Before the EPA

Coastal Resources Limited Marine Dumping Consent EEZ100015

In the matter of the Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012

And

In the matter of a board appointed to consider a marine consent application made by Coastal Resources Limited to undertake disposal of marine sediments at the Northern Disposal Area.

Supplementary Statement of Expert Evidence of Simon West on Marine Ecology on behalf of Coastal Resources Limited

27 November 2018

MAY IT PLEASE THE COMMITTEE

1. INTRODUCTION

1.1 My full name is Simon Andrew West. I confirm my qualifications and experience as provided in my previous Statement of Evidence dated 25th October 2018.

1.2 I confirm that I have read the Code of Conduct for expert witnesses contained in the Environment Court of New Zealand Practice Note 2014 and that I have complied with it when preparing my evidence. Other than when I state I am relying on the advice of another person; this evidence is entirely within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

1.3 This Supplementary Evidence covers issues related the presence of vulnerable habitats within the Northern Disposal Area, the use of layered chemical sampling, use of larger grab samplers for benthic biota, inconsistencies in foraminifera counting, comments arising from the NIWA review. Discussion on these issues was not able to be completed at the facilitated meeting. A record of the agreements at that meeting are reported in the Joint Statement of Experts in the field of Marine Ecology dated 20th November 2018.

2. MATTERS OUTSTANDING FROM CONFERENCING

2.1 The potential for the presence of Boulder habitats within the Northern Disposal Area was raised within the marine ecology conferencing and in earlier evidence.

2.2 A paper by Lee, *et al* (2015) mapped the benthic habitats to the north of the Northern Disposal Area using seafloor video surveys, from 119 locations in an area approximately 745 km^2. They found a large number of sites (53/119) had no visible sign of epifauna. Of those that did have epifauna, four biotopes were identified;

a) shallow water, macro-algae, *Ecklonia* sp. and *Ulva* sp. on rocky substrata

b) deeper water diverse epifauna of sponges and bryozoans on rocky substrata,

c) brittle star *Amphiura* sp. and sea anemone *Edwardsia* sp. on muddy sand,

d) hydroids on mud.

2.3 Of these four habitat types the hydroids on mud, best describes the Northern Disposal Area. Lee *et al*. found where mud dominated the seabed, especially at deeper than 90m, there were no identifiable epifaunal assemblages, except for occasional hydroids. However, in a few places, boulders rose above the muddy seabed, and there was a rich diversity of filter feeders and passive suspension feeders such as hydroids, ophiuroid brittle-star *Amphiura* sp., and anemone *Edwardsia* sp. On these deep reef habitats, Lee *et al*. recorded 47 invertebrate species, including sponges, gorgonians, black corals and anemones. Brook (1982) reported the scleractinians *Culicia rubeola* and *Sphenotrochus ralphae* in shallower water inshore attached to rock and shell. One of the most important features of the sponge fauna was the presence of several species (*Symplectella rowi*, *Rossella ijimai* and *Isodictya cavicornuta*) that are considered rare and restricted in distribution.

2.4 However these diverse habitats were only identified east of Rakitu Island on a known rocky reef outcrop as shown in the Sea Change Hauraki Gulf Marine Spatial Plan 2017, some 20 km north of the Northern Disposal Area.

2.5 A combination of seabed photographs (Flaim, 2011) and repeated seabed core samples from more than 22 sample sites in a 22 km^2 area (Flaim, 2011, Bioresearches, 2018) and Multibeam Echo sounder surveys (Flaim, 2011, Survey Worxs, 2017) covering the entire Northern Disposal Area have shown the seabed of the Northern Disposal Area to be flat, featureless, sandy silt with limited epifuana.

2.6 The Multibeam Echo sounder surveys have a vertical accuracy of 2 – 2.5m. Despite the accuracy, the use of backscatter analysis allows detection of denser material, which has shown the presence of the slightly different density disposal mound sediments. Taking direction from the surveyors any boulder habitats larger than 1m, being denser are likely to show as different from the background. No such trace outlines are present within the Northern Disposal Area or nearby surrounds as surveyed. Flaim 2011 highlight the presence of a very small trace patch on the edge of the CMA south of the Northern Disposal Area. However this was not detected in the later Survey Worxs surveys.

