MEMORANDUM

Bay of Plenty
REGIONAL COUNCIL

To: Rob Donald
Science Manager

From: Stephen Park
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Date: 22 February 2016

File Ref: A2272466

Subject: **Ecological health of Waihī Estuary**

1 Introduction

The following provides information on the current state and trends in ecological health of Waihī Estuary. This has been compiled in response to observations by staff and the community of changes occurring in the estuary (persistent and extensive macroalgal blooms), and to support the Freshwater Futures project.

2 Background

Waihī Estuary is one of the smaller coastal estuaries in the Bay of Plenty with an area of 3.34 km^2. The estuary is located to the east of Ōkurei/Town Point, is impounded by the Pukehina spit and receives freshwater inputs from a number of streams including the Pongakawa. It is shallow and most of the estuary dries at low tide leaving only relatively narrow and shallow channels. It has 62 hectares of saltmarsh and the ecology is typically estuarine in nature with similar species compositions as found in other estuaries on the north-east coast. At the entrance there are small beds of pipi and tuangi (cockle). The mid regions of the estuary are dominated by small tuangi and wedge shells. In the upper reaches bivalve shellfish are generally absent with titiko (mud snail) and crabs dominant over large areas.

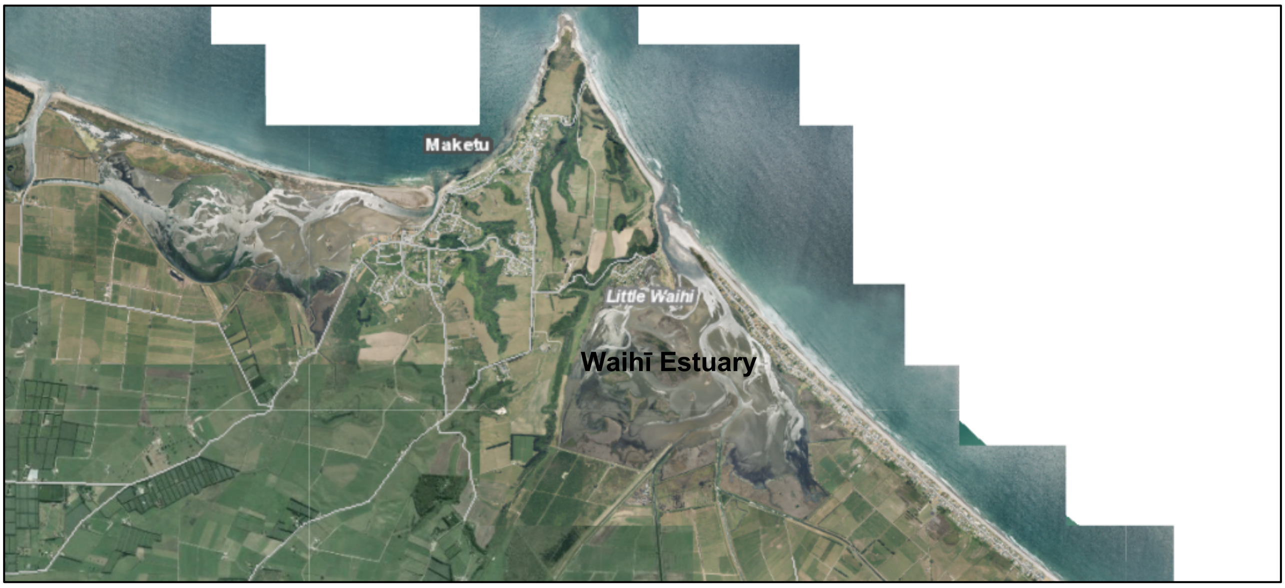

Figure 1: Waihī Estuary located in the central Bay of Plenty to the east of Maketū and Ōkurei Point.

Historically Waihī Estuary would have been unique for a system of its size as prior to the drainage of the vast wetlands to the south there was no direct water flow from the catchment. By 1926 most of the major streams, including the Pongakawa, Pokopoko, Mangatoetoe and Wharere, had channels cut directly into the estuary. This and the resulting loss of wetlands meant that contaminants such as sediment and nutrients were no longer filtered out.

These changes to the hydrology would have caused increases in sediment and nutrient inflows and a reduction in the amount of groundwater reaching the estuary. As a result there have been impacts on the nature of the habitat with significant ecological consequences. In terms of the sediment inflows the impacts are cumulative and the estuary is still slowly changing as a result.

