

Before the Board of Inquiry
Waterview Connection Project

in the matter of: the Resource Management Act 1991

and

in the matter of: a Board of Inquiry appointed under s 149J of the Resource Management Act 1991 to decide notices of requirement and resource consent applications by the NZ Transport Agency for the Waterview Connection Project

Statement of evidence of Dr Sharon De Luca (Marine Ecology) on behalf of the **NZ Transport Agency**

Dated: 10 November 2010

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STATEMENT OF EVIDENCE OF DR SHARON DE LUCA ON BEHALF OF THE NZ TRANSPORT AGENCY

INTRODUCTION

- 1 My full name is Dr Sharon Betty De Luca. I hold the qualifications of Bachelor of Science (Zoology) and Doctor of Philosophy (Environmental and Marine Science).
- 2 I am a Principal Ecologist with Boffa Miskell Limited specialising in marine ecology, working primarily in the Auckland and Bay of Plenty regions. I have previously worked for City University of Hong Kong (as a Post-Doctoral Fellow) on a variety of research projects focussing on coastal ecology, ecotoxicology, marine microbiology and the development of new techniques for monitoring sublethal stress in marine invertebrates.
- 3 I am a registered member of The Royal Society of New Zealand, the New Zealand Marine Sciences Society and the New Zealand Coastal Society and have practised as an environmental scientist for the past nine years. I am a Certified Environmental Practitioner with the Environment Institute of Australia and New Zealand and am bound by the Institute's code of ethics. I have published nine scientific papers in peer-reviewed international journals.
- 4 My relevant experience in marine ecology includes:
 - 4.1 Northshore Busway (2007): Preparation of assessment of effects of construction of busway lanes and motorway interchange structure adjacent to and within an area of intertidal habitat in North Shore City. The construction included temporary reclamation of an area of intertidal mudflat.
 - 4.2 Silverdale North Residential Development (2007-2008): Preparation of assessment of effects of the construction of two road bridges across the Orewa River and tributaries and the discharge of construction and operational phase stormwater to tidal areas within the Orewa River and estuary. The construction involved permanent subtidal habitat loss.
 - 4.3 Long Bay Structure Plan Change (2007-2008): Assessment of the potential adverse effects of land use change (from rural to urban) within the Awaruku and Vaughans Stream catchments at Long Bay on the marine ecological values within the receiving environment (Long Bay-Okura Marine Reserve). The project involved presentation of expert evidence at Environment Court.

- 4.4 Additional Waitemata Harbour Crossing (2008-2009):
Assessment of the effects of construction and operation of a proposed additional crossing of the Waitemata Harbour. The construction phase effects on marine habitat included dredging, disposal of dredge spoil, permanent loss of subtidal and intertidal habitat, reclamation works and disturbance of benthic sediment.
- 5 My evidence is given in support of notices of requirement and applications for resource consents lodged with the Environmental Protection Authority (EPA) by the NZ Transport Agency (NZTA) on 20 August 2010 in relation to the Waterview Connection Project (Project). The Project comprises works previously investigated and developed as two separate projects, being:
- 5.1 The State Highway 16 (SH16) Causeway Project; and
- 5.2 The State Highway 20 (SH20) Waterview Connection Project.
- 6 I am familiar with the area that the Project covers, and the State highway and roading network in the vicinity of the Project.
- 7 I have read the Code of Conduct for Expert Witnesses as contained in the Environment Court Consolidated Practice Note (2006), and agree to comply with it. In preparing my evidence, I have not omitted to consider material facts known to me that might alter or detract from my opinions expressed.

SCOPE OF EVIDENCE

- 8 My evidence will deal with the following:
- 8.1 Executive summary;
- 8.2 Background and role;
- 8.3 Summary of assessment of marine ecological effects;
- 8.4 Post-lodgement events;
- 8.5 Comments on submissions;
- 8.6 Comments on the s149G Report by the Auckland Regional Council; and
- 8.7 Proposed marine ecological conditions.

EXECUTIVE SUMMARY

- 9 The coastal works associated with the Project occur within and adjacent to Coastal Protection Areas (1 and 2) and within the Motu Manawa Marine Reserve.
- 10 The marine environment to the south of the SH16 Causeway between Great North Road and the Whau Bridges is characterised by low-moderate ecological values, whereas the marine environment to the north of the Causeway is characterised by moderate-high ecological values.
- 11 Contaminant concentrations in surface sediment are typically above biological effect threshold concentrations to the south of the Causeway and below biological effect threshold concentrations to the north of the Causeway.
- 12 Construction associated with the Project will have adverse effects on marine ecological values including permanent habitat loss (approximately 5.87 ha), temporary habitat loss and disturbance (approximately 7.25 ha), discharge of contaminants and sediment, and noise and vibration disturbance. I consider all of these effects, other than permanent habitat loss, to be adequately directly mitigated and/or minor or negligible.
- 13 Significant adverse effects during the construction phase of Sectors 1-5 of the Project arise from permanent reclamation of benthic habitat.
- 14 Minor adverse effects during the construction phase of the Project arise due to temporary reclamation and disturbance, which is required in order to protect the ecological values of the wider marine environment.
- 15 The adverse effects on marine ecological values arising from the trial embankment, other than those identified in the assessment of effects relating to the permanent embankment, are minor or negligible.
- 16 Operation of the widened SH16 alignment involves the discharge of highly treated stormwater (>80% removal of total suspended sediment (TSS), compared to the typical requirement of 75% removal of TSS) to the marine environment, resulting in a lower concentration of contaminants being deposited in marine sediment.
- 17 Mitigation of the adverse effects of permanent marine habitat loss arising from construction of the Project can be off-set through remediation of intertidal mudflat habitat (to a depth of 0.5m) over the toe of the Causeway revetments, a higher level of treatment efficiency of stormwater from Sectors 1-5 once operational,

treatment of stormwater arising from the existing road surfaces, restoration of coastal fringe habitat (revegetation and weed control), and removal of gross litter and debris from the coastal edge.

- 18 I conclude that the adverse effects from the Project's construction phase will be adequately mitigated, provided the off-set mitigation identified above is carried out, a requirement for which is included in the proposed marine ecology conditions discussed below.
- 19 I do not expect operation of the widened SH16 motorway, given the higher quality of road runoff treatment proposed, to have adverse effects on marine ecological values, other than contributing to the long-term continued accumulation of contaminants in the marine sediment, albeit at a lower rate.

BACKGROUND AND ROLE

- 20 The NZTA retained Boffa Miskell as consultants to assist with the management of ecological resources during the engineering and planning phases of the Project. I prepared an Assessment of Marine Ecological Effects Report (Report) in relation to the Project to assess marine ecological effects both during the construction period and once the Project was operational. Dr Leigh Bull, Senior Ecologist at Boffa Miskell peer-reviewed my Report.
- 21 My Report was lodged with the EPA on 20 August 2010 as part of the overall Assessment of Environmental Effects (AEE) (specifically, Part G, Technical Report G.11).
- 22 My Report was informed by, and relies upon, other technical reports lodged with the EPA in support of the Project, those reports being primarily:
- 22.1 Assessment of Coastal Processes (Technical Report G.4);
 - 22.2 Assessment of Stormwater and Streamworks Effects (Technical Report G.15);
 - 22.3 Erosion and Sediment Control Plan (Technical Report G.22);
 - 22.4 Coastal Works Report (Technical Report G.23);
 - 22.5 Associated Sediment and Contaminant Loads (Technical Report G.30);
 - 22.6 Assessment of Avian Ecological Effects (Technical Report G.3);
 - 22.7 Assessment of Freshwater Ecological Effects (Technical Report G.6);

22.8 Assessment of Terrestrial Vegetation Effects (Technical Report G.17);

22.9 Assessment of Construction Noise Effects (Technical Report G.5);

22.10 Assessment of Operational Noise Effects (Technical Report G.12); and

22.11 Assessment of Vibration Effects (Technical Report G.19).

SUMMARY OF ASSESSMENT OF MARINE ECOLOGICAL EFFECTS

23 In this section of my evidence I will briefly describe the key points of my Report.

The existing marine environment¹

24 The Project occurs adjacent to, and within parts of, the Waitemata Harbour, within the coastal marine area (CMA), between Oakley Inlet in the east, and a tidal tributary of Henderson Creek (Pixie Inlet) in the west.² The Project area occurs within the Motu Manawa (Pollen Island) Marine Reserve (MMMR), and Coastal Protection Areas (CPA1 and CPA2) and General Management marine environment areas classified in the Auckland Regional Plan: Coastal. These protection areas are illustrated in the Auckland Regional Council (ARC) Coastal Plan Maps shown in Figures 2 and 2a, pages 8 - 9 of Report G.11 (attached to my evidence as **Annexure B**).

25 Within these marine habitats, I have assessed the existing ecological values based primarily on the benthic invertebrate community composition and ambient sediment quality. I have concluded that, as a whole, the marine environment to the south of the SH16 Causeway is characterised by low-moderate ecological values whereas the marine environment to the north of the Causeway is characterised by moderate-high ecological values.³

26 South of the Causeway, the intertidal mudflats of the Waterview Estuary and Oakley Inlet are typically depositional areas and comprise deep soft mud, with mangroves being a dominant feature extending out towards the subtidal channels. These subtidal channels are similarly characterised by fine muddy sediment. The existence of the Causeway exacerbates the accumulation of fine sediment in these areas arising from catchment runoff. However, within the intertidal habitat, there are small areas of shellbank, where sediment grain size is coarser, and some saltmarsh vegetation is supported.

¹ Refer to section 5, pages 25-53 of my Report.

² See Figure 1, page 8 of my Report (copy attached as **Annexure A**).

³ Refer to pages 51-53 of my Report.

27 North of the Causeway, the marine environment is open to the wider Waitemata Harbour and is a higher energy environment than south of the Causeway. Consequently, it is less prone to deposition of fine grain sediment. The intertidal habitat comprises mudflats, sandflats, and shellbanks and is fringed by mangroves and saltmarsh vegetation in parts. The greater habitat diversity and coarser grain size of the benthic sediment provides habitat for a larger range of invertebrate species, including bivalves and gastropods.

28 The two island features surrounded by the MMMR (Pollen and Traherne Islands) comprise sandflats, mudflats, shellbanks, saltmarsh and terrestrial vegetation.

