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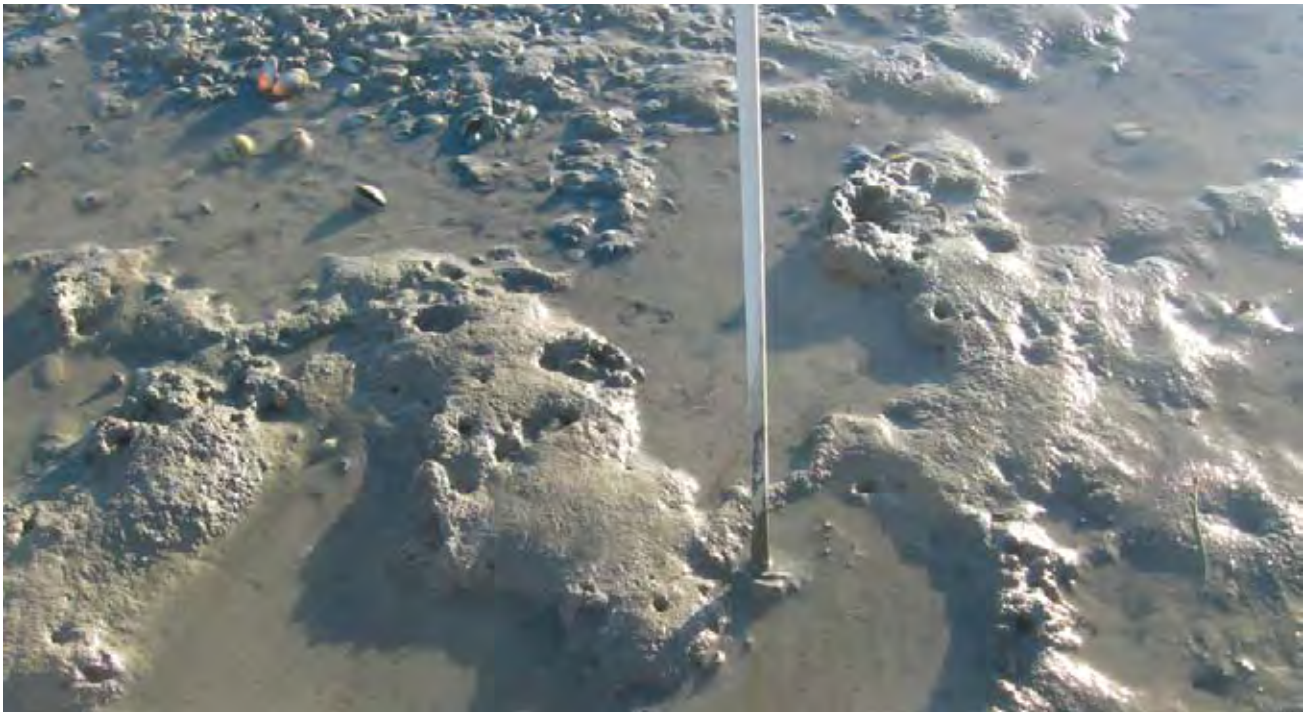
Whareama Estuary

Intertidal Sediment Monitoring 2010/11

Prepared for
Greater Wellington Regional Council
April 2011

Looking upstream to Site WhaA.

Cover Photo: Whareama Estuary - Site WhaB - upper estuary, 16 January 2011.



Fine muds at Site WhaB 16 January 2011.

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By

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1. INTRODUCTION AND METHODS

Whareama Estuary

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Vulnerability Assessment
Identifies issues and recommends monitoring and management. Completed in 2007 (Robertson and Stevens 2007)

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Whareama Estuary Issues
Moderate eutrophication
Excessive sedimentation
Habitat Loss (terrestrial margin)

↓

Monitoring

Broad Scale Mapping
Sediment type
Saltmarsh
Seagrass
Macroalgae
Land margin

5 -10 yearly
First undertaken in 2007. Next due 2017. Macroalgae not yet undertaken.

