Before the Board of Inquiry
Waterview Connection Project

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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 Robert Bell (Coastal Processes) on behalf of the **NZ Transport Agency**

Dated: 12 November 2010

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STATEMENT OF EVIDENCE OF DR ROBERT BELL ON BEHALF OF THE NZ TRANSPORT AGENCY

INTRODUCTION AND QUALIFICATIONS

1 My full name is Dr Robert Gordon Bell. I hold the degrees of Bachelor of Engineering (Civil) with First Class Honours and a PhD in Civil Engineering from the University of Canterbury. My PhD thesis examined the response of sediment transport to floods in gravel-bed rivers.

2 I have worked as a coastal scientist and engineer, researching and advising on coastal processes, oceanography, wastewater discharges, sediment transport and hazards since 1980.

3 I currently hold the position of Principal Scientist – Coasts and Hazards with the National Institute of Water and Atmospheric Research (NIWA), by whom I have been employed for the last 18 years. Prior to that, I was employed in the Coastal Group in Hamilton as part of the Water & Soil Division of the Ministry of Works (1980-1989) and then DSIR Marine & Freshwater (1989-1992).

4 I am on the Advisory Board for the Civil and Natural Resources Engineering Department at the University of Canterbury. I am a certified Hearings Commissioner under the Making Good Decisions programme, a member of the Institution of Professional Engineers NZ (MIPENZ) and a Chartered Professional Engineer (CPEng) in the practice area of Environmental Engineering. I hold a Day Skippers Certificate from The Moorings yacht charters.

5 I am leader of two NIWA coastal climate-change research projects developing national databases of present and future coastal storm surge, waves and sea level around New Zealand.

6 Of particular relevance to the Waterview Connection Project (Project) is my research on tidal and wind circulation in the Greater Hauraki Gulf area, dispersion and dilution processes associated with marine discharges and sea-level variability and trends based on the Port of Auckland tide gauge. I have undertaken a similar consultancy role for the bridge duplication and widening works associated with the Hobsonville-Greenhithe State Highway 18 Upper Harbour crossing project and completed numerous hydrodynamic and dispersion model studies for a wide variety of coastal engineering projects, including marine outfalls, stormwater discharges and port dredging works.

7 Recent examples of projects I have been involved in include:

7.1 The bridge duplication and widening for the Hobsonville–Greenhithe State Highway 18 Upper Waitemata Harbour crossing;

7.2 Assessment of effects for the widening and bridge upgrades of State Highway 16 (SH16) from Te Atatu to Huruhuru Creek Bridges;

7.3 Hydrodynamic and dispersion modelling for the Port of Otago capital-works channel dredging project; and

7.4 Revision of minimum ground levels (including climate change effects) for coastal development in Engineering Quality Standards used by Nelson, Manukau and Auckland City Councils.

8 I was a co-author of the Ministry for the Environment's Guidance for Local Government on Coastal Hazards and Climate Change published in 2008 which is used by councils, planners and engineers in selecting appropriate sea-level rise values that are commensurate with the potential consequences (risk).

9 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 Project. The Project comprises works previously investigated and developed as two separate projects, being:

9.1 The SH16 Causeway Project; and

9.2 The State Highway 20 (SH20) Waterview Connection Project.

10 I am familiar with, and have visited, the area that the Project covers, and the State highway and roading network in the vicinity of the Project.

11 I have read the Code of Conduct for Expert Witnesses as contained in the Environment Court Consolidated Practice Note (2006). My evidence has been prepared in compliance with that Code in the same way as I would if giving evidence in the Environment Court. In particular, unless I state otherwise, this evidence is within my sphere of expertise and I have not omitted to consider material facts known to me that might alter or detract from the opinions I express.

SCOPE OF EVIDENCE

12 My evidence is structured as follows:

12.1 Executive summary;

12.2 Background and role;

12.3 Causeway design: future-proofing for climate change;

12.4 Summary of assessment of coastal processes;

12.5 Post-lodgement events;

12.6 Comments on submissions;

12.7 Comments on the ARC's s149G Report; and

12.8 Proposed coastal conditions.

EXECUTIVE SUMMARY

13 My evidence covers two aspects of the Project. First, I will cover the hydrodynamic and climate-change components of the Causeway design to ensure its long-term resilience to coastal hazards and the exacerbating effects of climate change, including sea-level rise.

14 Secondly, I will outline the approach and investigations to assessing the degree of effects of the Project on coastal physical processes. I will also describe supplementary field and modelling work that was undertaken post lodgement in response to community feedback. My evidence ends with my responses to various submissions that are within my field of expertise.

15 The final design Causeway crest height of 3.0 metres above Auckland Vertical Datum–1946 takes into account a sea-level rise of 0.8 m by 2100, storm-tide and wave overtopping hazards. The design also incorporates "future proofing", where an additional crest height of 0.57 metres could be added when sea-level rise exceeds 0.8 metres above present-day levels.

16 The CMA has been substantially modified by the construction of the original Causeway in the early 1950s and, to a much lesser extent, the protruding abutments for the original Whau River Bridge. The new works proposed for SH16 between the Great North Road Interchange and Te Atatu are further lateral extensions of the existing Causeway footprint into the CMA. Establishing greater water flows through the western inlet of Waterview Estuary, via the existing or an upgraded Rosebank Road off-ramp culvert, is not feasible, given the degree of sedimentation that has occurred in this

inlet. Additionally, increasing the water flow has the potential to further redistribute contaminated sediment. In my opinion, the present culvert should be de-commissioned.

17 As a result of the lengthy assessment process for this Project, some mitigation or avoidance measures for potentially adverse effects have already been incorporated into the Project's engineering design and construction plans. With these measures included in the proposed design and the implementation of the other mitigation or remediation measures outlined in the Assessment of Coastal Processes Report,[1] I consider the short–term and long-term effects of the new works on coastal physical processes to be either minor or no more than minor, subject to the proposed coastal conditions.

BACKGROUND AND ROLE

18 The NZTA retained Tonkin & Taylor Ltd (Tonkin & Taylor) and NIWA as consultants to assist with certain aspects of the engineering and planning works for the Project and to provide an assessment of effects on coastal physical processes required for the Project. In conjunction with other scientists from Tonkin & Taylor and NIWA, I prepared an Assessment of Coastal Processes Report (Report) to assess the effects of the Project works on physical coastal processes during both its construction and operational periods. The other authors of the Report were:

18.1 Dr Alastair Senior, Senior Engineer, Coasts and Hydrodynamics (Tonkin & Taylor);

18.2 Dr Terry Hume, National Projects Manager (NIWA);

18.3 Andrew Swales, Group Manager, Coastal and Estuarine Processes (NIWA); and

18.4 Doug Ramsay, Manager-Pacific Rim (NIWA).

19 The Report was peer-reviewed by Dr Colin Christian (Director, Colin Christian Ltd), Dr Scott Stephens (Scientist, Coastal and Estuarine Processes Group, NIWA) and Dr Murray Hicks (Principal Scientist and Group Manager, Sediment Processes, NIWA).

20 The Report was lodged with the EPA in August 2010 as part of the overall Assessment of Environmental Effects (AEE) (specifically, Part G, Technical Report G.4).

21 The Report was informed by, or relies upon, other technical reports lodged with the EPA in support of the Project, those reports being primarily.

[1] Technical Report G.4.

21.1 Assessment of Stormwater and Streamworks Effects (Report G.15);

21.2 Erosion and Sediment Control Plan (Report G.22);

21.3 Coastal Works Report (Report G.23); and

21.4 Assessment of Associated Sediment and Contaminant Loads Report (Report G.30).

22 My evidence addresses the main connections between the Report and these other reports.

23 I have undertaken four separate visits to the key sites where the Project may have impacts on the CMA. My NIWA colleagues and fellow authors of the Report also undertook a day-long reconnaissance of the SH16 sites on 27 February 2009 as part of an in-field workshop with stakeholders and Project team members.

24 I have been the Project Director for the NIWA components of the Project since NIWA's first engagement with the Project in 2007. NIWA's involvement with the Project has included hydrographic surveying, sediment analyses, climate-change assessments, hydrodynamic and wave modelling for the Causeway design and assessment of the Project impacts on coastal physical processes. Latterly, I have worked collegially with Dr Alastair Senior of Tonkin & Taylor who carried out the suspended-sediment modelling of disturbances and sediment discharges to Oakley Inlet and Waterview Estuary. I am very familiar with this type of sediment-dispersion modelling, having used such models throughout my career and very recently for the Port of Otago dredging project. NIWA uses the same DHI MIKE numerical models that Dr Senior used on this Project.

CAUSEWAY DESIGN: FUTURE PROOFING FOR CLIMATE CHANGE

25 The Project includes widening the existing motorway footprint of SH16 between a tidal tributary of Henderson Creek (Pixie Inlet) in the west to the St Lukes Road Interchange in the east. The majority of these works are directly adjacent to, or impinge on, the coastal marine area (CMA).