In 1976 a report on the ecology of the estuary concluded that it was in good condition with moderate to high ecological values (Bioresearches Ltd for the Bay of Plenty Catchment Board). The report noted that impacts on the estuary's ecology, other than from reclamation and drainage of the saltmarsh, appeared to be mainly limited to accretion of fine sediments and local nutrient enrichment of waters near the mouth of the canals. The nutrient enrichment resulted in extensive areas of macroalgae beds (*Ulva* and *Gracilaria)*.

In 1990 regular water quality monitoring of the estuary and the Pongakawa Stream inflow was initiated. There were also three monitoring sites established for benthic macrofauna in the lower estuary and one of these (Site 1) is still monitored on an annual basis.

3 Monitoring information

3.1 Stream water quality

Monitoring of the Pongakawa Stream at State Highway 2 shows that the level of oxidised nitrogen in the water has increased by around 50% since 1989 (Figure 2). Other contaminants, including phosphorus and *E.coli*, are relatively stable. However, this site has a 'Suitability for Recreation Grade' (SFRG) of 'poor' based on *E.coli* results from the summer bathing suitability monitoring.

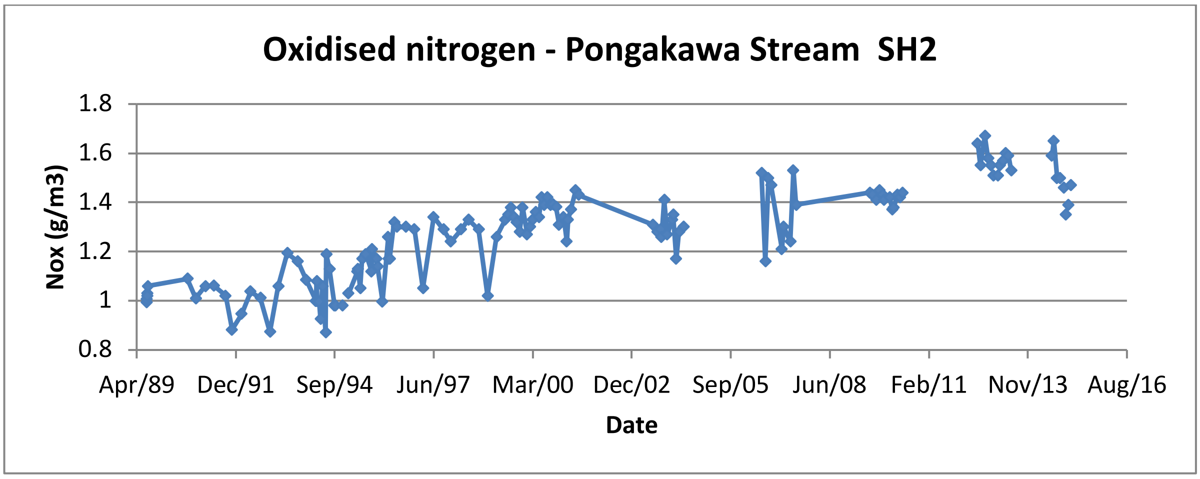

Figure 2: Levels of oxidised nitrogen measured in the Pongakawa Stream at SH2 from 1989 to 2015.

Monitoring of the other stream inflows to Waihī Estuary in 2014/15 has shown similar but slightly lower levels of nutrients compared to the Pongakawa Stream. In the Kaikokopu Canal, which receives water from the Pokopoko and Mangatoetoe Streams, sediment levels are elevated even during low flow periods. During rainfall events, the levels of nutrient and sediment recorded were higher than during the regular monitoring of base flows. Seasonal differences are also apparent with significantly higher nutrient levels during the wetter winter period than in summer.

3.2 Seagrass distribution

The main drainage works on the wetlands at the southern end of the estuary were completed in 1926. The resulting reduction in groundwater inflow to the estuary flats and the input of higher levels of sediment and nutrients had a significant detrimental impact on the extensive seagrass beds that were present. Seagrass distribution 17 years after the impact of the drainage works (in 1943) is shown in Figure 3, along with the 2011 distribution.

