BEFORE THE OTAGO REGIONAL COUNCIL

IN THE MATTER	of the Resource Management Act 1991
AND	
IN THE MATTER	of an application for resource consents for Project Next Generation
BY	**PORT OTAGO LIMITED**
	Applicant

STATEMENT OF EVIDENCE OF KEITH ORSBOURN BALLAGH ON BEHALF OF PORT OTAGO LIMITED
5 April 2011

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QUALIFICATIONS & EXPERIENCE

1. My name is Keith Orsbourn Ballagh and I am a partner in the acoustical consulting practice of Marshall Day Acoustics. I have a Bachelor of Mechanical Engineering (1st Class Honours) from Canterbury University. Since graduating in 1975 I have specialised in the study and practice of acoustics. I was formerly with the Department of Scientific and Industrial Research from 1975 to 1987, being head of its Acoustic and Vibration Section in Lower Hutt from 1980 to 1987. In 1982 I was a visiting scientist at the Physicalish-Technische Bundesanstalt (PTB) in Germany, carrying out research into noise measurements. In 1987 I joined Marshall Day Acoustics and in 1990 became a partner in the practice. I have written a number of scientific papers for international acoustic journals and presented papers at international conferences. I have held several positions in the New Zealand Acoustical Society, including Secretary and President.

2. My work in acoustics has included research into noise measurement and control, noise control engineering for many commercial and industrial clients, and the assessment of noise impact and presentation of expert evidence on the effect of noise on residential and rural areas.

3. I have read the Environment Court's Code of Conduct for Expert Witnesses and agree to comply with it. I have complied with it in the preparation of this evidence.

INTRODUCTION

4. I have worked with Port Otago Limited for more than 15 years, appearing as an expert witness at the District Plan Hearings in 1997 and the Environment Court Hearing in 2003 which led to the current noise management regime at Port Chalmers.

5. In 2009 I was engaged to investigate the effects of noise from their proposal to dredge the shipping channel to accommodate the larger container vessels. I prepared a report in October of 2009 which is the

basis of my evidence. The report is titled “Assessment of Noise Effects from Project Next Generation – Dredging and Operation” and is included as report 24 in the Next Generation application. I propose to refer to this report rather than repeat the detailed discussion and analysis in that report.

6. Port Otago is also applying for a consent for a multipurpose wharf extension and I will also discuss the noise implications of this.

EVIDENCE SUMMARY

7. My evidence will cover the following matters:
   a. Project summary from noise point of view
   b. Description of existing environment
   c. Description of noise sources associated with dredging and operation
   d. Summary of applicable noise rules
   e. Assessment of noise effects from construction and operation
   f. Prediction of underwater noise from blasting and dredging
   g. Management and mitigation of noise
   h. Response to submissions.

SUMMARY OF PROJECT NOISE ISSUES

8. Port Otago propose to deepen and widen the existing shipping channel to accommodate larger vessels. Dredges will operate along the channel, periodically motoring out to the offshore disposal areas and back. The dredging operation will produce noise from different operations; including up to two Trailer Suction Dredges and a Backhoe Dredge. The noise will propagate over the harbour to adjacent coastal areas and the houses along each side of the harbour. The noise at night (10pm to 7am) will be the most significant effect, as during the day, noise from other activity will mask the noise from the dredges.

9. Once the construction phase has finished there will be operational noise to consider. Over time cargo volumes will increase and therefore vessels will take longer to load/unload. There will be additional noise due to the longer duration that a vessel is in port, and an increase in the frequency of times when both of its two berths will be used. It should be noted that this increase in general port noise

and activity could occur as a result of increasing port activity even if the proposed development was not to take place or proceed.

EXISTING NOISE ENVIRONMENT

10. The noise effects from the construction of the channel widening project would be experienced along the sides of the channel and in areas around the swinging basin.

11. The channel passes close to small communities at Careys Bay, Deborah Bay, Waipuna Bay and Harington Point. In addition, there are a number of isolated dwellings at points along each side of the channel.

