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Regional Council
TE RAUHĪTANGA TAIAO

Regional Maps of Settling Zones and Outer Zones

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Regional Maps of Settling Zones and Outer Zones

Prepared for
Auckland Regional Council

Contents

1 Preamble

The maps presented in this report have been prepared for the Regional Discharge Project. They have divided Auckland's urban coastal marine area into two types of receiving environments for the purposes of monitoring the impact of stormwater and wastewater discharges:

- Settling Zone
- Outer Zone

The rationale for this subdivison is explained in ARC (2002a) "Environmental Targets for the Urban Coastal Marine Area". This is summarized below.

The red lines show the interface between the settling and outer zones. The blue line indicates the extent of a specific Outer Zone. A red dotted line is a special investigation area.

Suggested sampling locations are marked on the maps but these are only indicative. Site selection is described more fully in ARC (2002b) Blueprint for Environmental Monitoring in Urban Coastal Marine Receiving Environments Technical Publication No 168..

2 What are the Settling Zones and Outer Zones?

Within estuaries, catchments commonly discharged to sheltered estuarine arms (tidal creeks) or embayments. Catchment-derived suspended solids tend to settle and be trapped here, along with any associated contaminants. It is possible to define an area where a significant proportion of catchment-derived sediments accumulate, which we have termed the **Settling Zone**. Here, concentrations in the sediment are highest and the estuarine processes cause the concentrations of contaminants to be reasonably homogeneous spatially.

The Settling Zone (SZ) concept is useful for the Regional Discharges Project because it assists in the location of a representative sample sites, simplifies sampling because of the underlying homogeneity of the SZ, helps determine the quality of the receiving environment and provides a basis for predicting changes in concentrations with changes in land use and catchment management. It identifies an area that is most strongly impacted (at least in terms of concentration of contaminants in water and sediments), where, for pragmatic purposes, there may have to be some acceptance of environmental degradation. It also identifies those areas beyond the SZ, where there are greater benefits of protection from environmental degradation. These areas are more sensitive, more extensive and, being beyond the SZ, there is a high probability that these can be protected.

Immediately beyond this Settling Zone, deposition and accumulation may still be the primary process, but accumulation is slower (contaminants are mainly trapped further upstream). Beyond this, the estuary widens or discharges to the coast. In these areas, hydrodynamic energy is higher because they are more exposed, and experience larger and more frequent waves, so contaminants are more widely dispersed and moved on.

Settling Zones are defined arbitrarily and simply on the basis of morphology, catchment size and intertidal excursion. The marine areas beyond the Settling Zone we have termed the **Outer Zone**.

3 Different Guidelines for Settling Zones and Outer Zones

Some of the guidelines to be used to for monitoring the impact of stormwater and wastewater are different in the Settling and Outer Zone that reflect their different characteristics.

The Key Parameters for monitoring the impact of stormwater include:

- Water Quality,
- Sediment Quality,
- Benthic Ecology,
- Public Health.

Guidelines for Water Quality parameters (DO and toxic substances), and human health are the same for each zone. In the Outer Zone, the guidelines for sediment quality and benthic ecology are somewhat different, reflecting the higher degree of protection required more sensitive organisms and the markedly different benthic assemblage there.

The Guidelines are described in ARC 2002a, ARC 2002b and Williamson and Mills (2001).

4 How the extent of the SZ was determined

The procedures used were developed during case studies on the Tamaki and Upper Waitemata Harbour estuaries (Williamson and Green 2001). The method is outlined in the following.

1 Identify the estuary and the catchments. The catchments are specific stream or stormwater catchments that discharge to an identifiable, semi-enclosed subestuary. Identify the major discharges to the estuary.

2 Consider the scale at which this is to be done. Because this is a regional project, we have assumed a large scale and some minor estuaries and arms have been ignored.

3 Calculate catchment and estuarine receiving water areas. Some catchment areas are available in TA-ARC (1997) Technical Report No. 2. Analysis of Catchments and Receiving Environments. Estuarine areas can be worked out rapidly and adequately from the NZMS1 1:50000 maps by summing the fraction of estuarine areas in 1 km^2 grid squares Do not include narrow headwaters, but include channels etc.

