Before the Independent Hearing Panel appointed by the Canterbury Regional Council

IN THE MATTER OF The Resource Management Act 1991

AND

IN THE MATTER OF Application CRC190445 to discharge stormwater to land and water

Section 42A Officer's Report

Report of Dr Lesley Bolton-Ritchie

Introduction

Background

1. This report forms part of Canterbury Regional Council's (CRC) audit of the assessment of environmental effects (AEE) provided by Christchurch City Council (the applicant) in support of resource consent application for a comprehensive discharge permit to discharge stormwater from the reticulated stormwater network within the Christchurch City boundaries.

2. This report will provide the decision-makers with information and advice related to the actual and potential effects of the proposed activities on sediment quality in rivers, streams, brooks and creeks and coastal areas, and coastal water quality and ecosystems.

3. My name is Lesley Anne Bolton-Ritchie. I hold a PhD degree in Marine Ecology from Victoria University of Wellington and a Bachelor of Science with Honours in Zoology from the University of Canterbury. The title of my PhD is 'The effects of stormwater discharge on the nearshore benthic environment of inner Wellington Harbour'.

4. I have worked for local government, universities and private consulting organisations in New Zealand and within the Pacific region. I am currently employed by the CRC as a Senior Scientist - Coastal water quality and ecology. I have twenty-five years of work experience in coastal ecology and fifteen years of work experience in coastal water quality. I have been employed by the CRC for fifteen years as of 18 August 2018. Apart from dealing with coastal water quality and ecology for the CRC, I dealt with urban water quality and stormwater issues when Michele Stevenson, (Senior Scientist, Surface Water quality) was on maternity leave (April 2013-April 2014 and October 2014-November 2015). This included providing reports and advice to the zone committee, involvement with interagency and in-house teams on the issue of stormwater and involvement with the hearing for the Styx SMP.

5. I have read the Code of Conduct for Expert Witnesses in giving evidence to the Environment Court. I agree to comply with that code when giving evidence to the Hearing Panel in this matter. All my evidence is within my expertise and I have considered and stated all material facts known to me which might alter or qualify the opinions I express.

Scope of Report

6. This report is prepared under the provisions of Section 42A of the Resource Management Act 1991 (RMA). This section allows a Council officer or consultant to provide a report to

the decision-maker(s) on a resource consent application made to the Council, and allows the decision-maker(s) to consider the report at the hearing. Section 41(4) of the RMA allows the decision-maker(s) to request and receive from any person who makes a report under Section 42A *"any information or advice that is relevant and reasonably necessary to determine the application"*.

7. The Applicant originally lodged an application for resource consent in June 2015 (CRC160056), which was publicly notified in early 2016 at the Applicant's request. Following the receipt of submissions, further information from the applicant was requested. This information was audited and there were still outstanding concerns with regard to the proposal and potential effects on the environment and inconsistency with the planning framework. An amended application was provided to CRC on 9 July 2018 (CRC190445) including details of the Contaminant Load Modelling approach and revised resource consent conditions. An additional amendment to the proposal was the authorisation of all stormwater discharges to the reticulated network from 1 January 2025 or on the expiry of individual consents held by property owners. The original resource consent application excluded 'high risk' sites.

8. This report is supplementary to the Section 42A report prepared by CRC for the above consent application. Full details of the consent application are provided in that report. In my report I have reviewed the following information provided in the AEE, its appendices and accompanying technical reports:
    a. Resource Consent Application and Assessment of Effects on the Environment (June 2015)
    b. Amended Application Letter (July 2018)
    c. Proposed resource consent conditions (July 2018)
    d. Environmental Monitoring Programme (July 2018);
    e. Responses to Section 92 Further Information Requests (November 2015 and June 2016)
    f. Ōtākaro/Avon Stormwater Management Plan;
    g. Ōtākaro/Avon Stormwater Management Plan: Technical Reports;
    h. Surface water quality monitoring report for Christchurch City Waterways January-December 2016 (Margetts and Marshall, 2017)
    i. Sediment quality reports for different catchments

    I have attended meetings between CRC and relevant Christchurch City Council staff to discuss the Ōtākaro/Avon River Stormwater management plan and this consent application. In particular there have been a number of meeting to discuss the surface water quality, instream sediment quality and aquatic ecology aspects of the Environmental Monitoring Programme.

9. I have considered relevant issues raised by submitters in relation to the effects on the coastal receiving environment and sediment quality. I am hopeful that the submitters find that some of the issues they have raised are addressed in my response.

10. In my report I will address the following aspects:
    a. Coastal receiving environment water quality and ecosystems;
    b. Sediment quality in freshwater, estuarine and coastal receiving environments.

Introduction

11. Stormwater is a known contributor of sediment, metals, hydrocarbons, emerging organic contaminants, nutrients, organic matter (such as leaves), micro-organisms (notably from faecal matter from domesticated animals and birds) and rubbish e.g. cigarette butts and plastic, to the city rivers, streams, brooks, creeks, estuaries and open coast. On page 167 of the consent application document there is a section headed the Nature of the discharge. In this section it lists five broad groups of contaminants (sediment, metals, nutrients, hydrocarbons and microbes). There is also a description of the potential impacts of these contaminants on the receiving water environment. While I agree with the information that is provided in the consent application, the list of contaminants does not include:

    - organic matter which has the potential to have a significant influence on dissolved oxygen concentrations in the water column and sediments;
    - rubbish (gross pollutants), including plastics and cigarette butts; rubbish has a significant influence on aesthetics and wildlife while plastics and cigarette butts are a source of contaminants that can be toxic to aquatic life; and
    - a wide range of other potential 'contaminants of concern' (CoCs). For example, a recent New Zealand report (Stewart, *et al.,* 2016) does note that stormwater is one of five main sources of emerging organic contaminants to the environment.

12. Stormwater that flows into coastal water is a source of the contaminants listed in paragraph 11 above. Other contributors of the contaminants, listed in 11 above, to coastal water are:
    a. sediment - rivers, streams and creeks, dewatering water, re-suspension of bed sediment by the action of wind, waves and tide and bank erosion;
    b. organic matter - rivers, streams and creeks, leaf and aquatic plant litter, animal faecal matter and wastewater overflows;
    c. faecal matter - rivers, streams and creeks, waterfowl and wastewater overflows;
    d. nutrients - rivers, streams and creeks, groundwater (there is one know spring within the Estuary of the Heathcote and Avon Rivers/Ihutai), waterfowl and wastewater overflows;
    e. contaminants of concern - rivers, streams and creeks, and wastewater overflows, industries and large companies with their own stormwater discharge consent/s, wash down runoff from hard surfaces directly into the waterways, leachate from contaminated sites such as old landfills;
    f. various contaminants - hull antifouling paint, re-suspension of contaminated bed sediment, oil spills from vessels; and
    g. rubbish - direct input by humans, e.g. throwing litter into the sea from shore or from boats.

13. Around 158 km of waterways make up the stormwater discharge network (CCC, 2015). The Christchurch city waterways are the receiving environment for most of the flat land city stormwater (CCC, 2015). These waterways then flow into estuarine environments apart from the Halswell River that flows into Te Waihora/Lake Ellesmere. In the east, stormwater is discharged directly into the Estuary of the Heathcote and Avon Rivers/Ihutai or to the sea on the open coast, e.g. at Waimairi Beach. From the hill suburbs of the city the stormwater flows into streams and creeks to then flow into the Heathcote River/Ōpāwaho or directly into the estuary or the sea. In the urbanised areas of Te Pātaka o Rākaihautū/Banks Peninsula the stormwater typically flows into streams and creeks to then flow into the sea or a lake. However, some stormwater discharges are directly into the sea.

Coastal receiving environments

The Estuary of the Heathcote and Avon Rivers/Ihutai

14. In the AEE (pages 62 and 63) there is information on Ihutai/Avon-Heathcote Estuary. The information provides a good general description of the estuary but does not include detailed data or refer to reports on sediment contaminant concentrations, sedimentation or contaminant concentrations in water. Therefore, in the paragraphs below I will provide more information about the estuary and include data that have become available since the AEE was written in 2015.

15. The Regional Coastal Environment Plan (RCEP) (Environment Canterbury, 2012) classifies this estuary as an Area of Significant Natural Value with the particular values being Maori cultural values, protected areas, wetlands, estuaries and coastal lagoon, marine mammals and birds and ecosystems flora and fauna. The RCEP classifies the water within the estuary as either Coastal AE or Coastal CR. Coastal AE water is managed for the maintenance of aquatic ecosystems. Coastal CR water is managed for contact recreation and the maintenance of aquatic ecosystems.

16. To manage for the maintenance of aquatic ecosystems in an area designed as an Area of Significant Natural Value implies that the aquatic ecosystems should be managed to maintain the natural values listed for the area. However, given that this an estuary in an urban catchment, with a high level of development around the edges-reclamation, roading, housing, sea walls and high human recreational use - kayaking, paddling, wind surfing, swimming, sailing, shellfish gathering, the estuary environment can at best be considered as a moderately disturbed ecosystem. This description is important when applying ANZECC (2000) trigger values for toxicants in water. For slightly-moderately disturbed ecosystems the ANZECC (2000) guidelines refer mostly to the trigger values in marine water that provide protection to 95% of species.

17. This estuary is impacted by a multitude of disturbances, habitat loss, nutrient enrichment, sedimentation, toxicants and discharges. That is, cumulative effects are a significant issue for this estuary.

18. The quality of the estuary water has a significant influence on the health, abundance and survival of the plants and animals of the estuary and the suitability of estuary water for contact recreation and the gathering of shellfish. For the plants and animals it is the concentration of toxicants (metals, ammonia, PAHs, contaminants of concern), terrestrial sediments and oxygen in the water that can affect the survival of species and excessive nutrient concentrations can affect the growth of nuisance macroalgae, phytoplankton and microphytobenthos. For contact recreation the main concern is the concentration of faecal indicator bacteria in water and hence the likely presence of pathogens. For shellfish consumption the concerns are the concentration of faecal indicator bacteria in water (and hence likely in the shellfish flesh) and the accumulation of contaminants in the shellfish flesh. For the sediment dwelling (benthic) species the grain size distribution and quality (organic matter content, metals, PAHs, other contaminants of concern) of the sediment have a significant influence on the survival, health and abundance of benthic species.

19. The quality of water within this estuary is influenced by the quality of the water in the Avon/Ōtākaro and Heathcote/Ōpawahō rivers, the quality of water in the drains (City Outfall Drain (from Linwood canal), Charlesworth Drain, Estuary Drain and Lovett's Drain) that flow into the estuary, the quality of water in the streams that flow off the Port Hills, direct stormwater discharges from CCC infrastructure networks, stormwater discharges directly from individual properties, general runoff from land, Pegasus Bay seawater and the presence of large numbers of waterfowl and wading birds. Prior to 4 March 2010 Christchurch City treated wastewater was discharged into the estuary around high tide.

The treated wastewater had a significant impact on estuary water and sediment quality. Now that treated wastewater is no longer discharged into the estuary, it is now the stormwater discharged into the rivers, drains, streams and directly into the estuary that is the most significant source of toxicants to the estuary water and sediments.