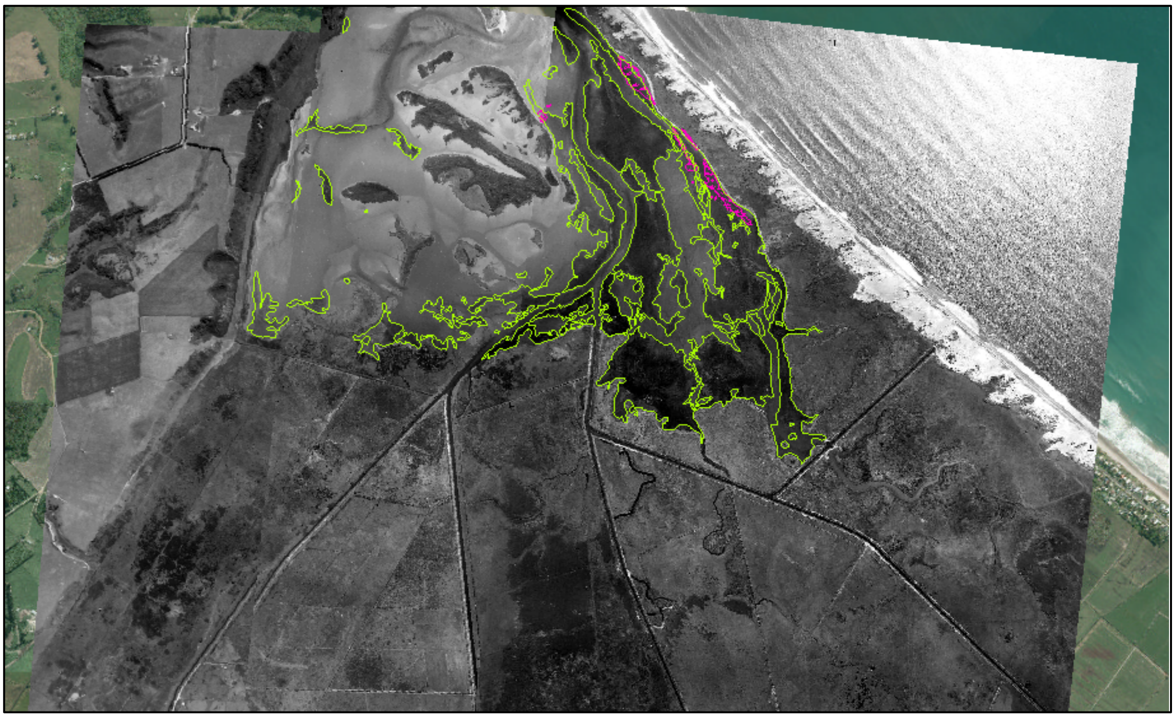

Figure 3: Seagrass extents in Waihī Estuary in 1943 (green) and 2011 (purple) overlain on the 1943 aerial photography.