4 Work out the theoretical settling zone on the basis of the 4% rule. Take into account proportion of urban and rural landuse. Apply to the catchment/estuary in question on the basis of location of outfalls and estuary morphology.

5 Do this by considering and identifying any overlapping deposition areas based on the 4% rule. If these strongly overlap, then combine, i.e., treat as one source. If they don't overlap strongly, then SZ principles are not met and there is a strong possibility of varying contaminant concentrations in the settling area. The next point needs to be considered when conducting this exercise.

6 Take into account intertidal excursion. If the 4% area lies completely within the intertidal area (excepting the low tide channel) then deposition will "stretch" downstream to include part of the subtidal portion of the estuary. Sometimes, it may not be possible to define the total settling area with any accuracy (e.g. Waiarohia), but in many cases the estuary morphology constrains the "intertidal excursion" and the total settling area can be identified relatively easily. The NZMS 1:50000 maps indicate subtidal areas, so these can be used for guidance.

7 The line demarking the SZ with its OZ was drawn using the above information and a sensible choice for the estuarine morphology. Inside (landward) is the SZ, outside (seaward) is the OZ.

Settling Zones are mainly affected by the catchments that drain into them and their morphology. However, Outer Zones for a specific SZ can, and usually, overlap with the OZ of other SZs. Therefore the quality of sediments within the OZ may reflect inputs from many catchments. For example, the Middle Waitemata is the OZ for all the catchments that drain into it from Hobsonville/Beachhaven (the Upper Harbour Bridge) through to Devonport/Orakei (the mouth of the Waitemata). These include land drainage to a particular well-defined SZ (e.g., Henderson), land draining to what we have regarded as insignificant SZ (e.g., Little Shoal Bay), land draining to arms that do not meet SZ criteria (e.g., Waipareira) and land draining directly to the OZ (e.g., Point Chevalier). Despite this overlap and the diffuse influence of many inputs to this large OZ, sampling sites in this OZ were chosen so that they would reflect, as close as possible, the influence of the major catchments.

Outer zones and settling zones can sometimes overlap. For example, the Outer Zone for Paremoremo, Rarawaru, Brighams and Lucas, overlaps with the Settling Zone for the Rangitopuni.

5 Monitoring Locations

The information and notes used to choose the Settling Zones and Outer Zones are summarized in Table 1 and 2.

Where a SZ has been able to be confidently located, this has been shown on the maps. Suggested sampling sites and locations are meant to be indicative only and site selection is detailed in the report "Blueprint for Monitoring and Assessing Coastal Marine Receiving Environments" (ARC 2002b). Some of these sites have sufficient information from past studies and further samples may not be required.

We have not been able to assign a Settling Zone to some catchments. In order to manage through monitoring we recommend the following options:

- Where the catchment discharges to high-energy environments, we recommend monitoring with Outer Zone samples.
- Where the catchment discharges to low energy environments, but these environments cannot be classified as SZ, then the assessment and monitoring can be based on a number of options:
  - Collect and composite multiple samples
  - Rely on results from comparable catchments
  - Rely on monitoring from the appropriate Outer Zones

Please note that the Settling and Outer Zone Maps are separately located on the CD as PDF files.

Table 1. Information and notes on selecting Settling Zones.

SZ_4 =the theoretical 4% settling area, SZ_2 = the theoretical 2% settling area.