20. Of the coastal areas within the district managed by the Christchurch City Council it is the estuary that is likely to be the most impacted by stormwater discharges. This is because of the number of sources of stormwater to the estuary, i.e. rivers, streams, drains and direct discharges (On page 131 of the AEE it states ' The Ihutai/Avon-Heathcote Estuary represents the final receiving environment for the largest volume of urban and industrial stormwater in the CSNDC area'), the extent of urbanisation within the estuary catchments and the enclosed nature of the estuary with an ~250 m wide channel opening to the open coast. The evidence of Michele Stevenson addresses the issues around stormwater discharges into the rivers and streams that flow into the estuary, while my evidence considers the overall water quality and ecology within the estuary.

21. The Healthy Estuary and Rivers of the City monitoring programme (Batcheler *et al.*, 2009) was developed by CCC, CRC and the Avon-Heathcote Estuary/Ihutai Trust. The monitoring programmes included are water quality in the rivers (carried out by CCC), water quality within the estuary (carried out by CRC), the sediments and biota within the estuary and the tidal reaches of the Avon/Ōtākaro and Heathcote/Ōpawahō rivers (carried out by CCC), water quality for contact recreation and shellfish gathering (carried out by CRC), food safe to eat (carried out by CRC) and culturally acceptable mahinga kai values (contracted out). The continuation of the Healthy Estuary and Rivers of the City monitoring programme is vital for the assessment of the state of the estuary and for the monitoring of changes over time. The monitoring that is undertaken within the estuary is not incorporated into the EMP for this consent. However the results obtained can be used to assess whether the ecological health of the estuary is changing over time, with stormwater discharges one of the potential drivers of this change.

22. The monitoring described in the Healthy Estuary and Rivers of the City monitoring programme has been underway since 2007. As part of this programme CRC undertakes monthly water quality monitoring at sites within the estuary. The data are presented in annual summary report, that are available on the CRC website (https://www.ecan.govt.nz/technical-reports/) and the 2007-2013 data are presented in a technical report that is also available on the CRC website. The following is a summary of results on measured water quality parameters likely influenced by stormwater discharges. Note, the sampling is in all weathers which means that at times it was raining and at other times it was not.

Dissolved metal concentrations (Cadmium, chromium, copper, nickel, lead and zinc)

23. In 2016 the dissolved copper concentration at five sites within the estuary exceeded the ANZECC (2000) trigger value providing protection for 95% of species on one out of the three times metals were measured through the year. At shag rock at the mouth of the estuary the dissolved copper trigger value was exceeded in two of the three samples collected at high tide and one of the three samples collected at low tide. In 2017 the dissolved copper concentration at two sites within the estuary exceeded the ANZECC (2000) trigger value providing protection for 95% of species on one out of the six times metals were measured through the year. There were no exceedances of the relevant ANZECC (2000) trigger value providing protection for 95% of species for dissolved cadmium, chromium, lead, nickel and zinc concentrations.

Total suspended solids and turbidity (as an indicator of the input of sediment)

24. The turbidity and TSS concentrations at sites within the estuary exhibit a wide range in values in any one year. The potential causes of high TSS and turbidity values are re-

suspended (by wind) seabed sediment and sediment inputs into the estuary. Detailed analyses will need to be undertaken to tease out the relative importance of these two sources. However, this is complicated by the fact that when there is heavy rainfall there is usually also high winds.

25. Both the Avon/Ōtākaro and Heathcote/Ōpawahō rivers are a source of TSS to estuary water. The concentration of TSS in Heathcote River/Ōpawahō water is higher than that in Avon River/Ōtākaro water (as measured at Bridge Street bridge – Avon River/Ōtākaro, and Ferrymead bridge – Heathcote River/Ōpawahō at low tide). For example, in 2017 the median and maximum TSS concentrations in Heathcote River/Ōpawahō water were 37.5 and 99 mg/L respectively, while the median and maximum TSS concentrations in Avon River/Ōtākaro water were 15.5 and 38 mg/L respectively (Bolton-Ritchie and Gray, 2018). One of the sources of sediment to these rivers is stormwater.

Sedimentation within the estuary

26. Sedimentation is the accumulation of sediment on the seabed. The rate of sedimentation is determined by the availability of terrestrially-derived sediment, sediment delivery processes and the features/capacity of the estuary to retain or export the sediment. Sedimentation is a significant issue for many NZ estuaries. In particular, the issue is the accumulation of fine-grained sediment particles, i.e. mud, in low-energy areas of an estuary.

27. A report produced in 2007 (Burge, 2007) assessed the input of sediment and sediment contaminants into the estuary from the rivers and the wastewater plant and provided information on the sediment accumulation zones within the estuary (as of the 1980s). However, it was found that there was insufficient robust data from all inputs to provide reliable estimates of the long-term input of sediment to the estuary. There has been no specific recent work, in particular since the earthquakes, on this issue for this estuary. The annual monitoring of the sediments and biology at sites within the estuary and at the tidal reaches of the Avon/Ōtākaro and Heathcote/Ōpawahō rivers does provide site specific information on the sediment grain size distribution at each site. Temporal analysis of sediment grain size distribution at each site does allow for the assessment of changes in the percentage mud at the sites. Such an analysis was undertaken on the data collected from 2007 to 2013 (Bolton-Ritchie, 2015). However, the data collected since 2014 have yet to be assessed for changes over time.

Brooklands Lagoon

25. There is no information on Brooklands Lagoon in the AEE. It is likely that there are now few localised sources of stormwater flowing directly into the lagoon, because most of the Brooklands township was red-zoned following the 2010-2011 earthquake sequence. However, the Styx River/Pūharakekenui flows into this lagoon. This river receives stormwater from the urbanised parts of its catchment and hence is a potential source of stormwater contaminants such as metals and sediment to Brooklands Lagoon.

26. The Regional Coastal Environment Plan (RCEP) (Environment Canterbury, 2012) classifies Brooklands Lagoon as an Area of Significant Natural Value with the particular values being Maori cultural values, protected areas, wetlands, estuaries and coastal lagoon, marine mammals and birds and ecosystems flora and fauna. The RCEP classifies the water within the lagoon as Coastal CR. Coastal CR water is managed for contact recreation and the maintenance of aquatic ecosystems.

To date neither the CCC or CRC have undertaken water quality monitoring within Brooklands Lagoon. That is, there are no data on dissolved metal concentrations or other water quality parameters within the lagoon.

Pegasus Bay

27. In the AEE there is a description of the receiving environment and the likely water quality impacts of the stormwater discharges directly into Pegasus Bay. I agree with the information provided. Any stormwater contaminants discharged into this open coast area where there is notable wave action undergoes turbulent mixing with coastal water. The diluted contaminants are then dispersed away from the point source through the action of wind, tide and currents. At these sites it is unlikely that dissolved metal, metalloid and contaminant concentrations in coastal water would exceed guideline values beyond a mixing zone. It is also unlikely that there would be an accumulation of stormwater contaminants in the sediment in this area. This is because the contaminants do not adhere to sandy sediments as they do to the fine-grained silts and mud, and the sediments are continuously re-suspended and dispersed through natural processes.

28. The RCEP does not provide a specific classification for the water along the area of Pegasus Bay where these stormwater pipes are. Where there is no specific RCEP classification the water must be maintained as natural state.

Banks Peninsula

29. In the AEE (pages 63-65) there is information on the harbours of Banks Peninsula. The information provides a good general description of these harbours. Since the writing of the AEE information the inner ~2/3s of Whakaraupō/Lyttelton Harbour has become a mātaitai. The AEE does not include detailed data or refer to reports on contaminant concentrations in water in these harbours. Therefore, in the paragraphs below I provide additional information from work undertaken by CRC.

30. The RCEP classifies the water within Whakaraupō/Lyttelton Harbour as either Coastal AE or Coastal CR or Coastal SG. The water within Akaroa Harbour is classified as either Coastal CR or Coastal SG. Coastal SG water is managed for shellfish gathering, contact recreation and the maintenance of aquatic ecosystems.

31. The stormwater from the urban areas of Banks Peninsula either flows into streams/creeks/drains via stormwater networks or possibly directly from properties, to then flow into harbour water or it flows directly into harbour water. Within these harbours these inputs can be onto intertidal areas that are exposed to air at low tide but there are also discharges to areas which are always submerged, e.g. within the Port of Lyttelton. Where stormwater flows into areas which are always submerged the freshwater will form a layer on the surface. At the interface of the seawater and freshwater particles flocculate and settle to the seabed. This results in the accumulation of contaminants, such as metals and organic matter, in the seabed sediment in proximity to stormwater outlets.

32. No specific work has been undertaken to date by CCC or CRC to assess the impacts of stormwater on Banks Peninsula coastal receiving environments. However, results from CRC investigations and monitoring have identified stormwater as one of the potential sources of contaminants resulting in elevated concentrations of contaminants in water or sediment in some areas. For example, above guideline value dissolved copper concentrations have been found to be higher after rainfall than during dry weather in the Port of Lyttelton (Bolton-Ritchie and Barbour, 2013).

33. Rainfall, and hence stormwater discharges affect the microbial water quality at Akaroa main beach. There is a large stormwater pipe that crosses this beach.

Assessment of the Receiving Environment Objectives and Attribute Targets Levels

34. The Receiving Environment Objectives and Attribute Target Levels for Coastal Waters are provided in Schedule 5 of the proposed consent conditions. There are three objectives. The first objective is to 'Reduce sediment input to prevent adverse effects on water clarity and aquatic biota'. The second objective is to 'Decrease copper, lead and zinc levels in water to prevent adverse effects on aquatic biota'. The third objective is to 'Enhance Mana Whenua coastal values*'.* Below is my assessment of the first and second objectives but not the third objective. The third objective should be assessed by a mana whenua representative. I do support the inclusion of this third objective into the list of receiving environment objectives for coastal waters.

35. These objectives do align with the objectives of chapters 6, 7 and 8 in the RCEP.

36. It is appropriate to measure dissolved copper, lead and zinc and TSS concentrations and set Objectives and Attribute Target Levels for these.

TSS concentrations

37. For TSS concentration in coastal water there is not a national or regional guideline value. It is for this reason that the proposed consent condition Schedule 5 Attribute Target Level is *no statistically significant increase in TSS concentrations*. However, this proposed Attribute Target Level does not align with the Schedule 5 Objective which is to reduce sediment input to prevent adverse effects on water clarity and aquatic biota. While, the proposed attribute target should ensure sediment inputs do not increase over time there needs to be another component to the target to ensure that the objective is met. I recommend that the Attribute Target Level also includes the statement '*a statistically significant decrease in TSS concentrations'*.

Copper, lead and zinc concentrations

38. For copper, lead and zinc concentrations the proposed consent condition Schedule 5 Attribute Target Level does not align with the Schedule 5 Objective. The Schedule 5 objective is to decrease copper, lead and zinc levels in water to prevent adverse effects on aquatic biota. The proposed attribute target of no statistically significant increase in copper, lead and zinc levels should ensure concentrations do not increase over time but will not ensure that the objective is met. I recommend that the Attribute Target Level also includes the statement '*a statistically significant decrease in copper, lead and zinc concentrations'*.