Fine Scale Monitoring
Grain size, RPD, Organic Content
Nutrients, Metals, Invertebrates, Macroalgae

3yr Baseline then 5 yearly
Baseline complete. Next survey 2015.

Sedimentation
Annually

↓

Condition Ratings
Area soft mud, Area saltmarsh, Area seagrass, Area terrestrial margin, RPD depth, Benthic Community, Organic content, N and P, Toxicity, Sedimentation rate.

Other Information
Previous reports, Observations, Expert opinion

↓

ESTUARY CONDITION
Moderate Eutrophication
Excessive Sedimentation
Low Toxicity
Habitat Degraded (terrestrial margin)

↓

Recommended Management

- Manage sediment and nutrient inputs.
- Set nutrient, sediment guidelines.
- Margin vegetation enhancement..
- Manage weeds and pests.

Soil erosion is a major issue in New Zealand and the resulting suspended sediment impacts are of particular concern in estuaries because they act as a sink for fine sediments or muds. As a consequence of a catchment dominated by steep hills, combined with a soft rock type and a primary landuse of pastoral grazing, Whareama Estuary receives elevated inputs of fine sediments, has turbid waters, and a muddy bed.

Recent monitoring (Robertson and Stevens 2008, 2009, 2010) has shown the estuary has high sedimentation rates, poorly oxygenated sediments with a high mud content, and a benthic invertebrate community dominated by high numbers of a few mud and organic enrichment tolerant species. These findings indicate the estuary is experiencing problems related to excessive muddiness and poor sediment oxygenation. This triggers annual monitoring of sedimentation rates, grain size, and RPD depth.

The current report summarises the intertidal sediment monitoring results for these indicators in Whareama Estuary, one of the key estuaries in the Greater Wellington Regional Council (GWRC) coastal monitoring programme. The report presents the results from sampling on 16 January 2011, and uses condition ratings developed for Wellington's estuaries to rate the condition of the estuary, and recommend monitoring and management actions.

Detailed descriptions of sampling sites and methods are provided in (Robertson and Stevens 2008, 2009, 2010), and are briefly summarised below.

Sedimentation Rate

To measure the sedimentation rate from now and into the future, a set of 4 concrete plates were buried in the estuary in 2008. Each plate, marked by wooden pegs and GPS referenced, was located and the depth of sediment over the plate measured by pushing a probe into the sediment until it hit the plate. A number of measurements on each plate were averaged to account for irregular sediment surfaces.

Grain Size

To monitor changes in the mud content of sediments, three samples (two a composite from four plots, one a composite from two plots) of the top 20mm of sediment were collected from each fine scale site (WhaA and WhaB) and analysed by Hill Laboratories for grain size (% mud, sand, gravel).

Redox Potential Discontinuity (RPD) depth

To assess sediment oxygenation, the depth to the RPD was measured at 10 plots at each fine scale site by digging down from the surface with a hand trowel until the RPD transition was located.

Figure 1. Location of fine scale sites and buried sediment plates in Whareama Estuary.

1. Introduction and Methods (Continued)

WELLINGTON ESTUARIES: CONDITION RATINGS

A series of interim fine scale estuary "condition ratings" (presented below) have been proposed for Whareama Estuary (based on the ratings developed for Southland's estuaries - e.g. Robertson & Stevens 2006). The ratings are based on a review of estuary monitoring data, guideline criteria, and expert opinion. They are designed to be used in combination with each other, and with other fine and broad scale indicators (usually involving expert input) when evaluating overall estuary condition and deciding on appropriate management. The condition ratings include an "early warning trigger" to highlight rapid or unexpected change, and each rating has a recommended monitoring and management response. In most cases initial management is to further assess an issue and consider what response actions may be appropriate (e.g. develop an Evaluation and Response Plan - ERP).

Sedimentation Rate

Elevated sedimentation rates are likely to lead to major and detrimental ecological changes within estuary areas that could be very difficult to reverse, and indicate where changes in land use management may be needed.