Estuary	Catchment area	SZ_4	Estuary Area	Rationale for site selection	Recommended action
Middlemore Upper Tamaki	800	32	50	Deposition areas overlap in narrow arm, but intertidal nature stretches SZ boundary to low-tide basin near motorway	1 sample
Otahuhu	268.3	10	45	Deposition areas do not overlap in estuary that is poorly mixed, SZ_4<<Estuary, and intertidal area extends into OZ, so SZ boundary is ill-defined. Representative sample unlikely	Characterise with multiple samples
Panmure	246	10	50	Although SZ_4<<Estuary, and deposition areas do not overlap, the basin is well-mixed, so a representative sample can be taken near middle of basin, but not near main freshwater input	1 sample
Omaru	506.2	20	660	No SZ, but major catchment Strong concentration gradient near stream mouth Already investigated by Metrowater	Review Metrowater data
Wakaaranga	120	5	8	Very inefficient settling because strongly intertidal, lots of mangroves, minor catchment	Do not sample
Pakuranga	2500	100	105	Deposition areas overlap in narrow arm, SZ_4~Estuary. There are presently 2 ARC LTB sites. Major past study.	Investigate concentration gradient in lower estuary
Otara	3509	140	50	Weir creates a settling basin with strong concentration gradients, so no SZ site. Under investigation by MCC	Review MCC data

Estuary	Catchment Area (ha)	SZ_4	Estuary Area (ha)	Rationale for site selection	Recommended action
Rarawaru	200	8	6.7	Intertidal nature and SZ_4>Estuary extends settling area into UWH. Well-defined morphology allows us to define SZ by mouth.	1 sample upstream SZ_2
Brighams Totara	2200	88	53	Deposition areas overlap in narrow arm, intertidal nature and SZ_4>Estuary extends settling area into UWH. Well-defined morphology allows us to define SZ by mouth	1 sample upstream SZ_2
Rangitopuni Riverhead	10261 1260	410	413.6	Presently rural catchment. SZ_4 covers all of main body of UWH. Investigate known elevated levels in this important water body through gradient study	3 samples
Paremoremo	Total 1212	48	44	Efficient settling, SZ_4~Estuary	1 sample upstream SZ_2
Lucas (main channel)	2500	100	178	Deposition areas overlap in narrow arm, intertidal nature extends settling area down to mouth	1 sample
Te Wharau	630	25	37	Discharges from multiple arms overlap in Te Wharau Bay. SZ defined by mouth but overlaps strongly with Lucas SZ	1 sample
Hellyers	1450	56	113	Several SZ, depositional areas poorly overlap Main body is an OZ	See Outer Zone
Kaipatiki	941	38	35	Inefficient settling extends into Hellyers main body. Define SZ by morphology.	1 sample
Upper Hellyers	417	16	10	Inefficient settling extends into Hellyers main body. Define SZ by morphology.	1 sample
Waiarohia	528	23	35	SZ_4<Estuary, inefficient settling extends into bay. SZ defined by morphology	1 sample

Estuary	Catchment Area (ha)	SZ_4	Estuary Area (ha)	Rationale for site selection	Recommended action
Orewa				Main body is an OZ	See Outer Zone
Orewa North	175	7	6	SZ defined by sub-estuary morphology	1 sample
Orewa South	210	8	15	SZ defined by sub-estuary morphology, but full of mangroves	No SZ sample
Weiti	1911	76	~100	Deposition areas overlap in narrow arm, intertidal nature extends settling area to low tide basin, which defines SZ	1 sample
Okura			412	Main body is an OZ	See Outer Zone
Okura South	176	7	8	Small SZ defined by sub-estuary morphology	1 sample
Okura West	1700	68	42	Deposition areas overlap in narrow arm, SZ constrained to upper reaches by higher energy in main body	1 sample
Milford	1437	60	~5	SZ_4>>>Estuary, very inefficient settling, sediment quality affected by marina and dredging	No SZ sample
Ngataringa	~250	10	~200	SZ_4<<Estuary, many minor inputs, Bay is an OZ	No SZ sample
Hillcrest, Shoal Bay	368	15	40	Intertidal nature stretches settling area out into Shoal Bay, SZ defined by shell banks, mangroves and low energy environment	1 sample
Onepoto Shoal Bay	89			Small catchment, very inefficient settling, many minor inputs, poorly mixed, full of mangroves and difficult to sample for management purposes	Do not sample
Northcote	228	~8	~8	Very inefficient, full of mangroves, not suitable for SZ	Do not sample