2.7 The only way to completely rule out the occurrence of the boulder habitats is conduct a seabed video survey of the entire Northern Disposal Area. However to conduct this would be extremely time consuming and expensive. Assuming the an area 3 km by 3 km, and a 10m wide video sample path with a video travel speed of approximately 2 knots, this would require a 900 km of transects and some 283 hours of underwater video operation with numerous accents and descents to recharge batteries, to collect, plus many hours to analyse the video results.

2.8 The lack of presence of denser potentially rocky or boulder habitats virtually eliminates the presence of this diverse epifauna habitat with in the Northern Disposal Area. Thus the benthic biota of the Northern Disposal Area has been described in the monitoring reports and summarised in the application Appendix 5. The biota is numerically dominated by foraminifera, with species from other taxonomic groups such as polychaete worms, sipunculid worms, molluscs, amphipods, isopods, cumaceans, mysids, ostracods, anemones, ophiuroid starfish and a sponge were present but at very low numbers.

2.9 The use of sampling more than one layer of sediment from the monitoring sites listed in the draft Schedule 1 Table 1 has been proposed (by Mr Leduc) as a way of providing a background concentration for each site with which to compare changes in the surface sample. In theory this would work if the surface layer (0-5cm) was affected by the disposal material and the lower layer (5-10cm) was not, such as is likely to occur beyond the detectable disposal mound. However if the lower layer is also affected by the disposal material as would likely occur within the disposal mound, then this lower layer will not provide a background concentration with which to compare changes in the surface layer.

2.10 For such a sampling plan to be effective and not require sampling locations known to be affected by the disposal mound, the sampling plan would need to be adapted based on the location of the disposal mound. The sampling as proposed in the draft conditions included in Mr Hay's evidence compares the surface layer sediment quality with that of a number of control sites. This is more practical and workable while still providing a suitable comparison to detect changes. It also has the benefit of not requiring adaptive management of the sampling sites.

2.11 The current proposed condition 8A involves the continued use (for continuity) of the gravity core sampler to provide six benthic biota macrofauna samples at each site listed in Schedule 1 Table 1, and a single 200m long video transect per site. It has been suggested (in the NIWA report) that the 100mm diameter core does not sample a large enough area to adequately sample the larger biota and that a larger grab or box core sample is required. The addition of the video transect sampling, in my opinion will provide sufficient additional information on the presence or absence of larger macrofauna. While the video will not show what large fauna that are below the seabed surface, these biota will in some way be connected to the seabed surface, either by showing track patterns or burrow / siphon holes. If these biota are rare and sparsely distributed, as suggested by Lee *et al*. (2015), the use of a larger grab sampler is not likely to sample these biota on every grab nor can it be used to sample a specific point identified on a video transect.

2.12 The disturbance to the seafloor of the use of such a grab sampler would be greater than 5 times that currently sampled if only a single grab core replicate was used per site, in my opinion this could result in an effect in itself. In addition, the use of grab sampler in the order of 0.5x0.5m would require a vessel of significant scale and capability. The National Assessment Guidelines for Dredging (2009)[1] suggested large grab samplers are preferable to smaller ones and should have a minimum grab size of 0.02 m^2, based on this 0.5x0.5m seems overly large. In some cases it may be appropriate to improve the representativeness of the samples by compositing a number of grab samples taken from the one location, as has been done to date with the core samples.

2.13 Some valid doubt has been expressed as to the reliability of the foraminifera count data obtained to date. When studying the distribution of foraminifera it is crucial to ascertain whether individuals were alive or dead at the time of sampling. This is because shells can remain in the sediments for very long periods (centuries or more) after the death of the organism inside, to the extent that dead shells outnumber shells with living foraminifera. This would suggest the use of a stain to determine if the Foraminifera were alive at the time of sampling.