39. In the proposed consent condition Schedule 5 the Attribute Target Levels for the dissolved metals for all sites, except the Operational Area of the Port of Lyttelton, are from the RCEP (Environment Canterbury, 2012). The values in the Canterbury RCEP are different to the trigger values for coastal waters in the ANZECC (2000) guidelines (Table 1). A comparison of RCEP values to the ANZECC (2000) coastal water trigger values shows that the RCEP values do not provide for an adequate level of protection for species in Canterbury estuary, harbour and open coastal waters. I recommend the use of the ANZECC (2000) trigger values for dissolved metals be used as the Attribute Target Levels rather than the RCEP values.

Table 1: Comparison of RCEP and ANZECC trigger values for dissolved metal concentrations in sea water

	RCEP	ANZECC (2000)		
		Level of protection (% species)		
		95%	90%	80%
	Concentration (mg/L)			
Copper	0.005	0.0013	0.003	0.008
Lead	0.005	0.0044	0.0066	0.012
Zinc	0.05	0.015	0.023	0.043

40. There is a process underway to revise the ANZECC (2000) toxicant trigger values for copper and zinc in coastal waters, and draft guidelines that have been released propose changes to the default trigger values. It is important that there is a mechanism available for the Attribute Target Levels in proposed consent conditions Schedule 5 to be amended if the national guidance changes; I note this is provided for by Condition 46 of the proposed consent conditions.

41. When using the ANZECC (2000) trigger values the metric for the contaminant where the definition is shall not exceed, actually means the 95th percentile of the data (for 12 data points for a site this means that one value can exceed the trigger value) must comply with the trigger value. The guidance on how the collected data should be assessed against the trigger values is from section 7.4.4.2 ANZECC (2000).

42. I recommend the use of the ANZECC (2000) trigger values providing for the protection of 95% of species, as the Attribute Target Levels for all areas except the Operational Area of the Port of Lyttelton. The operational area of the port is classified as Coastal AE water, however, the RCEP dissolved metal concentrations do not have to be met in the operational area of the port. Within the Operational Area of the Port of Lyttelton, which is a highly disturbed system, to **maintain** current water quality the trigger values providing for the protection of 80% of species could be the Attribute Target Level. However, to **improve** water quality within this area a higher level of protection, such as protection of 90% of species or even 95% of species, is required.

43. Within the operational area of the port there are multiple sources of dissolved metals to harbour water (e.g. leaching from anti-fouling paint on ship hulls, leaching from wharf piles, re-suspension of contaminated sediment (in proximity to the dry dock)). Nonetheless discharges should not have 'the capability of causing significant adverse effects on aquatic life or the capability of causing a significant loss of indigenous biological diversity'. Given the multiple sources of dissolved metals to the coastal water within the operational area of the port, I recommend that CCC undertake an investigation/modelling to determine the dissolved copper, lead and zinc concentrations in the stormwater from the urban areas of Lyttelton township. The results can then be used to determine the extent of mitigation required to ensure the impact of the discharged stormwater on the copper, lead zinc concentrations within the operational area of the port is no more than minor.

Assessment of the EMP

44. The Environmental Monitoring Programme (EMP) is a key tool proposed for the CSNDC to monitor whether the proposed receiving environment Objectives and Attribute Target Levels are being met. Overall, the sections of the EMP that are relevant to coastal water quality and sediment quality monitoring provide an appropriate level of detail about site locations, frequency of monitoring, methods, and reporting requirements.

45. CCC have proposed water quality monitoring for a range of parameters at four estuarine/coastal sites. One site is within the Estuary of the Heathcote and Avon Rivers/Ihutai, one in the operational area of the Port of Lyttelton, one is in Cass Bay and one is in Akaroa. The sites are to be sampled monthly and the data assessed and reported annually.

46. The proposed four estuarine and coastal monitoring sites are new CCC sites. I have had discussions with Belinda Margetts from CCC on the location of these sampling sites. I agree that the four sites are suitable sampling sites. I recommend that there is an additional coastal monitoring site within the Estuary of the Heathcote and Avon Rivers/Ihutai and that this site is in proximity to where either the City Outfall Drain or the Charlesworth Drain flows into the estuary. These drains are a significant source of stormwater to the estuary and have potentially significant sources of contaminants within their catchments. The City Outfall Drain receives water from Linwood Canal and has a catchment area of ~454 ha (Hack, 2007). Which, in 2007, was 65% commercial and 13% industrial. The Charlesworth Drain receives water from a catchment area of ~171 ha (Hack, 2007). Which, in 2007, was 59% industrial and a refuse station covered 13% of the catchment.

47. The four sites are in front of stormwater outlets. The distance of the sampling from each of the outlets is described on page 17 of the S92 response for CRC160056. I concur with the proposed location of the sampling sites.

48. As part of this monitoring surface water samples will be collected monthly from the sites. The water quality data are collected monthly with sampling carried out on a pre-determined day rather than around the weather and specifically around rainfall events. Therefore, some of the data are collected during or after rainfall but many are not (Margetts and Marshall, 2015). With most of the water quality samples collected in dry weather the data predominantly represents ambient water quality conditions, rather than the water quality during or soon after rainfall when stormwater discharges are occurring. Monthly sampling is a suitable frequency for the collection of water quality data used to describe the general state of receiving environment water quality. The use of monthly monitoring data collected over time is also appropriate for a general assessment of trends over time and assessment of the copper, lead and zinc against the trigger values. These trigger values are based on chronic toxicity data and are therefore appropriate for assessing long-term risk (Gadd *et al.* 2017). The use of these trigger values for compliance purposes is discussed in paragraphs 105 and 106 of Michele Stevenson's evidence.

49. The proposed monitoring and assessment of the results against trigger values is not robust enough to assess whether the overall objectives for the coast (Section 1.4.3 of the consent application), i.e. reduce sediment input to prevent adverse effects on water clarity and aquatic biology and decrease copper, lead and zinc levels in water to prevent adverse effects on aquatic biota, are being met. This is because there is insufficient collection of data when stormwater is actually being discharged. If the annual monitoring included targeted sampling of ideally at least 3, but preferably more, of the samples per year being collected during or immediately after rainfall and the data then grouped for state and trend analyses into dry weather and wet weather sampling then it will likely be possible to assess whether the overall objectives for the coast are being met. I am of the opinion that this wet

weather sampling does not have to meet the requirements of the five yearly wet weather sampling as described in 5.2.2 of the EMP. This collection of wet weather samples could be achieved by doing additional sampling over and above the routine monthly sampling programme or having a more flexible monthly sampling regime. The results from this annual wet weather sampling could then be used to assess whether the proposed receiving environment Objectives and Attribute Target Levels are being met when stormwater is flowing into the receiving environment. I recommend that the monthly sampling be flexible enough to allow for sampling of at least three wet weather events per year. If the above recommendation is included in the consent conditions, I recommend that for annual reporting the data are grouped into dry weather and wet weather, with state and trend analyses undertaken on each group of data.

50. In the draft EMP it is proposed that there is targeted wet weather sampling at the four coastal sites every five years. It is also proposed that this targeted wet weather sampling will consist of collecting samples during two wet weather events in that year. This wet weather sampling will not provide sufficient data to assess whether surface water targets and guideline values for the receiving environment are being met, i.e. there will be insufficient data for calculating medians and 95th percentile values for assessing trends and for assessing improvements in water quality when stormwater treatment initiatives are put in place. Trends cannot be assessed using this five-yearly data because there are insufficient wet weather samples collected in each of the five years at a given site and it will take around 50 years to obtain ten data points and 180 years to obtain 36 data points to assess for trends over time. However, this monitoring will provide a small data set that will provide some useful information on first flush impacts of stormwater and allow for the identification of sites where there is an issue.

51. The state of the tide is an important consideration for the sampling within the Estuary of the Heathcote and the Avon Rivers/Ihutai. I recommend that sampling at the Beachville Road site in the estuary is undertaken around the time of high tide and that this information is included in the EMP. At the other coastal sites the time of sampling does not need to be determined by the state of the tide.

52. Field results and laboratory testing of collected water samples will provide data on the water quality parameters listed in Table 3 of the EMP. In my opinion, CCC does not need to monitor for nutrients (nitrogen and phosphorus based parameters) at any of the coastal sites. The proposed monitoring is to assess for the impacts of stormwater discharges not state of the Environment monitoring and reporting as is done for the freshwater receiving environments.

53. The listed parameters, except nutrients, are appropriate ones to measure as they will possibly allow for the assessment of the effect of stormwater discharges. However, I recommend that faecal coliform concentrations are also measured at the Akaroa Harbour because the water at this site has a RCEP classification of Coastal SG water.

54. In the draft EMP (pages 40 and 41) there are coastal water quality guideline values for twelve water quality parameters. The guideline values have been sourced from the Canterbury RCEP (Environment Canterbury, 2012) and ANZECC (2000). It is appropriate to use many of these guideline values to assess the general state of the coastal water quality and determine whether the receiving water meets the requirements for the maintenance of aquatic ecosystems[1]. For the dissolved metal concentrations, I recommend that the ANZECC (2000) values rather than RCEP values should be used as

25.

[1] To assess whether the coastal water at each monitoring site meets the requirements for the maintenance of aquatic ecosystems (Coastal AE water), i.e. life-supporting capacity of ecosystems and ecosystem processes, measured parameter concentrations for all but enterococci concentrations, are used.

the guideline values within the EMP. This aligns with the recommendation I have made about using the ANZECC (2000) values in Schedule 5 of the proposed consent conditions.

55. At present NIWA staff, on contract to CRC, are developing guideline values for nutrients, chlorophyll-a, turbidity and TSS for Canterbury open coastal water and the water in Lyttelton Harbour/Whakaraupō and Akaroa Harbour. Once these values are available I recommend that the TSS values for Lyttelton Harbour/Whakaraupō and Akaroa Harbour are incorporated into Table 3 of the EMP and into Schedule 5 of the proposed consent conditions. This does align with proposed consent condition 46. At present there is no Attribute Target Value for TSS in coastal water. Therefore, having a value for Lyttelton Harbour/Whakaraupō and Akaroa Harbour will allow for the assessment of the actual impact of stormwater discharges on receiving environment TSS concentrations.

56. At three monitoring sites the coastal water has a classification of Coastal CR water and hence under the RCEP the water quality must be managed for aquatic ecosystems and contact recreation. The faecal indicator bacterium enterococci is used to assess the water quality for contact recreation in sea water. The enterococci guideline values for Cass Bay, Akaroa Harbour, Lyttelton (which should read Lyttelton Port) in Table 3 of the EMP are appropriate. However, I recommend that the guideline value, in Table 3 of the EMP, for the Beachville Road site in the estuary is the same as that for Cass Bay and Akaroa Harbour.

