

15.3 Conclusion – Aongatete River

The Aongatete River is mostly bordered with vegetation; banks were well vegetated in most areas. Some minor erosion has occurred, probably as a result of previous high flows.

Willows frequently overhang the river from approximately 2km till SH2, none of which are too serious. The channel is clear below the SH2 bridge, except for a partial tree blockage. Stopbanking is in good condition.

Chapter 16: Poupou Stream

16.1 History

There appear to be no stream related problems in this catchment in recent council records, and no major works carried out.

16.2 Current Situation

From Hume Road bridge to its confluence with the Aongatete River.

Initially the 3m wide stream is bordered by bush and the stream is shallow and clear, with loose boulders forming the bed. Downstream the dense bush subsides partially, although the 1-2m high banks continue to have good vegetation cover. Farmland surrounds the stream, with a floodplain of 10-20m available for flood waters. Small amounts of debris on the rock beds, and small branches overhang the stream occasionally.

Figure 16.1 Looking downstream from Hume Road Bridge, the water is clear and banks are well vegetated. In places vegetation over hangs in the stream.

Figure 16.2 Farmland surrounds the stream, but banks continue to have good vegetation cover.

Figure 16.3 Previous undermining of the right bank exposes tree roots. The lower bank remains well vegetated.

Figure 16.4 400m below Hume Rd bridge a lone willow does restrict the flow.

Downstream to the confluence with the Aongatete River the banks are well vegetated, although undermining occurs on several occasions often exposing roots of trees. Small amounts of dead wood on the banks and on the bed itself, with small branches overhanging the stream. The channel is generally clear of obstructions. Prior to entering the Aongatete River bank height increases to 3m.

16.3 Conclusion

Only a small section of the stream was surveyed, this area being surrounded by farmland. No major obstructions were found and the stream channel was relatively clear. Some small minor erosion has occurred, probably as a result of high flows, exposing banks on several occasions.

Chapter 17: Whatakao Stream

17.1 Description

The Whatakao stream rises in the Kaimai Ranges and joins the Aongatete River near SH2. The catchment area is 2290 ha, of which about 70% is bush covered. The stream is approximately 12km long and falls at a very steep gradient for the first 10km. The last 2km the stream is tidal. The lower tidal reaches of the stream flow across a floodplain of up to 1km which is subject to frequent flooding. The catchment produces high flows because of its steep topography and relatively shallow soils.

17.2 History

Inspection of the middle catchment in 1973 found that gully erosion is a constant factor at gully heads. Study of the lower reaches in 1974.

Stopbank breached in several places and light silting after heavy rainfall in 1974. Stopbank repairs in the lower reaches carried out following rainfall.

Unauthorised stopbank constructed in 1977 along with river clearing and maintenance work for security against flooding. Complaints of flooding from neighbours after stopbank erected.

Isolated stopbanking for 800m to protect an individual property (from Walford Rd bridge till 800m downstream) in 1983.

Reconstruction of an old stopbank in 1986.

Some willow removal and the establishment of a riparian strip in 1997.

17.3 Current Situation

Beginning 6km above SH2 the stream is 6m wide with steep farmland to the waters edge. The banks are generally 1 – 2m high, where hills do not bind the stream. Good vegetation cover of grass.

Figure 17.1 The upper Whatakao Stream catchment.

Farmland continues to border the stream, although a floodplain of 10-20m becomes available. Patches of vegetation cover the banks and in these areas the banks are well vegetated and stable. Small minor erosion occasionally occurs in the more open grassy areas and on several occasions stock tracks to the streams edge have exposed the banks. Some trees overhang the stream in this section.

Figure 17.2 A floodplain of 10-20m becomes available. Grass covered banks are more susceptible to erosion.

Figure 17.3 Banks are stable and well vegetated with bush.

Figure 17.4 The first partial tree blockage occurs at 4.9km. Here stock tracks expose the banks and make them more susceptible to erosion.

4.5km above SH2, banks have become eroded due to stock access on several occasions. 100m downstream of this, the first of the willow blockages occur. Several willows partially block the flow exacerbating minor erosion. Downstream to the Walford Road Bridge, willows frequently grow in patches and partially or fully block the stream. The worst blockage occurring at approximately 4km.

Figure 17.5 Typical willow blockage at 3.8km above SH2. The 1-2m high banks have a good vegetation cover of blackberries and other vegetation.

Below the Walford Road Bridge, several willows overhang the stream partially blocking the flow. A stopbank is situated 10m away which is in good condition. The banks are mostly well vegetated with grasses, although sheep have access to the stream to 2.6km. Small patches of slumping are visible.

Figure 17.6 Minor erosion of the low grassy banks at 3.2km. Downstream a willow can be seen overhanging the stream.

The stream banks then become well vegetated with little erosion. The stream is generally obstruction free, although at 2.85km above SH2 willow debris is in the channel. 50m downstream of this a willow partially blocks the flow. Frequently debris is seen collecting on vegetation and branches over the length of the stream (refer Figure 17.7).

Figure 17.7 At 2.6km debris catches on branches in the stream and on vegetation on the banks.

Downstream of this, clearing of vegetation has recently occurred. Stockpiles of burnt wood are situated next to the stream. The stopbank on the right of the stream appears to deteriorate somewhat, especially where stockpiled vegetation have been burnt, often exposing the stopbank.

Figure 17.8 Banks become well vegetated with little erosion. Stockpiled cleared vegetation have been burnt (seen to the right of the stream) often exposing the stopbank.

Downstream to the SH2 bridge, the 1m high banks continue to be well vegetated with small willows occasionally overhanging the stream. Clearing of vegetation has occurred down the length of the stream, and stockpiles of burnt wood are seen periodically on the banks.

Figure 17.9 For the first 3km above SH2 the banks have good vegetation cover, with little erosion. A wide grassy floodplain extends up to small hills.

Below the SH2 bridge, the stream concludes on entering the Aongatete River.

17.4 Conclusion – Whatakao Stream

Farmland surrounds almost the entire length of the stream. In the upper reaches some very minor erosion was evident, with stock tracks exposing the banks on several occasions.