SEDIMENTATION RATE CONDITION RATING		
RATING	DEFINITION	RECOMMENDED RESPONSE
Very Low	0-1mm/yr (typical pre-European rate)	Monitor at 5 year intervals after baseline established
Low	1-2mm/yr	Monitor at 5 year intervals after baseline established
Moderate	2-5mm/yr	Monitor at 5 year intervals after baseline established
High	5-10mm/yr	Monitor yearly. Initiate ERP
Very High	>10mm/yr	Monitor yearly. Manage source
Early Warning Trigger	Rate increasing	Initiate Evaluation and Response Plan

Redox Potential Discontinuity

The RPD is the grey layer between the oxygenated yellow-brown sediments near the surface and the deeper anoxic black sediments. It is an effective ecological barrier for most but not all sediment-dwelling species. A rising RPD will force most macrofauna towards the sediment surface to where oxygen is available. The depth of the RPD layer is a critical estuary condition indicator in that it provides a measure of whether nutrient enrichment in the estuary exceeds levels causing nuisance anoxic conditions in the surface sediments. The majority of the other indicators (e.g. macroalgal blooms, soft muds, sediment organic carbon, TP, and TN) are less critical, in that they can be elevated, but not necessarily causing sediment anoxia and adverse impacts on aquatic life. Knowing if the surface sediments are moving towards anoxia (i.e. RPD close to the surface) is important for two main reasons:

1. As the RPD layer gets close to the surface, a "tipping point" is reached where the pool of sediment nutrients (which can be large), suddenly becomes available to fuel algal blooms and to worsen sediment conditions.
2. Anoxic sediments contain toxic sulphides and very little aquatic life.

The tendency for sediments to become anoxic is much greater if the sediments are muddy. In sandy porous sediments, the RPD layer is usually relatively deep (>3cm) and is maintained primarily by current or wave action that pumps oxygenated water into the sediments. In finer silt/clay sediments, physical diffusion limits oxygen penetration to <1cm (Jørgensen and Revsbech 1985) unless bioturbation by infauna oxygenates the sediments.

RPD CONDITION RATING		
RATING	DEFINITION	RECOMMENDED RESPONSE
Very Good	>10cm depth below surface	Monitor at 5 year intervals after baseline established
Good	3-10cm depth below sediment surface	Monitor at 5 year intervals after baseline established
Fair	1-3cm depth below sediment surface	Monitor at 5 year intervals. Initiate ERP
Poor	<1cm depth below sediment surface	Monitor at 2 year intervals. Initiate ERP
Early Warning Trigger	>1.3 x Mean of highest baseline year	Initiate Evaluation and Response Plan

2. RESULTS, RATING AND MANAGEMENT

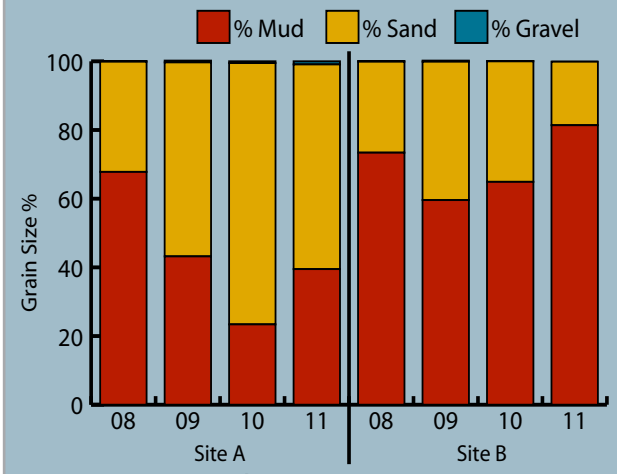

Figure 2. Grain size, Whareama Estuary (2008-2011).