Benthic invertebrates

29 All of the benthic invertebrate species detected are common and typical of the habitat they were found in. No rare or threatened invertebrate species⁴ have been detected within or adjacent to the Project area. The dominant groups of invertebrate groups detected in the study included gastropods (snails), bivalves (shellfish), oligochaete worms, polychaete worms, isopods (slaters), amphipods (e.g. sand flea), decapods (crabs), Tanaidacea (a shrimp-like crustacean) and anthozoa (anemone).

30 The most commonly detected invertebrate taxa were oligochaete worms and the Capitellid polychaete worm *Heteromastus filiformis*. Both these taxa are commonly found in degraded habitats often where the sediment is fine grained and contains contaminant concentrations above effects thresholds.

31 Of the taxa detected, highly mobile organisms such as mud crabs, and, to a lesser extent, amphipods, would be expected to tolerate relatively deep deposition of sediment, whereas small less mobile groups such as polychaete worms, Nemertean worms, estuarine snails and nut shells would most likely be smothered at sediment deposition depths greater than 5mm.

Fish

32 Fish were not sampled as part of my assessment because: (i) recent descriptions of fish species likely to be present in the marine habitat potentially affected by the Project were available (ii) fish are highly mobile and this gives them the ability to avoid areas of disturbance; and (iii) the inherent difficulties associated with sampling marine fish in a comprehensive but non-destructive manner in conditions of often low visibility. More than ten fish species were identified by Morrison

⁴ Freeman, D.J., Marshall, B.A., Ahyong, S.T., Wing, S.R., Hitchmough, R.A., 2010. Conservation status of New Zealand marine invertebrates, 2009. *New Zealand Journal of Marine and Freshwater Research*, 44(3): 129-148.

et al.⁵ as likely to be present in Waitemata Harbour intertidal flats and mangrove forests, but only three species were considered to use mangrove forests as juvenile nursery grounds (grey mullet, long-finned eel and parore). Of these species, long-finned eel have a threat classification of “at risk–declining”.⁶

Saline vegetation

- 33 Saline vegetation within the Project area includes mangroves and saltmarsh. Potential adverse effects on saltmarsh are assessed by Mr Slaven, in the Assessment of Terrestrial Vegetation (Report G.17) and mangroves are considered in my Report and in my evidence.
- 34 Mangroves (*Avicennia marina* subsp. *australasica*) are common within the intertidal habitat in the Project area, and are particularly dense within the Waterview Estuary and Oakley Inlet. Whilst a native species, the ubiquitous distribution and increasing colonisation of intertidal mudflats by mangroves in northern New Zealand has led to resource consents being obtained for their partial removal from several estuarine areas including Tauranga Harbour, Pahurehure Inlet (in the Manukau Harbour, Auckland) and several areas in the Northland Region.

Sediment contaminants

- 35 I have compared the concentration of common stormwater contaminants in surface sediments against ARC’s Environmental Response Criteria (ERC).⁷ ERC thresholds were developed based on Australian and New Zealand Environment and Conservation Council (2000) guidelines and other internationally recognised sediment quality guidelines. Contaminant concentrations in the green range indicate that the biology of the site is unlikely to be impacted, whereas the amber range indicates possible impact and the red range indicates probable impact.
- 36 Surface sediment throughout the Waterview Estuary and Oakley Inlet contains concentrations of copper, lead and zinc that typically exceed biological effects thresholds, particularly in the fine sediment fraction.⁸ Concentrations of these metals in sediment in areas immediately north of the Causeway are typically below effects thresholds. The concentration of high molecular weight polycyclic

⁵ Morrison, M., Schwarz, A., Francis, M., Reed, J., Lowe, M., Webster, K., Carbines, G., Rush, N. (in prep). Expanding temperate mangrove forests – are they important as juvenile fish nurseries?

⁶ Allibone, R., David, B., Hitchmough, R., Jellyman, D., Liing, N., Ravenscroft, P., and Waters, J. , 2010. Conservation status of New Zealand Freshwater Fish, 2009. New Zealand Journal of Marine and Freshwater Research, first published 27 September 2010.

⁷ Auckland Regional Council, 2004. Blueprint for monitoring urban receiving environments. Auckland Regional Council Technical Publication No. 168, Auckland.

⁸ See Figures 10a-13b, pages 30-37 of my Report (copy attached as **Annexure C**).

aromatic hydrocarbons in surface sediment was detected at below effects threshold concentrations at all but three sites.

Assessment methodology

- 37 In the absence of national guidance on the value of marine environments, I have developed some criteria, based on my experience and research in Auckland estuarine habitats, to guide my assessment of marine ecological value, broadly based on benthic invertebrate community composition and sediment characteristics. Table 1 shows the criteria I used to guide the determination of ecological value using benthic invertebrate community species richness, the number of sensitive or pollution intolerant invertebrate species present, the proportion of silt and clay in surface sediment (top 2 cm), depth of surface sediment that is oxygenated, the concentration of common stormwater contaminants in surface sediment with reference to effect threshold guidelines, qualitative assessment of degree of habitat modification (e.g. coastal edge reclaimed or retained, tidal flow restricted by structures etc.).

Table 1: Criteria for guidance of assessment of marine ecological value

	Ecological Value		
	High	Moderate	Low
Benthic invertebrate community species richness	>10 taxa present	5-10 taxa present	<5 taxa present
Sensitive/pollution intolerant invertebrate species	Many present	At least one present	None present
Proportion of silt and clay in surface sediment	<50%	50-70%	>70%
Depth of oxygenated surface sediment	>1.0 cm	0.5-1.0 cm	<0.5 cm
Concentration of contaminants in surface sediment	Typically below possible effects thresholds (e.g. ARC ERC Green)	Typically above possible effects thresholds (e.g. ARC ERC Amber)	Typically above probable effects thresholds (e.g. ARC ERC Red)
Degree of habitat modification	Negligible modification	Limited modification	Highly modified

38 My assessment of each identified effect was based on ecological value, extent and magnitude of the impact/effect and duration of the impact/effect. These factors, analysed in combination, resulted in the determination of the degree of an effect as significant (major or moderate), minor or negligible.⁹

Construction effects¹⁰

39 Construction associated with the Project will have adverse effects on marine ecological values arising from permanent habitat loss, temporary habitat loss, habitat disturbance from the discharge of sediment and contaminants and, to a lesser extent, noise and vibration.

Permanent habitat loss

40 I consider the permanent marine benthic habitat loss resulting from the Project (of approximately 5.87 ha¹¹ of primarily intertidal mudflat) to be a significant adverse effect.

41 The organisms (benthic invertebrates and mangroves) living on and within the sediment within reclamation areas will be permanently lost. The ecological values of the areas of permanent habitat loss are not homogenous and I consider them to be moderate to high to the north of the existing Causeway, and low to moderate to the south of the existing Causeway. Chenier ridges (shell banks) are also present within the area of habitat loss to the north of the Causeway. These will be removed from the site, stockpiled elsewhere, and replaced within the coastal fringe once widening of the Causeway has been completed.¹² The area of permanent habitat loss comprises less than 1% of the Motu Manawa (Pollen Island) Marine Reserve.

Temporary habitat loss

42 Temporary marine benthic habitat loss as a result of the Project (estimated at 7.25 ha¹³) will be primarily caused by the use of coffer dams and other erosion and sediment control devices, the excavation of marine sediment, re-alignment of low tide channels, and the installation of temporary staging platforms.

43 Temporary habitat loss and disturbance is likely to involve the mortality of benthic invertebrates, increased concentration of

⁹ Refer to pages 23-24 of my Report.

¹⁰ Refer to page 54 of my Report.

¹¹ The area of permanent marine benthic habitat loss was calculated as the area extending from the existing CMA boundary to the furthest extent of permanent occupation, less the marine habitat remediation area (see Figure 1 of Dr Hsi's Evidence): Refer to **Annexure E** of my Evidence.

¹² Refer to page 68, Technical Report G.4.

¹³ The area of temporary marine benthic habitat loss comprises the area of temporary occupation (excluding aerial occupation) and the marine habitat remediation area (see Figure 1 of Dr Hsi's Evidence): Refer to **Annexure E** of my Evidence.

suspended sediment, deposition of sediment and associated contaminants, noise and vibration. I consider these adverse effects to be minor due to their short-term temporal magnitude, medium to neutral ecological impact and likely resilience of the biological communities.

44 Cofferdams and other erosion and sediment control devices protect the wider marine environment during construction from the discharge of sediment and potentially contaminants. Thus, whilst their use in this Project involves the sacrifice of marine benthic invertebrates and mangroves contained in the area, once the cofferdams and other devices are removed, it is expected that invertebrates and mangroves will recolonise the sediment over time.

45 Excavation, stock piling and replacement of marine sediment to a depth of 0.5m will occur at the toe of the Causeway revetments. Whilst excavation and stock piling of the marine sediment will result in: the removal of mangroves, the death of a large proportion of the benthic invertebrate community contained within the sediment, and anoxic sediment conditions within the stockpile; once replaced, the sediment is expected to be recolonised over time by mangroves and typical invertebrate species (such as polychaete and oligochaete worms, mud crabs, amphipods and gastropods). Bioturbation and other biological processes will also, over time, assist with oxygenation of the surface sediment layer.

Habitat disturbance from the discharge of sediment and contaminants

46 Re-alignment of the low tide channel will occur at two locations within Oakley Inlet (A and B) and one to the south of the existing Causeway embankment (C).¹⁴ Excavation of sediment to create new channel meanders out from the Causeway and the infilling of areas of existing low tide channel directly affected by the Causeway widening, will result in the discharge of suspended sediment, the deposition of sediment as it drops out of suspension, and the mortality of some marine organisms.

47 The concentration of total suspended sediment (TSS) and the spatial extent of deposition have been modelled conservatively, assuming the excavation areas are always open to tidal flows.¹⁵ The modelling predicts that the concentration of TSS and depth of deposition likely to occur during re-alignment of the channel meanders within Oakley Inlet will be of a small magnitude, below effects thresholds.¹⁶ In reality, the excavations will be carried out in a staged fashion at low-tide periods to minimise sediment release. Based on the modelling

¹⁴ Refer to pages 39-40, Technical Report G.23.

¹⁵ Refer to pages 69-70, Technical Report G.4.

¹⁶ Refer to pages 75-78 and Appendix C, Technical Report G.4.

results, I conclude that effects on benthic invertebrates will be negligible.