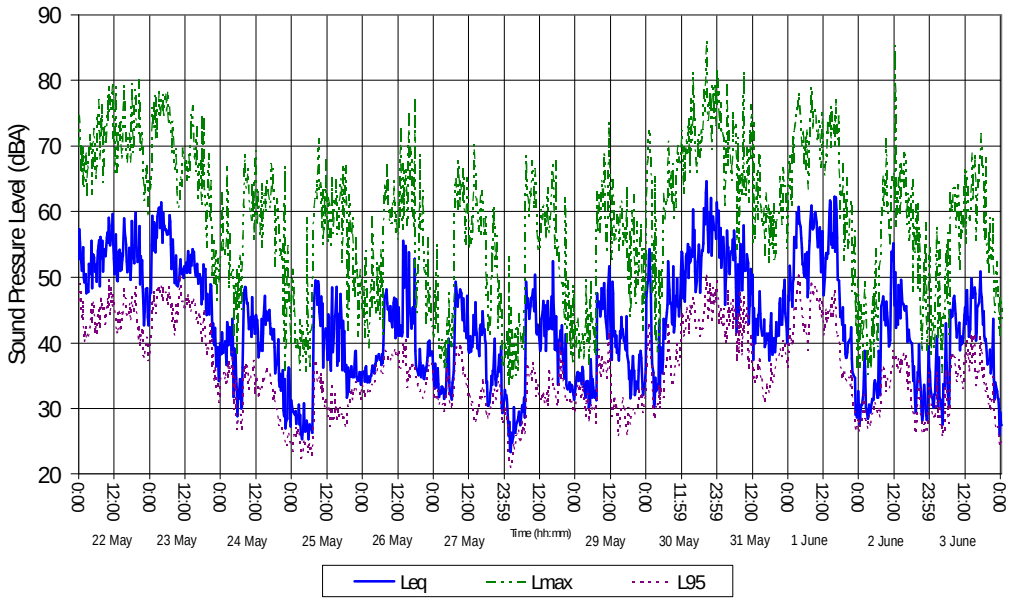
12. These settlements are well away from major roads or commercial activity and consequently the noise environment is mostly dominated by natural noise sources such as wind, sea, insects, birds and other animals, with at times contribution from human activity such as cars, farming and shipping using the harbour. It could be described as a quiet coastal environment, with many residents undoubtedly valuing the low noise levels as an important feature of the local amenity. To quantify the existing noise environment three noise monitors were set up at representative points along the Peninsula. The results are shown in Table 1.

Table 1: summary of Ambient Noise Measurements

Location	**L_{eq} Day dBA (mean and range)**	**L_{eq} Night (mean and range)**
30 Pakihau Road (Harington Point)	50 (57 – 44)	50 (57 – 30)
128 Aramoana Road (Deborah Bay)	54 (53 – 54)	42 (43 – 40)
26 Coomb Hay Tce (Careys Bay)	49 (52 – 43)	49 (55 – 40)

13. The results show the ambient noise environment is typical of a rural coastal area. At times when the weather is calm the ambient noise level can be as low as 25 dBA, particularly at night. But when the

weather is more unsettled, the noise levels can be 50 dBA or higher, right through the day and night. As an example in the figure below I show the noise levels measured at 30 Pakihau Rd between 22 May and 3 June 2010.



Ambient Noise measurements at 30 Pakihau Rd (22 May-3 June 2010)

14. It can be seen that the noise fluctuates over a wide range; the $L_{eq\ (15min)}$ varies from 25 dBA to 60 dBA. The quietest times are at night, where noise levels can go below 30 dBA on calm nights (e.g. around midnight on the night of 24/25 May). But at times the noise levels can be above 50 dBA for long periods (for instance from midnight on 22 May through to 6pm on 23 May, and from mid day on 30 May to mid day on 31 May) which is due to the noise from wind and waves. Noise levels are generally between 40 – 50 dBA during the day, but can at times be up to 60 dBA.