26 My initial involvement with the Project was to advise and peer-review hydrodynamic and climate-change aspects of the design of the SH16 Causeway to ensure it considered extreme storm-tide levels, wave run-up and overtopping and the future effects of climate change. In particular, the NIWA design advice to Aurecon focused upon the wave dissipation performance of the revetment and meeting moving vehicle safety guidelines with respect to wave

run-up, wave splash and wave overwash. The two main design parameters were:

26.1 Height of the crest of the Causeway to accommodate extreme storm-tide levels and climate change effects arising from sea-level rise and potentially increased wave heights; and

26.2 Various combinations of revetment crest width and revetment slope.

27 I address the Causeway height and revetment crest width below, while the Causeway slope is discussed by Dr Hsi in his evidence.

Causeway Design: Height and Crest Width

28 The design height of the Causeway, after allowing for post-construction settlement, is a function of several parameters including:

28.1 Storm-tide water level from a combination of high spring tides and storm surge for a given annual exceedance probability;

28.2 Wave run-up and overtopping processes;

28.3 Accommodating sea-level rise based on various projections up to 2100;

28.4 Changes in extreme wave climate and storm surges due to climate change;

28.5 Design judgement on the magnitude of wave-overtopping volume that is tolerable for the safety of moving vehicles; and

28.6 Flexibility for further adaptation to climate change, particularly increased sea-level rise beyond 2100 or if sea level was to rise faster than the adopted design value for 2100.

29 These factors were determined for various options of Causeway revetment crest heights, slopes and crest widths, taking into account joint-probabilities of combining storm-tide and wave processes, and incorporated into the geometric design of the Causeway as discussed by Mr Hind in his evidence. The design decisions on key parameters are outlined in paragraphs 30 to 35 of my evidence.

30 Based on my calculations from tide measurements at the Port of Auckland up to 2008, sea level has been rising in Auckland's Waitemata Harbour since 1899 at a rate of 1.5 mm per year. This rate of rise has been recently confirmed by Professor John Hannah

of University of Otago and myself in a report for the Auckland Regional Council.[2] However, the rise in sea level is projected to accelerate by the end of this century, and beyond, due to thermal expansion of ocean water and an expected increasing contribution from polar ice sheet discharges. A sea-level rise of greater than 1 metre by 2100 cannot be ruled out.

31 Recommendations for accommodating future sea-level rise by 2100 were promulgated by the Ministry for the Environment in its 2008 Guidance Manual for Local Government entitled Coastal Hazards and Climate Change.[3] This Manual, which I co-authored, recommends that a risk-based approach be used when considering what sea-level rise to accommodate in a planning timeframe. The risk-based approach is to include a balanced consideration of the possibility of particular sea levels being reached, the potential consequences and future adaptation costs of sea level rise and how residual risks could be managed.

32 Based on such an approach, the decision was made by the Aurecon and NIWA Project team to accommodate a sea-level rise of 0.8 metres by 2100 into the crest height of the Causeway design. However, the Project team has also implemented added flexibility or "future-proofing" into the design, where up to an extra 0.57 metres could be added to the crest height, when required to accommodate sea-level rise above 0.8 metres. This additional future-proofing also meets the requirements of the 2010 NZ Coastal Policy Statement (Policy 10(2)(a)) that effects of sea-level rise on reclamations should be assessed over no less than 100 years (i.e. by at least 2110).

33 "Future-proofing" of the Causeway will be achieved by providing sufficient ground-treatment strength and a 3 metre wide crest along the top of the revetment that will allow the Causeway height to be raised in the future, but with a shorter revetment crest width of 0.75 metres. Providing flexibility in the Causeway design deals pragmatically with the uncertainty surrounding projections and timeframes for the upper range of sea-level rise and is in line with adaptive climate-change design being used in other international infrastructure projects (such as the upgrade to the Thames River storm-surge barrier in the United Kingdom that I recently visited).

34 The Project team also accepted that the design for the crest height and revetment crest width should be based on a limiting average wave splash and overtopping rate of 0.02 litres per second per metre width of Causeway. Beyond this threshold, it would be

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[2] Hannah, J.; Bell, R.G.; Paulik, R. (2010). Sea level change in the Auckland region. Auckland Regional Council Technical Report TR 2010–065 prepared for Auckland Regional Council by the University of Otago and NIWA. 36 p.

[3] Available on the Ministry for the Environment web site: http://www.mfe.govt.nz/ publications/climate/#local.

unsafe for vehicles travelling at high speed. The influence of this safety threshold on the Causeway revetment design assumes that the shoulder of the carriageway is adjacent to the landward end of the revetment crest width of 3 metres.

35 For a 3 metre Causeway height and at the landward end of the revetment crest, this vehicle safety threshold is met by a joint occurrence of a storm-tide and wave event with a recurrence interval of 50 years in combination with a sea-level rise of 0.8 m by 2100. It also included a climate-change scenario where wave model simulations included a possible 20% increase in storm mean wind speeds by 2100.

Conclusions on Causeway design

36 Considering all the factors listed in paragraph 28, the Aurecon Project team determined that the target crest elevation for the Causeway should be 3.0 metres above Auckland Vertical Datum–1946 (AVD-1946) after allowing for post-construction settlement. The selection of this final design crest height takes into account a sea-level rise of 0.8 m by 2100, reduces the exposure of vehicles to wave-overtopping and wave splash hazards and that there is inbuilt flexibility to further raise the Causeway height by up to 0.57 metres in the future when sea-level rise exceeds 0.8 m above present-day levels.

Causeway Design: Channel Realignments

37 The widened Causeway on the southern side and associated ground-treatment and temporary works will encroach on an adjacent sub-tidal[4] channel in three sections, namely:

37.1 Western drainage channel in the Waterview Estuary along an approximately 160 metre section about half way between the Causeway Bridges and Traherne Island.[5]

37.2 Western-most north-going meander in Oakley Inlet channel for about a 60 metre section.[6]

37.3 Next north-going meander to the east in Oakley Inlet channel for about a 40 metre section.[7]

[4] That is, channels where the channel bed remains inundated at low tide.

[5] Refer to pages 59, 60 and 68 of Technical Report G.4.

[6] Refer to pages 61, 62 and 75 of Technical Report G.4.

[7] Refer to pages 61, 62 and 76 of Technical Report G.4.

38 I considered two realignment options for these sections of channel:

38.1 One - allow the channel to naturally erode the opposite banks to realign itself after installation of the temporary coffer-dam; or

38.2 Two - to undertake a managed or controlled excavation of a realigned channel before infilling and applying ground treatments to the by-passed section of channel.

39 I suggested the second option of controlled excavation be preferred because:

39.1 Allowing the channels to migrate laterally and reform (i.e. Option One) could lead to upstream and downstream instabilities or slumping in the flanks of the channels, particularly during periods of high velocities such as spring tides and/or Oakley Creek rainstorm flood events;

39.2 With Option One, much larger quantities of seabed sediments and associated contaminants would be disturbed, released and dispersed within the CMA if natural channel migration were to occur, compared with the situation of controlled excavation of the sediments. Contamination levels in the sediments in the vicinity of these affected channel sections are discussed by Dr De Luca in her evidence;

39.3 With Option One there is potential for undermining of ground-treatment or temporary retaining works (such as coffer-dams or sheet-piling) by channel flows if the channels were left to migrate naturally; and

39.4 A managed excavation of a realigned channel (Option Two) allows the swapping from the existing channel across to a pre-excavated by-pass channel to be accomplished in a carefully controlled manner and the excavated sediments can be re-used for mudcrete treatments in the vacated sections of channel, rather than being released into the water column to be dispersed (as in Option One).

40 The staging of the channel realignment excavations and refilling the vacated channels is outlined in the Coastal Works Report (G.23) in Section 3.5.5. The sequence of operations is designed to minimise the release and dispersal of sediments and contaminants into the receiving waters and undertake the works in an orderly manner.

Conclusions on channel realignments

41 For the three areas where the widened Causeway and associated ground-treatment will encroach on adjacent tidal channels, consideration was given to either allow the channels to naturally

realign themselves or to undertake a controlled excavation of a by-pass channel to realign the tidal channel. The latter approach has been adopted by the Project team after considering the potential environmental effects on sediment processes and the release and dispersal of sediment-bound contaminants that would occur with the former approach.

Causeway Design: Existing Culverts (Rosebank)

42 Twin 600 mm diameter culvert pipes pass under the existing SH16 Causeway opposite the middle section of the Rosebank Road Westbound off-ramp bridge. From viewing historical aerial photographs from 1959, attached to my evidence as **Annexure A**, it is evident that the culvert pipes were constructed as part of the original Causeway construction project in 1952.

43 The question is whether these culverts should be used to enhance further tidal flushing of the Waterview Estuary in addition to the single channel under the Causeway Bridges.

44 The invert level of the culverts is 0.25 metres above AVD–1946. Originally, tidal waters would only have been exchanged through these culverts once the tide exceeded 0.2 metres above the mean level of the sea or during about 40% of the tide cycle transiting high water. As-built drawings from the time of construction of the original Causeway (and culverts) are unavailable, so the historical reasons for designing/constructing the culvert pipes at this elevated level are not clear. However, as the original construction in this area included reclamation across a substantial channel draining the western side of Waterview Estuary (see **Annexure A**), the culverts were probably constructed to provide some form of ongoing connection to the Central Waitemata Harbour.