2.14 The conventional method to distinguish live from dead benthic foraminifers uses Rose Bengal, a stain that reacts with both live and dead cytoplasm. Using

[1] National Assessment Guidelines for Dredging, Commonwealth of Australia, Canberra, 2009.

multiple staining techniques Bernhard *et al.* (2006)[2] found that on average, less than half the Rose Bengal–stained foraminifera were actually living when collected. A lack of differentiation was also found when weak Rose Bengal was used on the biota samples from the 100,000m[3] monitoring study. The Rose Bengal was taken up by the majority of foraminifera in the samples including those that showed signs of shell erosion. This may have a been a result of the samples being left in the stain solution for too long and the stain seeping into the foraminifera shell rather than the protoplasm (live foraminifera) within the shell. In a number of species the opening in the shell is very small reducing the success of stain reaching the protoplasm. To date a standard reliable method for determining whether foraminifera were alive or dead has not been identified. To date those foraminifera that have exhibited a healthy appearance, such as uneroded shells, have been counted as alive. Unless a suitable method is identified it may be prudent to exclude foraminifera from the species data statistically analysed.

3. SECTION 54

3.1 I have provided advice to David Hay for inclusion in the response to the EPA's further information request dated 14 November. I confirm that I authored the text in response to questions 1 and 4, and that they form part of my evidence.

3.2 In addition, I understand the DMC have a particular concern that the Bioresearches report in the application documents does not refer to several publications/databases referred to in NIWA's 6 November report; to which I respond below.

3.3 I have examined the publicly available National Marine Invertebrate Collection, NIWA. Once the data is confined by geographic reference to east of Great Barrier Island and restricted to depths between 100 and 300m, only three species are included: A bryozoan *Conescharellina pala* found east of the Mercury Islands in 132m of water, a sea squirt *Aplidium orthium* found 32km east of the Northern Disposal Area in 263m of water and a foraminifera

[2] Bernhard, Joan M., Dorinda R. Ostermann, David S. Williams, and Jessica K. Blanks. "Comparison of two methods to identify live benthic foraminifera: A test between Rose Bengal and CellTracker Green with implications for stable isotope paleoreconstructions." *Paleoceanography* 21, no. 4 (2006).

Globocassidulina canalisuturata found in 179m of water 13.5km northeast of the Northern Disposal Area.

3.4 The database likely includes a number of other species present in similar habitat to that present within the Northern Disposal Area, however the database does not include habitat type, other than depth, and their presence outside the Northern Disposal Area suggests they are not exclusively found within the Northern Disposal Area. This was also a consensus reached by the marine ecology experts conference that the likelihood of threatened species being present within the Northern Disposal Area but not outside was none to very low.

3.5 Correspondence with NIWA suggests there is significantly more information that is only available on special specific request. Hence NIWA has made the comment in its review that the Stony coral *Kionotrochus suteri* is present within 5 km of the Northern Disposal Area. A point was made within the original Appendix 5 of the application that Stony corals have been found to the north (*Kionotrochus suteri* included) and that Stony corals would be adversely effected by burial by sediment (assuming they are present where the sediment settles) as they are sedentary. However stony corals either alive or dead have not been recorded in the study area as part of either the predisposal studies (University of Waikato, 2011) or the post disposal monitoring studies (Bioresearches, 2013, 2015, 2017, 2018). In addition stony corals require a firm substrate to attach to, either rock or large shell fragments. No such habitat has been shown to be present or is expected to be present within the Northern Disposal Area.

4. NIWA REVIEW REPORT

Threshold for detecting the location of the disposal mound

4.1 The NIWA review report raised concerns over the threshold of detection of the disposal mound sediments. The clear core samples collected from all sites, were photographed and reported as appendix 3 within Appendix 5 of the application. The cores clearly show the presence of a layer approximately 5 to 7 cm thick below the surface at all sites beyond 500m. This has been taken as a layer of bioturbation. At distances closer to the disposal point the presence of darker sediments at greater depths than 7cm, this has been taken as disposal sediment. The ability to detect this darker disposal sediment within the top 5 –

7 cm is limited. Thus the threshold of detection of the disposal sediment is considered to be between 5 and 7 cm based on the visual determination from the cores.