15. The ambient noise levels are higher in Port Chalmers and in Careys Bay due to port activity and a larger number of dwellings (which each generate some noise from domestic activity and car traffic). Noise data collected in surveys between 1997 and 2003 were reviewed. The ambient noise levels in these areas will not have changed appreciably since then. Careys Bay is mostly shielded from port noise except for higher street numbers in Harbour Terrace and some sites higher up

the hill. Noise sources are a mixture of natural sources such as wind, insects and birds, and low levels of traffic noise and other typical suburban sources, with the major noise source being trains (for instance Coombe Hay Tce and Ocean Terrace locations). At a typical location such 26 Coombe Hay Tce in Careys Bay the average daytime ambient level was between 43–52 dBA and the average night time level was between 40 to 55 dBA Leq although at times the ambient levels could be above 50 dBA for more than a day during bad weather, similar to what was observed at the other positions further up the harbour.

NOISE EMISSION

Dredging

16. Dredging will be generally be a continuous operation, but because the activity moves up and down the channel, the effects at any particular location will be quite intermittent. For instance, at any one location dredging activity might only be noticeable for a few weeks over the whole duration of the project, and within that period of a few weeks the noise would not be present continuously as the dredging activity will move up and down the channel, passing the location a few times over a period of a few hours.

17. There are different types of dredging operation that will be carried out, and these will use a variety of dredging vessels. These include a large Trailing Suction Hopper Dredge (TSHD) with an estimated sound power level of 112 dB, the existing small TSHD (the New Era) with an estimated sound power level of 110 dB, and a Backhoe or Grab Dredge with an estimated sound power level of 118 dB which is required to remove more difficult material. The primary noise sources on a dredge are the diesel motors that provide propulsion to the dredge. In addition there would be secondary noise sources such as generators, pumps and gearboxes. When heard from a distance the noise from a dredge would be perceived as a relatively steady noise, although atmospheric propagation effects would cause some gradual fluctuation of noise, depending on wind and temperature gradients and the noise would vary slowly as the dredge moved past the receiver.

The character of the noise would be similar to shipping which uses the channel.

18. Information on similar dredges has been supplied by two dredging companies and the New Era (owned by Port Otago) was measured. This data was used to predict noise levels along the channel. In the case of each dredge I have assumed a reasonable worst case sound power level, that could realistically be expected to occur. I understand that the sound power level used in the modelling will be used in any tendering process so that the dredging contractor would be obliged to use appropriate machinery.

19. The large TSHD would move back and forth along an area until full (about 80 minutes) and then motor out to the offshore disposal area, Site A0 and back, a return journey between 90 to 130 minutes. The dredging of the whole 12km channel would take up to seven months.

20. The small TSHD (New Era) is currently used for maintenance and would be used for Incremental Capital work. A typical cycle for the New Era would be up to 90 minutes to fill and 20 minutes to two hours to motor to the disposal areas and back. Dredging of the whole 12 km channel using the small TSHD would take place over many years.

21. The Backhoe dredge is used to remove harder material such as rock, which is present off Acheron Head, and Rocky Point. It might also be used on sand material on the eastern side of the swinging basin. The total time at each location would be a few days or weeks, with a total of six to seven weeks for the whole contract.

22. A noise model has been constructed for a large TSHD dredging off Acheron and Pulling Points, Figure 1 illustrates the situation. Because the dredge is always moving, the noise level at any point would not be continuous at one particular value. Typically, the dredge would dredge in a straight line for two to three kilometres, at a speed of two to three knots, then motor to the disposal area outside the heads at about 10 knots. Dredging for 80 minutes and then travelling out past the Heads before returning to the start point. The noise level is

averaged into a 15 minute assessment period, in accordance with accepted practice and the various noise Standards. In this case the whole cycle would take about 3¼ hours (200 minutes). The noise level at the receiving location would be up to 50 dBA at times as the dredge moves past the closest approach point, and then would reduce to low levels when the dredge travels out to the disposal areas. The noise levels are averaged over 15 minute periods, but because of the relatively slow movement of the dredge instantaneous levels should not be significantly higher. Within a 3¼ hour dredging cycle the noise level would be inaudible for well over half the time, and would be above 45 dBA for less than 40% of the time. The noise level has been calculated as a function of time at the closest dwelling in Hamilton Bay. This noise level has been superimposed on a plot of the noise level measured on a quiet day at the noise monitor in Deborah Bay.