57. At the Akaroa site the coastal water has a classification of Coastal SG water and hence the water quality must be managed for aquatic ecosystems, contact recreation and shellfish gathering. To assess the water quality for shellfish gathering, receiving water faecal coliform concentrations need to be measured. The Canterbury RCEP standard for evaluating suitability for shellfish gathering based on faecal coliform concentrations is not workable for data collected monthly. However, I recommend that the annual data are assessed against the MfE/MoH (2003) guidelines for water over lying shellfish. That is:
    - the median concentration of faecal coliforms should not exceed 14/100 mL and the single sample concentration of 43/100 mL should not be exceeded in more than 10% of the samples.

58. I recommend that Table 3 of the EMP is updated to include the faecal coliforms as a parameter and the MfE/MoH (2003) guidelines for water over lying shellfish be used to assess the faecal coliform concentrations. If these guidelines are met it is an **indication** that the shellfish will not contain high concentrations of faecal indicator bacteria (and hence pathogens) and therefore they are safe to eat. If these guidelines are not met it is an **indication** there is a potential health risk for those collecting and eating shellfish from the area around the site. If the (MfE/MoH, 2003) guidelines are not met, signage warning against collecting and eating shellfish from the area must be erected. CCC will then also need to undertake an investigation and take actions that result in a reduction in faecal coliform concentrations in the stormwater.

59. The metals and other contaminants in stormwater have the potential to contaminate shellfish flesh. There are food safety guideline values for mercury cadmium, lead and arsenic concentrations in shellfish flesh. I recommend that if the water quality monitoring results indicate that dissolved metal concentrations at the Akaroa site are above guideline values, the flesh of the shellfish species that occur in proximity to the sampling site should be assessed for cadmium and lead concentrations. The results obtained must be compared to food safety guidelines and the follow-up actions will be dictated by the results obtained.

Assessment of the Reporting of data

60. The water quality data collected monthly for a calendar year and the data collected over the calendar year for the five-yearly wet weather sampling are to be presented in an annual report. It is appropriate to have annual reporting of data.

61. The monthly data are to be analysed and reported against guideline values and temporal trends in parameter values assessed once three years of data (36 data points) have been collected. The annual analyses and reporting will provide an update on the general state and trends of receiving environment water quality. The assessment of a single year of data is appropriate for annual compliance assessment purposes. This will result in the responses to monitoring required by the consent conditions (proposed Condition 51) being in response to breaches of Attribute Target Levels that have occurred within the relevant monitoring year.

62. Trend analysis cannot be performed when a high proportion of the data are below the analytical level of detection, for example dissolved copper, lead and zinc concentrations in coastal water. Therefore, for copper, lead and zinc concentrations in coastal water, reporting could consist of listing the number of times in the year each metal concentration was above the analytical level of detection, how many values exceeded the guideline value and by how much they exceeded the guideline value. The Attribute Target level of no statistically significant increase (or decrease) in copper, lead and zinc concentrations may not be able to be assessed at some sites.

Assessment of Responses to Monitoring

63. Consent condition 51 outlines the response that the Christchurch City Council will apply if either TSS or copper or lead or zinc concentrations at a site do not meet the Attribute Target Levels in proposed consent conditions Schedule 5. The response involves an investigation and report on whether the monitoring results are due to stormwater network discharges and an assessment of options for correction/remediation. There could well be situations where the attribute target levels are exceeded at more than one coastal site as well as at freshwater sites. This will require CCC to undertake investigations at multiple sites within a year I recommend that the Implementation Plan proposed in Condition 14 of the proposed consent conditions includes details of a process that describes how CCC will respond when many sites do not meet Attribute Target Levels.

64. The steps described in consent condition 51 must be undertaken in given timeframes. Either timeframes for each report must be stipulated in consent condition 51 or it must be assumed the reports must be completed by the 30th of June each year (page 58 of the EMP and in Consent condition 53 e). If the timeframe for the reports is 30th June each year then consent condition 53e needs to state: “All reports and a summary of any discussions, consultation or responses carried out under Conditions 49 – 51”. I recommend that consent conditions stipulate a time frame for any work undertaken to fulfil consent condition 51.

Assessment of Stormwater management plans and other mitigation

65. In consent condition 5a it states the purpose of a Stormwater Management Plan (SMP) is to ‘Demonstrate the means by which the quality of stormwater discharges will be progressively improved towards meeting the receiving environment Objectives and

Attribute Target Levels'. My concern with this statement is for the receiving environments where the existing conditions may already meet and be well below the Attribute Target Levels. For these areas the purpose of the SMP should be to maintain the quality of the existing receiving environment and ensure that stormwater discharges do not result in degradation of the receiving environment into the future. Being below the Attribute Target Levels should not mean that there is no need for a detailed SMP because without future management Attribute Target Levels may well be exceeded.

66. The Stormwater Management Plans (SMPs) that cover stormwater discharges directly into coastal waters have yet to be completed. The timetable for completion of these plans is:
    - Estuary and coastal Christchurch 20 Dec 2019; and
    - Te Pātaka o Pākaihautū/ Banks Peninsula Settlements 20 December 2020

    Therefore, I will comment on the consent conditions which refer to SMPs and in particular consent condition 6. This condition is about what an SMP should include. I recommend that the wording of two of the sub-section of condition 6 are changed. The changes I recommend are in blue.

    6. b. A definition of the extent of the stormwater infrastructure, including any portions of waterways including drains, that forms the stormwater network within the catchment for the purposes of this consent;

    6.d.v. Prioritising stormwater treatment in catchments that discharge: into areas designated as having significant or high natural value (including Maori Cultural Values; Protected Areas Wetland, Estuaries, and Coastal lagoons; Marine Mammals and Birds; Ecosystems, Flora and Fauna habitats; scenic sites and historic places; coastal landforms and associated processes), in proximity to areas of significant or high ecological or cultural value, such as habitat for threatened species or mahinga kai/kai moana species and/or in areas which receive or have existing high contaminant loads;

67. I recommend that consent condition 6 includes a requirement for alignment with relevant non-statutory plans, for example, the Avon-Heathcote Estuary/Ihutai Estuary Management Plan and the Whakaraupō/Lytttelton Harbour Catchment Management Plan.

68. I have particular concerns in regard to the SMP for the Estuary of the Heathcote and Avon Rivers/Ihutai. This is for the reasons described in paragraph 14 of my evidence. Therefore, I recommend that the SMP for the estuary should include the following:
    - details on the volumes of stormwater flowing directly into the estuary from stormwater pipes discharging directly into the estuary, drains, the rivers and hill-fed streams;
    - details on the loads of stormwater contaminants, particularly metals and terrestrial sediment, flowing into the estuary from all sources;
    - details on the current impacts on stormwater discharges on estuary water quality and ecology including kai moana species, for example, sediment quality immediately in front of representative stormwater outlets;
    - an assessment of the assimilative capacity of the estuary with respect to stormwater contaminants, particularly the metals and terrestrial sediment, and hence likely effects of stormwater discharges on the long term ecological functioning of this estuary.
    - A comprehensive and relevant model (along the lines of C-CLM or Medusa) for the City Outfall Drain and Charlesworth Drain and the streams flowing from the hills directly into the estuary including projected contaminant load reduction within defined timeframes with the implementation of Best Practice Infrastructure;
    - A list of sites identified as 'high risk' (including large construction sites and contaminated sites) within the catchment, including the likely contaminants and their risk to receiving environments;

- Details of the process to be implemented to ensure that risks are sufficiently mitigated for stormwater from 'high risk' sites to prevent 'more than minor' negative effects on the estuary;
- Details on the management measures that will be used, particularly for the hill catchments, to reduce the quantity of terrestrial sediment flowing into the estuary. These measures will be most applicable to construction phase discharges from sites. However, there also needs to be details on the management measures for developed hill and non-hill areas.

69. Many of the recommendations listed above also need to be considered in the Te Pātaka o Pākaihautū/ Banks Peninsula Settlements SMP as well as Brooklands Lagoon which is part of the Estuary and Coastal Christchurch SMP.

70. I recommend that a consent condition is added after proposed Condition 7 that requires the SMP to be audited and approved by a Technical Advisory Panel. The CSNDC application does not include the detailed information that would typically be required for a discharge consent application. Rather it is at the catchment SMP level that the details are provided and specific receiving environment effects are addressed. If the consent is granted then each new SMP should require detailed scrutiny as occurred prior to the CSNDC, when an individual catchment consent, e.g. the Styx River/Pūrākaunui, was applied for. Proposed consent condition 7 outlines a collaborative process for the development of SMPs, with input from key stakeholders. The proposed Technical Advisory Panel would complete this process by reviewing the final document to ensure that best practice has been applied in all technical and planning areas covered. The panel could consist of a range of independent technical experts with expertise in areas such as stormwater engineering, stormwater modelling, water quality, sediment quality, aquatic ecology, groundwater quality, erosion and sediment control, flood hazards and hydrological modelling, and contaminated site management.

Sediment quality

71. The bed of the waterways, estuaries, harbours and open coast is sediment of varying grain sizes. There can be boulders, cobbles and pebbles but there are also the smaller grained sands and the finest grained sediments of all the silts and clays. The composition of the bed sediment determines the animals that live on/in the bed of waterways, estuaries, harbours and open coast. The grain size composition of the bed sediments can change through the input of sediment of varying grain sizes. For example, stormwater which flows across impermeable surfaces entrains wind-blown fine sediments and deposited dirt. This is then transported into the receiving environment, initially affecting water clarity and colour and then eventually settling to the bed. This addition of the typically sand, silt and clay particles affects the aquatic animals by changing their habitat.

72. The sediment deposited on the bed may be contaminated with metals and other contaminants before reaching the aquatic receiving environment. This is particularly the case in urban environments where fine sediments accumulate on roads and in roadside gutters during dry conditions. Metals adsorb to the surface of fine grained sediments, i.e. silt and clay. Contaminated soil from HAIL sites is also another source of contaminated sediment from the land. Within the aquatic environment the contaminants in the overlying water are a source of contaminants to bed sediment. These contaminants, such as dissolved metals, can partition out of the water column to adsorb to fine grained bed sediments. Therefore, in terms of stormwater inputs, the sources of contaminants to the bed sediments come from the water column and from sediment inputs.

Existing sediment quality in freshwater receiving environments

73. Sediment quality sampling has been carried out for CCC at sites along the Avon River/Ōtākaro, Heathcote River/Ōpāwaho, Styx River/Pūharakekenui, Halswell River/Huritini and Otukaikino River and their tributaries over time (Golder, 2005; Golder, 2009; Golder, 2012; Gadd and Sykes, 2014; Whyte, 2014; Gadd, 2015). The sampling sites are at various locations in the tributaries and down the rivers which has allowed for the evaluation of geographic differences in sediment quality. This sediment quality work has consisted of the collection of one composite sediment sample from each site being analysed for total recoverable concentrations of metals (typically cadmium, copper, chromium, nickel, lead and zinc) and the metalloid arsenic and polycyclic aromatic hydrocarbons (PAHs). In some of the studies, 4 or 5 semi-volatile organic compounds (SVOCs), including plasticisers and compounds from the combustion of coal, petroleum and wood, have been tested for. The results obtained have allowed for the evaluation of the likely sources of the contaminants. Detailed analyses have revealed that stormwater is the likely source of elevated cadmium, copper, lead, zinc and PAHs concentrations in the sediment.