45 The culvert on both sides of SH16 was inspected by Aurecon engineers and surveyors in 2009 and in February and June 2010. Inspections revealed that there are two culvert pipes, but only one culvert is working - the other being completely blocked. This was confirmed when I made a site visit in October 2010 to the Rosebank culvert area on the south side of the Causeway (Figure 1) to undertake supplementary field observations and hydraulic measurements.

Figure 1: Rosebank Road Off-ramp culvert (blue line) with an estimate of the minimum (A1) and maximum (A2) areas of tidal flushing serviced by the culvert for a 3.4 m high water at the Port of Auckland (12 October 2010)

46 My hydraulic and salinity measurements showed that infilling from sedimentation of this western inlet of Waterview Estuary (see Figure 1) has reached 3.0 m Chart Datum (1.26 m AVD-1946) and therefore the culvert only provides tidal flushing on spring high tides that are above this level for up to 3 hours transiting high water, but reducing to no flushing for tides below 3.0 m Chart Datum. My calculations, based on field observations and the two areas shown in Figure 1, indicate that the culvert only provides between 0.05% to 0.07% of the total tidal volume that enters and leaves the Waterview Estuary on a spring tide. This percentage of the tidal flushing volume would diminish to zero for high tides less than 3.0 m above Chart Datum. On the southern side of SH16, there remains a small 4 metre long and 3 metre wide scour hole down to the culvert, from which the tidal waters emerge prior to local high water, followed by an ebbing flow back out the culvert when the tide level drops at the seaward end.

47 In widening the Causeway for the proposed works, these culvert pipes could be:

47.1 Blocked off and decommissioned;

47.2 Extended to the new width of the motorway; or

47.3 Completely replaced with a new culvert over the new width of the motorway, and at a lower invert level. Channel excavation would also be required.

48 In my assessment of the current culvert situation, the rapid infilling and associated mangrove colonisation in the western inlet of Waterview Estuary, between Traherne Island and Rosebank Peninsula, precludes any effective tidal flushing from the existing or extended culvert, other than the small area in the vicinity of the boardwalk (see Figure 1). Further, the limited tidal flushing provided by the culvert itself will continue to decline with time if left open, becoming restricted to higher spring high water levels and eventually block off anyway. To achieve any increase in tidal flushing from the culvert would require major excavation of the infilled tidal channel in the western inlet.

49 My supplementary measurements of salinity, and observations of current movements in the western side inlet through to the western side of Traherne Island, show that brackish water from the Causeway Bridges inflow does inundate the inlet. Also on the falling tide, the currents reverse to flow towards the Causeway Bridges channel after the culvert outflow diminishes.

50 The estuary sediments in the western inlet of Waterview Estuary are contaminated, as covered by Dr De Luca in her evidence (and Technical Report G.11). Therefore, even if the culvert(s) were to remain open to enable a small degree of flushing of Estuary waters with the Pollen Island drainage channel on the northern side, there would, in my opinion, be an additional environmental risk arising from the ongoing transfer of contamination through to the less-contaminated Pollen Island environment.

Conclusions on existing culverts

51 Aurecon engineers, Dr Alastair Senior and myself came to the conclusion that the only feasible option, taking into account the infilling of the channel from sedimentation and the transfer of contaminants, is to decommission the culverts. A further supplementary field survey provides further information to support this decision. Rehabilitating the culvert pipes and excavating the infilled channel to enable a functioning hydraulic connection would likely cause contaminants on the landward side of the Causeway to be released, directly affecting the wetland drainage channel behind Pollen Island. Further, the degree of hydraulic flushing achieved would, in my opinion, be minimal because of the extensive channel infilling and limited tidal flushing volume compared to that flushed through the Causeway Bridges channel.

SUMMARY OF ASSESSMENT OF COASTAL PROCESSES

52 Following the Causeway scheme design phase, NIWA was sub-contracted by Aurecon to assess the environmental effects of a widened Causeway on coastal physical processes.

53 In this section of my evidence I will briefly describe the key aspects of the assessment of effects on coastal physical processes and the estuary modelling of sediment inputs, which provided information to Dr De Luca for her assessment of ecological effects.

54 The assessment, which forms the basis of the Report, considers the effects of the construction and operation of the upgraded motorway system on coastal physical processes within the CMA.

55 The processes of primary consideration in the assessment of coastal physical processes are:[8]

55.1 Hydrodynamic processes - e.g. flows, water levels, drainage patterns and navigation;

55.2 Sediment transport and deposition processes - e.g. sediment pathways, sedimentation, erosion and scour, suspended sediment plumes; and

55.3 Geomorphology - changes in characteristic features and morphology of the seabed in the coastal zone, which are the product of hydrodynamic and sediment processes, e.g. changes in the form of intertidal banks and channels.

56 Effects discussed within the Report are aligned with the various categories of activities in the operative Auckland Regional Plan: Coastal, these activities being:[9]

56.1 Structures in the CMA;

56.2 Reclamation in the CMA;

56.3 Disturbances of the foreshore and seabed; or

56.4 Discharges of contaminants into the CMA.

Assessment methodology[10]

57 The assessment of the Project's potential effects on coastal physical processes was undertaken through a series of investigations commencing in December 2008 through to July 2010. These

[8] Refer to page 5 of Technical Report G.4.

[9] Refer to page 12 of Technical Report G.4.

[10] Refer to page 11 of Technical Report G.4.

investigations comprised an evolution of approaches to assessing the potential effects of the Project that were commensurate with the magnitude and degree of certainty about the likely level of impacts, given that the existing Causeway is essentially being widened.

58 In particular, two integrated approaches were used on the Project:

58.1 Heuristic or expert-opinion approach: Expert opinion was gathered to assess the environmental effects of activities in Sectors 1–4 of the Project, where the works for SH16 are predominantly focused on widening the existing carriageway and its footprint within the CMA. Consequently, additional effects of widening the existing footprint could be assessed relative to the effects on coastal physical processes that have occurred historically - i.e. since the reclamation was constructed in the early 1950s and subsequently widened around 1959, with further bridge widening in the 1990s. We gathered expert advice from the following experts:

(a) My colleague Dr Terry Hume who had also previously carried out one of the few studies on Waterview Estuary undertaking measurements of total tidal volume and current speeds and soundings of the channel bed profile in 1983, so we drew on his expertise in estuarine processes.

(b) Another NIWA colleague, Mr Andrew Swales is a specialist is estuary sedimentation rates and their interplay with mangrove colonisation. He undertook a major study on sedimentation in Central Waitemata Harbour for the Auckland Regional Council.

(c) My third NIWA colleague, Mr Doug Ramsay is an expert on the interaction of coastal structures with sedimentary coastal environments and incorporating climate-change effects.

58.2 Numerical-modelling approach: This complementary approach was adopted primarily to quantify and assess the effects of sediment and stormwater discharges on the CMA from SH20 activities (in Sectors 5–9). Modelling was also used to cross-check the conclusions from the expert-opinion approach for critical areas in Waterview Estuary and Oakley Inlet, focusing on the short sections of drainage channel that will require realignment (due to widening the Causeway), and the effect of additional piers on flow hydraulics under the Whau River Bridges (where the flow approaches the existing piers at a slight skew angle of 15–20 degrees).

59 Experts and stakeholders from various organisations were involved in the expert opinion approach, including NIWA, Aurecon, Green Group Ltd, the NZTA, Auckland Regional Council and the Department of Conservation. Tonkin & Taylor carried out the numerical modelling component of the investigations with NIWA supplying Waitemata Harbour boundary conditions and hydrographic soundings.

60 In conjunction with Dr Senior and the wider coastal Project team, in December 2009 a numerical modelling strategy was developed where the level of detail, and hence sophistication and field work, would be escalated if the early results from a partially-calibrated model demonstrated that the effects of the Project would be more than minor. After completing the modelling described in paragraph 58.2 (based on testing the sensitivity of input parameters and undertaking conservative scenarios), the results were deemed sufficient to show the effects of sediment disturbances and discharges on the CMA as a result of the Project would be no more than minor.

Environmental areas assessed[11]

61 The assessment, which forms the basis of the Report, can be summarised by comparing the effects of the Project works on physical coastal processes within the existing environment for three environmental areas of the Waitemata Harbour. This is described below and illustrated in Figure 1.3, page 9 of Report G.4 (attached to my evidence as **Annexure B**).

The Whau River[12]

62 This is a sheltered tidal creek, currently used primarily for recreational boating and moorings. The original Whau River Bridge and associated abutments were constructed around 1952. The bed sediments are predominantly fine sand, though a high proportion of mud and silt is found where the river enters into the Central Waitemata Harbour. The river channel depth through the bridged section appears to be stable based on previous measurements of the channel cross-sectional area and maximum depth on the northern side of the Bridge published by Dr Hume in 1991.[13]

63 New structures within the Whau River will include temporary piers (to support staging platforms for construction) and additional permanent bridge piers and widened abutments. Although the bridge pier groups are set at 15-20° to the tidal flow, the overall effect of these additional structures on hydrodynamics and general geomorphology of the river channel is expected to be no more than minor. This assessment takes into account the effect of wakes,

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11 Refer to page 10 of Technical Report G.4.