- 48 Re-alignment of the channel to the south of the existing Causeway within Waterview Estuary may result in the deposition of sediment (assuming coarse silt grain size) above benthic invertebrate effects threshold depth (>7mm) over an area of approximately 1,915 m², but of that only 250m² is outside the area that will be lost to permanent reclamation. Medium silt grain size is considered to be more realistic than coarse silt grain size.¹⁷ Modelling of the channel realignment in Waterview Estuary using medium silt grain size predicts there will not be sediment deposition at depths that is likely to cause significant adverse effects on marine organisms.¹⁸
- 49 Conservative modelling of TSS concentrations arising from the re-alignment of all three channels indicates that the TSS concentration may approach effects thresholds of the most sensitive marine invertebrates, but the duration of the increase in TSS will be short-lived and highly unlikely to cause adverse effects on these organisms. The redistribution of contaminants associated with sediment disturbed during the channel re-alignments is unlikely to have adverse effects on marine organisms (invertebrates and fish) as the concentration of contaminants in surface sediments within areas where there may be some deposition of sediment is relatively similar to that of the area of excavation. Thus, there may be deposition of "like upon like" and as such the resident benthic invertebrate community composition is likely to reflect the ambient sediment values.
- 50 The transport and dispersion of sediment and contaminants in Oakley Inlet and Waterview Estuary, sourced from Oakley Creek during construction earthworks in Sectors 7-9 have been modelled for different return-period storms.¹⁹ The derivation of sediment and contaminant loads from the catchment and construction works is covered by Dr Moores in his evidence. The depth of deposition and concentration of TSS in Oakley Inlet and Waterview Estuary is predicted to be below effects thresholds during a 2 year return-period storm. Therefore, adverse effects on marine ecology from stormwater arising from construction earthworks in Sectors 7-9 are considered to be negligible.

¹⁷ Refer to pages 69-72 and Appendix C, Technical Report, G.4.

¹⁸ Nicholls, P., Norkko, A., Ellis, J., Hewitt, J., Bull, D., 2009. Short term behavioural responses of selected benthic invertebrates inhabiting muddy habitats to burial by terrestrial clay. Prepared by NIWA for Auckland Regional Council. Auckland Regional Council Technical Report 2009/116.

¹⁹ Refer to pages 98-99 and Appendix B, Technical Report G.4.

Other effects

- 51 The installation and removal of piers associated with the temporary staging platforms at the various locations throughout the Project area will involve the mortality of some marine organisms, short-term elevation in TSS and some vibration and noise disturbance. However, the area occupied by the piers is small and only a small number of marine organisms will perish during installation and removal. The increase in TSS and disturbance from noise and vibration during installation and removal is likely to be relatively small and short-term in relation to the marine ecology.
- 52 The discharge of stormwater during the construction phase is unlikely to have adverse effects on marine ecological values, given the high level of treatment proposed.²⁰
- 53 The removal of mangroves is predicted to occur over a total area of approximately 2.79 ha²¹. Given the abundance of mangroves in the Project area, their ubiquitous nature in Auckland estuaries and the ability of this species to rapidly colonise intertidal mudflats and sandflats, I consider the effect of vegetation removal from within the CMA to be negligible, provided the vegetation matter is removed from the CMA.
- 54 Noise and vibration associated with the Project construction phase is temporary in nature and considered to have negligible adverse effects on marine ecological values.

Conclusion for construction effects

- 55 My assessment of effects on marine ecological values arising from the construction phase of the Project concluded that, other than permanent habitat loss, all effects were either minor or negligible and did not require further mitigation. Permanent habitat loss is an unavoidable adverse effect of the Project and requires off-set mitigation. Mitigation of the adverse effects of permanent marine habitat loss arising from construction of the Project can be off-set through remediation of intertidal mudflat habitat (to a depth of 0.5m) over the toe of the Causeway revetments, a higher level of treatment efficiency of stormwater from Sectors 1-5 (80% removal of TSS, compared to the minimum requirement of 75%) once operational, treatment of stormwater arising from the existing road surfaces, revegetation and weed control treatment of coastal fringe habitat, and removal of gross litter and debris from the intertidal habitat within the Project area.

²⁰ Refer to Section 5.2, page 20, Technical Report G.22.

²¹ Refer to Mr Slaven's Evidence.

Operational effects²²

- 56 The stormwater treatment design proposed in Sectors 1-5 of the Project is, in my opinion, one of the primary mechanisms for off-setting the significant adverse effects of permanent loss of marine habitat. Once the Project is operational, all stormwater that discharges to the CMA, from both existing (currently untreated) and new road surfaces, will receive improved treatment to achieve at least 80% removal of TSS and associated contaminants, compared to the minimum requirement in the Auckland region of 75% removal. The higher level of treatment will directly benefit the marine environment by decreasing the concentration of contaminants discharged.
- 57 Given the stormwater treatment proposed, I do not expect operation of the widened motorway to have adverse effects on marine ecological values, other than contributing to the unavoidable long-term accumulation of contaminants in marine sediment along with the wider catchment runoff. However, that accumulation will occur at a lower rate than that which would occur without the Project.

Conclusions in my assessment²³

- 58 Construction associated with the Project will have adverse effects on marine ecological values including permanent habitat loss (approximately 5.87 ha²⁴), temporary habitat loss and disturbance (approximately 7.25 ha²⁵), discharge of contaminants and sediment, and noise and vibration disturbance. I consider all of these effects, other than permanent habitat loss, to be minor, negligible and/or directly mitigated.
- 59 It is difficult to mitigate the adverse effects of permanent habitat loss in a marine context, as it is difficult to create additional marine habitat. However, there are opportunities to off-set the adverse effects of the Project on the marine environment through remediation of the mudflat at the base of the Causeway revetments, achieving better contaminant removal efficiency in operational phase stormwater (from both existing and new road surfaces in Sectors 1-5) that discharges directly to the marine environment, restoration of coastal fringe vegetation along the alignment (including planting into the rock revetment itself where the wave exposure conditions permit)²⁶, and removal of gross litter and debris from within and adjacent to the CMA.

²² Refer to page 87 of my Report.

²³ Refer to page 96 of my Report.

²⁴ Refer to **Annexure E** of my Evidence.

²⁵ Refer to **Annexure E** of my Evidence.

²⁶ Refer to Annexure E of Mr Slaven's evidence.

- 60 I conclude that the adverse effects from the Project's construction phase will be adequately mitigated, provided the off-set mitigation identified above is carried out, a requirement for which is included in the proposed marine ecology conditions discussed below.
- 61 I do not expect operation of the widened SH16 motorway, given the higher quality of road runoff treatment proposed, to have adverse effects on marine ecological values, other than contributing to the long-term continued accumulation of contaminants in the marine sediment, albeit at a lower rate.

POST-LODGEMENT EVENTS

Trial Embankment

- 62 I have read the Trial Embankment Report and have considered the potential adverse effects on marine ecology. The trial embankment is to be constructed within the footprint of the proposed SH16 coastal works, outside of areas containing chenier ridges, within an area where a permanent embankment will be constructed, using virtually the same construction methodology and erosion and sediment control measures.²⁷ Given this, I do not consider that there will be any additional adverse effects relating to construction other than the effects identified in my Report arising from the permanent embankment construction.
- 63 Removal of the trial embankment (not including the ground improvements or mudcrete) is an additional activity to that of the permanent embankment. Removal will occur immediately prior to the construction of the permanent embankment, and will be carried out within a dry working environment, such as a coffer dam.²⁸ Therefore, disturbed sediment will be retained within the coffer dam. Provided that removal of the trial embankment is carried out within a coffer dam, I consider the adverse effects arising from removal of the trial embankment to be minor.
- 64 It is possible that some marine organisms may recolonise the marine habitat remediation zone of the trial embankment prior to the construction of the permanent embankment. Mortality of these organisms during construction of the permanent embankment would be an additional adverse effect. However, as the abundance of recolonised taxa is likely to be low and comprise common opportunistic species that will readily recolonise the marine habitat, I consider the adverse effects to be negligible.

²⁷ Refer Section 6.0, Trial Embankment Report, an Annexure of Dr Hsi's evidence.

²⁸ Refer Section 6.3, Trial Embankment Report, an Annexure of Dr Hsi's evidence.

COMMENTS ON SUBMISSIONS

- 65 I have read submissions lodged on the Project that raise marine ecology or related issues relevant to my area of expertise. In this section of my evidence I will address these submissions.
- Auckland Regional Council**²⁹
- 66 The Auckland Regional Council (ARC) raises a number of concerns regarding avoidance of permanent and temporary habitat loss in the marine intertidal area, primarily on the northern side of the Causeway between the Whau Bridges and the Causeway Bridges. Causeway design issues are dealt with by Mr Jon Hind in his evidence.
- 67 In recognition of the higher ecological values of the intertidal marine habitat along the northern side of the Causeway, in particular to the west of the Causeway bridges between Traherne Island and the Whau Bridges, and because ground conditions are more firm in this area, sheet piling has been selected as the preferred coffer dam type, as significantly less area of temporary habitat loss is required compared to a portable water filled dam.³⁰ However, for a large proportion of this part of the alignment coffer dams are not required at all.³¹
- 68 In its submission, the ARC states that “Neither the coastal processes assessment or the marine ecological effects assessment considers the potential benefits or practicability of avoiding (rather than mitigating or remedying) adverse effects ... of permanent and temporary habitat loss...”.³² I agree that avoidance of adverse effects on marine ecological values would be the best outcome. However, in order to widen SH16, the design engineers have determined that reclamations within the CMA are necessary and unavoidable.³³ Therefore, we have developed mitigation measures to protect marine ecological values outside of the reclamation areas, using best practice techniques.
- 69 The ARC raises a concern that hydrocarbons were not addressed in the AEE.³⁴ PAHs were analysed in surface marine sediment samples throughout the CMA adjacent to the Project, and all but two samples revealed concentrations within the ERC-green range, i.e. unlikely to

²⁹ Submitter No. 207.

³⁰ Refer to Coastal Works Report G.23, Section 3.5.2.1.

³¹ Refer to Erosion and Sediment Control Plans 3-8, G.22.

³² Submitter No. 207, at 4.6.16.

³³ Refer to Report G.23 (page 2), Causeway Options Report, L Rutt, Aurecon, (September 2010) and Coastal Works Engineering Report, S Dupre, A Broadbent, N Hopkins, J Owusu and R Lo, Aurecon, (August 2010).