The most notable problems were found to be concentrated between 3.5km and 2.8km. These were frequent willow and tree blockages, and some minor erosion. Stopbanks were mostly in good condition, although one area will require maintenance.

In the lower reaches, clearing has already taken place, and the channel is relatively obstruction free.

Chapter 18: Waitekohe Stream

18.1 History

Some willow removal and minor easing of bends downstream of the Waitekohe-Tuapo confluence in 1970.

Upgrading of stopbank near the mouth in 1972.

Meander straightened and some tree removal below the SH2 bridge, in 1975.

Unauthorised straightening in 1987, owners downstream affected and complained of flooding.

Considerable amount of bank erosion after heavy rainfall in 1977, 1979 and 1987. Erosion works undertaken.

Stream bank protection and realignment in 1988.

Concrete ford constructed, with minor clearing and earthworks in 1981. Removal of obstructions and protective plantings over a 300m length, downstream of the Railway bridge in 1995.

18.2 Current Situation

Beginning 2.7km above SH2 the 5–6m wide stream has many boulders forming the bed. The stream is shallow and clear. The stream is bordered by bush, the 1–2m high banks are well vegetated. Within this stretch there is a ford.

Downstream, the surrounding area opens out partially although trees still vegetate the banks. A floodplain of 15-20m is available on either side of the stream, a smaller floodplain (1–2m) is present when bank height is low (less than 0.3m). Undermining of trees and minor erosion of the banks has occurred on several occasions (refer Figure 18.1), in one instance (at 2.3km), two trees have fallen into the stream, partially blocking the flow.

Figure 18.1 Undermining of trees at 2.35km.

1.65km above SH2 two areas of minor erosion are noted, 10m apart, where the bank lacks thick vegetation cover. Small minor erosion occurs 100m downstream.

Figure 18.2 Bank vegetation consists mainly of grasses. An island divides the flow at 1.45km.

Downstream of this, the stream flows over a ford. From this point to 1km above SH2 the banks become well vegetated with very minor erosion and slumping. A floodplain of 10–20m is available, extending up to farmed hills.

In the final 1km above SH2, the 0.5–2m high banks are mainly vegetated with grasses. Minor erosion of the banks occurs periodically down the length of the stream.

Figure 18.3 At 800m, willows overhang the stream. Minor bank erosion.

Figure 18.4 The banks become eroded at 300m above SH2.

At the SH2 Bridge rock protection along the right bank is fenced to prevent collapsing. Minor amounts of debris have lodged between the pillars of the bridge.

50m below the SH2 Bridge two willows partially block the flow. 50m downstream of this, as the stream bends around, wire fencing extends for 10m along the 3m high left bank. The fence holds back loose rocks, trees, branches and debris. The body of a car has washed into the stream, while another car body is lodged between trees up on the bank. Tyres, concrete and other debris were seen behind the fence which appears to be deteriorating slightly in condition. The stream is still and has deepened (refer Figure 18.5).

Figure 18.5 Fencing along the left bank holds back trees, rubbish and other debris.

Several metres downstream of this, a wire fence extends for 20m along the right bank. It appears to be in much better condition and withholds loose rocks and several trees.

The banks continue to be well vegetated, with several willows overhanging the stream. 300m below SH2, the right bank becomes exposed and eroded for 10m. The bank, at this point, is vegetated by grass only. Another point of erosion is noted 200m downstream, prior to a blockage where two large trees and cut willow branches fully block the stream and collect debris (refer Figure 18.6).

Figure 18.6 A willow overhangs the stream at 400m below SH2.

Figure 18.7 Vegetation debris partially blocks the stream flow.

Between 600m and 1.2km below SH2 farmed land extends to the streams edge. Minor slumping and erosion has occurred where stock have entered the stream (refer Figure 18.8).

Figure 18.8 Upstream view at 800m of an open floodplain with grasses to the waters edge. The stopbank on the true left is in good condition.

The next part of the stream is an open section with a floodplain of 100m extending up to hills. The adjacent flat area to the left of the stream is under construction to become an extension of the golf course (refer Figure 18.9).

Figure 18.9 Construction work is underway at 1.3km. Heavy vehicle tracks are present down to the streams edge.

For 200m to 1.4km below SH2 the stream is obstruction free. The banks which are vegetated by grasses erode several times in lengths of 5–15m. The stream is sandy in pooling areas.

1.4km below SH2 the left bank becomes eroded, while tree debris and small willow branches have collected to the side, causing small swift currents. 2m downstream of this, the first of several willow blockages occur.

Intermittent patches of willows frequently partially or fully block the stream flow. Some clearing of willows appears to have been attempted (at1.7km below SH2), cut willow debris has found its way into the stream adding to blockages. Bank erosion (5–10m lengths) occurs periodically down the length of the stream.

Figure 18.10 Typical willow blockage and bank erosion at 1.5km.

From 2.1km to the harbour farmland extends to the streams edge (stock generally have access). Within the first 500m, the 2m high banks become eroded, and slumping occurs frequently. Clearing of bank vegetation has taken place in two small areas (refer Figure 18.11). Two small, isolated willows partially block the flow at 2.2km below SH2, and several instances of logs partially blocking the flow (minor).

Figure 18.11 Small area of clearing here at 2.4km.

The banks then continue to slump and erode periodically down the length of the stream to the estuary. A floodplain of up to 400m is available for floodwaters. Five more instances of small isolated willows partially blocking the flow were noted (minor).

Figure 18.12 Bank erosion and slumping is frequent in this open section.

The stream then enters the estuary.

18.3 Conclusion – Waitekohe Stream

From the upper reaches to SH2, minor bank erosion is evident where banks lack thick vegetation cover (i.e. banks are grassed). The channel in this section is relatively free of obstructions.

Most of the problems are situated below the SH2 bridge, these being partial and full willow blockages (especially between 1.4km and 2.1km), and frequent bank erosion.

Chapter 19: Tuapo Stream

19.1 History

Some willow removal below SH2 to the confluence with Waitekohe Stream in 1968/69.