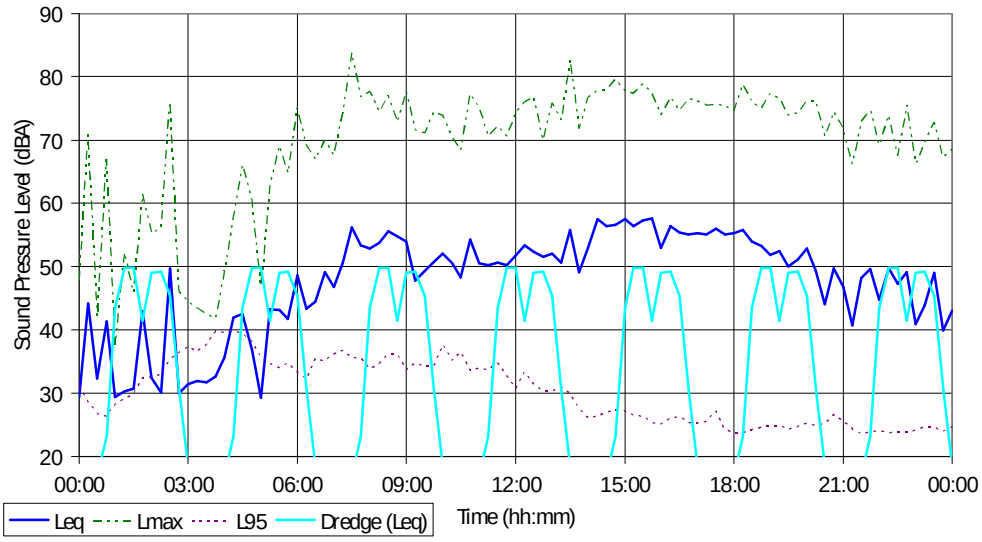


FIGURE 1 - Noise level of large TSHD super-imposed on measured ambient of a "Quiet" day

23. It can be seen that the noise from the large dredge would be up to 50 dBA as it passes at its closest approach, with a period of no noise from the dredge as it travels out and back to a disposal area. During the day the ambient noise level is generally higher than the noise from the dredge. There would be two to three dredging cycles over the

night time period (10pm to 6 am), when the dredging noise would be above the ambient noise level for periods of up to one to two hours.

24. Noise contours are shown in Figure 2 below. The coloured lines represent the highest noise level which might be reached at some time during the course of the dredging. As an example, it is estimated that the properties at Harington Point/Otakou which are between the yellow (45 dBA) and red (50 dBA) noise contours would be exposed to these levels intermittently over about 14 nights.

25. As another example, the red line (50 dB) passes through the closest dwelling in Hamilton Bay. It can be seen from my Figure 1 that 50 dB is reached for only a few 15 minute periods (when the dredge is at its closest approach) during the night-time period, and there are significant periods of quiet between.