4.2 In addition sediment chemistry analysis is conducted on the top 5cm of sediment from sites at 500m intervals away from the disposal point. The aim of this was to determine if sediment chemistry changed as a result of disposal material being present but not visible. However to date the volume disposed has only resulted in changes at the disposal point and not at any sites at 500m from the disposal point. As the volume disposed increases it is expected that sediment chemistry at the 500 m sites will show differences adding to the weight of evidence that the mound has grown.

Disturbance of samples collected with gravity corer

4.3 The use of a gravity corer may not be the most widely used method to collect sediment samples and benthic biota samples. It may have issues with disturbance to the surface of the core, however in my opinion this is relatively minor. The clear sediment cores show little disturbance to the surface layer with the presence of small polychaetes, hydroids and other biota still present at the sediment-water interface. The use of a significantly larger and heavier multicorer and or grab sampler would require a much larger vessel and sampling crew, with little benefit in that even with the use of a muliticorer sediment surface disturbance is not completely eliminated.

Power of statistical analysis

4.4 The NIWA review suggests no power analysis was conducted to determine the likelihood of detecting a 50% change in benthic biota measurements at the NDA boundary. However, all statistical analysis reports included in the monitoring reports (which are provided to the EPA) were not included in the application document. These statistical reports included a power analysis and none of them reported power less than 0.80 for the tests conducted.

4.5 In general, the larger the sample size (N), the smaller sampling error tends to be. If we are to make accurate decisions about a parameter, we need to have an N large enough so that sampling error will tend to be "reasonably small." If N is too small, there is not much point in gathering the data, because the results will tend to be too imprecise to be of much use. On the other hand, there is also a point of diminishing returns beyond which increasing N provides little benefit.

Once N is "large enough" to produce a reasonable level of accuracy, making it larger simply wastes time and money.

4.6 No power analysis test is possible for multivariate testing, as there are too many combinations, making the mathematics intractable.

4.7 Based on the 150,000m^3 monitoring data which collected 3 replicate benthic biota samples from four sites on the Northern Disposal Area boundary at 1500m and 3 replicate samples from a Control site, the following indicative power analysis can be reported.

	Minimum Detectable Difference in Means	Expected Standard Deviation of Residuals	Number Of groups	Group Size	Alpha	Power	Group size require to achieve 0.8 power
	based on difference of 50% of Control						
Mean number of taxa	9.667	3.381	5	3	0.05	0.59	4
Number of individuals	79.500	45.342	5	3	0.05	0.24	9
Diversity Index	0.896	0.230	5	3	0.05	0.88	3
	based on difference of 25% of Control						
Mean number of taxa	4.833	3.381	5	3	0.05	0.17	13
Number of individuals	39.750	45.342	5	3	0.05	0.09	32
Diversity Index	0.448	0.230	5	3	0.05	0.29	8

4.8 Assuming the same detection difference and standard deviation increasing the number of groups to 9 (8 boundary sites and a control group as included in the draft conditions) and increasing the replication to 6 cores, the following indicative power analysis can be reported.

	Minimum Detectable Difference in Means	Expected Standard Deviation of Residuals	Number of groups	Group Size	Alpha	Power	Group size require to achieve 0.8 power
	based on 50% of Control						
Mean number of taxa	9.667	3.381	9	6	0.05	0.93	5
Number of individuals	79.500	45.342	9	6	0.05	0.46	11
Diversity Index	0.896	0.230	9	6	0.05	1.00	3
	based on 25% of Control						
Mean number of taxa	4.833	3.381	9	6	0.05	0.31	16
Number of individuals	39.750	45.342	9	6	0.05	0.13	40
Diversity Index	0.448	0.230	9	6	0.05	0.57	9

4.9 Based on these calculations of power and number of samples required the proposed sampling plan of 8 Northern Disposal Area boundary sites and 2 control sites each with 6 replicate core samples has sufficient power to reliably detect changes in the values of number of taxa and diversity in the order of less than 50 % change of the control. The greater number of samples within the control group will increase the power of each test; while further increasing the number of samples per site would also increase the power and thus the reliable minimum detectable level of change. In my opinion, the point at which costs outweigh the benefits is likely to fall within the range between 6 and 12 replicates. The use of inherently more powerful statistical tests such as multivariate analysis, would suggest the replication rate should be in the order of 6 per site.

Simon West
27 November 2018