Diversion and straightening of the channel in 1979.

19.2 Current Situation

Beginning 5km above SH2, the 1-2m wide stream is bordered by trees. There is moderate amount of debris on the channel bed. Steep farmland surrounds the stream, banks are generally 1–2m high when hills do not bind the stream. Loose rocks form the streambed. The banks are mostly well vegetated, but several incidences of minor erosion are noted where banks lack thick vegetation cover. Debris has collected on four separate occasions in this area, all of which partially block the flow. There is a ford in this stretch.

Figure 19.1 Bank erosion at 4.7km. Debris collects on a fallen tree, downstream of this is another partial blockage.

Between 4.3km and 1km above SH2, the stream meanders with farmland to the streams edge. Trees and vegetation commonly line the 1–2m high banks, in these areas the banks are stable and well vegetated. Bank erosion is seen on several occasions in the more open areas where banks lack thick vegetation cover.

Figure 19.2 Exposed right bank at 4.15km.

Figure 19.3 Downstream view at 3.8km of an open section with grasses to the waters edge.

Figure 19.4 The grassy left bank becomes eroded at 2.6km above SH2.

Small amounts of debris and small branches frequently lie in or across the stream, though none at present block the flow.

Figure 19.5 Debris is caught on vegetation above the normal flow. The 1-2m high banks are stable in these well vegetated areas.

Figure 19.6 Minor erosion of the grassy banks occur at 1.55km.

At 900m, banks have a good vegetation cover, increasing in height to 2-3m. Debris is commonly seen on the streambed. At 800m branches and debris collect to the side of the stream partially blocking the stream flow. Downstream of this, two trees lie in the channel within 5m of each other. The first of the trees, fully blocks the stream (refer Figure 19.7), while the second partially blocks the stream.

Figure 19.7 A fallen tree fully blocks the flow at 750m.

Debris continues to lie in the streambed, with a partial blockage at 600m where debris has collected. Downstream of this, several small willows vegetate the banks, though they do not presently block the flow.

Figure 19.8 Banks have good vegetation cover, with several small willows overhanging the stream.

Between 250m and the SH2 bridge stock access has resulted in small areas of slumping and erosion on the right bank. The banks are generally well vegetated, with some debris on the channel bed.

Downstream of SH2 to its confluence with the Waitekohe Stream, a wide grassy floodplain is present, with farmland to the streams edge. A willow blockage occurs 40m below SH2. Patches of willows continue to congest the channel to 300m, occasionally completely blocking the stream flow. The banks are mostly well vegetated, but patches of erosion are seen where thick bank vegetation is absent.

Figure 19.9 A typical willow blockage at 70m below SH2.

At 400m below SH2 stock tracks have exposed the banks (refer Figure 19.10). Bank vegetation consists mainly of grasses and further small erosion and slumping occurs downstream.

Figure 19.10 An e*xposed grassy bank at 400m below SH2*.

At 550m below SH2 several willows completely block the stream flow. At this point minor slumping and erosion has occurred. From here to its confluence with the Waitekohe Stream the banks are well vegetated with grasses.

Figure 19.11 Confluence of the Tuapo and Waitekohe Streams.

19.3 Conclusion – Tuapo Stream

Farmland was generally in contact with the stream between 5km and 1km. In this section patches of erosion were evident in the more open areas. In many places vegetation surrounded the stream, these areas being well vegetated and stable. Several debris dams were seen in the upper reaches and lower reaches (above SH2) where vegetation surrounded the stream.

The stream below SH2 has frequent willows restricting the channel. Some minor erosion was seen in this open section especially where stock have entered the stream.

Chapter 20: Te Mania Stream

20.1 Description

The top section of the stream is very steep, while the bottom section is relatively flat. The total catchment area is 1144 ha, of which approximately one third is bush covered. The rest is farmed in both agriculture and horticulture.

20.2 History

Drainage problems after heavy rainfall, and some minor flooding experienced in the lower areas.

Clearing of the channel below SH2, ranging from heavy clearing of willows to light clearing of blackberries and some pines occurred in 1981.

Unauthorised straightening in 1982, resulting in complaints from neighbours.

Plastic sheeting washed into the watercourse was removed in 1986.

Removal of small trees from the stream and a riparian strip below the SH2 bridge proposed in 1993.

20.3 Current Situation

Beginning 4.6km above SH2 the 2m wide stream is shallow and clear. Loose rocks form the channel bed, with sands in pooling areas. The stream is surrounded by bush and the 1–2m high banks are well vegetated. Small hills bind the stream.

300m downstream, the area opens out partially, with farmland to the streams edge. A small floodplain 2–5m wide is available for floodwaters. Stock have access, very minor slumping and erosion has occurred (refer Figure 20.1).

Figure 20.1 At 4.3km, bush subsides with farmland to the streams edge.

Downstream of this, bank erosion occurs at several sites (approximately 5m lengths) where thick bank vegetation is absent (refer Figure 20.2). A reasonable amount of tree debris is seen on the channel bed.

Figure 20.2 Erosion of the left bank at 4km above SH2. Downstream of this banks continue to erode in approximately 5m lengths in the open areas.

At 3.75km above SH2 the banks are mainly vegetated with grasses, with the floodplain increasing up to 100m in places. Between 3.75km and 2.5km farmland surrounds the stream and erosion of the banks occurs frequently.

Figure 20.3 Bank erosion at 3.55km. Dead wood has collected on four occasions in this area, all of which partially block the flow.

Figure 20.4 Erosion of the 2m high banks at 3.2km.

Figure 20.5 The banks become exposed at 2.9km.

Downstream of this a fence which borders the stream begins and concludes 1.7km. Bank vegetation consists mainly of grasses with erosion occurring periodically down the length of the stream (refer Figure 20.6). This area appears to have been diverted and modified, due to its straightened course and often exposed steep banks.

Figure 20.6 Bank vegetation consists mainly of grasses in this section. The 1-2m high banks are often exposed.