³⁴ Submitter No. 207, at 4.7.35a.

affect the biology.³⁵ Given that these low concentrations of PAHs have arisen under a regime where the existing run-off discharges untreated to the CMA, then the high stormwater treatment efficiency proposed for Sectors 1-5 of the Project will only assist with ensuring that PAHs remain below effect threshold concentrations. Total petroleum hydrocarbons (TPH) (which includes PAHs) were not analysed as part of my assessment, as TPH provides more of a coarse screen for hydrocarbons, and PAHs are typically directly related to motor vehicle emissions (plus the burning of fossil fuels and wood).³⁶

Forest & Bird Motu Manawa Restoration Group³⁷ (Forest & Bird)

- 70 Forest & Bird states that "... building a larger causeway footprint through the ... Marine Reserve ... will permanently remove some of the physical area of the reserve from its function as part of the conservation environment".³⁸ There will be permanent loss of marine habitat associated with the Project, but the loss will not, in my opinion, affect the functioning of the wider marine environment, including the MMR, Waterview Estuary and the surrounding Waitemata Harbour.
- 71 Forest & Bird also queries whether the Project's stormwater system "is of itself sufficient to compensate for loss of marine reserve area".³⁹ The mitigation for permanent marine habitat loss (including the marine reserve areas) incorporates several measures and is discussed earlier in my evidence (paragraph 55).
- 72 Forest & Bird is concerned that "... no research had been done on the environmental and ecological effects of cutting off the Rosebank Peninsula culvert or its retention and repair".⁴⁰ However, as part of my assessment, I undertook sediment quality studies in this part of the estuary. Analysis of surface sediment adjacent to the culvert revealed that the concentration of copper, lead and zinc in both total sediment and the <63µm grain size fraction was above ARC's ERC-red threshold concentration indicating probable adverse effects on biology. In particular, zinc was detected at a concentration more than five times the ERC-red threshold in total sediment, and more than nine times the ERC-red threshold in the <63µm grain size fraction.⁴¹ The concentration of contaminants detected at this site

³⁵ Refer to Appendix B, Technical Report G.11.

³⁶ Refer ARC Technical Publication No. 231, page 65.

³⁷ Submitter No. 217. Shirley Westwood Upton (Submitter No. 103) raised similar concerns to those of Forest & Bird.

³⁸ Submitter No. 217, 4.1, 1.

³⁹ Submitter No. 217, page 8, 4.1, 2.

⁴⁰ Submitter No. 217, page 15, 4.2, 3.

⁴¹ Refer to Appendix B, Technical Report G.11.

was the highest of all the data analysed in my Report. Accordingly, my research identifies sediment adjacent to the culvert as highly contaminated and I recommend that the culvert is cut off to avoid remobilisation of contaminated sediment.

73 Forest & Bird seeks a condition requiring the NZTA to ensure that the “concentration of road-derived contaminants will decrease in the marine reserve and its sediments, allowing affected species and communities to recover”.⁴² As discussed earlier in my evidence, the efficiency of removal of TSS and associated contaminants from operational phase stormwater arising from the existing and new road surfaces in Sectors 1-5 is significantly higher than that typically required in the Auckland Region. This higher level of treatment will result in a reduction of the concentration of contaminants discharged to the CMA and depositing in marine sediments from SH16 in these Sectors, which will directly benefit the marine environment. This higher level of treatment will be a Project requirement and forms a significant part of the mitigation for the permanent marine habitat loss resulting from the Project.

74 However, it should be recognised that runoff from SH16 Sectors 1-5 is not the only source of contaminants discharged to the MMMR. There are many other inputs of contaminants into the MMMR arising from industrial, commercial and residential landuses in the area.

Rosebank Road culvert

75 Two submitters⁴³ have requested that the culvert adjacent to the Rosebank Road be retained. However, establishing greater water flows through and around the Rosebank Peninsula culvert has the potential to redistribute contaminated sediment, which may result in contaminants that are currently buried or not biologically available to become bioavailable, and consequently cause toxicological effects on marine organisms. It is my opinion that greater water flow in this part of the estuary may cause adverse effects on marine ecological values over a larger area.

David Clendon, Gareth Hughes, Kevin Hague⁴⁴

76 These submitters request that the NZTA work with local authorities to reduce or remove toxic metals from sediment within the Waterview Estuary. As discussed in my evidence above (paragraph 56), the Project team has worked hard to offer significantly greater removal of sediment and associated contaminants from stormwater arising from Sectors 1-5, where discharges are into the CMA.

⁴² Submitter No. 217, at 4.4, 3.

⁴³ Submitter Nos. 217 and 156.

⁴⁴ Submitter No. 156.

77 Removal of toxic metals from estuarine sediments is extremely difficult, involves mortality of marine organisms and redistribution of contaminants, and is often prohibitively expensive. Furthermore, in many parts of the estuary, the sediment quality at depth is likely to be lower than surface sediment quality. In my opinion, instead of attempting to remove existing toxic metals, it is better to focus on reducing contaminant concentrations in run-off entering the estuary, which is what is proposed for operational phase stormwater in this Project. Thus, in the long-term, as sediment containing lower concentrations of contaminants is deposited on the mudflats, the more contaminated sediment will be buried and not become bioavailable. However, it must be recognised that road run-off is not the only source of contaminants entering the Waterview Estuary.

Motu Manawa Marine Reserve

78 Several submitters⁴⁵ have raised concerns regarding adverse effects on the Motu Manawa Marine Reserve and its biodiversity, and the Project's lack of recognition of the marine reserve status. Some submitters⁴⁶ have also sought a compensatory area be added to the MMMR. Additionally, several submitters⁴⁷ are concerned about the negative impacts of the Project on marine biodiversity and disturbance to marine organisms.

79 The marine organisms that will be sacrificed during the construction of the Project are ubiquitous (and no rare or threatened marine invertebrates have been detected in the Project area). Therefore, I do not consider that there will be a loss of marine organism biodiversity due to the Project. Further, marine organisms will readily recolonise areas of intertidal and subtidal habitat that are disturbed during construction.

80 The adverse effects identified in my assessment and the mitigation proposed ensures that the ecological values and functioning of the marine reserve will not be significantly adversely affected, other than the permanent loss of intertidal marine habitat amounting to less than 1% of the total marine reserve area. In addition, the mitigation proposed to offset the permanent habitat loss directly benefits marine organisms.⁴⁸

81 Surface sediment within the MMMR (in particular, Waterview Estuary and Oakley Inlet) currently contains copper, lead and zinc in

⁴⁵ Submitter Nos. 18, 26, 33, 53, 86, 87, 88, 89, 96, 103, 115, 119, 121, 126, 129, 131, 136, 154, 156, 159, 173, 180, 184, 185, 186, 191, 192, 199, 203, 206, 208, 210, 213, 219, 220, 223, 225, 228, 235, 238, 245, 246, and 250.

⁴⁶ Including Submitter Nos. 115 and 119.

⁴⁷ Submitter Nos. 13, 44, 55, 56, 70, 74, 121, 122, 126, 136, 159, 170, 186, 192, 199, 203, 206, 208, 213, 220, 223, 225, 228, 229, 230, 241, 245, and 246.

⁴⁸ Refer to paragraph 57 above.

concentrations that exceed biological effects thresholds.⁴⁹ As discussed above, the high level of treatment of stormwater from Sectors 1-5 that will be discharged to the CMA following completion of the Project will decrease the rate of contaminant accumulation in the MMMR.

- 82 Some submitters⁵⁰ have raised a concern regarding loss of coastal marine habitat within the MMMR and have sought a change to the MMMR boundary to incorporate a compensatory area of marine environment to off-set the area to be permanently reclaimed.
- 83 The mitigation measures that the Project team have proposed to off-set permanent loss of coastal marine habitat, in my opinion, are of greater benefit to the marine ecological values of the MMMR and surrounding marine environment, than the benefits that would accrue from an extension of the MMMR area. Specifically, a significant decrease in the concentration of stormwater contaminants entering the CMA from Sectors 1-5 is of direct benefit to marine organisms and higher order organisms that feed upon them. I do not consider that an extension to the MMMR provides significant benefit to marine ecological values.

Potential adverse effects on marine water quality

- 84 A number of submitters⁵¹ have raised concerns about potential adverse effects on marine water quality during both construction and operational phases of the Project. Water quality is protected throughout the construction phase of the Project through implementation of the Erosion and Sediment Control Plan⁵² and associated water quality monitoring. In addition and as I have already discussed above (paragraph 56), the higher treatment of operational phase stormwater in Sectors 1-5 directly benefits the marine environment as there will be a reduction in the concentration of contaminants discharged to the CMA. I do not consider that there will be significant adverse effects on marine organisms arising from impacts on water quality due to the Project.

Mangrove removal and/or protection

- 85 A number of submitters⁵³ raised concerns about mangrove removal and/or protection. Mangroves are ubiquitous within the Waterview Estuary, Oakley Inlet, the Waitemata Harbour and estuaries and harbours throughout the northern part of the North Island of New

⁴⁹ Refer to **Annexure C** of my evidence.

⁵⁰ Submitter Nos. 53, 69, 115, 119, 131, 154, 156, 186, 199, 210, 219, 220, and 225.

⁵¹ Submitter Nos. 44, 55, 56, 87, 96, 107, 121, 126, 136, 170, 185, 186, 192, 192, 199, 203, 206, 208, 209, 213, 220, 223, 225, 229, and 230.

⁵² Refer to Section 5.2, page 20, Technical Report G.22

⁵³ Submitter Nos. 55, 69, 131, 154 and 179.

Zealand. The evidence presented by Dr Robert Bell⁵⁴ shows how over past decades the mangrove population in the Project area has increased significantly.

- 86 A variety of common marine invertebrate species typically occur within mangrove forests. Whilst many marine organisms will be sacrificed due to permanent and temporary marine habitat loss associated with the Project, these species are found throughout the marine environment adjacent to the Project area and the community does not contain any rare or threatened invertebrates.
- 87 Fish and birds use mangroves as feeding grounds, roosting areas and for providing protection from predation. In his evidence, Mr Graeme Don considers the effect of habitat loss on avifauna. Recent research indicates that mangroves are not as important as fish nursery grounds as previously thought,⁵⁵ with only grey mullet, long-finned eel and parore using mangroves during their juvenile phase.
- 88 Given the small area of mangroves to be removed during construction of the Project (2.79 ha), compared to the total area of mangroves remaining within the Waterview Estuary, Oakley Inlet and surrounding Waitemata Harbour (which cover more than 200ha and will continue to provide adequate habitat for the fish species noted above), I do not consider that the loss of mangroves associated with the construction phase of Sectors 1-5 will have any adverse effects on the availability of habitat for fish by way of habitat loss.
- 89 Mangroves readily colonise intertidal mudflats and will readily recolonise areas of intertidal habitat that will be temporarily disturbed during the construction of the Project.