Estuary	Catchment Area (ha)	SZ_4	Estuary Area (ha)	Rationale for site selection	Recommended action
Little Shoal Bay	120	~5	~50	Exposed, part of OZ	Do not sample
Chelsea	130	~5	~20	Exposed, part of OZ	Do not sample
Birkenhead-Beachhaven				Many small catchments, recommend sampling two as representative estuaries/catchments, e.g., Soldiers, Beachaven	
Soldiers	180	~4	10	Mostly bush, inefficient settling (SZ_4<Estuary). Well-defined morphology allows us to define SZ by mouth.	1 sample
Beachaven	~100	~4	~4	Well-defined morphology allows us to define SZ by mouth.	1 sample
Bomb, Nimrod	~130	~3	~10	Poor SZ because deposition areas from many small inputs may not overlap, both full of mangroves, but might require a special study if developed	Await development
Catalina	v. small		~10	SZ_4<<<Estuary, no catchment, no SZ Dominated by UWH/MWH exchange	No SZ sample
Waipareira	~150	3	3	Unsuitable because full of mangroves and freshwater wetland, highly influenced by Henderson	No SZ sample
Lawsons	~400	16	15	Poorly defined morphology, inefficient Lots of mangroves, highly influenced by Henderson	No SZ sample
Swanson Hendersons	3440	136	35	Strong overlap between 'twin streams' and full of mangroves, SZ_4<<Estuary, intertidal, very inefficient	No SZ sample
Oratia	6153	245	65	Strong overlap between 'twin streams' and full of mangroves, SZ_4<<Estuary, intertidal, very inefficient	No SZ sample
Henderson	9594	~400	~400	Big mangrove area to east of mouth and sand bars to north defines SZ to include Limeburners Bay to Scott Pt	Sample mid reach @ Lawsons Ck (ARC site)

Estuary	Catchment Area (ha)	SZ_4	Estuary Area (ha)	Rationale for site selection	Recommended action
Whau	3012	120	370	SZ_4<<Estuary, suggests settling spread out, but probably get strong gradients, therefore treat upper reaches as SZ and lower as OZ	See below
Upper Whau	2093	84	86	Efficient SZ	1 sample
Wairau	401	16	18	Efficient SZ	1 sample
Glendene				Minor catchment, estuary full of mangroves	Do not sample
Waterview				SZ_4<<Estuary. Oakley Ck discharge near inlet outlet, so at low tide discharges to harbour. Strong gradients across inlet	No SZ sample
Meola	1693	68	?	SZ defined by reef and mangroves and constrained to upper reaches by higher energy in harbour	1 sample
Motions	463	16	?	SZ defined by reef and mangroves and constrained to upper reaches by higher energy in harbour	1 sample
Coxes	420			Exposed, not a SZ	No SZ sample
Hobson	1284	51	130	Multiple inputs. High energy environment	See OZ
Newmarket	777	31	130	SZ_4<<Estuary. Muddy deposition area consists of eroding channel and mangroves, so small, ill-defined SZ. Subject of Metrowater and other past studies.	No SZ sample Review study results
Orakei				Settling basin, not SZ. Subject of other studies	No SZ sample
Purewa	286	11	`10	Efficient SZ	1 sample
Judges Bay	<50			Small catchment, minor inputs	No SZ sample
Mangamangaroa	937.3	40	44	Efficient SZ	1 sample upstream SZ_2