At 1.6km above SH2 the stream flows through a culvert. Several metres downstream of this tracks to the streams edge have exposed the left bank in two different places. The right bank is mostly well vegetated except for a small area of erosion immediately after the culvert.

100m downstream of this, a tributary flows into the stream. The tributary is generally 0.5m wide, with 1–1.5m high banks. Erosion and slumping has occurred over a length of 150m (the tributary was not looked at past here due to the small flow). Weeds grow in the stream, often narrowing the flow to 0.3m.

The stream meanders through its floodplain and banks become well vegetated with grasses in this relatively open area with little erosion.

Figure 20.7 At 950m above SH2, banks are mostly well vegetated with little erosion. Small amounts of debris on the channel bed.

550m above SH2 the stream flows under a stock bridge. A small patch of erosion is noted prior to the bridge. The banks then become well vegetated with grasses. Previous slumping has formed small islands which diverts the flow and narrows the width of the stream. As the stream bends around, the right bank becomes eroded for a stretch of 10m (refer Figure 20.8).

Figure 20.8 Looking upstream at 400m, the true right bank has areas of ersosion. The left bank has a good vegetation cover of grass.

The left bank then becomes surrounded by vegetation, while the right bank remains open and fenced with good bank vegetation cover. 50m above SH2 the right bank has collapsed on three occasions. 10m downstream of this, willows overhang the stream and erosion is noted on the right bank. 20m above SH2 a fallen tree collects debris that almost fully blocks the stream. Small erosion of the bank occurs at the point of the blockage (refer Figure 20.9).

Figure 20.9 Debris collects in the stream and partially blocks the flow. Downstream to the SH2 bridge banks are well vegetated.

Below SH2 banks have a thick vegetation cover, often overhanging the stream. A sawmill is situated on the left of the stream, while farmland on the right is fenced from stock with an established riparian strip. Debris is commonly seen on the channel bed, and on several occasions has collected causing partial debris dams. Three incidences were noted, where sawn logs have collected in the stream along with debris and branches (refer Figure 20.10). The stream is murky in this area.

Figure 20.10 Thick bank vegetation below SH2, often overhangs the stream.

Figure 20.11 Sawn logs and debris collect at 300m below SH2

900m below SH2 fencing along the right bank stops, and the stream opens out partially. 50m downstream, the left bank is eroded, and downstream of this several more incidences of bank erosion are noted (5m lengths).

At 1.1km below SH2 the banks have slumped in several places, branches and debris have collected so that the stream is fully blocked. Directly after the blockage erosion of the left bank has caused the stream to widen (refer Figure 20.12).

Figure 20.12 Full blockage at 1.1km below SH2.

Downstream of this bank vegetation increases, with trees often overhanging the stream. Some dead wood was seen on the channel bed.

Figure 20.13 Overhanging willows are potential blockages.

Figure 20.14 Debris situated on the channel bed at 1.8km below SH2.

The stream then concludes becoming part of the Tauranga Harbour.

20.4 Conclusion – Te Mania Stream

The most frequent erosion was seen between 3.7km and 1.8km, where farmland was in contact with the stream. The stream has several sharp bends and carries a high sediment load, both of which increase the water levels to exacerbate flooding.

Below the SH2 bridge the banks are slightly overgrown occasionally restricting the waterway. Several debris blockages were seen in this section, with patches of erosion in the more open areas.

Chapter 21: Uretara Stream

21.1 Description

The Uretara (also known as Wharawhara) catchment rises in the Kaimai Ranges and comprises of about 50% steep bush and 50% rolling to easy farms and orchards. At the point where it flows through Katikati, the catchment area is 24.4km^2. A further 7.8km^2 contributes to the stream between the town and the Tauranga Harbour mostly via the McKinney Stream. Normal tidal influence extends to just above SH2.

21.2 History

Noxious animal control in the upper reaches by the New Zealand Forest Service started in 1964.

Heavy rainfall in 1966, 1969, 1974 and 1976 caused considerable damage to the water supply scheme, as well as severe bank erosion, silting and damage to adjacent land and roads. Restoration measures carried out by the Council (clearing of growth and bank protection).

Investigation into the causes of pollution in response to a petition signed by 171 residents in 1970 found that the quarry has caused silting in the lower reaches of the stream. Cow sheds and piggeries also have a major effect on the water quality of the river.

Some clearing in 1970, 1975, and in 1977.

Bank erosion in some areas.

Extensive survey work over the years

Complaints of siltation and discoloration of the stream from the 70's onwards. Quarry assists in channel works to improve the channel waterway near the quarry in 1976.

A five year River Control Scheme was approved in 1975. Works included channel clearing, channel protection and improvements and minor stopbanking.

Five lengths of stopbanking totalling 4.9km, all below Rapaka Rd in 1975, 1977/78 and 1981/82, as part of the overall catchment scheme.

Survey design and investigation work carried out in the lower reaches in 1979 and 1996. Concerns of silting and bank erosion.

Minor realignment and remedial work in 1972 and again in 1987.

Some tree clearing in 1994 and 1995, bank erosion repairs and fencing on three individual properties.

Channel improvements, including planting and stream bank fencing proposed in 1994, completed by 1998. Note survey was prior to works.

21.3 Current Situation

Beginning 8.7km above SH2 the stream is surrounded by bush. The 1–2m high banks are well vegetated and stable. The channel is 8m wide with large boulders forming the bed. The waterworks is situated here.

Figure 21.1 The stream is surrounded by bush and the banks are stable and well vegetated.

Bush continues to surround the stream with little erosion evident apart from a small area at 6.8km where thick vegetation is absent. 200m downstream of this, a small area of fencing bordering the stream has slumped due to erosion of the bank.

Between 6.8km and 4.8km farmland surrounds the stream with dense vegetation frequently bordering the stream often making the stream inaccessible. In visible areas the banks appear well vegetated. Small branches commonly overhang the stream and several trees have been uprooted and lie across the channel (refer Figure 21.2).

Figure 21.2 At 6.4km, a fallen tree lies across the channel.

4.8km above SH2, the right bank becomes less vegetated and in small areas the bank becomes exposed. Rocks situated along the bank appear to protect it from further erosion (refer Figure 21.3).