The Department of Conservation (DOC)⁵⁶

- 90 In its submission, DOC notes that a range of activities are proposed to be undertaken within the Hauraki Gulf Marine Park (or within its catchment), which contains habitats of threatened species. Other than long-finned eel, no rare or threatened marine organisms were detected in the field investigations I undertook nor did I learn of any through my searches of relevant published literature relating to investigations within, and/or immediately adjacent to, the Project area. I do not consider the Project will have adverse effects on habitats of threatened species within the Hauraki Gulf Marine Park, because other than permanent habitat loss, all other potential adverse effects on marine ecological values that have been identified are robustly avoided or mitigated through the construction,

⁵⁴ Refer to Annexure A, Dr Bell's evidence.

⁵⁵ Morrison, M., Schwarz, A., Francis, M., Reed, J., Lowe, M., Webster, K., Carbines, G., Rush, N. (in prep). Expanding temperate mangrove forests – are they important as juvenile fish nurseries?

⁵⁶ Submitter No. 32.

stormwater treatment and erosion and sediment control methodologies specified.

Alex Winstone⁵⁷

- 91 The submitter requests that the “remnants of unmodified marine habitat be protected in order to allow marine and birdlife habitat to live and breed”. The marine habitat within the Project area is relatively modified given the existing SH16 roadway and surrounding industrial and residential landuse practices. Whilst some marine organisms will perish during the construction phase of the Project, I do not consider that the Project will adversely affect the breeding of marine organisms or marine biodiversity.

Springleigh Residents Association⁵⁸

- 92 The submitter raises a concern regarding consideration of ecological sites. I understand the concern to be that in the AEE for the Project, ecological issues are divided into specialist ecological disciplines, without an overarching assessment of ecological effects. However, throughout all stages of the Project there was considerable interaction and discussion between specialist ecologists in order to ensure that all aspects of ecology (including ecological sites) were robustly analysed and assessed. Accordingly, I do not consider an overarching assessment was required.

Murray Wilson⁵⁹

- 93 The submitter raised concerns regarding degradation of habitat for coastal and marine birds in areas adjacent to SH16 and Pollen Island. Intertidal marine habitat will be permanently and temporarily reclaimed in these areas, involving the mortality of benthic marine organisms and mangroves. The area of permanent habitat loss contains benthic marine organisms that marine and wading birds feed upon. However, the area of permanent habitat loss is small in proportion to the remaining MMR and surrounding Waitemata Harbour and will not result in adverse effects on the supply of marine organisms as food for birds.⁶⁰ In the areas of temporary habitat disturbance, both the marine invertebrates and the mangroves will re-establish and over time the ecological values of these areas will be restored.

⁵⁷ Submitter No. 173.

⁵⁸ Submitter No. 43.

⁵⁹ Submitter No. 17.

⁶⁰ Refer to Mr Don's evidence.

Additional flushing for Waterview Estuary

94 Several submitters⁶¹ have requested as relief that additional flushing be provided to the Waterview Estuary.

95 If the original SH16 had not been constructed, the Waterview Estuary would not have retained as much sediment and associated contaminants as it currently does. Increasing the tidal exchange through the provision of another causeway outflow bridge or extension of the existing bridge may assist with reducing the further accumulation of sediment and contaminants, but would also have the potential to redistribute the contaminated sediment from within the Waterview Estuary to the uncontaminated sediments to the northern side of the Causeway, where higher ecological values exist. I do not support the provision of additional tidal flushing of the Waterview Estuary, as redistribution of contaminated sediments should be avoided.

Bryan Lester Mehaffy⁶²

96 The submitter requests that "a study be carried out with a view to replacing the reduction in the size of Traherne Island, by the construction of an artificial island...". I do not agree with the submitter that marine habitat should be reclaimed for the purpose of off-setting loss of terrestrial habitat.

Friends of the Oakley Creek⁶³

97 The submitter raised an issue regarding the effects of light flow and spill of circadian rhythms of wildlife. Within Sector 4, the proposed lighting is to be located within the central median area, which will ensure minimal spill of light to the surrounding marine environment.⁶⁴ I consider that there will be negligible adverse effects on marine ecological values arising from lighting during both the construction and operational phases of the Project.

North Western Community Association⁶⁵

98 The submitter considers that there has been insufficient provision for habitats of native fauna in the coastal areas of SH16. One component of the mitigation developed to off-set permanent habitat loss in the marine environment was the remediation of intertidal mudflat at the base of the revetment, which results in the restoration of 1.32 ha of intertidal habitat. In addition, revegetation of the

⁶¹ Submitter Nos. 96, 131, 154, 169, 180, 225 and 229.

⁶² Submitter No. 162.

⁶³ Submitter No. 179.

⁶⁴ Refer to Sections 6.1.1, and 10.2, Technical Report G.10.

⁶⁵ Submitter No. 185.

coastal fringe (above MHWS) is proposed, including planting of appropriate coastal species into sheltered areas of revetment.⁶⁶

Waitakere City Council⁶⁷

- 99 The submitter requests that opportunities to plant native coastal species into the coastal revetments be investigated. Planting into the revetment has been investigated by the Project team, with planting to occur along the sheltered areas of revetment. The wave exposed revetment cannot be planted, as planting could result in a reduction of the attenuation of wave energy.⁶⁸

COMMENTS ON S149G REPORT BY THE ARC

- 100 In its s149G Report, the Auckland Regional Council provides a description of the ecological values of CPA 53 (Pollen Island) as per the ARP:C. This description, which largely pertains to the marine environment around Pollen Island itself, states that CPA 53 is “the best remaining largely unmodified area of its type in the Waitemata Harbour”. No clear distinction is made in the description between the ecological values within Waterview Estuary/Oakley Inlet and the ecological values of marine environment to the north of the Causeway (surrounding Pollen Island), to which the description mainly pertains.
- 101 It is my opinion that the ecological values of the marine environment to the north of the Causeway are significantly different to those values south of the Causeway. Furthermore, the marine environment within and immediately adjacent to the Project area should, in my opinion, be considered relatively modified (not unmodified as per the ARP:C description of CPA 53), given the concentration of contaminants in surface sediments to the south of the Causeway and the presence of the existing SH16 road, which was constructed through the harbour and had significant effects on coastal processes and marine ecological values.

PROPOSED MARINE ECOLOGY CONDITIONS

- 102 In the documentation lodged with the AEE, the NZTA included a set of Proposed Consent Conditions (see Part E, Appendix E.1). This included proposed marine ecology conditions, which I consider appropriate to attach as conditions to the resource consents sought.
- 103 Following lodgement, the proposed marine ecology conditions have been amended to make them more specific and a new condition has been added concerning the treatment of sediment within the marine

⁶⁶ Refer to Annexure E of Mr Slaven’s evidence.

⁶⁷ Submitter No. 212.

⁶⁸ Refer to Annexure E of Mr Slaven’s evidence.

habitat remediation zone. A red-lined version of these proposed conditions is contained in **Annexure D** of my evidence.

104 I consider that the amended conditions are still appropriate.



Dr Sharon De Luca
10 November 2010

Annexure A	Marine/Estuarine Environment Context Map
Annexure B	Auckland Regional Plan: Coastal Maps 26 and 29
Annexure C	Contaminant concentrations in marine sediment
Annexure D	Proposed Marine Ecology Conditions
Annexure E	Habitat Loss Calculations (Aurecon)

ANNEXURE A: MARINE/ESTUARINE ENVIRONMENT CONTEXT MAP⁶⁹

⁶⁹ Refer Figure 1, page 8, Report G.11.



Waterview Connection Assessment of Environmental Effects

1. Marine reserve boundary location is indicative only

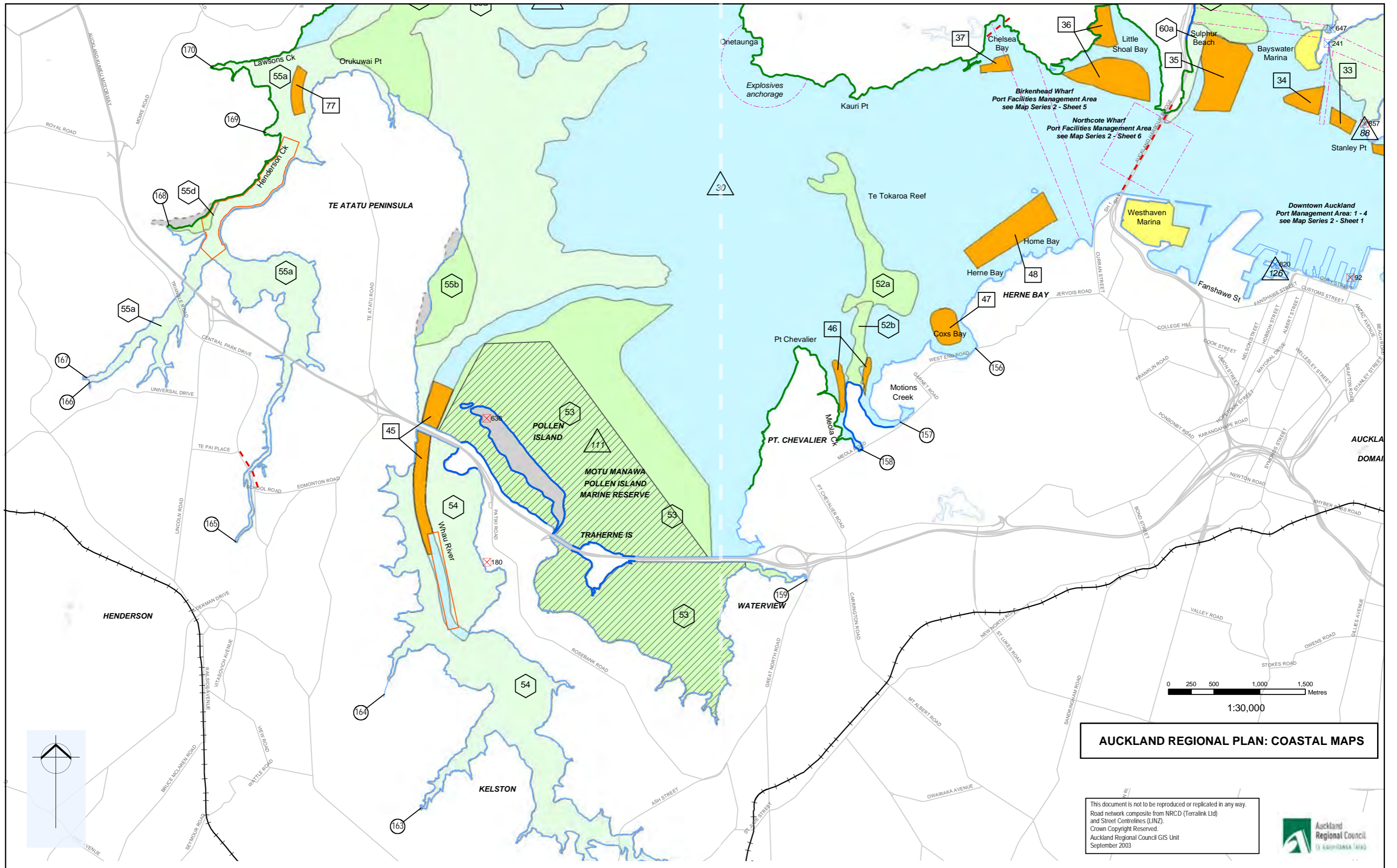
Figure 1: Marine/Estuarine Environment Context Map