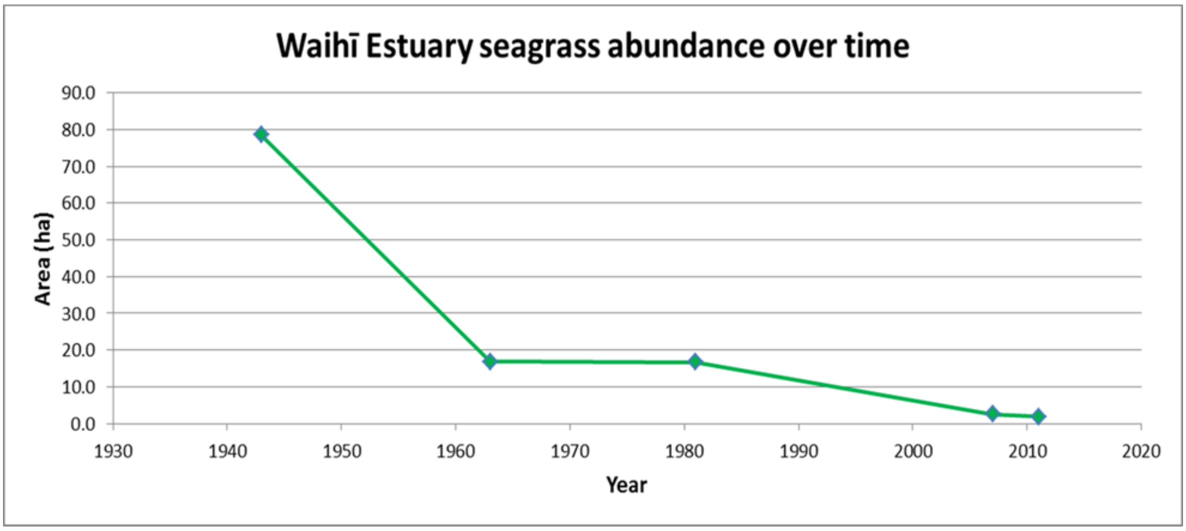

Figure 4: Seagrass abundance in Waihī Estuary from 1943 to 2011.

Seagrass abundance over time is shown in Figure 4 above. It is very likely that some seagrass loss had already occurred prior to the first available aerial photography (1943). For the period 1963 to 1981 seagrass beds may have reached a semi stable state and it is likely that the later decline to the 2007/11 extent is linked to declining water quality, with nutrient and sediment levels in excess of those tolerated by seagrass.

3.3 Macroalgal abundance

High abundance of persistent macroalgal blooms in estuaries is often an indicator of nutrient enrichment. Aerial photography was used to map macroalgal mats from 1943 to 2015. The 2014 distribution of macroalgal mats is very similar to 2015 (Figure 5). Classes of algal mat density (% cover) were used in the mapping and these are commonly used as a grading indicator of nutrient impact. As seen in Figure 5 there are very extensive areas that have high cover of algal mats indicating a poor to very poor environment due to nutrient enrichment. The aerial photos and mapping show that the two main stream channels provide enough energy to keep the sediment cleaner and free of macroalgae where they enter the estuary.