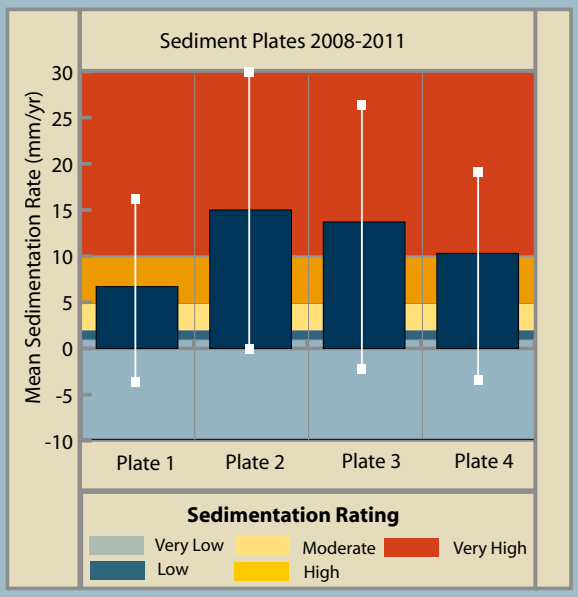

Figure 3. Sedimentation rate from plate data (mean and range), Whareama Estuary (2008-2011).

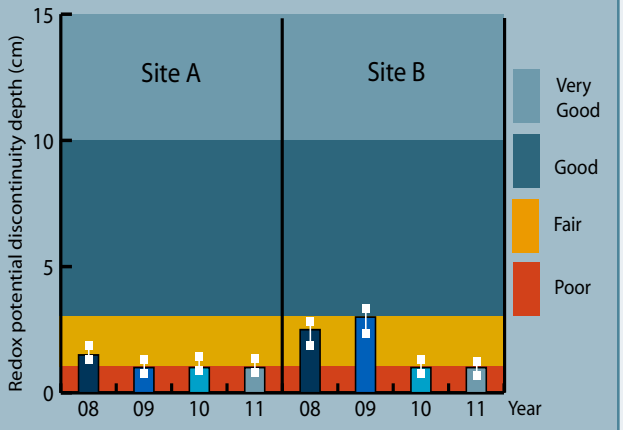

Figure 4. RPD depth (mean and range), Whareama Estuary fine scale sites, (2008-2011).

The three indicators used to assess sedimentation in 2011 were grain size, sedimentation rate, and RPD depth.

Grain Size

Grain size (% mud, sand, gravel) is a key indicator of both eutrophication and sediment changes. In tidal river estuaries that lack large intertidal flats, like Whareama, elevated levels of mud are often present along the narrow channel banks in the lower estuary. Increasing mud content signals a deterioration in estuary condition.

Grain size monitoring results at fine scale sites (Figure 2) show the mud content increased at both sites between 2010 to 2011 - from 23% to 40% at Site A, and 65% to 80% at Site B. This reverses the recent trend evident at Site A where the mud content decreased from 2008-2010.

Overall, both sites are dominated by muds (Table 1) sourced almost certainly from the surrounding catchment. The higher sand content at Site A reflects its location at the boundary between muddy terrestrial sediments and sandy marine sediments in the lower reaches of the estuary.

Rate of Sedimentation

The depths to four plates buried in Whareama Estuary (see Robertson and Stevens 2008) were measured in January 2011 as part of annual long term monitoring of sedimentation rates in the estuary (Figures 3 and 5, Table 2).

Mean annual sedimentation rates for the site since 2008 range from -2 to +21.8mm/yr. The variance between years is almost certainly due to river related deposition and erosion of sediment. The highest rate of sedimentation (21.8mm/yr) was recorded in 2011. This rate, and the overall site mean of 11.4mm/yr, fall within the "very high" category and coincide with obvious indications of floods or high flow events - several large trees and a layer of fine mud deposited on the intertidal flats.

These results indicate that the intertidal flat in the mid Whareama Estuary is currently infilling at a variable, but high rate.