Estuary	Catchment Area (ha)	SZ_4	Estuary Area (ha)	Rationale for site selection	Recommended action
Mangere	3695	148	587	SZ_4<<Estuary, many inputs, mostly an OZ Contaminants spread out, strong gradients multiple inputs Past industrial pollution?	See below
Harania, Mangere	800	32	17	SZ_4>Estuary, inefficient settling extends out into main body of estuary, but has low tide basin because of causeway	1 sample
Tarata, Mangere	700	28	<10	SZ_4>Estuary, very inefficient settling (stongly intertidal) Also not suitable because full of mangoves	No SZ sample
Anns Creek, Mangere	~450	18		Very poor morphological controls, poor SZ (Inefficient, diffuse settling area)	Presently ARC LTB site
Hillsborough Bay				Small catchments, exposed embayment Impoundment traps inputs from main catchment	No SZ sample
Little Muddy	740	30	100	Low density residential and low level of contamination. SZ_4<<Estuary. SZ constrained by higher energy in lower estuary	1 sample
Rest of NE Coast				Catchments tiny, exposed embayments. Huia minor urban area. Big Muddy bush runoff intercepted by reservoir.	No SZ sample
Oruarangi				Awaiting consents To reconnect stream to CMA.	Do not sample
Pukaki	1759	51	130	SZ_4<<Estuary, multiple inputs, tortuous and many arms, settling spread out because very intertidal, so deposition areas overlap in narrow arms. Regionally important, although mainly rural, high concentrations have been found. Need to understand impacts of airport and expanding commercial zone	2 samples in main bodies of 2 largest arms and 1 sample in "Airport" SZ in embayment north of bridge
Puhinui	2671	106	70	Shellbanks extend SZ into harbour. SZ_4>Estuary and high flood velocities in estuary, lots of erosion so very inefficient.	2 samples needed to characterize this SZ

Estuary	Catchment Area (ha)	SZ_4	Estuary Area (ha)	Rationale for site selection	Recommended action
Weymouth Waimahia	877	35	140	SZ_4<<Estuary, multiple inputs, deposition areas poor overlap, poor mixing	No SZ sample
Papakura Stm	5403	216	120	SZ_4>Estuary, but mostly rural. Poor morphological controls (embayment), high flood velocities over intertidal banks, embayment is somewhat exposed. SZ boundary is diffuse and deposition is spread out Regionally important large catchment	3 samples needed to characterize this SZ
Takanini				SZ_4<<Estuary, poor PDA overlap, full of mangoves, no SZ	No SZ sample
Papakura town basin	660	26	65	SZ_4<Estuary, poor overlap of deposition areas of the many small inputs. Poorly mixed	Present ARC LTB site
Drury Creek				Large, long estuary, multiple inputs, multiple arms, multiple landuse. Present urban inputs minor, but some past large industrial inputs, major catchment inputs are rural and will dilute any impact Hingaia Development very flat, input will depend on stormwater plan - some potential sites in embayments.	Await development scenarios
Waiuku	496	20	40	Estuary>SZ, but inefficient settling because of intertidal excursion. Low level contamination because mostly rural with small urban area	1 sample
Putiki, Waiheke	~200	8	40	Multiple small inputs, SZ_4<<Estuary, poor deposition area overlap	No SZ sample
Rest of Waiheke				Exposed, relatively small urban inputs. No or very minor SZ	No SZ sample
Helensville				Major rural river. Minor urban inputs flushed out into large harbour area	Await development

Table 2. Information and notes on selecting Outer Zones

Estuary	Inputs	Rationale for sampling	Recommended action
Upper Tamaki	Otara, Upper Tamaki, Otahuhu, Panmure, Pakuranga	Muddy settling area, most contaminants trapped upstream in SZ Local exceptions for direct discharges from industrial areas (e.g., Gabador Place)	2 samples Special samples may be needed for Gabador Place outfalls
Middle Tamaki	Omaru, Glen Innes Whakaaranga coastal Pakuranga, upper Tamaki	Complex texture and gradients One major input from Omaru and many minor coastal input Large important sand bank	2 samples
Outer Tamaki	Glendowie, Bucklands Beach	One major input (Glendowie)	1 sample in middle of sandbank off Glendowie
Wairaohia	Waiarohia, Herald Is, Upper Harbour Drive	Muddy settling area Modest coastal inputs and Wairaohia overflow Exposed, and probably well-mixed	1 sample in middle of inlet
Hellyers	Kaipatiki, Upper Hellyers, coastal Birkenhead	Muddy settling area Concentration gradients between SZs and mouth Major past study	ARC Study 3 samples to understand gradient along estuary axis
Rangitopuni	All UWH catchments	Throat, high energy, rock ledges, muddy, minor area. No significant inputs or changes	Not suitable for OZ sample
Middle Harbour	Birkenhead - Beach Haven	Little suitable substrate Minor catchment inputs	Not suitable for OZ sample
Middle Harbour	Henderson	Major catchment inputs to Middle Harbour	1 sample on sandbank outside SZ
Lower Whau	Upper Whau, Wairau, Avondale	Other minor catchment inputs including industrial Rosebank Rd	1 sample at ARC LTB site
Middle Harbour	Whau	Major estuary outflows sweep across sand banks	1 sample on sandbanks north of Pollen