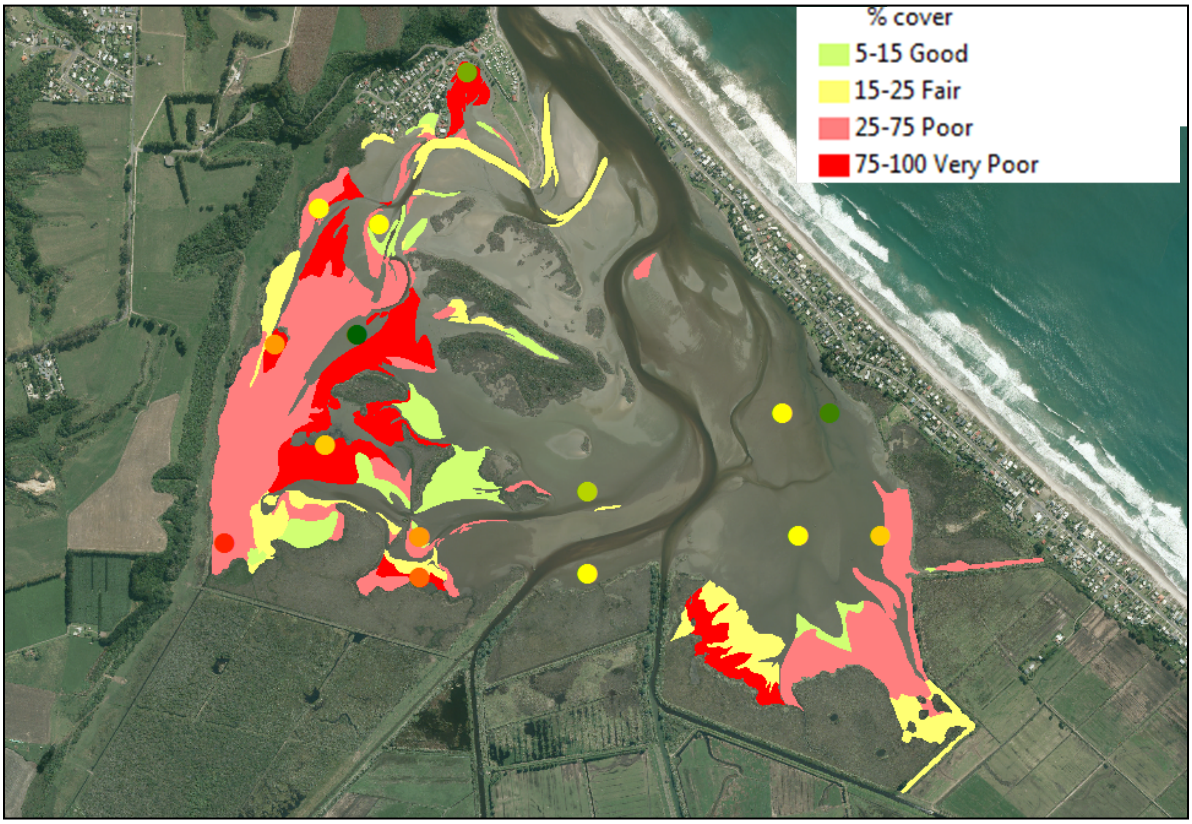

Figure 5: Macroalgal distribution and percentage cover in Waihī Estuary mapped from the 2014 aerial photography.

In addition to the mapping of macroalgal cover on the intertidal flats, some sampling has been done at a number of sediment sampling sites (also shown in Figure 5 above) to measure the biomass of the algal mats. Of the seven sediment sites sampled three recorded algal biomass between 100-500 g/m^2 wet weight which is “good” from an ecological perspective. One site recorded between 1,000-2,000 g/m^2 which is “poor” as adverse ecological impacts can be expected, and three sites had greater than 3,000 g/m^2 which is “very poor” with significant adverse ecological impacts likely. Overall the limited evidence gathered to date indicates that the algal beds (mainly *Gracilaria* and *Ulva*) are likely to be having widespread and significant adverse ecological impacts.

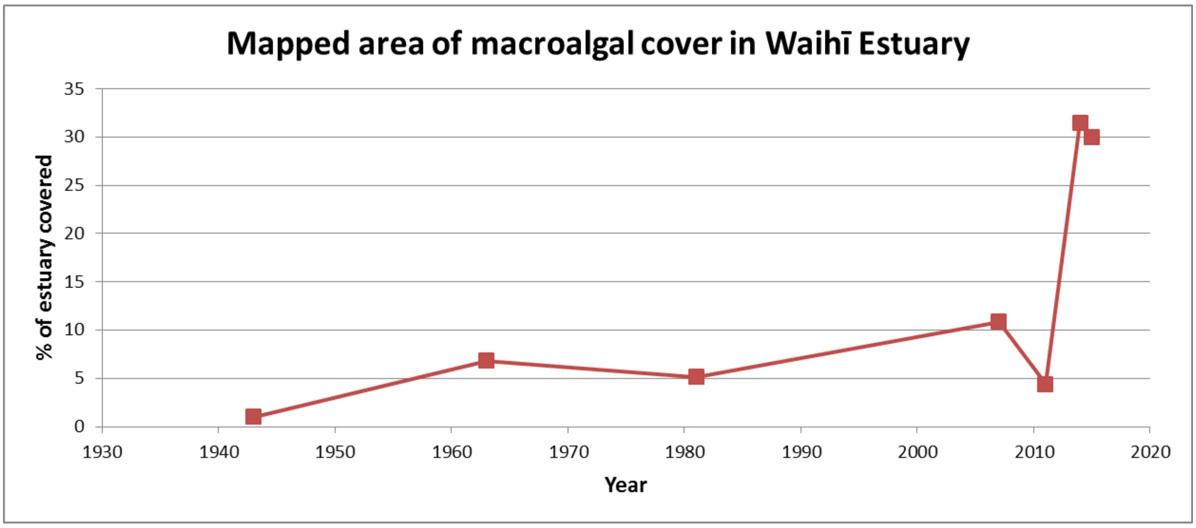

Figure 6: Macroalgal abundance in Waihī Estuary from 1943 to 2015.

In Figure 6 above the extents of the macroalgal beds over time is plotted to show the trend which has occurred since 1943. It can be seen that there appears to have been a small increase over time up to 2007 with only a relatively small proportion of the estuary affected. In 2011 the extents declined and then in 2014/15 there is a very large increase.

The mapping and other observations in 2014/15 have indicated that the macroalgal mats are persistent blooms. Most of the new areas are dominated by the red algae, *Gracilaria chilensis*, which grows in situ and does not drift around to any great extent. These changes may indicate a worsening condition of the estuary in terms of nutrient enrichment, or that the estuary has reached a 'tipping point' due to long term build-up of nutrients in the sediments.