12 Refer to page 20 of Technical Report G.4.

13 Refer to page 21 of Technical Report G.4.

hydraulic backwater head differences that were modelled, local scour, channel bank erosion and tidal flushing of the Whau River system. Discharges or seabed disturbances in this bridge area, using erosion and sediment control measures where feasible, are expected to have only minor effects on sediment processes and water appearance (after allowing for reasonable mixing).

64 Construction of the widened bridges and new cycleway from temporary staging platforms will somewhat constrain navigation by vessels passing under the Bridges, but these effects on navigable passage will be alleviated by leaving a wider 18 metre gap between temporary-staging piers towards the western side of the channel where the Bridge superstructure is higher off the water. A condition (see **Annexure C**, C.11) is proposed that navigation of vessels beneath the Whau River Bridges during construction shall be maintained to the satisfaction of the Auckland Harbour Master.

65 The Aurecon bridge designers advised that once completed, the north and south edges of the widened bridge superstructures will be lower to the water by 0.18 and 0.20 metres respectively, to allow for drainage camber on the bridge decking. Aurecon also advised that the existing eastbound bridge is slightly lower than the westbound bridge, so at the mid-point of the main navigation span, the minimum soffit level will reduce by 0.18 metres from 5.42 metres to 5.24 m AVD-1946. This theoretically will result in a slight reduction in the time window for the passage of vessels with higher flying bridges, of approximately 18 minutes around mid tide, when the clearance will be 5.3 metres, and 18–30 minutes towards spring low tide, when the clearance will be 6.6 metres. However, in my opinion, this is unlikely to have more than a minor effect on navigability, as a 0.18 m difference in height clearance is probably imperceptible when viewed from the water, and skippers would need to consider a larger safety margin, taking into account other differences in local conditions and water levels that are of similar or greater magnitude, e.g. sea state at the Whau River mouth, storm surge and wind set-up of the tide (which can be 0.1–0.3 metres or more) and changes in monthly sea level (which can be plus or minus 0.2 metres in the Waitemata Harbour).[2]

66 On the southern side of SH16 to the east of Rosebank Park Domain, a 125 metre section of a relatively small (2 metre wide) channel that drains into the Whau River will require infilling or permanent occupation of the CMA for ground treatment.[14] The channel will be allowed to naturally migrate laterally and reform a channel on the outside of the ground-treatment works. To this end, the infilling works need to be carried out in successive stages to provide sufficient response time for the channel to migrate laterally. Also, the removal of the fringing mangroves and their roots will be

[14] Refer to pages 57-58 of Technical Report G.4.

required on the southern side of the existing channel for construction and ground-treatment access. The removal of the above-ground and shallow subterranean roots, while removing the fringing mangrove trees, will be necessary to allow natural bank-erosion processes to operate freely on the southern flank of the channel from the new revetment toe line out to a distance equivalent to the present 2 metre wide channel.

67 With these measures in place, and the passage of time, the effects on drainage patterns, geomorphology and sediment processes will be no more than minor. Nonetheless, the migration of the channel should be monitored regularly (see **Annexure C** proposed condition C.13) to ensure the natural migration of the channel is proceeding unimpeded by mangrove roots.

Conclusion – the Whau River

68 Given that the successive widening of the original Whau River Bridge abutments has not given rise to any further obvious effects on the geomorphology of the Whau River mouth channel, the effects of the additional widened abutments is likely to be minor. Dr Senior of Tonkin & Taylor has modelled the effect of the skewed flow orientation on a longer set of piers and it shows the hydrodynamic effect will be minor. Where the widened SH16 embankment for the access road to the Rosebank Domain will encroach on the CMA, allowing the narrow drainage channel to migrate naturally will only result in minor and temporary effects on tidal-flat drainage patterns, provided the mangroves along the southern fringe of the channel are removed as well as their roots.

The Central Waitemata Harbour (north of the Causeway)[15]

69 Coastal fringes of the Waitemata Harbour have been extensively modified as Auckland has developed, including through the development of the SH16 Causeway, which was constructed from 1952-53.

70 The Harbour seabed generally consists of sand with a higher proportion of fine grained sediments (muds and silts) typically found along the intertidal and sheltered embayment areas of the Harbour. The CMA in the shelter of Pollen Island on the northern (seaward) side of the Causeway is the biggest and least disturbed area of saltmarsh remaining in the Waitemata Harbour, as described in the Auckland Regional Plan: Coastal (ARP:C) for the designated CPA 53 area. The main eastern and western drainage channels that service this extensive wetland behind Pollen Island play a key hydraulic control on the drainage and inundation of the wetland.

71 The upper intertidal morphology and associated chenier (shell) ridges also appear to have been relatively stable throughout the last

[15] Refer to page 28 of Technical Report G.4.

60 years, although the upper-tidal beaches on either side of the Causeway to the west of the Causeway Bridges has been controlled to some extent by groynes placed during the original construction. Chenier ridges also occur offshore (to the north of the Causeway), with the western group of chenier banks having migrated shoreward, but do not appear to have been directly affected by the introduction of the Causeway because they are influenced by offshore wave conditions.

72 No new structures will be located within this water body as a result of the Project, with the Patiki Road off-ramp and Rosebank Road on-ramp structures in the CMA remaining as they are.

73 The reclamation required for the widened Causeway is not expected to change the flow regime of this environment, particularly as most of the reclamation works will either avoid the CMA (e.g. the design includes vertical retaining walls to avoid encroachment of the main Pollen Island drainage channel) or will be located on upper-intertidal areas that are only inundated around high tide periods.

74 The reclamations to widen the Causeway will cause minor adjustments to the upper-intertidal geomorphology, particularly along the wave-exposed northern toe-line, which will occur over periods of months as waves and tides re-work seabed sediments and chenier deposits into a re-adjusted upper-tidal morphology.

75 Small areas of chenier deposits will have been buried by the widened reclamation. However, remediation will be achieved by excavating these shell deposits, stockpiling them and subsequently re-positioning them in the same general area after the reclamation has been widened. This re-deposition will allow waves to re-form the chenier ridges and re-attach them to the unmodified ridge deposits.

Conclusion – the Central Waitemata Harbour

76 Overall, the effects on coastal physical processes of widening the Causeway and embankments on the northern side of SH16 will be no more than minor, as the Causeway design includes vertical retaining walls to avoid encroaching on the Pollen Island eastern drainage channel and remediation of the stockpiled chenier material takes place. The avoidance of any encroachment on the main drainage channels to the south of Pollen Island means, in my opinion, that the effects of the Project on the geomorphology and hydrodynamics of the Pollen Island intertidal area to the north of both the eastern channel and the smaller western channel draining into the Whau River mouth, will be indiscernible.

The Waterview Estuary and Oakley Inlet[16]

77 The Waterview Estuary system has been substantially modified by catchment land-use changes and construction of the original Causeway. Catchment run-off has lead to an accumulation of muddy sediments since land clearing or urban development commenced. Decades of industrial activity and a long history of poor environmental practices have also resulted in degradation in water quality within the Estuary.

78 The construction of the Causeway in 1952-53 also had a significant effect on the flow dynamics of the two previously separate inlet systems, including the scouring of the outlet channel under the Causeway Bridges. However, the outlet from Waterview Estuary has been relatively stable since the mid to late 1970s.

79 The existence of the Causeway will continue to exacerbate sedimentation in Waterview Estuary arising from catchment run-off and sediment inputs from the Central Waitemata Harbour. Due to the short wind fetches within the Estuary and protection of the Causeway from northerly wind fetches, the Estuary is a low wave energy environment, which favours sedimentation.

80 Structures associated with the Project within the Waterview Estuary and Oakley Inlet area will include temporary piers (to support staging platforms) and additional permanent bridge piers (including the cycleway bridge) and widened bridge abutments. These will cause no more than minor changes to the flow regime when compared to the existing environment. This assessment takes into account the effect of wakes, hydraulic backwater head differences, and tidal flushing of the Waterview Estuary and Oakley Inlet system. The flow orientation under the Causeway Bridges is also parallel with the pier groups, minimising any backwater effects.

81 The widened Causeway Bridge abutments to the south may cause minor erosion on the flanking banks and channel depth in the shortened confluence area, where channels from Waterview Estuary and Oakley Inlet converge. Mitigation of these effects has been incorporated into the design of the widened Causeway, by paring back the bridge abutments under the cycleway and introducing additional piers at both ends of a longer cycleway bridge. This approach will require less reclamation adjacent to the cycleway and will provide a smoother flow transition in the confluence area from the sideways-approaching Oakley Inlet channel.

82 With the appropriate use of erosion and sediment control measures where feasible, discharges or seabed disturbances along the Causeway and bridge abutment works are expected to only have

[16] Refer to page 30 of Technical Report G.4.

minor effects on sediment processes and water appearance (after allowing for reasonable mixing).