Estuary	Inputs	Rationale for sampling	Recommended action
Middle Harbour	Oakley, Avondale Waterview	Major catchment. Outlet to Waterview inlet No SZ within the inlet	1 sample on intertidal sand bank near hospital north of motorway
Middle Harbour	Meola	Major urban catchment	1 sample on either LHB, RHB of low tide channel on sandbank outside SZ
Middle Harbour	Motions, Coxes, Westmere	Major urban catchments	1 sample mid-tide level on intertidal sandbanks
Middle Harbour Reference sites		There is a need for general background data with which to compare OZ sites	2 samples (1 is ARC LTB site)
Shoal Bay		Coastal inflows from Northcote, Belmont, Takapuna, and overflow from Hillcrest stream. Investigate gradient through Bay	2 samples on intertidal sands or in mud behind shellbanks
Shoal Bay Ngataringa	Belmont, Devonport	Old residential, Naval Base, landfill	1 sample in middle of Bay in mud
Hobson	Newmarket, coastal Parnell, Remuera,	Complex receiving environment. A number of near-shore samples have been taken. Need information throughout Bay	3 samples throughout Bay
Purewa	Meadowbank, Orakei Basin	Minor OZ	1 sample
Orakei – Archilles Pt	Mission Bay, St Heliers, Kohimara-mara	Relatively large catchment inputs and influenced by Waitemata Harbour Designated a Special Investigation Area to assess the impact of urban catchments on contaminant build-up in subtidal coastal regions	Investigate subtidal sampling
Cheltenham		Intertidal, small catchments but strongly affected by outflow from Waitemata Harbour	1 sample at ARC LTB site
NE Coast Narrow Neck to Long Bay	East Coast Bays, Takapuna – Long Bay	Designated a Special Investigation Area to assess the impact of urban catchments on contaminant build-up beyond the surf zone of the coastal marine area	Samples to measure gradient across and up coast

Estuary	Inputs	Rationale for sampling	Recommended action
Okura	Okura town, rural intensification	Expect low contamination, but sensitive, well-studied estuary. Key site for model calibration and verification	1 sample inside spit
Weiti	Silverdale	Minor urban area, lots of dilution. Monitor depending on development	Await development
Whangaparoa Orewa Beach		Expect low contamination, exposed, small catchments	Await results of East Coast Special Investigation
Orewa Estuary	Orewa, mostly rural	Presently rural, increasing development planned	1 sample
Whitford	Urban development and rural intensification	Catchment and estuary undergoing major investigation. Key site for model calibration and verification	Await development
Beachlands-Maraeti		Expect low concentration Monitor depending on development	Await development
Waiheke Putiki Huruhi	Blackpool, Ostend, Surfdale	Very small catchments, expect low levels	Await development
Mangere	Past industrial discharges. Mangere, Onehunga, Otahuhu	Mangere Inlet has been historically contaminated from industrial discharges. Pollution abatement haS reversed this situation	Special investigation on the direction and rate of change of contamination
NE Coast Mangere Br to Corwallis		Expect low level from small catchments	Do not sample
Pukaki in Manukau		Minor inputs Very exposed with low mud content	Do not sample

Estuary	Inputs	Rationale for sampling	Location
Puhinui in Manukau		Major urban catchment with industrialization Inefficient SZ exporting to OZ	On sandbank beyond SZ near low tide channel
Puherehere main body		Large rural area to south, smaller urban area to north, strong gradients across estuary Large complex water body	Need 3 samples to understand this complex water body
Waiuku		Large SZ traps small urban input Dominated by past and present steel mill discharge	Do not sample
Helensville		Contamination very dilute and dispersed	Await development

6 References

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