3.4 Macrofauna

Three NERMN monitoring sites were set up in Waihī Estuary in the 1990s to assess the long-term state of the habitat and intertidal animal communities present (shellfish, crabs, worms etc.). Site 1 (Wai1) shown in Figure 7 is monitored on an annual basis while sites 2 and 3 were monitored for a shorter period and provide a baseline against which later comparisons can be made.

Figure 7: Estuarine macrofauna monitoring sites in Waihī Estuary (established 1990).

The results of monitoring the macrofauna at Site 1 are presented in Figure 8. Both the number of species present and the species diversity index (measures evenness of the number of individuals of each species present in the community) have been relatively stable over time and then show a marked decline in 2015 (summer 2014/15) and 2016 (summer 2015/16). In the 2015/16 data there are only half the number of species present and the diversity index indicates that the communities are being numerically dominated by a small number of the remaining species.

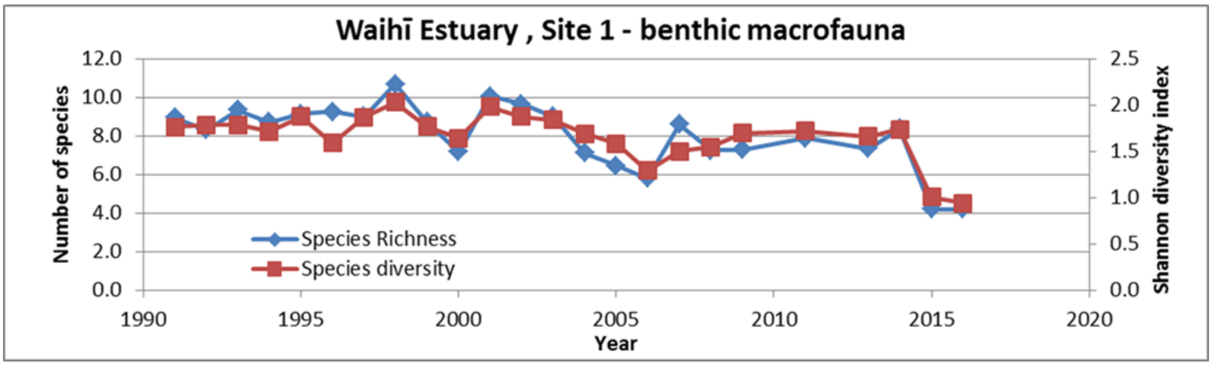

Figure 8: The number of species and species diversity (Shannon diversity index) recorded at the Waihī Estuary Site 1 benthic macrofauna monitoring site since 1990.

This significant decline in the diversity of the benthic macrofauna community is the result of the macroalgal blooms. At the time of sampling in both 2015 and 2016 a persistent mat of *Gracilaria chilensis* covered three of the four sampling blocks that make up the site. It is notable that the fourth block, which had no algal mat cover in each year, had a mean number of species of up to nine which is similar to the situation recorded at this site since 1990. In the blocks covered by algae the mean number of species was below three, which is very poor compared to the fourth block and other comparable sites elsewhere.

3.5 Sediment health

An initial investigation of the sediment quality at 15 sites throughout Waihī Estuary measured sediment particle size, total organic carbon, total nitrogen, total phosphorus and heavy metals in the top 2 cm of sediment. All of these parameters can be used as indicators of sediment quality and have been graded to score the state of the sediments. In Figure 9, the average overall grade based on the scores for sediment particle size, total organic carbon, total nitrogen and phosphorus has been calculated and plotted to show the location and state of the sites. Sites with scores in the fair range are likely to show some level of decline in ecological health while those with poor or very poor scores will likely show significant adverse ecological impacts as a result of the poor habitat quality.

The poorest quality sediment sites tend to be located in the upper reaches of the estuary and are also associated with macroalgal mats. Some areas of the upper estuary have very anoxic (oxygen deprived) sediments extending right to the surface. Where the main channels flow into the estuary, water flows provide sufficient energy to keep the sediments cleaner and free of algal mats. Higher current speeds occur in the main channels and near the lower estuary in the vicinity of the entrance and help to keep sediments there in a cleaner state.