74. In the listed studies the metal, metalloid and PAHs concentrations have been compared to ANZECC (2000) trigger values. In the ANZECC (2000) guidelines these trigger values are called ISQG-low and ISQG-high. In the revision of the sediment quality guidelines (Simpson *et al*., 2013) the terminology around the guideline values has changed but for metals/metalloids the actual guideline values have not changed. The revised terminologies are sediment quality guideline values (SQGVs) and SGV-high values (known as ISQG-low values and ISQV-high respectively in ANZECC (2000)). Concentrations below the SQGV are unlikely to result in any adverse effects to aquatic life on/in the sediment. For concentrations above the SQGV but below the SQG-high value, there is potential for adverse effects to aquatic life on/in the sediment. For concentrations above the SQG-high value there is likely to be adverse effects to aquatic life on/in the sediment. The use of the SQGV and SQG-high values is appropriate.

75. The listed studies have revealed that the measured copper, lead, zinc, arsenic and PAHs concentrations exceed the SQGV at quite a number of locations in the various catchments. The SQG-high has been exceeded for arsenic, lead, zinc and PAHs at some locations. A summary of the catchments and the percentage of sites where attribute target levels are not met are provided in Table 1 of Michele Stevenson's evidence. That is, aquatic biota at some sites are potentially being impacted or likely being impacted by the sediment contaminants. To date measured cadmium, chromium and nickel concentrations have been below SQGV.

76. The assessment for trends in sediment contaminant concentrations at sites has been hindered by the lack of sample replication at each site, changes in sampling sites over time, infrequency of sampling, liquefaction and large inputs of sediment as a consequence of the earthquakes.

Existing sediment quality in coastal areas

77. When stormwater flows onto an intertidal mudflat and the tide is out the freshwater and contaminants are in direct contact with the seabed. When stormwater flows out and the tide is in, the freshwater will form a layer on the surface. However, at the interface of the seawater and freshwater particles flocculate and settle to the seabed. Botherway and Gardner (2002) found that in front of stormwater outlets in tidal Porirua Inlet the:

- sediment copper, lead and zinc concentrations decreased linearly with distance from a stormwater outlet; and
- biological results suggest that the stormwater modifies benthic community composition in front of a stormwater outlet and up to 100 m away.

There is also a considerable body of information that has been produced by the Auckland Council over time about the accumulation of stormwater derived metals in estuarine and coastal sediments (http://www.knowledgeauckland.org.nz/).

78. At sites where stormwater flows into a coastal area that is permanently covered in water it has been found that sediment metal and organic matter concentrations decrease with increasing distance away from an outlet (Bolton-Ritchie, 2003). As well discharged stormwater causes disturbed benthic communities and influences the presence and abundance of benthic invertebrates. However, the impacts on benthic communities are outlet specific, can change over time and are localised around the outlet (10-44 m at sites studied) (Bolton-Ritchie, 2003).

Estuary of the Heathcote and Avon Rivers/Ihutai

79. The bed sediments of the City Outfall Drain, Charlesworth Drain and the Estuary Drain have elevated concentrations of one or more metals (Hack 2007; Gadd 2015). In both 2007 and 2015 the zinc SQG-high and the lead SQGV was exceed in City Outfall Drain sediment. In 2007 these exceedances were at a site 25 m upstream of the estuary while in 2015 they were at a site where Dyers Road and Linwood Ave meet. In both studies, all other recorded metal concentrations were lower than the SQGV.

80. In 2007 it was found that metal concentrations in estuary sediment decreased with increasing distance away from where the Estuary Drain, Charlesworth Drain and the City Outfall Drain flow into the estuary (Hack, 2007). All recorded metal concentrations, except zinc, were found to be below the SQGV. The zinc concentration at 10 m from Charlesworth Drain was higher than the SQGV but below SQG-high. That is, at this site the zinc concentration could have been having an adverse impact on aquatic life.

81. CRC has collected sediment quality data from sites within the estuary since 2010. In 2010 sediment metal concentrations at four out of five monitored sites within the estuary were determined to be above background soil concentrations and elevated as a result of human activities (Bolton-Ritchie and Lees, 2012). However, all measured concentrations were below the SQGV. The sediment quality at estuary sites has been measured three more times since 2010. In 2010 the sampling occurred prior to the earthquakes. The earthquakes caused liquefaction within the estuary with ~20-40% of the estuary covered with liquefaction mounds (Measures *et al.,* 2011). This liquefaction bought 5000-year-old sediment to the surface thereby diluting the existing contaminated sediment within the estuary. This dilution effect is reflected in the sediment quality results obtained since 2010 (Figures 1 and 2). However, the concentrations of some metals have since began to increase (Figure 1) with stormwater and road runoff likely a significant source of these metals. To date the metal and metalloid concentrations at five estuary sites monitored by CRC since 2010 have been below the SQGV. That is, at present they are unlikely to be having an adverse impact on aquatic life.

    As well as measuring sediment metal concentrations at the estuary sites, PAHs concentrations have also been measured (Figures 3 and 4). In 2010 the concentration of four individual PAHs at the City Outfall Drain and Mt. Pleasant Yacht Club sites exceeded the ANZECC (2000) ISQG-low but were below the ISQG-high. At the Mt. Pleasant Yacht Club site, concentrations of low molecular weight PAHs exceeded the ISQG-low, while at the City Outfall Drain, Mt. Pleasant Yacht Club and Causeway sites the ISQG-low for high molecular weight PAHs was exceeded. In 2016 the concentration of eight individual PAHs

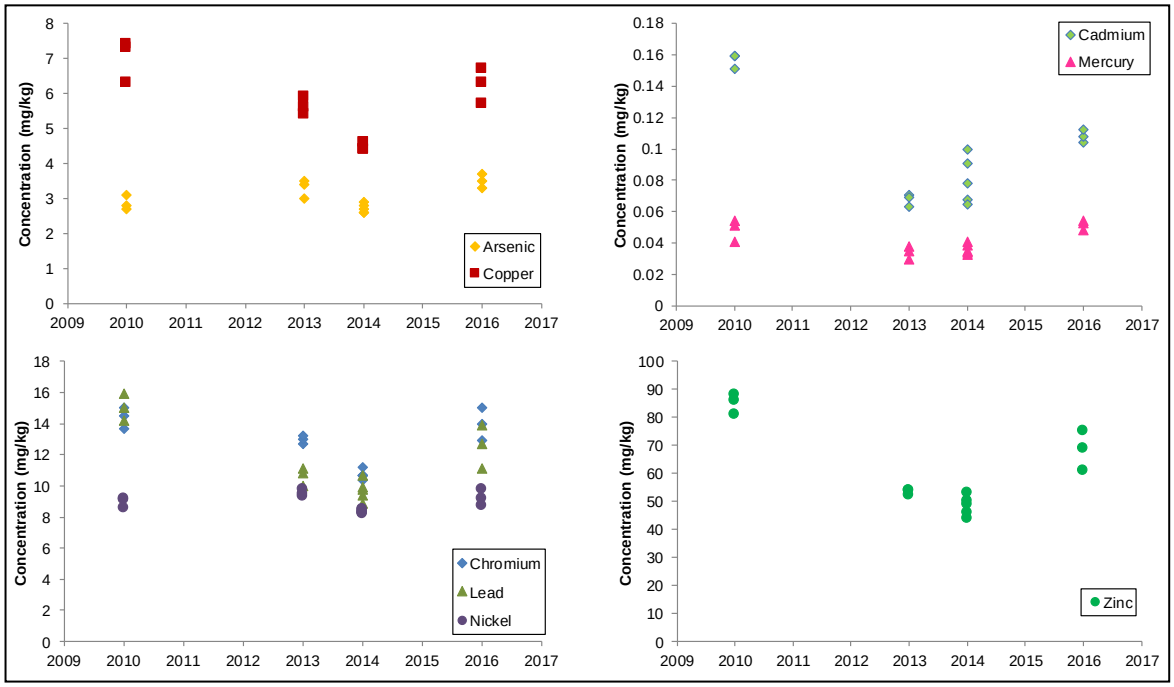


Figure 1: Metal and metalloid concentrations (mg/kg dry weight) over time in sediment from the site near the Mt Pleasant Yacht Club

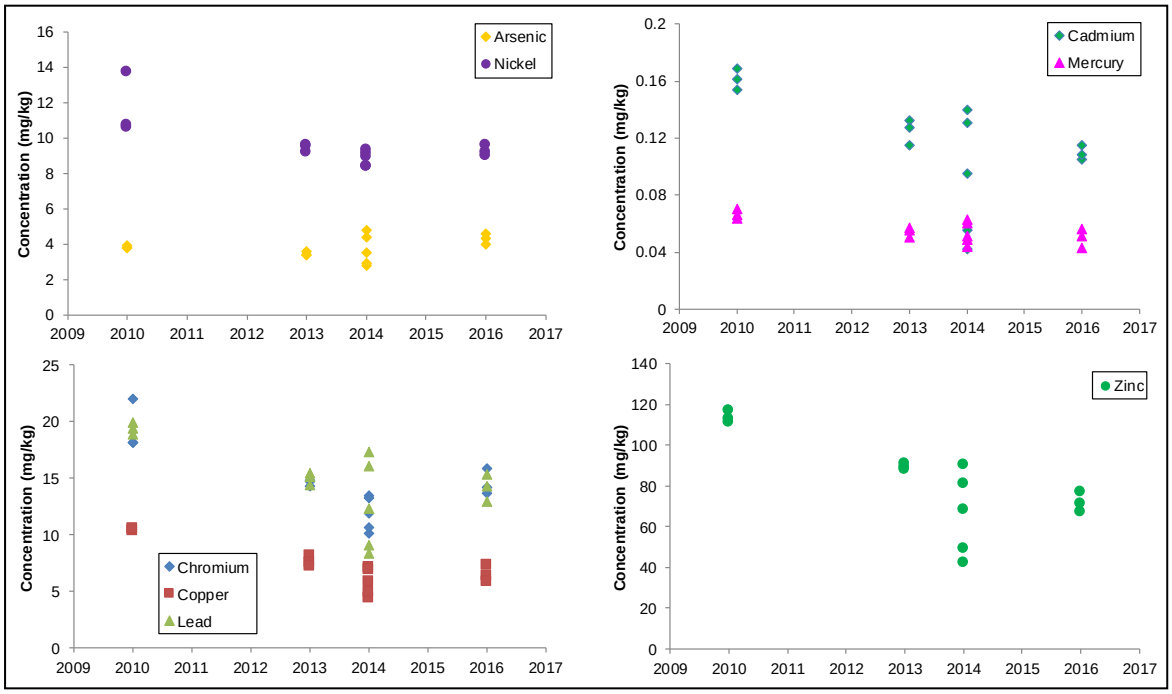


Figure 2: Metal and metalloid concentrations (mg/kg dry weight) over time in sediment from the site near the City Outfall Drain