Figure 21.3 The right bank is generally clear of trees, with small areas of exposed bank.

Downstream to 4km several islands divide the flow. Small branches occasionally overhang the stream. Some debris was noted on the streambed and lodged in vegetation on the banks. The banks are well vegetated in this section.

Figure 21.4 Gravel and rocks situated along the true left bank at 4.2km.

Between 3.9km and the Wharawhara Road Bridge the banks have good vegetation cover except for a 10m length of isolated erosion at 3.5km (refer Figure 21.5). Willows become more frequent and often overhang the stream (none at present block the stream channel) (refer Figure 21.6).

Figure 21.5 Isolated erosion of the true right bank. The bank is vegetated by grasses.

Figure 21.6 Willows growing on a rock bed, overhang the stream at 3.25km.

Below the Wharawhara Road Bridge there are many willows overhanging the stream, especially between 2.6km and 2.3km. In this section several willows have fallen into the stream and partially block the flow (refer Figure 21.7).

Figure 21.7 This blockage collects a large quantity of willow debris.

Downstream, willows continue to overhang the stream though do not restrict the flow at low levels.

Between 2.2km and the Henry Road ford several willows overhang the stream. At 2.0km a fallen willow partially blocks the flow. 200m downstream of this, the right bank is eroded and fencing which borders the stream has slumped (refer Figure 21.8).

Figure 21.8 At 1.8km, the right bank is eroded for a length of 15m.

Downstream, banks have a good vegetation cover.

50m below the Henry Road ford, a point of erosion was noted, with deposition of sediment on the bend. Downstream to 800m willows commonly overhang the stream. The banks here are generally well vegetated although a few small points of erosion were noted.

Figure 21.9 Willows commonly overhang the stream in this section.

Above the SH2 bridge the left bank opens out with a vegetation cover of grass. Vegetation continues to line the right bank, and the occasional tree overhangs the stream. The banks become exposed and eroded on several occasions, in one area erosion is potentially threatening the stopbank. Where vegetation cover is good the banks appear stable with little erosion.

Figure 21.10 Looking upstream at 750m the left bank has opened out, with some erosion .

Logs and debris were seen on several occasions in the channel, which has deepened. The water has lost much of its clarity.

Below the SH2 bridge the 1m high banks are generally exposed and appear susceptible to erosion.

Figure 21.11 Looking downstream from the SH2 bridge the 1m high banks are frequently exposed.

21.4 Conclusion – Uretara Stream

The Uretara Stream banks are well vegetated in most areas. Some minor erosion was seen when banks had a vegetation cover of grass, in the more open areas. Several willow blockages were present, in the section between Wharawhara Road Bridge and Henry Road, and downstream of this willows frequently overhang the stream. Banks were frequently exposed in the lower reaches.

Chapter 22: Boyd Stream

22.1 History

There appears to have been no major stream related problems in this catchment in recent council records, and no major works carried out.

22.2 Current Situation

Initially the 2m wide stream has many boulders forming the bed and is shallow and clear. The stream is bordered by bush, the banks are stable and well vegetated.

Figure 22.1
At 6.5km, the stream banks are stable and well vegetated

5.4km above its confluence with the Uretara Stream the surrounding area opens out, with farmed hills adjacent to the stream. The banks are mostly well vegetated, but small areas of erosion are occasionally seen. 200m downstream the stream becomes surrounded by vegetation, with undermining of trees on several occasions. The first blockage occurs at 4.9km, where a large fallen tree partially blocks the flow and collects debris.

Between 4.3km and 4km, pine trees surround the stream, the banks are stable and well vegetated. Downstream of this, very small erosion of the banks occurs in the more open areas.

The next section of the stream is open, with farmland to the waters edge. Bank vegetation consists mainly of grasses, where frequent stock tracks to the stream edge expose the banks making them more susceptible to erosion (refer Figure 22.2).

Figure 22.2 Thick bank vegetation reduces, farmed hills rise on either side of the stream

Figure 22.3 Tracks down to the stream expose the banks at 3.6km.

The 1-2m high banks commonly erode and slump in lengths of 5-10m. In one place (3km) loose rocks have been extracted and placed on the immediate stream bank to relieve flooding and protect the banks.

Figure 22.4 At 3.3km, two large trees have been uprooted and collect debris.

Figure 22.5 Typical bank erosion at 2.75km.

Downstream, farmland continues to surround the stream but the banks are generally well vegetated and stable, with bush commonly bordering the stream. Several small areas of erosion (5-10m long) are seen in the more open areas where thick bank vegetation is absent.

Figure 22.6 Shrubby vegetation surrounds the stream; there are small amounts of debris on the channel bed.

Figure 22.7 The left bank is eroded at 1.2km.

Between 700m and its confluence with the Uretara Stream, the stream becomes surrounded with vegetation. The banks have good vegetation cover. Again, minor erosion occurs in the more open areas.

Figure 22.8 Erosion of the right bank where thick bank vegetation is absent.

Figure 22.9 Debris collects in the stream at 550m and partially blocks the stream flow. Downstream of this the right bank is eroded for a length of 10m.

Figure 22.10 The banks have a thick vegetation cover, with some trees overhanging the stream.

The stream then concludes at the confluence with the Uretara Stream.

22.3 Conclusion – Boyd Stream

The most frequent erosion was seen between approximately 3.8km and 2.5km, this area being surrounded by farmland. Some protection work has already been undertaken in this section, which appears to be working. Several blockages are present, these occurring in the well vegetated areas.

Chapter 23: McKinney Stream

23.1 History

There appears to have been no major stream related problems in this catchment in recent council records, and no major works carried out.

23.2 Current Situation

4.6km above its confluence with the Uretara Stream, the stream is 0.5m-1m wide, with loose rocks forming the bed. The stream is bordered with bush, the banks have good vegetation cover.

Downstream, the surrounding area opens out, with farmland to the stream edges. The stream meanders through the land with an adjacent floodplain of 10–20m. Erosion and slumping of the 0.5–1.5m banks occurs periodically.