83 Discharges into the CMA also include discharges of sediments sourced from works and activities associated with SH20 construction in the Oakley Creek catchment. Several discharge scenarios for the Oakley Creek works were undertaken for different storm recurrence intervals and degrees of erosion and sediment control. The sediment inputs to the estuary model were based on Oakley Catchment modelling results for present-day and proposed construction situations described in Technical Report G.30 produced by NIWA's Urban Aquatic Environments Group in Auckland.[17] From an analysis of the estuary sediment-dispersion model results and the existing background water quality (including turbidity within the Waterview Estuary), the potential physical effects of sediment discharges on Waterview Estuary and Oakley Inlet receiving environments are assessed as no more than minor. The effects of these sediment discharges on the marine ecology are discussed by Dr De Luca in her evidence.

84 Seabed disturbances within the Waterview Estuary and Oakley Inlet area include construction works associated with widening the Causeway (including ground treatment), building new piers (Oakley Inlet) and widened reclamations. The managed excavation of three separate channel realignments, as I discussed earlier in paragraphs 37 to 41, have been included in the proposed works to mitigate potential hydrodynamic and geomorphologic effects of the existing channels being in-filled by reclamations or ground treatments to widen the Causeway. With these managed channel realignment options included, the long-term effects on coastal physical processes from temporary or permanent occupation of the CMA are also assessed as no more than minor.

85 Due to the low elevation of the Causeway Bridges, I made an assessment of the effects of the widened bridge superstructure on future conveyance of flows through the outlet channel arising from sea-level rise. The widened soffit level[18] on the lower southern side of the Bridges will provide sufficient clearance for a 100-year average recurrence interval storm tide and a sea-level rise of 0.6 metres (but excluding wave effects). However, this situation would only occur for a short period at high tide when current velocities are low. So, this extreme storm-tide event would not cause any hydraulic choking of the flow. The lowest level of the topside of the bridge deck is another 1.2 metres higher.

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[17] Refer to Section 3, pages 7-15, Technical Report G.30.

[18] The soffit here refers to the lowest elevation of the supporting bridge beams to check the water flow clearance.

Conclusion – the Waterview Estuary and Oakley Inlet

86 Mitigation of potential scour and erosion of flanking banks and channels in the confluence area due south of the Causeway Bridges has been achieved through design improvements, where wider abutments for the cycleway bridge have been pared back and replaced by a longer bridge supported by additional piers. Controlled excavations of the three channel realignments will substantially reduce the release and dispersal of contaminated sediments through the CMA. Overall, including these two mitigating measures, the effects of the Project on coastal physical processes in the Waterview Estuary and Oakley Inlet area will be no more than minor.

Conclusions in the assessment[19]

87 The CMA has been substantially modified by the construction of the original Causeway in the early 1950s and, to a much lesser extent, the protruding abutments for the original Whau River Bridge. The new works proposed for SH16 between the Great North Road Interchange and Te Atatu are further lateral extensions of the existing Causeway footprint into the CMA.

88 As a result of the lengthy assessment process for this Project, some mitigation or avoidance measures for potentially adverse effects have already been incorporated into the Project's engineering design and construction plans. With these measures included in the proposed design and the implementation of the other mitigation or remediation measures outlined in the Report, I consider the short–term and long-term effects of the works on coastal physical processes to be either minor or no more than minor, subject to the proposed coastal conditions.

POST-LODGEMENT EVENTS

89 Following lodgement of the application documents in August 2010, the following further field or estuary modelling studies were undertaken to provide further confirmatory evidence to support the findings of the Report:

89.1 A full 13-hour tidal gauging that I designed was undertaken by NIWA staff across the Causeway Bridges channel on 9 September 2010 measuring current speeds, tidal height and turbidity. This data was used to improve the calibration of the estuary model.

89.2 Dr Senior of Tonkin & Taylor carried out further calibration and verification of the estuary hydrodynamic model. This was achieved by matching the model predictions with the new field data on tide height, tidal currents and the tidal prism

[19] Refer to page 105 of Technical Report G.4.

(the volume of water that flows in or out of the Estuary during a half-tide cycle). This fine-tuning of the model calibration and some improvements in bathymetry of the model grid were not expected to change the sediment modelling results previously presented in the Report. However, to confirm this, the model simulation of "medium silt discharged from Oakley Creek due to a Water Quality Storm event during construction" was repeated.[20]

89.3 Dr Senior then changed the final calibrated model grid to represent the bathymetry of the Waterview Estuary after construction of the widened Causeway and produced plots of the differences in tidal currents before and after construction to confirm the magnitude of change.

89.4 I carried out a field survey of the tidal flushing characteristics of the culvert under SH16 near the Rosebank Road Off-ramp with my colleague Dr MacDonald and Mr Rutt from Aurecon on 12 October 2010. I previously discussed the key findings from this survey in paragraphs 45–51.

90 The tidal gauging provided an extensive set of tidal information for fine-tuning the estuary model calibration, which could be compared with a gauging in 1983 for a similar spring tide range by my colleague Dr Hume.[21,22] The peak mean velocity during the recent gauging was 1.26±0.05 m/s, which compares to 1.84±0.05 m/s in 1983. This difference equates to an approximate 30% reduction in the peak mean velocity. Comparing the tidal prism volumes, there has been a 20–25% reduction in the tidal compartment of Waterview Estuary and Oakley Inlet over the intervening 27 years. This reduction is largely a result of ongoing sedimentation.

91 Turbidity measurements were recorded by a DOBIE[23] instrument just below Chart Datum under the Causeway Bridges for one week straddling the recent 2010 gauging. Peak suspended-sediment concentrations were highest around peak ebb and flood tidal currents reaching at least 100 mg/L and following two small/moderate rainfall events, reached 200–350 mg/L. Therefore, the waters of the estuary system already have high background suspended-sediment levels.

92 The repeated sediment model simulation of "medium silt discharged from Oakley Creek due to a water quality storm event during

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[20] This simulation is originally presented in Figure B-3 of the Report.

[21] Refer to page 32 of the Coastal Processes Report (G.4).

[22] Hume, T.M. (1991). Empirical stability relationships for estuarine waterways and equations for stable channel design. Journal of Coastal Research 7(4): 1097–1112.

[23] http://www.niwa.co.nz/our-services/instruments/instrumentsystems/dobie

construction"[24] with currents from the fine-tuned hydrodynamic model. From the re-run simulation carried out by Dr Senior, the results of maximum suspended sediment concentration and total deposition were very similar to that originally reported. This would equally apply to the results from the other sediment modelling simulations.

93 Additional model simulations by Dr Senior, using the new bathymetry that includes the widened reclamation and permanent occupation, show almost indistinguishable changes in the flow discharge rate and tidal levels in the Causeway Bridge channel, relative to the present situation. Changes in current speeds from the widened Causeway were small, when compared to the existing currents as shown for the ebb and flood spring tides in Figure 2.

94 Figure 2 shows the difference in tidal current speeds for the existing situation subtracted from those simulated for the completed Project. The plots are for stages of the ebb and flood tides respectively when current speeds are highest. The effects of the channel realignments are clearly visible in Figure 2 by the largest changes in current speed, with red for an increase in speed and blue for a decrease. This is entirely expected, as the areas earmarked for realignment are currently on the intertidal flats experiencing slower current speeds, which will increase when the channel excavation is completed. Correspondingly, the present adjacent tidal channels, will become permanent-occupation intertidal areas, resulting in slower speeds for these sections. Over most of the rest of Waterview Estuary, Figure 2 shows that the difference in currents will be very small, being less than 0.05 metres per second in magnitude. This magnitude is within the accuracy of most conventional current meters mounted on a boat for cross-channel traverses. These model results confirm that the proposed works will have very little effect on the tidal currents within the Estuary as a whole. These mostly small differences demonstrate that the results and conclusions (particularly regarding effects on hydrodynamic, and by inference, sediment processes,) presented in Technical Report (G.4) remain valid.

[24] Refer p. 98-99, Appendix B and Fig. B-3 of the Coastal Processes Report (G.4).