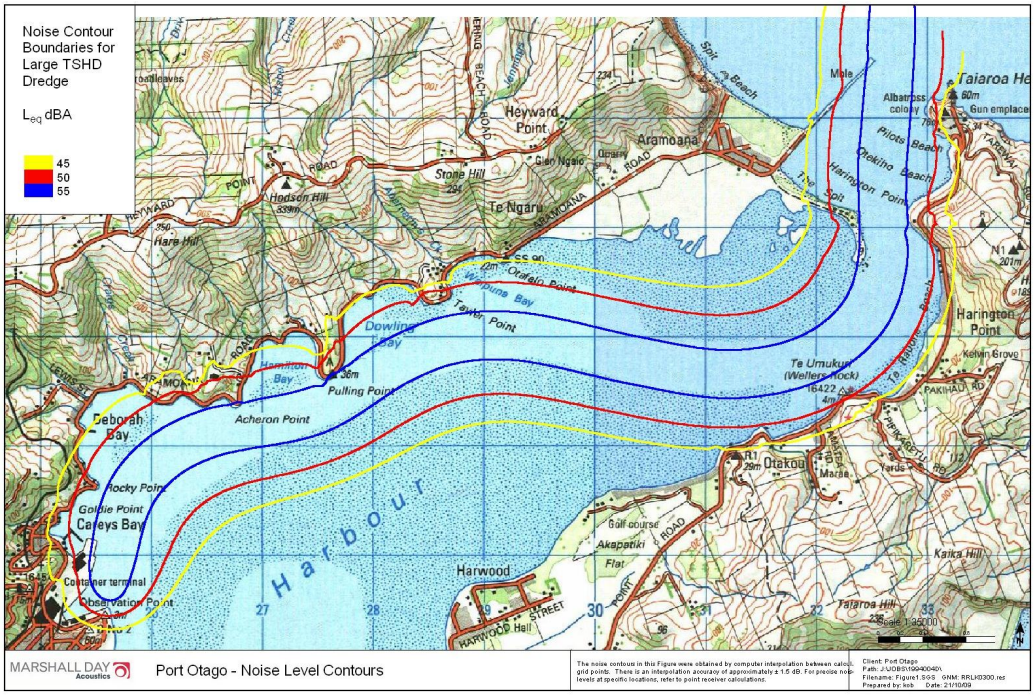


FIGURE 2 - Noise Boundaries for large TSHD operating along the channel

26. Note that these noise contours are for the larger TSHD, if a quieter dredge such as the New Era were used these noise contours would

shrink towards the channel. For instance with the New Era the yellow 45 dB contour would move about halfway towards the red 50 dB contour, the red 50 dB contour would then move about half way towards the blue 55 dB contour etc.

Operational Noise

27. Port Otago is applying to extend the multi-purpose wharf northwards to improve the operational efficiency of the Port during times of congestion involving container ships, cruise ships and log ships.

28. The larger vessels that are expected might at times be berthed and worked at the multi-purpose berth, although I have been informed by Port Otago that it is their preference to use the George Street (Container Wharf) berth for the larger vessels. Berthing and working the container vessels at the multi-purpose berth will move some of the noise sources further from the inner basin houses in for instance Scotia Street, Grey Street and Constitution Street, while moving it closer to Careys Bay.

29. Operational noise at Port Chalmers would also change over time. The vessel could potentially be berthed longer than current 4100's as there would be more containers to load and unload. There would be more machinery such as Straddle carriers, used to load and unload the vessel. However the increase would occur gradually over time as cargo volumes increase, the increase in noise would not occur suddenly.

30. I have modeled two scenarios. In both scenarios the vessel is berthed "bow out" with the noisier end of the ship facing Port Chalmers and away from Careys Bay. In the first scenario, the vessel (4100) is berthed and worked at the George Street Wharf (Container Wharf), this is effectively the current normal situation. In the second scenario the vessel (6000) is berthed and worked at the extended multi-purpose wharf which would potentially be the situation in the future at times when there is competing demands for the inner berths from cruise vessels. I have attached the detailed noise contours in

Appendix 1 to this evidence. I would like to summarise the conclusions broadly as follows:

a. The noise level in Port Chalmers residential areas decreases by about 1 dB with the vessel berthed at the multi-purpose berth, compared to the George Street berth.
b. The noise levels in Careys Bay generally increases by three to four decibels for the 6000 vessel at the multi-purpose berth, compared to the 4100 vessel at the George Street berth.

SUMMARY OF NOISE RULES

Construction Activities

Planning Documents

31. The proposed dredging activity would be carried out in the Coastal Marine Area of the Otago Regional Plan and would be subject to the provisions of that Plan. There are no noise rules contained in the Plan, but the Plan states:

"The objective and policy contained with this chapter give guidance to the consideration of activities that require resource consents under any or all of the other chapters of the plan.

32. The objective and policy sections contain the following:

Objective

"12.3.1 To manage and control noise levels with the Coastal Marine Area to minimise any adverse effect on amenity values, conservation values and the use of the Coastal Marine Area."

Policy

"12.4.1 In managing and controlling noise levels within the Coastal Marine Area:

a) Particular regard will be had to ensuring consistency with any noise control provisions or standards in any District Plan for adjacent land; and

b) Regard will be had to the New Zealand Standards NZS 6801 (1991), NZS 6802 (1991), NZS 6803P (1984) and NZS 6807 (1994); and

c) Regard will be had to any other relevant information relating to the emission and effects of noise, and the measures which may be taken to avoid, remedy or mitigate those effects; and

d) Regard will be had to the duration and nature of noise produced."