Figure 23.1 The surrounding area opens out, farmed hills rise on either side of a 10-20m floodplain. Bank vegetation consists of grasses.

Figure 23.2 Weed growth commonly reduces the width of the stream flow.

At 2.8km, pine trees surround the stream for 350m. The banks become well vegetated and stable, with some debris on the bed (refer Figure 23.3).

Figure 23.3 Banks have a good vegetation cover, with moderate amounts of debris on the channel bed.

Farmland then continues to border the stream, with frequent bank erosion and slumping, occurring commonly in 5–10m lengths.

Figure 23.4 The 1–2m high banks become eroded at 2.4km.

Figure 23.5 The stream meanders with farmland to the stream edges.

Figure 23.6 Bank erosion at 1.3km.

300m above SH2 the bank height decreases to 1m with slumping occurring on several occasions. The channel is 1m wide and very straight. Some growth in the stream (refer Figure 23.7).

Figure 23.7 The channel here is very straight, with slumping of the banks.

The stream then concludes at the confluence of the Uretara Stream.

23.3 Conclusion – McKinney Stream

The length of stream inspected was bounded by farmland. The banks are being vegetated with grasses but have frequent erosion sites. The channel was relatively clear of obstructions, but weed growth often restricted the flow.

Chapter 24: Tuapiro Creek

24.1 Description

The Tuapiro river rises in the Kaimai ranges and falls very steeply to the Tauranga Harbour and has a catchment area of 40.1km^2. The stream has built up a small floodplain in places varying from a few metres to approximately 200m elsewhere. The stream is very unstable due to the high slope and bedload and tends to change course and erode banks.

24.2 History

Heavy rainfall in the Tuapiro catchment in 1966 caused extensive flooding of farmland in the lower reaches, with damage to pasture and fences.

Intermittent willow growth removed between McMillans Road Bridge and Surtees Road in 1966. Erosion control works in the four worst sections of the Tuapiro Stream in 1975, and again in 1981.

A timber retaining wall was built below SH2 in 1980.

Removal of willow trimmings above flood level by individual property owners in 1985. Demolition of the old Tuapiro Railway Bridge in 1987, with complaints of concrete debris not being removed from the area.

Erosion control works proposed and approved in 1996.

24.3 Current Situation

9.3km above SH2 the 8-10m wide bouldery channel is bordered by bush, with well vegetated banks. Bush continues to line the 2–3m high banks for 700m, to 8.6km above SH2.

Figure 24.1 The water is clear and the banks are well vegetated

The surrounding land then partially opens out but vegetation cover is still good (refer Figure 24.2). Generally a floodplain of 100m is present on either side of the stream. A few small areas of erosion occur, where the banks lack vegetation in the more open grassy areas.

Figure 24.2 The surrounding area opens out partially, with a grassy floodplain of 100m for floodable waters.

At 6.8km above SH2 dense bush again surrounds the left bank. The bank is stable and well vegetated, except for a 15m length of erosion on a stream bend (refer Figure 24.3). At this point the bank is grassy.

Figure 24.3 Erosion of the true left bank.

Downstream, banks continue to be well vegetated with trees bordering the stream, small branches overhang the stream occasionally. No problems are apparent in this stretch except for two areas of erosion (at approximately 5.7km), each extending for 15m, where the bank lacks thick vegetation cover.

Figure 24.4 Banks are well vegetated.

Beyond this, a thick cover of bank vegetation evolves, with trees bordering the stream, and little erosion. Vegetated islands commonly divide the stream flow, with small amounts of debris on the bed.

Figure 24.5 At 4.2km, an island divides the flow. Banks have a good vegetation cover.

Farmed hills extend on either side of the stream to 3.7km above SH2. The 2–3m high banks are well vegetated, fencing borders the stream. A few trees overhang the stream, but do not presently restrict the flow. The right bank becomes exposed and eroded at 3.8km above SH2, where thick bank vegetation is absent (refer Figure 24.6). Another small patch of erosion occurs downstream of this. At this point a few trees overhang the stream.

Figure 24.6 Fencing and vegetation borders the stream in this farmed area. *Erosion of the right bank occurs where thick bank vegetation is absent.*

The banks continue to be well vegetated to McMillans Road bridge (2.9km above SH2). A few trees overhang the stream (refer Figure 24.7), upstream from the bridge the left bank is slightly eroded (minor). Below McMillans Road bridge, small sites of erosion occur in the more open, grassy areas. Otherwise the banks are well vegetated.

Figure 24.7 Trees overhang in the stream at 3.0km.

Figure 24.8 Minor erosion of the left bank at 2.6km.

2.5km above SH2 an island divides the stream flow. On the true left bank two relatively large trees have fallen in, 10m apart. The second of the fallen trees partially blocks the stream, with a small area of erosion on the right bank. The first significant obstruction occurs 5m downstream, where two trees fully block the stream (refer Figure 24.9).

Figure 24.9 A dam catches a large quantity of debris and fully blocks the stream flow.

A floodplain of up to 100m is available and a smaller grassy floodplain, 2–5m wide, is often available when bank height is less than 0.5m in the open areas. Banks are generally well vegetated, but very small intermittent erosion occurs where bank vegetation is absent.

Figure 24.10 At 1.9km a broken causeway lies across the stream..

Between 1.5km and 800m above SH2, the banks are mostly well vegetated, but small patches of erosion are seen occasionally. A ford is present 850m above SH2, small erosion occurs of 10m length after this.

Downstream of this willows vegetate the right bank, overhanging the stream and partially blocking the flow. The stream deepens and loses a lot of its clarity at this point. Erosion (10m long) is noted 650m above SH2 (refer figure177).

Figure 24.11 Looking upstream, willows overhang the main flow at 650m. Erosion of the true left bank extends for 10m.

Downstream, a large poplar tree has been uprooted and lies across the stream blocking the flow (refer Figure 24.12). From here to the SH2 bridge, the banks are well vegetated, except for a small area of exposed bank immediately upstream of the SH2 bridge.