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ANNEXURE B: AUCKLAND REGIONAL PLAN: COASTAL MAPS 26 AND 29⁷⁰

⁷⁰ Figure 2, Appendix 10, Report G.31 Technical Addendum Report and Figure 2a, page 9, Report G.11.



AUCKLAND REGIONAL PLAN: COASTAL MAPS

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**Waterview Connection
Assessment of Environmental Effects**

1. Marine reserve boundary location is indicative only































**Figure 2: Auckland Regional Plan:
Coastal Maps 26 and 29**



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AUCKLAND REGIONAL PLAN: COASTAL MAPS

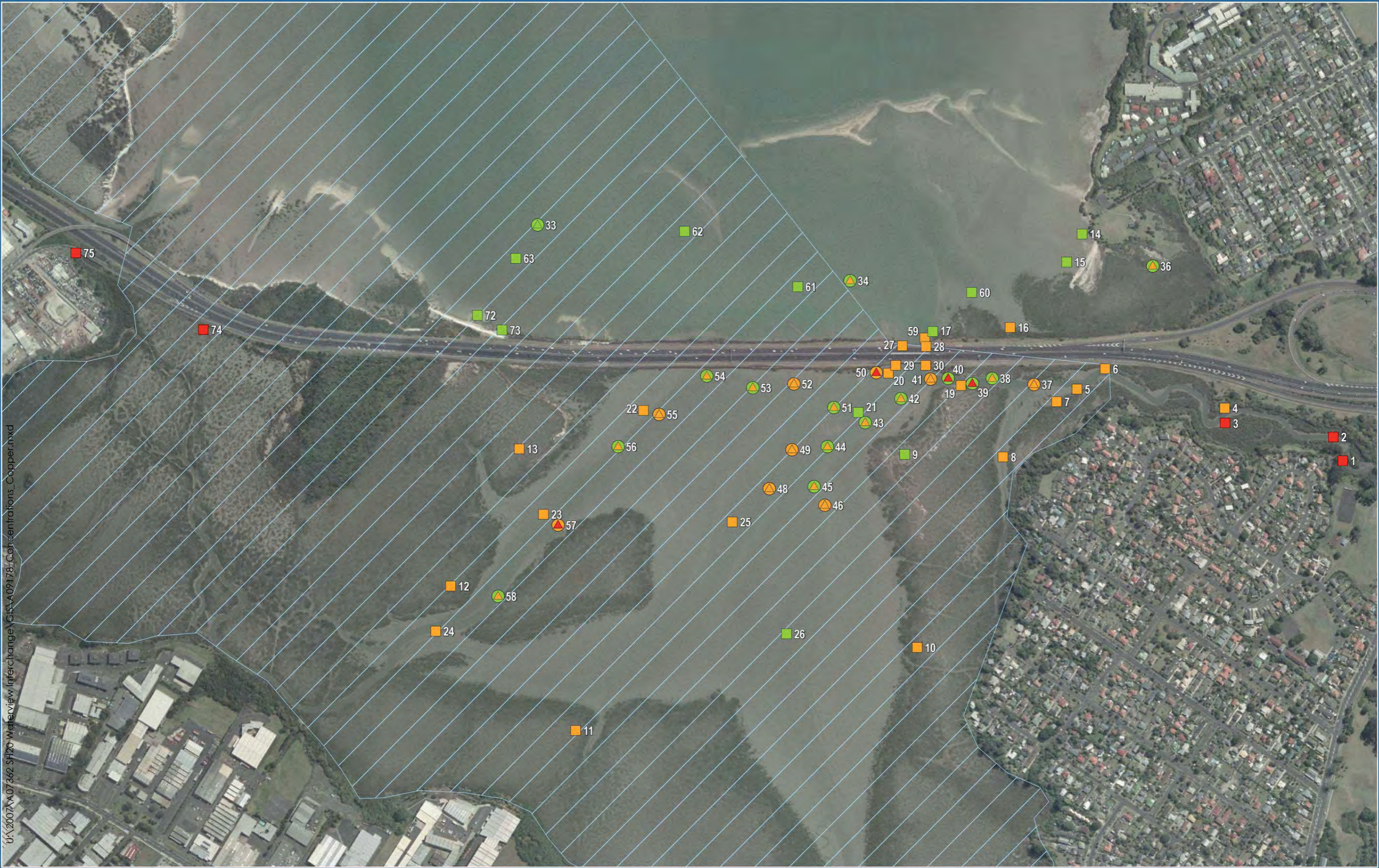
MAP SERIES 1 LEGEND

-  General Management Area
-  Tangata Whenua Management Area
-  Airport Management Area
-  Mooring Management Area (see Schedule 5)
-  Marina Management Area
-  Aquaculture Management Area (AMA) - (Variations 2, 4 - 6*, see Schedule 9)
-  Land Associated with Coastal Protection Areas (CPA)
-  Coastal Protection Area (CPA) 1
-  Coastal Protection Area (CPA) 2
-  Coastal Protection Area 1 (small sites)
-  Coastal Protection Area number (see Schedule 3)
-  Cultural Heritage Places and Areas for Preservation (see Schedule 1)
-  Cultural Heritage Places and Areas for Protection (see Schedule 2)
-  Area of Significant Conservation Value (see Schedule 4)
-  Gazetted Marine Reserve
-  Marine Park
-  Regionally Significant Landscape (Rating 5)
-  Outstanding Landscape (Rating 6)
-  Outstanding Landscape (Rating 7)
-  Coastal Marine Area (CMA) boundaries (see Schedule 7)
-  Airport Height Restriction
-  Airport Runway Protection Area (see Appendix H)
-  Special Activity Area
-  Defence Exercise Area
-  Prohibited Anchorage
-  Main Trunk Rail
-  Motorway/State Highway
-  Major Road
-  Gas Line
-  Auckland Regional Council (ARC) Boundary

* Variation 3 was withdrawn on 24 May 2006.

**ANNEXURE C: CONTAMINANT CONCENTRATIONS IN MARINE
SEDIMENT⁷¹**

⁷¹ Figures 10a-13b, pages 30-37, Report G.11.



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Legend	ARC ERC thresholds (mg/kg)		
	Copper < 63um	Copper 63 - 500um	Copper total
▲ < 19	● < 19	■ < 19	
▲ 19 - 34	● 19 - 34	■ 19 - 34	
▲ > 34	● > 34	■ > 34	

□ Motu Manawa Marine Reserve

Figure 10a
Concentration of Copper in Sediment
Waterview Estuary

2 June 2010

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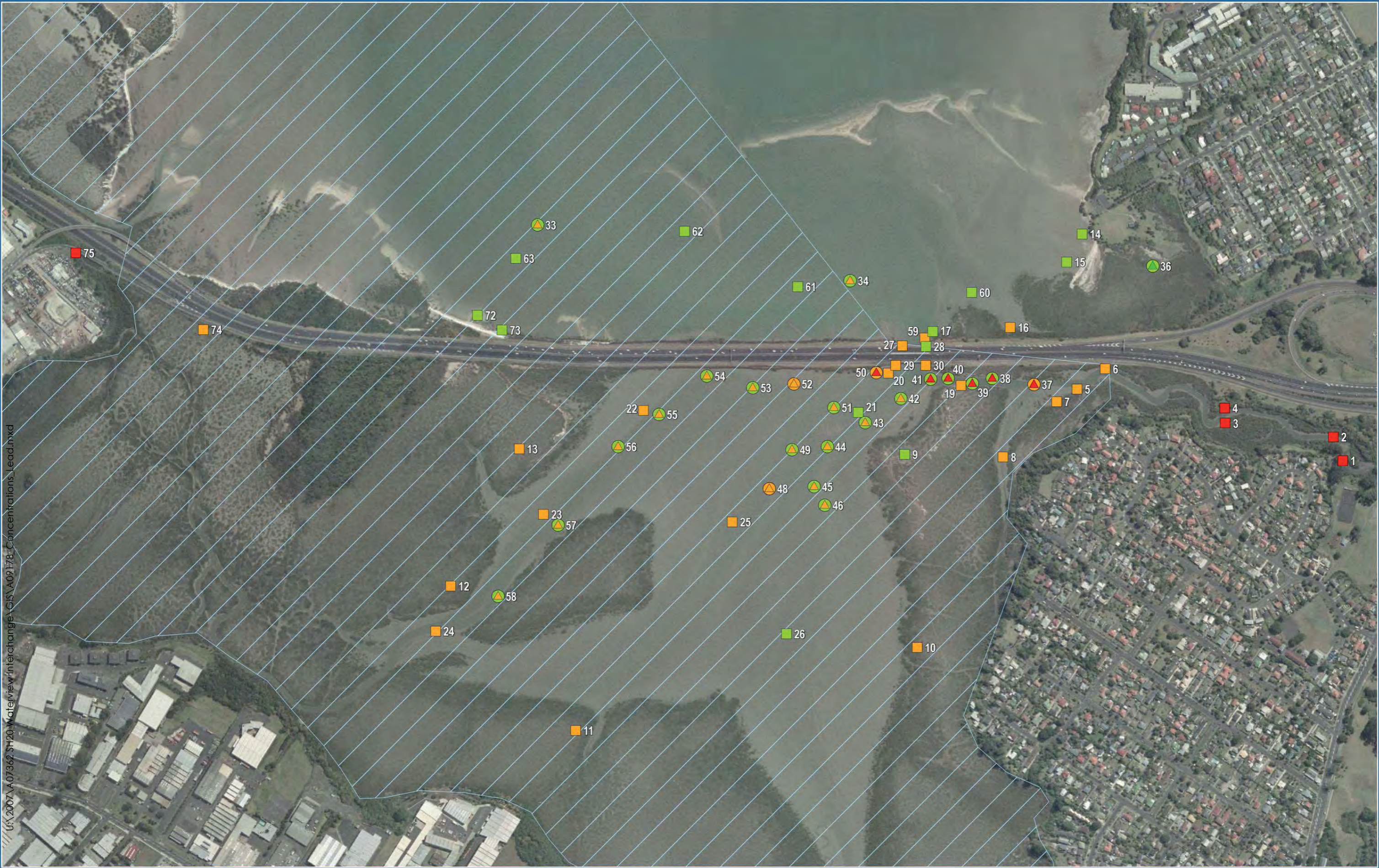
Legend	ARC ERC thresholds (mg/kg)		
	Copper < 63um	Copper 63 - 500um	Copper total
▲ < 19	● < 19	■ < 19	
▲ 19 - 34	● 19 - 34	■ 19 - 34	
▲ > 34	● > 34	■ > 34	