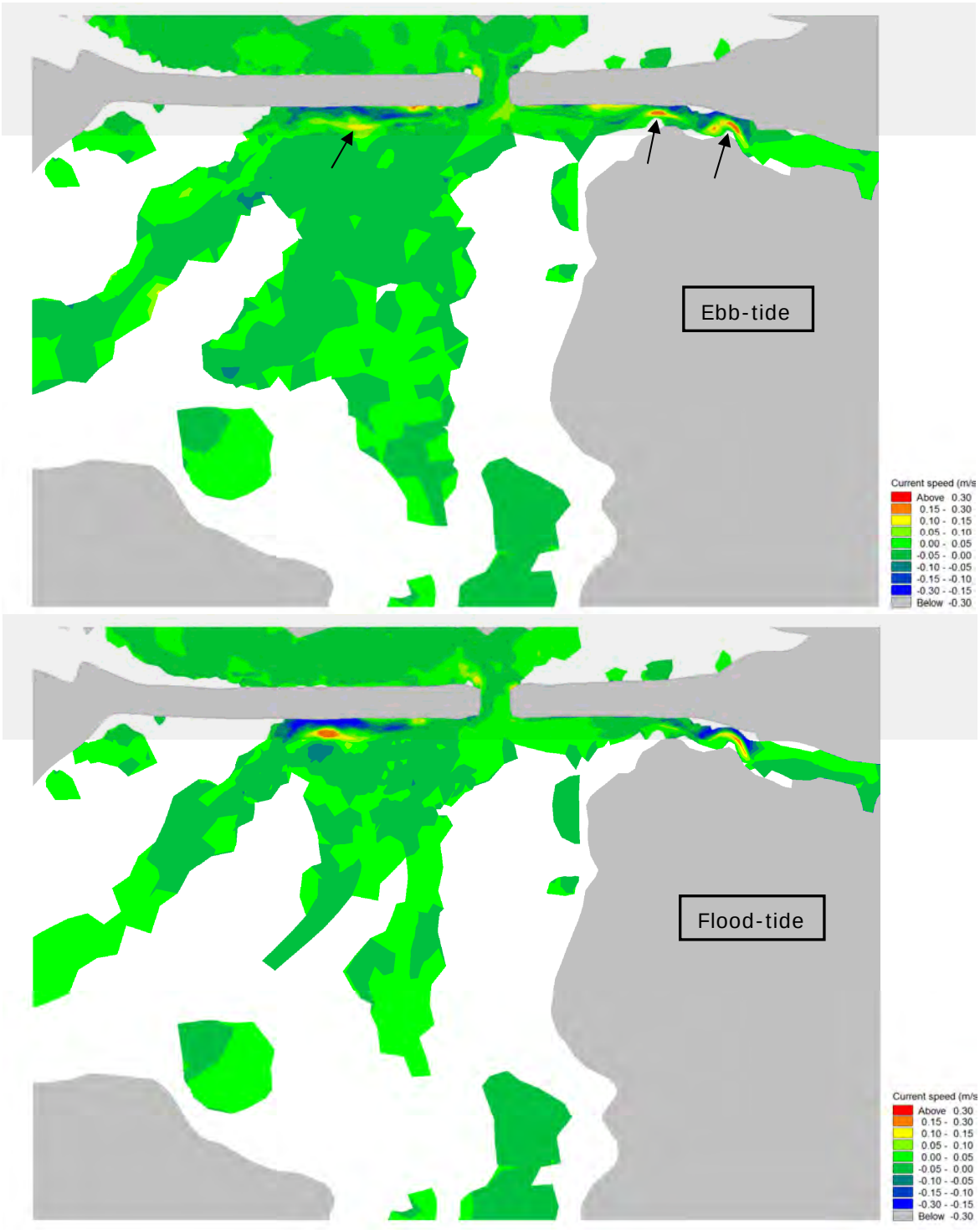

Figure 2: Plots of the differences of spring tidal current speeds before and after the widened Causeway for ebb and flood tides. The colours map the difference of tidal speed, with blue showing the most reduction and red the most increase. The map demonstrates that the changes in speeds are mostly small (<0.05 m/s) except for the channel realignment sites shown by arrows. The shoreline is that for the widened Causeway and white areas are “dry” intertidal areas.

95 From the Rosebank culvert survey, the tidal flushing volume to and from the Waterview Estuary that is currently serviced by the remaining open culvert was only 0.05 to 0.07% of the tidal prism measured during the September 2010 gauging at the Causeway Bridges.

COMMENTS ON SUBMISSIONS

96 I have read those submissions lodged on the Project that raise issues on coastal physical processes relevant to my area of expertise. In this section I respond to those submissions.

Insufficient tidal and sediment flushing

97 Of the issues raised by submitters on coastal physical impacts, the largest group[25] expressed concerns about insufficient tidal and sediment flushing of Waterview Estuary available through the narrow Causeway Bridges channel and associated sedimentation in the estuary and kayaking access under the Bridges. Specifically, I respond with the following points:

97.1 The volume of tidal water that enters Waterview Estuary and Oakley Inlet through the existing Bridges channel up to high tide will not be reduced as a result of the Project compared to the situation if there were more inlet channels or culverts. Overall tidal volumes that flow into estuaries are based on tidal water level differences between inside and outside the estuary, not the width of the inlet channel. A narrower channel will compensate to move this volume with higher current speeds, while a wider channel or multiple channels would have lower peak tidal speeds.

97.2 Presently, the peak tidal velocity is 1.2 to 1.3 metres per second on a spring tide, and while this is a relatively high "tidal rip" (as expressed by some submitters in respect of kayaking activities), it has diminished by 30% since the early 1980s.

97.3 As shown in my earlier evidence[26] and the Report[27], it is my opinion that widening the Causeway Bridges, with longer pier groups, and adjacent abutments will not result in any significant effects on flow characteristics through the channel, because the cross-sectional area of the channel will remain the same and the flow is parallel with the bridge pier groups.

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[25] Submitter Nos. 44, 69, 77, 96, 131, 154, 169, 178–180, 185–186, 191, 199, 203, 206, 213, 217, 225 and 229.

[26] See paragraphs 80-81.

[27] Refer to pages 84–85 and 97–98 of Technical Report G.4

Also, the widened Causeway reclamations and permanent occupation only account for a very small percentage of the tidal volume within Waterview Estuary and Oakley Inlet, because they are mostly located on the upper intertidal slopes. Considering all these effects, the changes in tidal volume exchanged through the outlet channel will be minor.

97.4 The existing Causeway, with effectively one outlet in addition to a minor culvert adjacent to the Rosebank Road off-ramp, has contributed to substantial sedimentation in Waterview Estuary, with reduced flushing of sediments and tidal waters in the western ends of the estuary. However, the existing Causeway is now part of the existing environment, so my assessment of effects only relates to the new widening of the Causeway and bridges, for which the additional effects on flushing will be minor.

97.5 Further culverts, or an additional outlet along the main body of the Causeway, east of Traherne Island, would make little difference to tidal flushing of the larger eastern compartment of Waterview Estuary as the present outlet is serviced by two tidal channels providing direct flushing of that area. But extra outlets would cause substantial re-adjustments of the estuary's geomorphology and mobilisation of contaminated sediments, including increased sedimentation to the south of the Causeway Bridges channel because flows in that area would be reduced.

97.6 The main area in the vicinity of the Project that could benefit from tidal flushing is the western inlets of Waterview Estuary, as highlighted by the Forest and Bird Motu Manawa Restoration Group,[28] but as I have already stated[29], past infilling by sedimentation of the former main tidal channel (compare 1940 with 2001 photograph in **Annexure A**) precludes any viable solution to flushing this area without major excavation of the former channel.

97.7 In terms of kayaking access under the Causeway Bridges, the headroom under the widened bridge beams to the water level at Mean High Water Spring (MHWS) will reduce slightly. At the lowest southern side, the reduction in headroom will be about 220mm, assuming a bridge camber slope of 2.5%. The minimum headroom at MHWS will be 1.24 m at the lowest landward edge of the Westbound Bridge.[30] Kayakers will still

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[28] Submitter No. 217

[29] At paragraphs 42-51.

[30] Refer to page 84 of Technical Report G.4.

have sufficient clearance at spring high tides, although this clearance will gradually diminish as sea level continues to rise.

Shell banks and spits

98 Four submissions[31] specifically identified concerns regarding the impacts of the Project on chenier (shell) banks and spits. In my opinion, the offshore chenier banks will not be affected by the Project, as they are maintained by waves from the north-west and north-east quadrants and, in terms of wave reflection, the widened Causeway will remain at the same alignment as present. However, for the chenier banks attached to the current northern shoreline, small sections lie within the widened footprint. As I have previously stated, the impact on these banks will be mitigated by stockpiling and re-positioning the shell after the works are complete.

99 In my recent September–October 2010 field visits, it has been obvious that waves arriving obliquely to the shoreline (from the north-west in these cases), can readily move and re-shape the shell banks at the places where they will be affected by the Project. In my opinion, and also that of my colleague Dr Hume, this re-shaping process by waves will occur within weeks to months of the re-positioning of the shell material in front of the new Causeway rock revetments with no more than minor effects. The Auckland Regional Council (ARC)[32] supports this approach.

Climate Change

100 Several submitters[33] have identified climate change as a general issue. In my evidence, I have covered adaptation of the Causeway design to address the effects of climate change, specifically the Causeway crest height. However, it is outside my expertise to discuss the effects of road transport emissions on climate change.

Navigation

101 The Te Atatu Boating Club[34] is opposed to a lower navigation clearance under temporary and permanent structures associated with widening the Whau River Bridges. I have previously outlined[35] the effects of the 180 mm reduction in clearance of the permanent eastbound Whau River Bridge and I have also discussed this with some of the Club Committee during an on-site meeting on 12 October.

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31 Submitter Nos. 43, 53, 112 and 180.

32 Submitter No. 207.

33 Submitter Nos. 121, 126, 186, 199, 203, 213, 223, 225, 230

34 Submitter No. 110

35 See paragraph 65.

102 During construction of the Project, separate temporary staging platforms will be built out from both the eastern and western bridge abutments, with a gap between them of 18 m to allow for navigation.[36] Accordingly, there will be no reduction in headroom clearance from the temporary staging platforms.