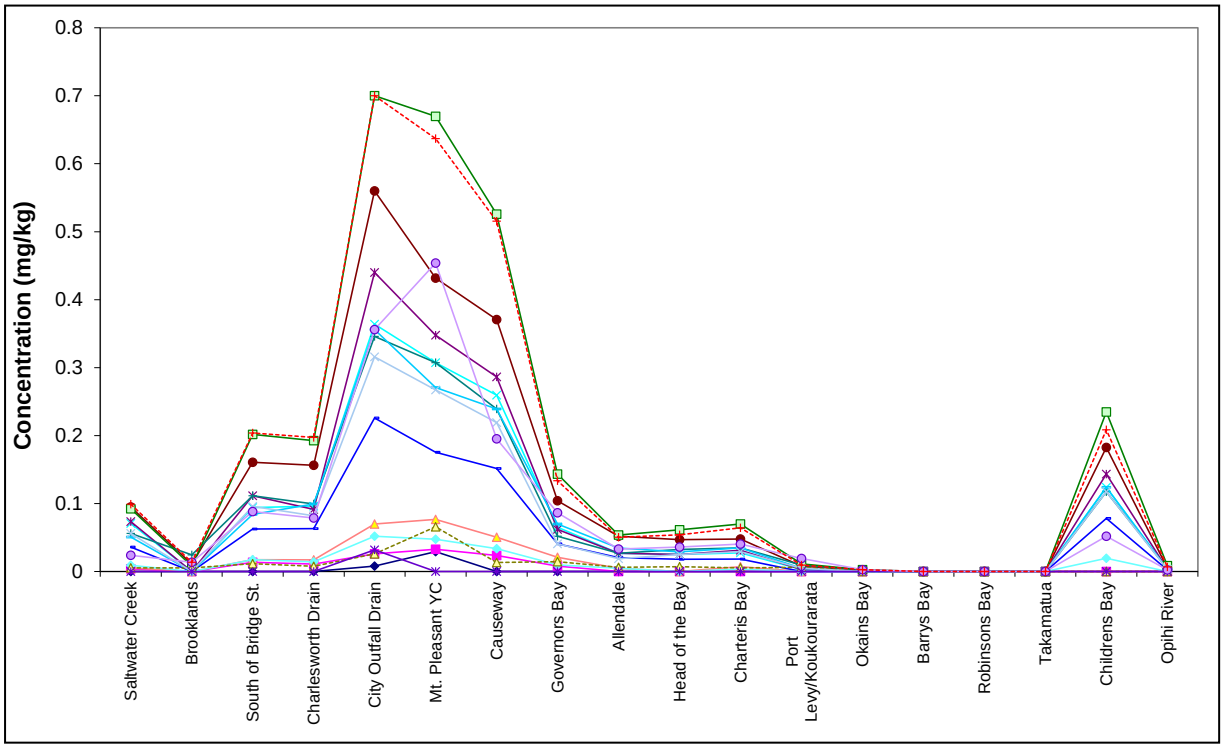


Figure 3: Normalised concentrations (mg/kg) of 16 individual PAHs (not named on the graph) at Environment Canterbury intertidal sediment monitoring sites in 2010

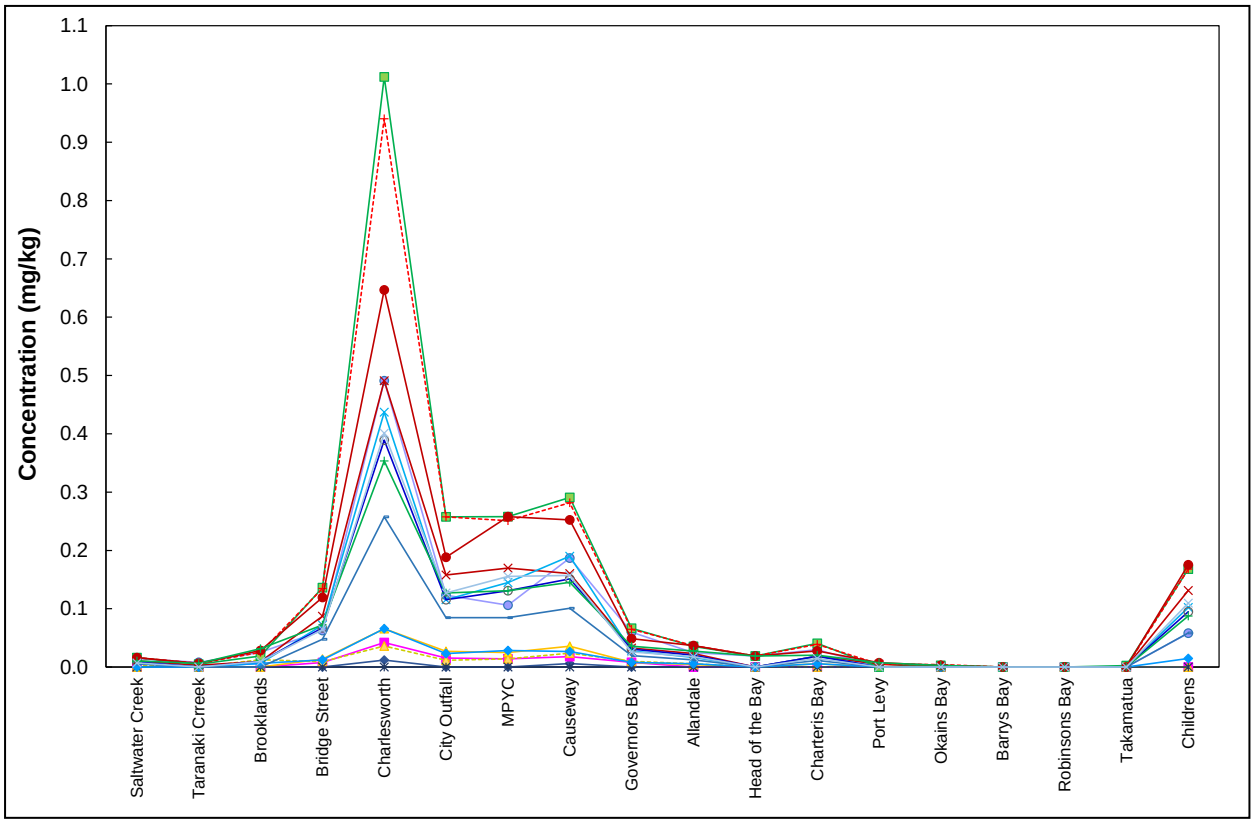


Figure 4: Normalised concentrations (mg/kg) of 16 individual PAHs (not named on the graph) at Environment Canterbury intertidal sediment monitoring sites in 2016

at the Charlesworth Drain site and one individual PAH at the Causeway site exceeded the ANZECC (2000) ISQG-low but were below the ISQG-high. At the Charlesworth Drain site concentrations of both low molecular weight and high molecular weight PAHs exceeded the low trigger value but were below the high trigger values.

82. The 2013 revision of the ANZECC/ARMCANZ sediment quality guidelines does not include trigger values for individual PAHs, or low molecular weight and high molecular weight PAHs. Instead there are trigger values for Total PAHs only, with the SQGV being 10 mg/kg (Simpson *et al*. 2013).

83. The Total PAHs concentrations at the five estuary sites has been below 10 mg/kg on all sampling occasions (Figure 5), but the Total PAHs concentrations at four of the five sites has varied over time (Figure 5). Liquefaction likely accounts for lower Total PAHs concentrations in 2013 than in 2010. However, the difference in Total PAHs concentrations between 2013 and 2014, and 2014 and 2016 at the City Outfall Drain and Mt. Pleasant Yacht Club sites suggest either PAHs can be gained and then lost from sediment or the sediment at the sites has been mobilised and transported from the site or there has been sediment deposition at the sites. The results for the Charlesworth Drain site suggest that Total PAHs are accumulating over time. The PAHs results suggest that the Charlesworth Drain and the City Outfall Drain are a source of PAHs.

Brooklands Lagoon

84. CRC has one sediment quality monitoring site within the lagoon with this site adjacent to Styx River/Pūharakekenui channel across the intertidal flat. In 2010 the concentrations of metals, metalloids were comparable to the background concentration and PAHs concentrations were low (Bolton-Ritchie and Lees, 2012). The 2016 concentrations of metals, metalloids and PAHs in sediment from this site were comparable to those from 2010. To date the metal, metalloid and PAHs concentrations at this site have been below SQGV. That is, at present they are unlikely to be having an adverse impact on aquatic life.

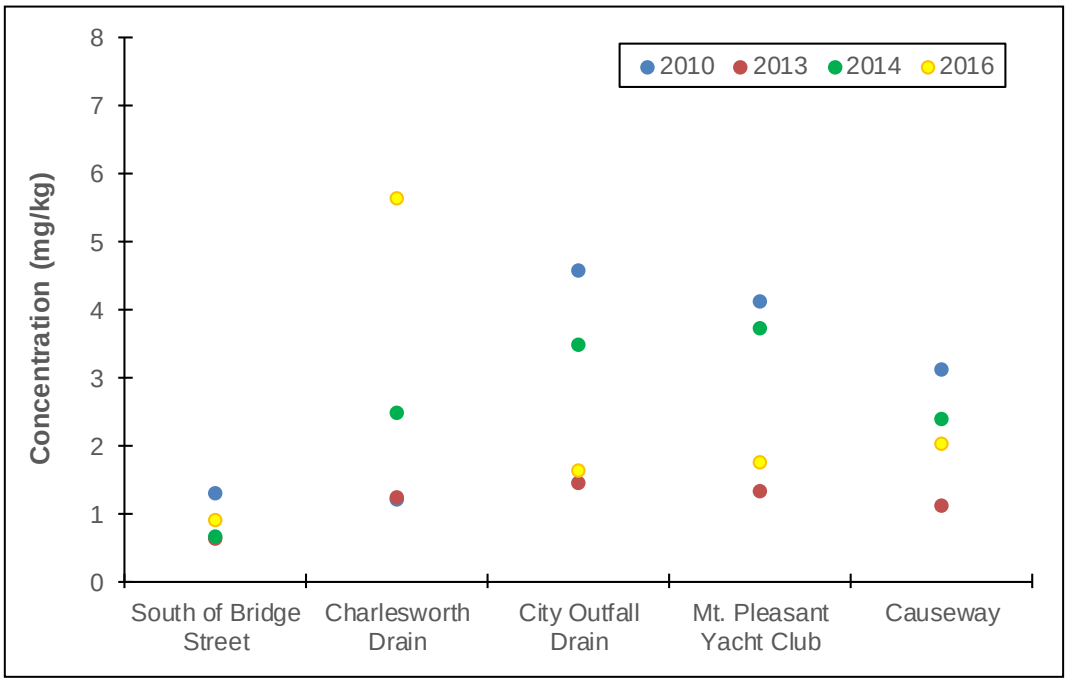


Figure 5: Total PAHs concentrations at five estuary sites, 2010-2016

Banks Peninsula

85. Included in CRC's intertidal sediment quality monitoring are four sites in Lyttelton Harbour/Whakaraupō and four sites in Akaroa Harbour. In 2010 the cadmium, chromium, copper, lead, nickel, zinc and the PAHs (Figure 3) concentrations in Childrens Bay (which is adjacent to Akaroa township) sediment were elevated above background concentrations. The likely sources of the metals and PAHs being stormwater from Akaroa township and all the on-water activities in the area (Bolton-Ritchie and Lees, 2012). There has been little change in the concentration of metal and metalloids at this site over time. However, PAHs results (Figures 3 and 4) show slight contamination of Childrens Bay sediment with PAHs in 2010 and 2016. To date the metal, metalloid and PAHs concentrations at this site have been below SQGV. That is, at present they are unlikely to be having an adverse impact on aquatic life.