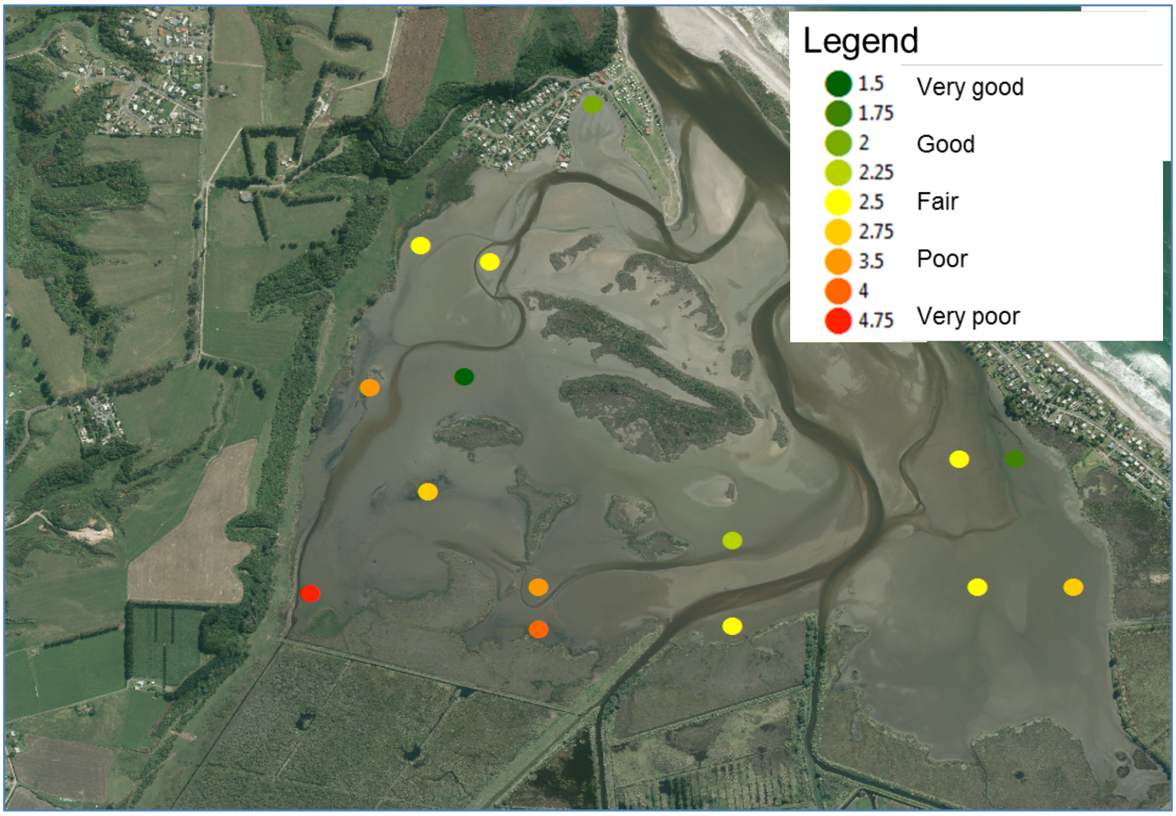

Figure 9: Sediment sampling sites in Waihī Estuary showing the sediment quality in February 2014 (based on particle size, organic content and nutrients).

All of the sites shown in Figure 9 had levels of metal contaminants below the ANZECC sediment quality guidelines ('ISQG-low' values for arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc). At these levels heavy metals would not be expected to cause any adverse ecological impacts.

4 Conclusions

The available information clearly shows that the ecological health of Waihī Estuary is poor, particularly in the upper and mid reaches, and that the decline in health is continuing. Indications are that nutrient inputs into the estuary, both historical and ongoing, are the main factor responsible for the recent decline. Another key factor is the input of sediment and while the loads may have stabilised since the extensive drainage works in the 1920s, the impacts will remain cumulative over the long term.

A key feature of poor condition of the estuary is the extensive and persistent macroalgal mats which are dominated by *Gracilaria chilensis*. These mats have a significant adverse impact on ecological health and are known to cause negative feedback (e.g. of nutrients) which can hasten further environmental decline.

Due to the nature of the historic ecological impacts that have occurred, it will never be possible to restore this estuary close to its original state. However it is recommended that remedial actions are considered to address the current decline in ecological health. While the key issues are the sediment and nutrient loads flowing into the estuary from the surrounding land, inputs of faecal contamination may also need to be addressed.

Stephen Park
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