Redox Potential Discontinuity (RPD)

The depth to the RPD boundary is a critical estuary condition indicator in that it provides a direct measure of sediment oxygenation. This commonly shows whether nutrient enrichment in the estuary exceeds levels causing nuisance anoxic conditions in the surface sediments, and also reflects the capacity of tidal flows to maintain and replenish sediment oxygen levels.

In well flushed sandy intertidal sediments, tidal flows typically oxygenate the top 10cm of sediment. However, when fine muds fill the interstitial pore spaces, less re-oxygenation occurs and the RPD moves closer to the surface.

In response to the presence of fine muds and, to a lesser extent, nutrient enrichment, the RPD depth has decreased at all sites in Whareama Estuary since 2008 (Figure 4, Table 1). In 2011 it remained relatively shallow (1cm) indicating sediments are poorly oxygenated. Such moderately shallow RPD values fit the "fair-poor" condition rating.

2. Results, Rating and Management (Continued)

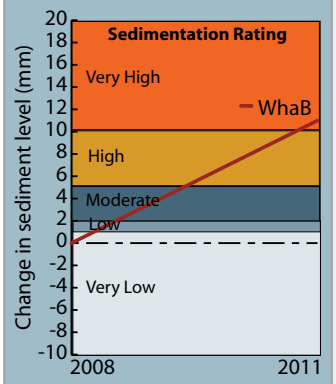

Figure 5. Mean change in sediment level from 2008-2011.

2011 SEDIMENTATION RATE RATING
VERY HIGH

Table 1. RPD depth and grain size results, Whareama Estuary fine scale sites, (16 Jan 2011).

Site	Replicate*	RPD	Mud	Sands	Gravel
		cm	%		
Wha A.	1-4	1	50.7	48.6	0.7
Wha A.	5-8	1	41.4	58.6	0
Wha A.	9-10	1	26.3	71.5	2.2
Wha B.	1-4	1	80.3	19.6	0
Wha B.	5-8	1	80.1	19.9	0
Wha B.	9-10	1	83.8	16.1	0

Table 2. Sediment plate data, Whareama Estuary (2008-2011).

Site	Sediment Depth (mm)				Change (mm)			Site Mean (mm/yr)			Overall Rate (mm/yr)
	18/1/08	18/1/09	22/1/10	16/1/11	2008-2009	2009-2010	2010-2011	2008-2009	2009-2010	2010-2011	2008-2011
Wha B. 1	182	188	185	202	6	-3	17	+14.5	-2.0	+21.8	+11.4
Wha B. 2	156	170	170	201	14	0	31				
Wha B. 3	215	234	232	256	19	-2	24				
Wha B. 4	216	235	232	247	19	-3	15				

CONCLUSION

The increase in sediment mud content, the very high rate of sedimentation, and "poor RPD" rating, signify rapid infilling of this important area of Whareama Estuary contributing to ongoing problems associated with excessive muddiness.

RECOMMENDED MONITORING

It is recommended that monitoring continue as outlined below:

Annual Monitoring. To address problems associated with excessive muddiness and a "poor RPD" rating, monitor sedimentation rate, RPD depth and grain size annually until the situation improves. Therefore the next monitoring is due in January 2012.

Fine Scale Monitoring. It is recommended that a "complete" fine scale monitoring assessment (including sedimentation rate and macroalgal mapping) be undertaken at 5 yearly intervals (next scheduled for Jan-Feb 2015).

Broad Scale Habitat Mapping. It is recommended that broad scale habitat mapping be undertaken at 10 yearly intervals (next scheduled for 2016-17).

RECOMMENDED MANAGEMENT

The fine scale monitoring results reinforce the need for management of fine sediment and, to a lesser extent, nutrient sources entering the estuary. It is understood that GWRC's Land Management department has developed 13 property plans (covering approximately 20% of the total catchment area) to manage erosion prone land in the Whareama catchment. This work should be complemented by an investigation of the sources of sediment within the catchment, so as to help target the best use of resources allocated to improving land management.

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ACKNOWLEDGEMENTS

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