Figure 24.12 At 400m, a large poplar blocks the flow.

F igure 24.13 Banks have good vegetation cover. The stream has widened and has lost much of its clarity.

The stream then enters Tauranga Harbour.

24.4 Conclusion – Tuapiro Stream

The bulk of the stream is surrounded by vegetation. Some minor erosion was evident on several occasions in the more open areas (when banks had a vegetation cover of grass rather than trees). The stream channel is relatively clear. Several partial tree blockages, and one full blockage occur and in the lower reaches several willows congest the channel.

Chapter 25: Summary

A wide variety of stream management practices exist within the Tauranga Harbour catchment. A proportion of the sediment that reaches Tauranga Harbour could be retained by improved management, especially riparian retirement, but also clearing of major obstructions. Riparian retirement also has the benefit of reducing bacterial and nutrient inputs to the streams.

25.1 Suspended Sediment Measurements

Many of the Tauranga Harbour streams were sampled monthly from July 1990 to June 1991 for the Water and Sediment Quality report (94/10). Additional sampling has continued quarterly. This discrete sampling method will help to give an overview of the relative contribution of sediment from each catchment, but it does not give total sediment yields, since the major sediment inputs occur during floods and have not been measured.

25.2 Total Estimated Sediment Supply

Only one site in the Tauranga Harbour catchment has a continuous sediment sampler; the Mangawhai stream at Omokoroa. The total sediment yield from this site is of the order of 90 tonnes/yr, or 30 tonnes/km^2/yr (D.Hicks, NIWA, pers.comm.). The Mangawhai catchment appears to be relatively stable, although fairly steep, but the sediment supply rate from this catchment is expected to be similar to or less than surrounding streams such as the Te Puna, Aongatete and Whatakao streams. If the mean measured sediment concentration in these streams (as per report 94/10) is multiplied by the mean flow rate for each stream, the results for these streams are in the range of 2-4t/km^2/yr. The discrepancy in these values (of roughly a factor of 10), is because a large proportion of the sediment yield occurs at high concentrations during flood events. For this reason, and for the purposes of this report, the estimates of sediment supply have been taken as 10 times the measured mean sediment supply multiplied by the mean flow rate for each stream. Where erosion is particularly obvious, with many exposed banks, the estimate has been doubled again. This is obviously only a rough approximation, but to improve the accuracy would require a great deal more information on each stream.

Note that bedload (the larger material which, during flooding, typically moves downstream but is deposited in/remains in the stream) for gravel bed rivers has been variously estimated at between 3% and 10% of suspended sediment load in various studies, so is neglected in these estimates as insignificant compared to the estimation error. The estimates give the ‘order of magnitude’ of animal sediment inputs into Tauranga Harbour.

Results are tabulated in Table 25.1 and graphed in Figure 180.

Table 25.1 Estimated annual sediment inputs to Tauranga Harbour via major streams.

Notes: Italics are assumed figures.

Estimated factor based on comparison of discrete vs continuous sampling and degree of active erosion.

Stream/River	Area (km^2)	Mean suspended sediment concentration (g/m^3)	Mean of recorded Flows (L/s)	Estimated Yield Factor	Yield g/s	Yield t/yr	Yield t/km2/yr
Waiau	23.2	*5*	500	10	25	790	30
Tuapiro	44.7	4.8	1056	10	51	1600	40
Tahawai	6.7	*5*	148	10	7	230	30
Uretara	23.8	*5*	549	10	27	870	40
Te Rereatukahia	18.2	*5*	329	10	16	520	30
Te Mania	10.8	26.9	409	10	110	3470	320
Waitekohe	10.8	*10*	421	10	42	1330	120
Tuapo	6.9	*10*	*150*	10	15	470	70
Aongatete	42.2	*5*	1087	10	54	1710	40
Whatakao	21.6	*10*	257	10	26	810	40
Wainui	29.6	16.1	1318	10	212	6690	230
Waipapa	29.6	2.4	896	20	43	1360	50
Te Puna	21.3	*2*	792	10	16	500	20
Wairoa to Ruahihi[1]	320	3.0	3821	10	115	3610	10
Omanawa	83	26.0	1980	20	1030	32470	390
Ngamuwahine	41	1.4	*1000*	10	14	440	10
Ohourere	28	*10*	*700*	10	70	2210	80
Wairoa – total[2]	449.5	*7*	17600	10	1232	38850	90
Kopurereroa	74.0	49.1	2450	10	1203	37940	510
Waimapu[3]	100.9	12.6	3366	10	424	13370	130
Waiorahi	38.6	*15*	*1000*	10	150	4730	120
Kaitemako	11.3	*5*	179	10	9	280	20
Waitao	30.4	14.9	769	20	229	7230	240
	Total 956					**Total 118020**	**Average 124**

[1]Includes Ngamuwahine
[2]Includes area below named tributaries
[3]Includes Waiorahi

The estimated average yield is within the range measured for pasture and pine forest catchments as reported in relevant literature. The yield is of the order of three times that measured for undisturbed catchments (Soil Conservation fact sheet SC02/98).

25.3 Stream Condition

A brief description of the condition and major problems for each stream is given below. Each stream is given a "condition score", from 1 (no problems) to 5(severe problems), to compare the severity of problems. This score system has also been used for a similar survey of other Bay of Plenty streams.