Rosebank Road culvert

103 Two submissions from the Forest and Bird Motu Manawa Restoration Group[37] and David Clendon, Gareth Hughes and Kevin Hague[38] specifically requested that the Rosebank Road off-ramp culvert be retained.

104 I have previously outlined[39] my reasoning for not supporting the continued use of the culvert. The information on which my opinion is based includes supplementary field surveys in October that were agreed to by the NZTA after meeting with Forest and Bird to hear their concerns.

105 The primary reason for de-commissioning the culvert is that past sedimentation in the western inlet has rendered the culvert ineffective— the contaminated sediments are a secondary issue. Following completion of the Project, "tidal irrigation" will still occur in the western inlet, albeit at a slightly lower salinity compared to the present direct access to Waitemata Harbour waters via the culvert. Further, widening works will fill in the present small 4-metre long scour hole on the estuary side, which means a new scour hole would have to be excavated if the culvert was to be retained for a small degree of tidal irrigation. The ARC[40] supports abandonment of the culvert.

Auckland Regional Council

106 The Auckland Regional Council (ARC)[41] provided support for various aspects of the Project applications, but raised several issues associated with the CMA.

107 In particular, the ARC does not support the proposed approach for CMA reclamations using sloping revetments on the northern side of SH16 between Whau Bridge and Rosebank Peninsula because of the area of habitat loss.

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36 Refer to page 45 of Technical Report G.4.

37 Submission No. 217.

38 Submission No. 156.

39 In paragraphs 42–51.

40 Submission No. 207.

41 Submission No. 207.

108 One of the key design reasons for the sloping rock revetment in this area, particularly from Rosebank Domain to the Whau Bridge abutments, is the exposure to wind waves from a north to north-north-east window across Central Waitemata Harbour outside the protection of Pollen Island. This section of SH16 has a similar wind fetch at spring high tide to the main Causeway of around 8 kilometres, although it would experience a shorter window of wave exposure due to the wider intertidal flats compared with the main Causeway. Adoption of vertical retaining walls are more likely to exacerbate erosion in front of the walls during high storm-tide events than a sloping rock revetment, and more so in the future with higher sea levels. Other design considerations taken into account in the decision to use revetments rather than vertical retaining are covered by Dr Hsi in his evidence.

109 Mr Moores, in his evidence, has responded to parts of the ARC's submission relating to the modelling of sediment and contaminant loads associated with the Project. The concern related ultimately to the accuracy of the cumulative impacts of contaminants and sediment predicted by the estuary modelling[42]. Mr Moores has pointed out that the sediment and contaminant loads from the Oakley sub-catchments in Sectors 5 and 7-9 will be either slightly reduced or about the same as the values previously presented in Technical Report G.30.

110 Following lodgement of Technical Report G.4, it has been determined that Dr Senior carried out the estuary sediment modelling using higher sediment loads than necessary by also including loads from Sector 6, which actually discharges to Meola Creek, rather than Oakley Inlet. Consequently, combining both these factors, the sediment modelling for Oakley Inlet and Waterview Estuary is conservative compared with the revised loads predicted by Mr Moores.

111 The ARC submits[43] that monitoring should be undertaken to verify that the effects of new bridge piers, abutments and reclamations are no more than minor. In my opinion, it would be very difficult to design and implement a robust monitoring programme that could isolate the effects of the new works, which are essentially widening the existing motorway footprint, from the ongoing effects of the existing Causeway, abutments and bridge pier groups. Such difficulties apply particularly to geomorphological changes, which tend to evolve more slowly, and are also influenced by natural variability from catchment sediment loads, rain-storm sequences and climate and wave variability. Modelling also shows that the hydrodynamic changes to the tide range and current speeds in

42 ARC Submission, Section 4.6.19-21.

43 Section 4.6.25-27.

Waterview Estuary will be mostly smaller than the accuracy of conventional oceanographic instruments. Designing monitoring conditions with the skill to isolate the minor effects of the widening works is, in my opinion, not technically feasible.

Auckland City Council

112 From the Auckland City Council's submission[44], I respond to the items related to the coastal environment:

112.1 Paragraph 329 (Section 4.6) requests monitoring of the channel infilling east of Rosebank Domain. I have proposed a condition (see **Annexure C**, proposed condition C.13) to address the removal of mangroves and ensuring the tidal-flat drainage is not impeded.

112.2 Auckland City seeks continued protection of Pollen island, its drainage channel and chenier (shell) ridges and sensitive stockpiling and re-positioning of affected shell material. I have covered these aspects elsewhere in my evidence.

112.3 Auckland City seeks confirmation that additional sedimentation from "restricted flows" is not occurring. I consider it would be very difficult to design a monitoring programme that had sufficient skill to isolate the minor effects of the widened elements of the Project on sedimentation from the ongoing sedimentation arising from the existence of the Causeway.

Further, the monitoring would need to clearly resolve and attribute effects from the background high variability arising from catchment sediment loads delivered during episodic rain-storms and re-suspension events from small waves within the estuary around high tides.

112.4 Auckland City supports the managed excavation of the three sections of realigned channel sections.

[44] Submission No. 111.

COMMENTS ON THE ARC'S S149G REPORT

113 I have read the Coastal Processes part (Section 2.2) and the Route Description (Section3.2.1) of the RMA Section 149G Report prepared by the ARC.

114 The main concern expressed by the ARC was its perception of an undue reliance on an experts' opinion assessment approach compared to the balance of the assessment process that used numerical modelling. The ARC had discussed these concerns with the Project team prior to the s149G Report. On that basis, NIWA advised the NZTA to fund a supplementary work programme to undertake a full tidal gauging under the Causeway Bridges. That gauging then fed into improvements to the calibration of the estuary model by Dr Senior. The ARC requested that the hydrodynamic modelling should be done for both the pre- and post-construction footprints of the Causeway to quantify the difference in water levels and tidal currents. I have discussed this supplementary work in paragraphs 89 to 94 above, and noted that the supplementary work, confirmed our earlier assessment.

115 In the Route Description Section of the s149G Report, the ARC describes the important features of the CPA 1 area (CPA 53) that encompasses the Motu Manawa Marine Reserve. The ARC's Report quotes part of the CPA 53 description from the ARP:C, which continues to concentrate on natural features pertaining to the environs of Pollen Island. Given, the high value placed on these environs by the CPA 53 description, all steps have been taken in the design to avoid any encroachment of the main drainage channels to the south of Pollen Island. Consequently, in my opinion, the effects of the widening Project on the geomorphology and hydrodynamics of the Pollen Island intertidal area to the north of both the eastern channel and the smaller western channel, draining into the Whau River mouth, will be indiscernible.

PROPOSED COASTAL CONDITIONS

116 In the documentation lodged with the AEE, the NZTA included a set of Proposed Consent Conditions (see Part E, Appendix E.1). The conditions included proposed coastal conditions, which I generally consider would be appropriate.

117 Following lodgement, the proposed coastal conditions were amended and an advice note added.[45] In addition, specific conditions relating to the monitoring of the migration of the drainage channel adjacent to the Rosebank Domain access road, the

[45] Refer to Technical Report G.31 Addendum Report.

three managed channel realignments, tidal flushing following the Rosebank culvert decommissioning and edge effects of construction sections on erosion and accretion north of the Causeway, were added. A redlined version of these conditions showing the amendments is contained in **Annexure C** to my evidence. I consider these conditions remain appropriate.

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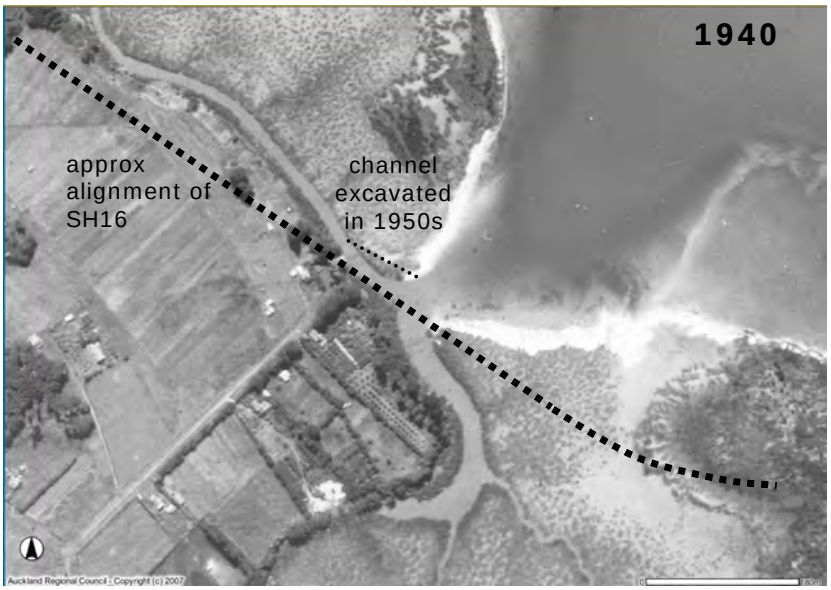
Robert Bell
November 2010