▨ Motu Manawa Marine Reserve

Figure 10b
Concentration of Copper in Sediment
Whau River

2 June 2010

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Legend	ARC ERC thresholds (mg/kg)		
	Lead < 63um	Lead 63 - 500um	Lead total
▲ < 30	● < 30	■ < 30	
▲ 30 - 50	● 30 - 50	■ 30 - 50	
▲ > 50	● > 50	■ > 50	

▭ Motu Manawa Marine Reserve

Figure 11 a
Concentration of Lead in Sediment
Waterview Estuary

02 June 2010

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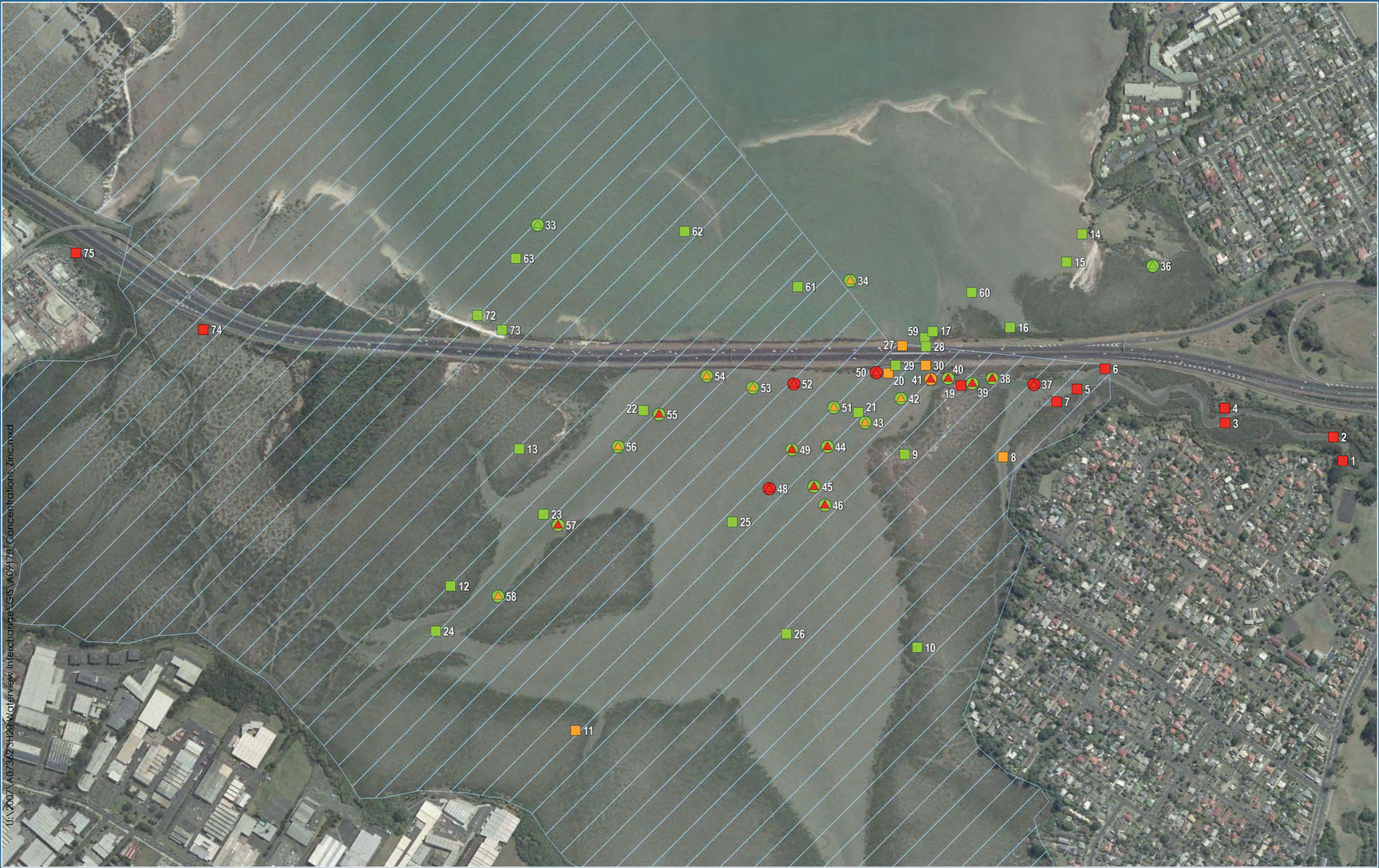
Legend	ARC ERC thresholds (mg/kg)		
	Lead < 63um	Lead 63 - 500um	Lead total
▲ < 30	● < 30	■ < 30	
▲ 30 - 50	● 30 - 50	■ 30 - 50	
▲ > 50	● > 50	■ > 50	

▨ Motu Manawa Marine Reserve

Figure 11 b
Concentration of Lead in Sediment
Whau River

02 June 2010

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Waterview Connection Assessment of Environmental Effects

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Legend	ARC ERC thresholds (mg/kg)		
	Zinc < 63um	Zinc 63 - 500um	Zinc total
▲ < 124	● < 124	■ < 124	
▲ 124 - 150	● 124 - 150	■ 124 - 150	
▲ > 150	● > 150	■ > 150	

▭ Motu Manawa Marine Reserve

Figure 12a
Concentration of Zinc in Sediment
Waterview Estuary

02 June 2010

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Waterview Connection Assessment of Environmental Effects

0 110 220 330 440 550 660 m

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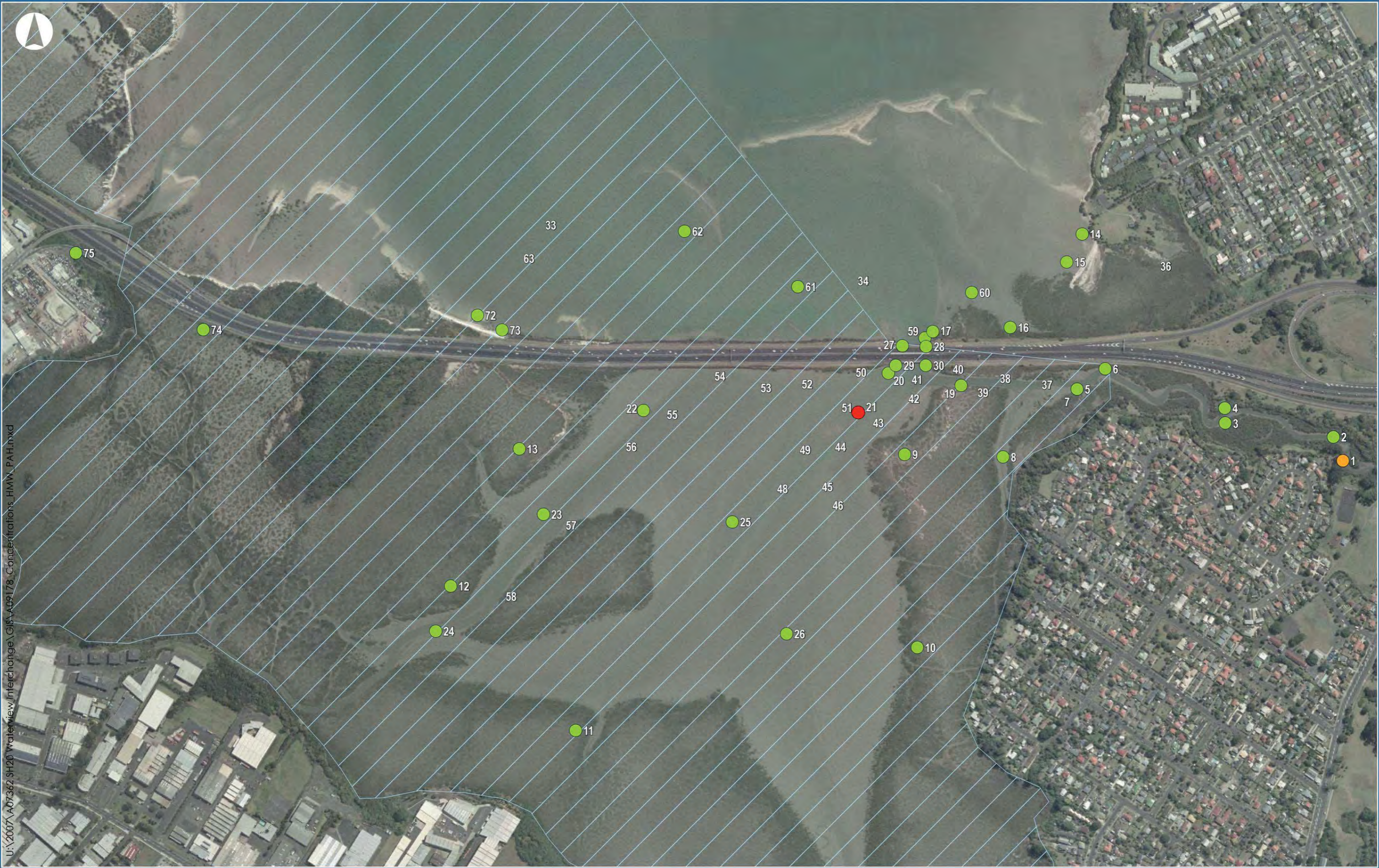
Legend	ARC ERC thresholds (mg/kg)		
	Zinc < 63um	Zinc 63 - 500um	Zinc total
▲ < 124	● < 124	■ < 124	
▲ 124 - 150	● 124 - 150	■ 124 - 150	
▲ > 150	● > 150	■ > 150	