Assessment of the Receiving Environment Objectives and Attribute Target Levels

86. The objective for copper, lead, zinc and PAHs concentrations in sediment within the bed of the freshwater receiving environments is to improve sediment quality to prevent adverse effects on aquatic biota. That is, over time the sediment copper, lead, zinc and PAHs concentrations at all sites must be below the relevant SQGV. The Attribute Target Levels in Schedule 4 of the consent conditions are currently the SQGV for copper, lead and zinc and the ANZECC (2000) ISQG-low value for Total PAHs. I agree with the use of the SQGV values for copper, lead and zinc. With the revision of the ANZECC/ARMCANZ sediment quality guidelines (Simpson *et al.*, 2013) the SQGV (ISQG-low value) for Total PAHs has changed. I recommend that the Total PAHs value in the Attribute Target Value should change to this revised value which is 10 mg/kg dry weight.

87. There are no Objective and Attribute Target Values for copper, lead, zinc and PAH concentrations in sediment within the bed of the coastal receiving environments. The EMP does not include sediment quality monitoring at coastal sites. The explanation for not including coastal sites is provided on page of the S92 response. I recommend that the sediment quality at coastal sites is measured if the water quality monitoring results indicate that dissolved metal concentrations are above guideline values. If sediment sampling of coastal sites is required, I recommend that CCC be required to work with CRC staff on the details of the sampling methodology, including but not limited to sample location, sample replication, depth of sediment sampled. If sediment quality sampling is undertaken at coastal sites, the results must be compared to the ANZECC/ARMCANZ SQGV guideline values. The values for coastal sediment are the same as those for freshwater sediment.

88. The objective of improve sediment quality to prevent adverse effects on aquatic biota is an appropriate objective for sites where sediment contaminant concentrations are above SQGV. My concern with this statement is for sediment at sites where contaminant concentrations are currently below the SQGV. For these sites the purpose of the objective should be to maintain sediment quality to ensure that stormwater discharges do not result in a decrease in sediment quality into the future.

89. The copper, lead, zinc and PAHs in the surface sediments can be reduced through reducing stormwater contaminated sediment loads, deposition of non-contaminated sediment over contaminated sediment or instream sediment removal. It is possible that they could be reduced through reducing concentrations of dissolved concentrations of the contaminants. That is, if the Schedule 4, of the proposed consent conditions, Objective of 'Reduce copper, lead and zinc levels in **surface water**' is achieved, then sediment copper, lead, and zinc concentrations may also reduce over time. That is, the objective to improve

sediment quality may be met. However, the Schedule 4 Attribute Target Level for copper, lead, and zinc in **surface water** of 'No statistically significant increase in copper, lead and zinc concentrations' may not result in a reduction in sediment contaminant concentrations. If the Schedule 4 Objective to 'decrease sediment input' is achieved then sediment copper, lead and zinc concentrations in the sediment should decrease over time. However, the Schedule 4 Attribute Target Level for sediment of 'No statistically significant increase in TSS concentrations' may not result in a reduction in sediment contaminant concentrations.

90. High risk sites and particularly HAIL sites, are sources of contaminated sediment to the receiving aquatic environments. CCC have proposed that these sites are included within the scope of this consent after 1 January 2025 (proposed consent condition 3). There do need to be standards in place on the quality and quantity of sediment going into stormwater from these sites. There also needs to be standards in place for the quality of the water from these sites. In paragraphs 82-85 of Michele Stevenson's evidence the matter of including high risk sites is addressed. I agree with her recommendation that 'Additional consent conditions are required to address the increased contamination risk that will be introduced post-2025 when high risk sites are included under the CSNDC. These may outline the steps that CCC will need to go through in developing a process for identifying, assessing, managing and monitoring these sites. Details of these processes will need to be included at the catchment scale in SMPs, which will require amendment of existing SMPs prior to 2025.'

91. The percentage reduction in TSS, copper and zinc loads over time (Table 2 in the draft consent conditions) may halt increases in copper and zinc concentrations in bed sediments and likely the concentrations of other contaminants such as lead and PAHs as well. However, they are percentage reductions, not based on what conditions are at present but compared to what they would be in a given year without there being any treatment. That is, will there actually be less zinc, copper, sediment and hence other contaminants discharged into the waterways in the future compared to now? The percentage reductions provided in Table 2 of the draft conditions are not broken down by catchment. Therefore, it is not possible to determine if the reductions in stormwater contaminant loads are going to improve instream sediment quality in the areas where sediment contaminant concentrations are already above SQGV. That is, there is uncertainty of where stormwater contaminants loads are to be reduced through mitigation actions and hence could lead to improvements in sediment quality over time. In paragraph 40 of Michele Stevenson's evidence is the recommendation that Table 2 should detail percent reductions for each of the modelled catchments rather than being presented as a single figure that applies across the whole CSNDC area. I concur with this recommendation.

Assessment of the EMP/Reporting/Responses to Monitoring

92. At the beginning of the section entitled instream sediment quality there is background information but the Purpose of the monitoring is not described. I recommend that the purpose of the instream sediment quality monitoring is added to the EMP to make it clear how this monitoring is related to the stormwater discharges that fall under the CSNDC.

93. As part of the EMP the plan is to undertake sediment quality monitoring at 44 sites in Christchurch's main river catchments and four sites in Banks Peninsula. The sites are shown in Figures 9-14 of the EMP. While the location of the existing sites does provide a good coverage of the main rivers and significant tributaries there is no monitoring in many of the smaller streams and drains. With more subdivisions occurring within the stream and drain catchments, e.g. Prestons, Cranford Basin, I recommend that more sediment quality monitoring sites are added over time as urban areas grow. I also agree with the statement in paragraph 98 of Michele Stevenson's evidence. That is, 'I also encourage CCC to

consider further targeted sediment quality in sub-catchments with elevated contaminant levels to aid with deducing contaminant sources and treatment options.' At present there is no planned sampling at coastal sites.

94. The sediment sampling at each freshwater site is to be every five years. This is an appropriate time interval for sediment quality monitoring in order to be able to detect a measurable change. The sediment quality sampling is to coincide with the five-yearly catchment rotation for aquatic ecology monitoring. The ideal is for the sediment quality and aquatic ecology monitoring to occur at the same sites. This will provide for an evaluation of possible links between sediment quality and aquatic ecology. At 36 of the 48 sites there is both sediment quality and aquatic ecology monitoring. I question if there could be alignment of the sites for this monitoring in the Kilmore Street/Manchester Street area, the Mona Vale area, and on Kā Pūtahi Creek.

95. The EMP describes the sediment quality parameters that are measured as total recoverable zinc, copper and lead, total organic carbon, total phosphorus, total PAHs and SVOCs and particle size distribution. These are appropriate parameters to measure. However, there are many SVOCs that could be measured with these including plasticisers, pesticides and fire retardants. It may well be that over time either more SVOCs will need to be measured or the actual SVOCs measured will change. I recommend that a review is undertaken every five years of the SVOC's that are measured as part of the sediment quality monitoring programme.

96. At each site, five subsamples of sediment to a depth of no more than 3 cm are collected. The subsamples are then combined to make one sample which is sent to the laboratory for analysis. The collection of the top 3 cm of sediment is appropriate as is the amalgamation of subsamples to make a single composite sample for analysis. However, having data from only one sample per site precludes robust statistical analysis of the results, both between sites and over time. That is, there is an insufficient number of samples collected at each site for meaningful analysis of the data. The issue of sample replication was raised by Gadd and Sykes (2014). For statistical analyses a minimum of three composite samples should be analysed per site on each sampling occasion. I recommend that three composite sediment samples should be analysed per site on each sampling occasion.

97. The sediment is to be collected by making multiple sweeps with a container across the streambed. Water is drained off the sample container either directly or using a 500 µm sieve. The use of a 500 µm sieve is not appropriate as it results in the loss of the fine sediment particles, i.e. the silts and clay which are sediment particles smaller than 63 µm. It is these fine sediment particles that metals adsorb to rather than the coarser sand particles in the > 63 µm to 2mm size range. I recommend that the collected sample is not sieved through a 500 µm sieve or any other sieve larger the 2µm.

98. The reporting of the sediment quality data is to include (see section 6.4, page 43 of the EMP) an assessment of measured values against guideline values, spatial comparisons within and between catchments, comparisons to historic results to assess whether sediment quality is stable, improving or declining and an assessment of whether the proposed consent conditions Schedule 4 Objectives and Attribute Target Levels are being met. In terms of meeting the Schedule 4 Objective for sediment contaminants it is the comparison of measured values to the guideline values and an assessment of whether sediment quality is improving, that are relevant. There is no Attribute Target Levels descriptor rather there are trigger values (SQGV) which should not be exceeded. At best the data will only be able to provide an indication of whether sediment quality is stable, improving or declining because lack of sample replication precludes statistical analyses. If there is sample replication at each site then robust analyses to assess for trends in

concentration over time will require at least 25 years of data. The data that CCC have collected to date from many of the sites, while not statistically robust do provide some data against which future results can be compared.

99. In the 'Response to monitoring' in the proposed consent conditions there is no planned response to above guideline values or increasing sediment contaminant concentrations. The sediment contaminant concentrations results must be used to inform the management actions undertaken by CCC. Therefore, I recommend that there is a consent condition that requires corrective actions or remediation for sites where the concentration of one or more sediment contaminants is above SQG-high. I also recommend a consent condition that requires a response when one or more sediment contaminants is above SQGV. This should be in line with condition 51. Alternately an SQGV exceedance could trigger a Weight of Evidence approach, as described in Simpson *et al.*, (2013). This Weight of Evidence approach integrates four major lines of evidence comprising chemistry, toxicity, bioaccumulation and ecology. Fortunately, aquatic ecology monitoring is undertaken at many of the sediment quality sites and this will provide relevant data. Using the Weight of Evidence approach an overall weight-of-evidence score is determined. With the weight-of-evidence scores equating to either significant adverse effects, possible adverse effects or no adverse effects. The result obtained would then determine the actions needed by CCC.

Assessment of Stormwater Management Plans and other mitigation

100. Many of the points I have raised in paragraphs 65-68 are also applicable here.

101. The purpose of an SMP is given in condition 5 and the details of what they shall include is provided in condition 6 of the proposed consent conditions. SMPs are an appropriate approach for addressing stormwater issues and impacts on sediment quality over numerous catchments in a large area. I recommend one change to proposed consent condition 6; this change is in blue below.