Table 25.2 Stream Condition

Stream	Comments	Condition
Waitao	850m willow removal over 3km required. Moderate erosion	4
Kaiate	Considerable lengths of bare bank, several small blockages	4
Kaitemako	2 minor blockages	2
Waiorahi	1.6km extensive congestion, moderate erosion	4
Waimapu	Moderate blockages, minor erosion	3
Kopurererua	Moderate blockages, significant erosion, ok below SH29	4
Wairoa below Ruahihi	Some bank erosion	2
Ohourere	Some blockages	3
Omanawa	Significant lengths of exposed banks, some blockages.	4
Wairoa to Ruahihi	No significant problems	1
Te Puna	Stable bed, some debris, mostly free of problems	2
Waipapa	Some blockages, significant erosion for short stretches.	4
Apata	Several blockages, minor erosion	3
Wainui	Minor erosion	2
Whatakao	Generally minor problems, one stretch with frequent blockages and erosion.	2
Aongatete	Minor erosion, several willows with potential for blockages.	2
Poupou	Minor erosion	2
Tuapo	Moderate erosion and frequent blockages.	3
Waitekohe	Minor erosion above SH2. Frequent blockages and erosion below SH2, inappropriate debris dumped for erosion control.	3
Te Mania	Significant erosion above SH2. Frequent blockages below SH2	4
Uretara	Generally stable banks. Several blockages and minor erosion.	3
Boyd	Some erosion and blockages	2
McKinney	Frequent minor erosion	2
Tuapiro	Minor erosion, blockages (including outflanked concrete ford)	2

25.4 Discussion

Most streams surveyed have some potential debris or blockage problems where maintenance or management is limited. A large number of these are from overgrown or self-established willows. These blockages have the potential to create extensive lengths of bank erosion, especially where they are growing in the streambed.

The other extreme is where bank vegetation is limited by grazing. Extensive lengths of bank erosion are evident where stock is allowed to graze to the waters edge, while there is significantly less erosion in areas where grazing is restricted. The extent varies from site to site, depending on catchment size, stream gradient, soils etc, but it

is clear that the integrity of bank vegetation is an important factor in stream bank stability.

In general, there are more problems and higher sediment loads from the streams entering the southeastern part of the harbour, especially the Omanawa, and Kopurererua catchments. In addition, the Waitao, Waiorahi, Waimapu, Wainui, Te Mania and Waitekohe streams appear to discharge disproportionately high quantities of sediment. Although the Wairoa River represents about 45% of the area of the catchments surveyed, it appears to contribute only about 33% of the sediment from the streams surveyed, and the majority (about 80%) of this is from the Omanawa River.

The areas that would benefit most from works to reduce congestion are the lower reaches of the Waitao Stream, the lower section of the Waiorahi Stream and a section of the Kopurererua. In some places, the Waiorahi Stream is so congested that removing the willows will create a much larger channel. Overbank flows may be reduced significantly – this has the potential to increase erosion if not done carefully.

Perhaps a reasonable medium-term target would be to aim for a condition score of 2 for most streams, i.e. where only minor erosion and congestion is acceptable.

25.5 Stopbanking

A stopbanking scheme would be of most benefit on the Waiorahi Stream, (but may require a change in land use to be economically viable). Further minor stopbanking may be useful on the Waitao. No other areas were identified as being particularly suitable for stopbanks because floodplains are generally narrow and little land would receive flood protection. Note that stopbanking may have the effect of increasing sediment discharge further downstream by removing ponding areas.

25.6 Stream Improvement

Examples of the work involved in clearing each stream thoroughly is as follows:

Waitao – 850m (discontinuous) willow removal, plus approximately fifteen other minor blockages and seventeen potential problem trees over a 3km stretch.

Kaiate – Several small blockages and overhanging willows.

Kaitemako – Two isolated trees to remove, two partial blockages.

Waiorahi – 1.6km moderate to thick willow removal, often from in-stream. Two other sites that require willow removal.

Waimapu – 400m clearing of blockages. 500m removing overhanging limbs and partial blockages. 4 isolated tree removal sites.

Kopurererua – 500m of heavy willow congestion may relieve pressure on other eroded sites further down. Intermittent willow removal over 2km.

The lengths of riparian protection and stream clearing works that would be required to create a similar stream environment to the Ngongotaha Stream in the Rotorua catchment (where sediment transport has been estimated to have reduced by 85% following retirement), are summarised in Table 25.3. The "order of cost" assumes rates of $14/m for willow clearing and $9/m for fencing and planting.

Table 25.3 Estimated works required for "ideal" stream management.

Stream/River	Length Surveyed (km)	Condition Score	Planting + fencing Required (km)	Clearing Required (km)	Order of Cost	Ongoing Cost $/yr
Tuapiro	9	2	4	Occasional	$37,000	$4,000
McKinney	5	2	8	-	$72,000	$8,000
Boyd	6	2	6	Occasional	$55,000	$6,000
Uretara	9	3	6	0.5	$61,000	$6,000
Te Mania	6	4	9	0.3	$85,000	$9,000
Waitekohe	5	3	8	0.3	$76,000	$8,000
Tuapo	5	3	5	0.3	$49,000	$5,000
Aongatete/Poupou	8	2	4	0.3	$40,000	$4,000
Whatakao	6	2	3	0.2	$30,000	$3,000
Wainui	7	2	7	-	$63,000	$7,000
Apata	5	3	5	Occasional	$46,000	$5,000
Waipapa	5	4	5	1.0	$59,000	$5,000
Te Puna	6	2	1	Occasional	$10,000	$1,000
Wairoa to Ruahihi	1	1	-	-		
Omanawa	6	4	9	0.5	$52,000	$9,000
Ohourere	2	3	1	Some	$12,000	$1,000
Wairoa below Ruahihi	12	2	6	Occasional	$55,000	$6,000
Kopurereroa	12	4	18	0.7	$172,000	$18,000
Waimapu	7	3	6	0.7	$64,000	$6,000
Waiorahi	3	4	6	1.6	$76,000	$6,000
Kaitemako	2	2	1	Occasional	$10,000	$1,000
Waitao/Kaiate	6	4	6	1.0	$68,000	$6,000
	133km			**Total**	**$1,192,000**	**$124,000**

Based on the proportion of each stream surveyed and an estimate of the proportion of the sediment supply rate that can easily be retained (20-80%, depending on current erosion severity), it is estimated that the sediment supply to the Tauranga Harbour could be reduced by around 40% if all of the above works were implemented. It is estimated that the streams surveyed cover around 80% of the total length of streams most likely to contribute sediment to the harbour through bank erosion.

Chapter 26: References

AB Cooper, R B Williamson, C M Smith 1990: Assessment of soil conservation works in the Ngongotaha catchment and the implications to Lake Rotorua, DSIR, Hamilton.

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