▨ Motu Manawa Marine Reserve

Figure 12b
Concentration of Zinc in Sediment
Whau River

02 June 2010

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- Legend**
- HMW PAHs
 - < 0.66
 - 0.66 - 1.7
 - > 1.7

Motu Manawa Marine Reserve

Figure 13a
Concentration of High molecular Weight PAHs in Sediment
Waterview Estuary

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Legend

- HMW PAHs
- < 0.66
 - 0.66 - 1.7
 - > 1.7

Motu Manawa Marine Reserve

Figure 13b
Concentration of High molecular Weight PAHs in Sediment
Whau River

02 June 2010

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ANNEXURE D: PROPOSED MARINE ECOLOGY CONDITIONS⁷²

M.1.	<p>The NZTA shall finalise and implement through the CEMP, the Ecological Management Plan (ECOMP) submitted with this application. The ECOMP shall be revised to accurately reflect the conditions of this consent and changes to the details of construction processes prior to construction commencing. The ECOMP shall include, but not be limited to, details of:</p> <ul style="list-style-type: none"> (a) Monitoring of marine habitats and ecological values; (b) Trigger event criteria for undertaking additional monitoring; (c) Procedures for responding to accidental discharges to the marine environment; (d) Complaints investigation, monitoring and reporting; and (e) The identification of staff and contractors' responsibilities.
M.2.	<p>The NZTA shall engage a suitably qualified ecologist to undertake a marine habitat monitoring programme, as described in Conditions M.3 to M.6.</p>
M.3.	<p>The marine <u>benthic</u> habitat monitoring programme shall be undertaken every 6 months:</p> <ul style="list-style-type: none"> (a) At least 12 months prior to construction commencing, to allow for two baseline surveys to be undertaken; (b) During construction; (c) For a maximum of 3 years following completion of the Project, or for a lesser time if the monitoring indicates no significant effects, as agreed with the [Auckland Council].
M.4.	<p>The marine <u>benthic</u> habitat monitoring programme shall be undertaken in accordance with the details set out in the ECOMP and include:</p> <ul style="list-style-type: none"> (a) Sampling of the marine invertebrate community composition (<u>collection of sediment cores</u> to a depth of approximately 15 cm); (b) Sampling of the sediment surface (top 2cm) for sediment grain size; (c) Sampling of the sediment surface (top 2cm) for sediment quality (<u>analysis of the concentration of</u> copper, lead, zinc and polycyclic aromatic hydrocarbons).
M.5.	<p>The marine <u>benthic</u> habitat monitoring shall be undertaken within sampling grids (<u>50 m x 30 m</u>) broadly established at the following locations:</p> <ul style="list-style-type: none"> (a) Two locations within Oakley Inlet; (b) Four locations within Waterview Estuary; and (c) Four locations north of the Causeway. <p>Specific locations <u>and experimental design</u> shall be detailed in the ECOMP, and the design of the monitoring programme will be based on the Estuarine Environmental Assessment and Monitoring: A National Protocol (Cawthron 2002).</p>
M.6.	<p>The NZTA shall undertake additional marine habitat monitoring in the event of a 'trigger event' for marine ecology habitats. For the purposes of this consent, a 'trigger event' for marine ecology habitats is defined in the ECOMP.</p>
M.7.	<p>The NZTA shall review the marine benthic habitat monitoring results (pursuant to Conditions M.3 to M.6) and in the event that potential adverse effects are identified, the NZTA shall develop and implement appropriate contingency plans and/or remedial measures.</p>
M.8.	<p>The marine <u>benthic</u> habitat monitoring results shall be compiled by the NZTA, and a report provided to the [Auckland Council] annually.</p>

⁷² Amendments to the proposed conditions as lodged (AEE, Part E.1, page 78) are shown in underline and strikethrough.

M.9.	The NZTA shall undertake planting within the rock revetment of the reclamation along the alignment of SH16 where practicable, in places where such plantings will be sheltered from erosion and in such a way that they will not undermine the structural integrity of the revetment. Any such planting will be in general accordance with the Urban Design and Landscape Plans (Plan Set F.16) submitted with this application.
M.10	The NZTA shall maintain the coastal marine area free of any gross litter, rubbish and debris generated from construction activities.
<u>M.11</u>	<u>Prior to excavation of sediment from the marine habitat remediation zone (MHRZ), mangrove vegetation will be removed from the sediment and disposed of at an appropriate offsite facility. The excavated sediment shall be stockpiled within an adjacent dry working area. When the sediment is returned to the MHRZ it will be levelled out to marry in with that the existing mudflat. Where a routine marine benthic habitat monitoring site is within an area of MHRZ, additional monitoring of the depth of sediment overlying the improved ground/mudcrete will also be undertaken.</u>

**ANNEXURE E: WATERVIEW CONNECTION PROJECT – HABITAT LOSS
CALCULATIONS⁷³**

⁷³ Aurecon (November 2010).

Waterview Connection Project - Habitat Loss Calculations

Sector 1

	A	B	C	Coastal Vegetation Removal (m ²)		1000	
	Reclamation (m ²)	Perm Occupation (m ²)	Ecological Mitigation Zone (m ²)	Temp Occupation (m ²)	Perm Works/Habitat Loss (m ²)	CPA 1 (m ²)	CPA 1 %
Intertidal	1000	100	0	550	1200	0	0%
Subtidal	0	0	0	0	0	0	0%
Aerial	0	0	0	0	0	0	0%
Total	1000	100	0	550	1200	0	

Sector 2

	A	B	C	Coastal Vegetation Removal (m ²)		2350	
	Reclamation (m ²)	Perm Occupation (m ²)	Ecological Mitigation Zone (m ²)	Temp Occupation (m ²)	Perm Works/Habitat Loss (m ²)	CPA1 (m ²)	CPA 1 %
Intertidal	4100	1700	1600	3200	4200	3150	75%
Subtidal	0	60	0	10	60	0	0%
Aerial	0	9300	0	2700	0	0	0%
Total	4100	11060	1600	5910	4260	3150	

Sector 4

	A	B	C	Coastal Vegetation Removal (m ²)		28500	
	Reclamation (m ²)	Perm Occupation (m ²)	Ecological Mitigation Zone (m ²)	Temp Occupation (m ²)	Perm Works/Habitat Loss (m ²)	CPA 1 (m ²)	CPA 1 %
Intertidal	42000	21300	11550	50000	51750	44500	86%
Subtidal	0	1400	0	5500	1400	1400	100%
Aerial	0	4100	0	1100	0	0	0%
Total	42000	26800	11550	56600	53150	45900	

Sector 5

	A	B	C	Coastal Vegetation Removal (m ²)		15	
	Reclamation (m ²)	Perm Occupation (m ²)	Ecological Mitigation Zone (m ²)	Temp Occupation (m ²)	Perm Works/Habitat Loss (m ²)	CPA 1 (m ²)	CPA 1 %
Intertidal	0	20	0	15	20	0	0%
Subtidal	0	0	0	5	0	0	0%
Aerial	0	3400	0	3200	0	0	0%
Total	0	3420	0	3220	20	0	

Summary

	m ²	Ha
Total Temporary Intertidal Work	53765	5.38
Total Permanent Intertidal Work	57170	5.72
Total Temporary Sub tidal Work	5515	0.55
Total Permanent Sub tidal Work	1460	0.15
Total	11.79	

Ecological offset mitigation obtained through lowering Coastal Toe

1.75	Without 500mm of marine sediment over coastal toe (Ha)
0.43	With 500mm of marine sediment over coastal toe (Ha)
1.32	Reduction (Ha)

% of Total works within CPA 1

Marine Reserve Area (Ha)	% Area	Coastal Veg Removal (Ha)
4.9	84%	3.19

Habitat Loss within the Motu Manawa Marine Reserve

Total Marine Reserve Area (Ha)	% Habitat Loss
500	1%

Notes -

- To calculate Vegetation Removal, the following percentages have been assumed and applied in each Sector
Percentages represents the approximate area of vegetation within the affected CMA, for each respective Sector.
Sector 1 - 80% of the affected CMA contains vegetation
Sector 2 - 55% of the affected CMA contains vegetation
Sector 4 - 55% of the affected CMA contains vegetation
Sector 5 - 75% of the affected CMA contains vegetation
- Ecological offset mitigation achieved through lowering Coastal Toe -
This relates to the effective reduction in Causeway width due to lowering the coastal toe. Lowering the coastal toe by 500mm allows half a meter of marine sediment to sit on top of the engineered revetment, providing intertidal mudflat habitat. Of the 1.75Ha of mudcrete/coastal toe, 1.32Ha can be restored as intertidal mudflat habitat to the Coastal Marine Area by lowering the coastal toe.
- % of Total works within the Marine Reserve Area -
Of the 5.87Ha of Permanent works (both subtidal and intertidal), 84% is within the Marine Reserve. Leaving 16% which is outside the Marine Reserve.
- For the purpose of this exercise, the Sectors have been defined as follows -
Sector 1: CH4900-6600
Sector 2: CH4400-4900
Sector 4: CH600-4400
Sector 5: up to CH600
- The Motu Manawa Marine Reserve protects some 500 hectares of the inner reaches of Auckland's Waitemata Harbour. It includes the intertidal mudflats, tidal channels, mangrove swamp, saltmarsh, and shellbanks surrounding Pollen and Traherne Islands.' (source: Department of Conservation). The Habitat Loss % was based on this 500Ha.
- CPA 1 stands for Coastal Protection Area 1. Motu Manawa (Pollen Island) Marine Reserve is contained with the Coastal Protection Area.
- Aerial Occupation refers to any occupation that is OVER the Coastal Marine Area, not within the Coastal Marine Area.