102. 6.h. An interpretation of environmental & cultural monitoring and how this information has been used to develop water quality mitigation methods and practices, and their location.
This addition to 6.d.h. should ensure that appropriate methods and practices are implemented (at least initially) where most needed, i.e. where the receiving environment is degraded.

103. In terms of receiving environment sediment quality it is critical the stormwater from high risk sites is well managed. These sites are a potential source of contaminated sediment and other potential surface water contaminants including metals, PAHs, SVOCs and other contaminants of concern. The contaminants in soil and water from a high risk site will depend on the activities that occur/occurred there and therefore likely differ between sites. To begin with, each site should be assessed in terms of the likely contaminants and concentrations/loads that could come from the site. An assessment of the risk of contaminants getting into the stormwater should then be carried out. I recommend that CCC has robust processes and requirements for stormwater discharges from high risk sites to ensure that contaminated sediment and stormwater from them does not increase contaminant concentrations in surface water and bed sediments.

Response to submissions

104. My responses are to the submissions made that are specific to the coastal receiving environments.

105. Avon-Heathcote Estuary Ihutai Trust

Points raised

- the applicant needs to show more commitment in its consent application to actually cleaning up the stormwater;
- the objectives will not be met by merely maintaining the current poor water quality;
- The current consent conditions are not adequate to achieve the objectives of the consent;
- contaminants need to be addressed at the source;
- there need to be measures to facilitate water quality improvements and a plan to incrementally improve the water quality of the rivers and the estuary.

106. In my evidence I have discussed the Receiving Environment Objectives and Attribute Target Levels in Schedules 4 and 5 of the proposed consent conditions and made recommendations for some changes to these. I have also made recommendations on changes to proposed consent condition 6, 14 and 51. These changes should address some of the concerns raised by the Trust.

107. I agree that the draft conditions would benefit from changes to align them with the objectives of the consent. In my evidence are recommendations for changes to the consent conditions. These may go some way to address what the trust consider are the issues with the consent conditions.

108. CCLM or equivalent modelling and the then projected reductions in contaminant loads within given timeframes for each individual catchment (along the lines of Table 2 in the proposed consent conditions) and a requirement to achieve these reductions is a means by which the water quality of the rivers and estuary could incrementally improve. Michele Stevenson has discussed the modelling and the proposed projected reductions in contaminant loads. Her recommendations along my recommendations of changes to proposed consent condition 6 address this issue and may provide for the incremental improvement water quality of the rivers and estuary.

109. I agree that the ideal is for contaminants to be addressed at the source. To get buy in from the pubic and industries re taking actions at the source, there needs to be data that describes the extent of the issue and the potential effects on the receiving environment. Such data can be produced for each catchment using CCLM or equivalent modelling.

Southshore Residents Association Inc.

110. Points raised

- Support for the Avon-Heathcote Estuary/Ihutai Trust submission;
- Discharges into the waterways should be at a reduced level to increase the water quality over time.

111. I am uncertain if the Southshore Residents Association Inc. are specifically seeking a reduction in the volume of water discharged to the waterway or a reduction in contaminants

discharged to the waterways over time. My expertise is not stormwater quantity so I cannot comment on this aspect. With respect to a reduction in contaminants discharged, the points I have raised and my recommendations if adopted should result in stormwater being better managed in the future. To this end, the receiving environment should not decline and could improve over time.

Department of Conservation

112. Points raised

- the CCC needs to give effect to the NZ coastal policy statement;
- That SMPs have regard for the NZ coastal biodiversity action plan;
- That CCLM or equivalent modelling is run for different catchments including those of Banks Peninsula

113. I note that the coastal policy statement is referred to in the application document. I assume that the SMPs for Estuary and coastal Christchurch and Te Pātaka o Pākaihautū/ Banks Peninsula Settlements will give effect to both the NZ coastal policy statement and the NZ coastal biodiversity action plan. To ensure this happens there does need to be an addition to proposed consent condition 6.

114. With respect to CCLM or equivalent modelling, I consider that this should be undertaken in the urbanised catchments of the estuary and the larger population centres of Banks Peninsula. This modelling will provide an understanding of the contaminant loads originating from these catchments. This will allow for an assessment of the 'size' of the issue and whether mitigation is required in these catchments. This information will allow for an evaluation of potential effects on the receiving environment and data that can be used to prompt actions by the community.

Lyttelton Port Company Limited

115. Points raised

- That an SMP is developed for Whakaraupō/Lyttelton Harbour rather than including it within the Te Pātaka o Pākaihautū/ Banks Peninsula Settlements SMP. This is to allow for the SMP to be integrated with the Whakaraupō/Lytttelton Harbour Catchment Management Plan.
- The draft conditions would benefit from a thorough review to improve their certainty, internal consistency and be readily understood. Without amending the conditions, the conditions will not achieve a list of issues.

116. In my evidence I have recommended that 'proposed consent condition 6 includes a requirement for consideration of relevant non-statutory plans, for example, the Avon-Heathcote Estuary/Ihutai Estuary Management Plan and the Whakaraupō/Lytttelton Harbour Catchment Management Plan.' I see merit in having a Whakaraupō/Lyttelton Harbour specifc SMP, but the decision to have a separate SMP will ultimately lie with CCC. If there is no Whakaraupō/Lyttelton Harbour specifc SMP, the Banks Peninsula SMP should consider each harbour separately.

117. I agree that the draft conditions would benefit from a thorough review. In my evidence are recommendations for changes to the consent conditions. These may go some way to address what LPC consider are the issues with the consent conditions.

Summary of my recommendations

118. The recommendations I have made through this document are listed below.

- The Attribute Target Level for TSS includes the statement 'a statistically significant decrease in TSS concentrations'.
- The Attribute Target Level also includes the statement 'a statistically significant decrease in copper, lead and zinc concentrations'.
- The use of the ANZECC (2000) trigger values for dissolved metals rather than the RCEP values as the Attribute Target Levels. The ANZECC (2000) trigger values providing for the protection of 95% of species, should be the Attribute Target Levels for all areas except the Operational Area of the Port of Lyttelton.
- CCC undertake an investigation/modelling to determine the dissolved copper, lead and zinc concentrations in the stormwater from the urban areas of Lyttelton township.
- An additional coastal water quality monitoring site within the Estuary of the Heathcote and Avon Rivers/Ihutai and that this site is in proximity to where either the City Outfall Drain or the Charlesworth Drain flows into the estuary.
- The monthly sampling be flexible enough to allow for sampling of at least three wet weather events per year.
- If the above recommendation is included in the consent conditions, for annual reporting the data are grouped into dry weather and wet weather, with state and trend analyses undertaken on each group of data.
- The sampling at the Beachville Road site in the estuary is undertaken around the time of high tide and that this information is included in the EMP.
- Faecal coliform concentrations are measured at the Akaroa Harbour site and Table 3 of the EMP is updated to include the faecal coliforms as a parameter. The MfE/MoH (2003) guidelines for water over lying shellfish be used to assess faecal coliform concentrations.
- If the water quality monitoring results indicate that dissolved metal concentrations at the Akaroa site are above guideline values, the flesh of the shellfish species that occur in proximity to the sampling site should be assessed for cadmium and lead concentrations.
- When TSS trigger values become available for Lyttelton Harbour/Whakaraupō and Akaroa Harbour these values are incorporated into Table 3 of the EMP and into Schedule 5 of the consent conditions.
- The Implementation Plan proposed in Condition 14 of the proposed consent conditions includes details of a process that describes how CCC will respond when many sites do not meet Attribute Target Levels.
- The consent conditions stipulate a time frame for any work undertaken to fulfil consent condition 51.

- The wording of proposed condition 6.b, 6.d.v. and 6.h is altered to incorporate the wording proposed in paragraphs 66 and 102 of my evidence.

- Consent condition 6 includes a requirement for consideration of relevant non-statutory plans, for example, the Avon-Heathcote Estuary/Ihutai Estuary Management Plan and the Whakaraupō/Lytttelton Harbour Catchment Management Plan.

- The SMP for the Estuary of the Heathcote and Avon Rivers/Ihutai covers the topics listed in Paragraph 68 of my evidence.

- Adding a consent condition requiring each SMP to be audited and approved by a Technical Advisory Panel.
- The revised SQGV (ISQG-low value) for Total PAHs should become the Attribute Target Value for this parameter, in Schedule 4 of the consent conditions.
- Sediment quality at coastal sites is measured if the water quality monitoring results indicate that dissolved metal concentrations are above guideline values.
- The purpose of the instream sediment quality monitoring is added to the EMP to make it clear how this monitoring is related to the stormwater discharges that fall under the CSNDC.
- More sediment quality monitoring sites are added over time as urban areas grow.
- A review is undertaken every five years of the SVOC's that are measured as part of the sediment quality monitoring programme.

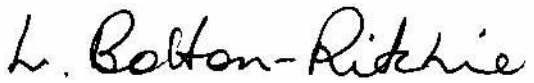
- Three composite sediment samples should be collected and analysed from each site on each sampling occasion.
- Each collected sediment sample must not be sieved through a sieve with a mesh size larger than 2 µm.
- A consent condition that requires corrective actions or remediation for sites where the concentration of one or more sediment contaminants is above SQG-high. A consent condition that requires a response when one or more sediment contaminants is above SQGV.
- CCC has robust processes and requirements for stormwater discharges from high risk sites to ensure that contaminated sediment and stormwater from them does not increase contaminant concentrations in surface water and bed sediments.

My overall evaluation of this consent

119. The CCC processes described in this consent, that is, producing SMPs, having implementation plans for the SMPs, potential investigations, monitoring, Receiving Environment Objectives and defined responses to monitoring where Attribute Target Levels are not met, indicate that in the future there should be improvements in the quality of the stormwater discharged into the aquatic environments within the area managed by CCC. However, changes do need to be made to the EMP and the consent conditions including what should be included in the SMPs to provide some certainty that the consent objectives outlined in the CSNDC application will be met. The granting of this consent should result in stormwater being better managed in the future than it has been in the past. While there are many uncertainties about the improvements to stormwater quality that will be achieved in the future, there is the certainty that it is better that something is done about stormwater quality rather than not doing anything as is the situation in many of the coastal

catchments at present. If this consent is granted the effects of stormwater discharges on coastal receiving environments and bed (freshwater and coastal) sediments should not cause a decline and could improve water quality, habitats and ecosystems in the future.

120. I am concerned about cumulative effects particularly for the Estuary of the Heathcote and Avon Rivers/Ihutai. Stormwater is just one of the many stressors on the estuary, but one where management actions can be taken. This consent and the processes which will be put in place for stormwater discharges should ensure the concentrations of stormwater contaminants within estuary water and sediments don't get worse and they should improve in the future, provided there are robust conditions, a very good EMP, a detailed SMP and a thorough and timely implementation plan.

Signed:  Date: 28/09/18

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Reviewed by: 

Signed: Date: 28/09/18

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