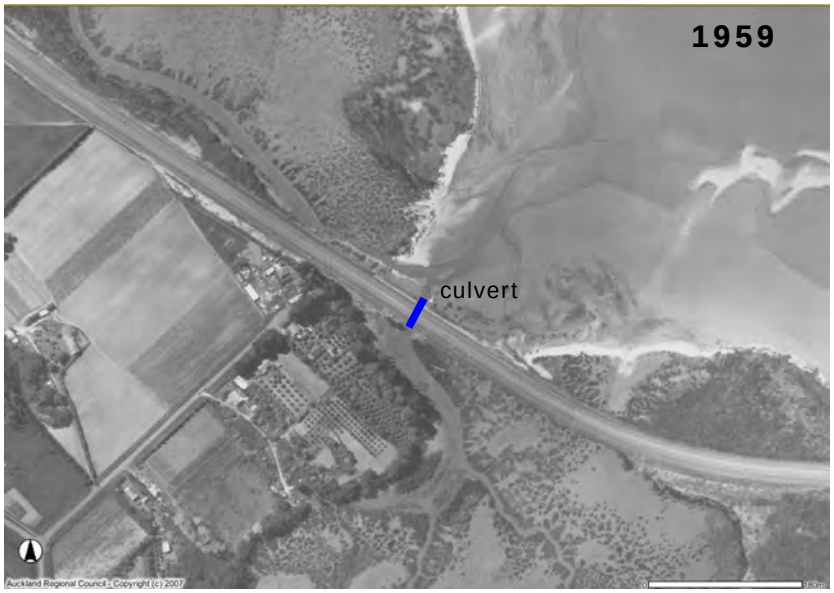
Annexure A – Aerial photographs of the SH16 Causeway and Culvert Area for 1940, 1959 and 2001.

Annexure B – Environmental Areas of the Waitemata Harbour.

Annexure C – Proposed Coastal Conditions.

ANNEXURE A: AERIAL PHOTOGRAPHS OF THE CULVERT AREA[46]





[46]Sourced from the Auckland Regional Council.

ANNEXURE B: ENVIRONMENTAL AREAS OF THE WAITEMATA HARBOUR[47]

[47] Figure 1.3, page 9, Report G.4.

ANNEXURE C: PROPOSED COASTAL CONDITIONS[48]

C.1	The NZTA shall provide to the [Auckland Council] plans and drawings (including dimensioned, cross sections, elevations and site plans of all areas of proposed reclamation (including associated permanent and temporary CMA occupation), permanent structures and temporary structures) at least 20 working days before the proposed date of commencement of the construction of the reclamation, bridge piers or temporary structures.
C.2	Construction shall be undertaken in accordance with the construction methodology detailed in the application, specifically Technical Report G.23 Coastal Works and Technical Report G.22 Erosion and Sediment Control Plan. The construction methodology shall include: (a) The use of temporary coffer dams to create dry working areas; (b) Realignment of sections of existing low-tide channels in Oakley inlet and Waterview Estuary that will be directly affected by the reclamation works; (c) Removal of mangroves to provide construction and ground-treatment access, placement of temporary cofferdams and to facilitate natural channel migration in the Whau River side drainage channel (east of Rosebank Domain); (d) Installation or removal works to be undertaken at the best practicable time to minimise potential sediment ~~generation~~ disturbance.
C.3	The NZTA shall notify the [Auckland Council] in writing of the proposed commencement date of the reclamation, structures and/or channel realignment works at least 10 working days prior to the proposed start date
C.4	The NZTA shall notify the [Auckland Council] in writing within 10 working days of the completion of each discrete area of reclamation, structures and/or channel realignment works.
C.5	The NZTA shall supply to the [Auckland Council] and ~~the~~ LINZ Hydrographic Services ~~Office~~ and LINZ Topographic Services ~~Office~~ (~~Chief Hydrographer, National Topo/Hydro Authority,~~ Land Information New Zealand, ~~Private Box~~ PO Box 5501, Wellington 6145), a complete set of "as built" plans, final topographic and bathymetric data, and appropriate certification confirming that the new reclamations, structures and~~/or~~ channel realignment works have been built in accordance with sound engineering practice, within 60 working days of the completion of the reclamation works.
C.6	The NZTA shall maintain the site in good order and shall, as far as practicable, remedy all damage and disturbance caused by vehicle traffic, plant and equipment to the foreshore during construction, to the satisfaction of the [Auckland Council].
C.7	Removal or pruning of vegetation in the CMA shall be limited to the areas of permanent and temporary occupation as shown on the Waterview Connection Project Assessment of Environmental Effects Plan Set F.12 and F.13 submitted with the application. Removal of ~~any~~ mangroves shall be implemented in accordance with the principles detailed in the Ecological Management Plan.
C.8	The NZTA shall ensure the~~, remove~~ removal of all equipment, erosion and sediment control measures, surplus ~~soil~~ sediment and construction materials from the CMA within 20 working days following the completion of the construction works, to the satisfaction of the [Auckland Council].
C.9	**Cleanfill** All imported fill material to be used in the reclamations shall be in accordance with the Ministry for the Environment "cleanfill" definition, as detailed in Publication ME418 "A Guide to the Management of Cleanfills, 2002" or subsequent updates.
C.10	The NZTA shall maintain a log recording the source of fill material imported onto each reclamation site. This log shall be made available to the [Auckland Council] for inspection on request.
C.11	**Navigation of Whau River Bridge** ~~Boating access~~ Navigation of vessels beneath the Whau River Bridges during construction shall be maintained to the satisfaction of the Auckland Harbour Master.

[48] Contained in Technical Addendum Report G.31, Appendix 9, pages 76-77, with proposed amendments shown in underline and strikethrough.

C.12	**Shell Banks** On completion of the relevant stage of reclamation, the NZTA shall ensure that ~~reinstate the~~ stockpiled chenier shell deposits from the northern side of the existing Causeway are reinstated to suitable locations along the northern side of the newly reclaimed Causeway in consultation with the Department of Conservation and the Auckland Council. The placement of the shell bank material shall be to the satisfaction of the [Auckland Council]. The movement of these reinstated shell deposits should be monitored quarterly for the first year after placement to confirm they have been reworked by waves and re-attached to the unmodified shell banks by undertaking topographic survey transects at low tide and photographs to document the transition. The monitoring information shall be made available to the [Auckland Council].
Advice Note	All works during construction in the CMA shall be undertaken so as to meet the Project noise criteria, as specified in the Waterview Connection Assessment of Environmental Effects submitted with the application.
C.13	**Whau River side drainage channel** During preparation works in the CMA for ground improvement and reclamation works adjacent to the Rosebank Domain access road, mangroves required to be removed on the southern side of the existing drainage channel are to be extracted together with their root systems and removed from the CMA to facilitate the lateral migration of the channel to the south prior to infilling. The evolution of the channel shall be monitored by a baseline cross-section survey of the channel at two sites prior to construction, then monitoring the same sections every 2 months until 6 months after completion of the reclamation, together with photographs along the affected section, to confirm the natural migration of the channel is proceeding unimpeded by mangrove roots. The monitoring information shall be made available to the [Auckland Council].
C.14	**Managed tidal channel realignments** Following final excavation of each of the three (3) realigned sections of low-tide channels in Waterview Estuary and Oakley Inlet (two sites) shall be monitored quarterly for one year after completion of the excavation, to confirm that the channel (thalweg and the transition sections with the unmodified channel) has reached a stable configuration. The monitoring can be achieved around low tide (average tide range) by an on-water visual reconnaissance, spot depth soundings and documented with photographs. The monitoring information shall be made available to the [Auckland Council].
C.15	**Rosebank culvert** Within a month of the closure the Rosebank culvert under SH16 (adjacent to the Rosebank Westbound Off-ramp), undertake a single tidal salinity survey on a high spring tide (High Water at or above 3.4 m at Port of Auckland) without significant prior rainfall, to confirm and document that tidal flushing of brackish waters occurs in the boardwalk area presently serviced by the culvert. Salinity, water depth and the length of time either side of high water that the area is effectively inundated should be monitored at one site near the eastern end of the boardwalk section of the shared cycleway [WGS-84 Map ref: -36.87057° N, 174.67408° E]. The monitoring information shall be made available to the [Auckland Council].
C.16	**Intertidal beach seaward of construction areas in the CMA to the north of the Causeway** On the northern side of the Causeway, from just before the commencement of construction in the CMA for each section of works, until 6 months after completion of each section, undertake every two (2) months or after a severe wave-storm, intertidal beach profile surveys down to the spring low-tide mark along offshore-directed transects (one off the centre of the construction section and one either side at 20 m away from the ends of the construction site) and photographs documenting the physical state of the seabed around the perimeter of the cofferdam. If excessive erosion or accretion occurs from corner or end effects of the construction section, as confirmed by a coastal processes expert, then NZTA will ensure further seabed erosion control measures or a sediment by-passing method (for accretion) are implemented to reduce localised effects seaward of the temporary occupation or permanent occupation designation (whichever applies). The monitoring information shall be made available to the [Auckland Council].