33. The noise effects would occur within the area covered by the Dunedin City Plan. Although the noise rules in this Plan may not directly apply to the activity, the Regional Plan as noted in a) above shall have *"particular regard to ensuring consistency with noise control provisions or standard in any district plan for adjacent land"*, such as this.

34. It is worth noting at this point that in the Dunedin City Plan the relevant noise control is Rule 21.5 which contains the following exemption:

"v) Exemptions

……

e) Construction noise , except within the Abbotsford Residential 6 Zone outside the period between 7.00 am to 7.00 pm Monday to Saturday inclusive, and all Sunday."

35. My interpretation of this exemption is that there is no specific rule to control construction noise in the Coastal Marine Area, and therefore other provisions of the Resource Management Act such as Section 16 (duty to avoid unreasonable noise) and Section 17 (duty to avoid, remedy or mitigate adverse effects) would govern activities.

36. After consideration of both Regional and District Plans my assessment is that there are no specific noise rules applying to construction activity in the Coastal Marine Area. Since the dredging would clearly be a construction activity, there are therefore, no specific noise rules applying to the proposal.

37. Thus for granting consent regard shall be had to the Construction Noise Standard NZS 6803P:1984, and to Sections 16 and 17 of the Resource Management Act.

Construction Noise Standard

38. Because construction noise is usually difficult to control, but is of limited duration, normal noise limits are inappropriate. A New Zealand Standard, NZS 6803 has been developed to provide a better assessment of construction noise effects. This Standard was published in 1984 and revised in 1999. The two Standards are quite similar and for this project the difference in noise limits would be small. It is recommended that the most recent Standard is used.

39. The recommended noise limits depend on the duration of construction and the time of day. The table below sets out the recommended limits.

Table 2: Recommended Upper Limits for Construction Noise received in Residential Zones and dwellings in Rural areas.

Time of Week	Time Period	Duration of Work					
		Typical Duration (dBA)		Short-term duration (dBA)		Long-term duration (dBA)	
		L_{eq}	L_{max}	L_{eq}	L_{max}	L_{eq}	L_{max}
Weekday	0630-0730	60	75	65	75	55	75
	0730-1800	75	90	80	95	70	85
	1800-2000	70	85	75	90	65	80
	2000-0630	45	75	45	75	45	75
Saturdays	0630-0730	45	75	45	75	45	75
	0730-1800	75	90	80	95	70	85
	1800-2000	45	75	45	75	45	75
	2000-0630	45	75	45	75	45	75
Sundays and Public Holidays	0630-0730	45	75	45	75	45	75
	0730-1800	55	85	55	85	55	85
	1800-2000	45	75	45	75	45	75
	2000-0630	45	75	45	75	45	75

40. Note that the definition of short term is work lasting 14 days or less, and long term is work lasting 20 weeks or more.

41. I have recommended to Port Otago Ltd that they should comply with these standards to the greatest extent practicable and they have accepted this recommendation.

Operational Noise

42. The use of the wharf extension would be covered by existing provisions in the Dunedin City Council District Plan. Rule 21.5 sets performance standards generally, but noise generated within the Port 1 Zone at Port Chalmers is specifically exempt (21.5(d)). Rule 21.5.2 sets noise mitigation standards for Port Chalmers and specifies that operations should be in accordance with the Port Noise Management Plan. Thus use of the wharf extension for port activities would come within the existing noise management regime and no new noise consents would be required. The Port Noise Management Plan has

four main aspects; firstly a duty to adopt the best practicable option to minimise noise, secondly to implement a Noise Mitigation Plan for the purchase or treatment of Noise Affected Properties, thirdly to establish a Port Noise Liaison Committee and fourthly to monitor noise on an ongoing basis. I understand that the Port Company will manage operations at the wharf extension appropriately under the Port Noise Management Plan

ASSESSMENT OF NOISE

Construction Noise

Small TSHD Dredge (New Era)

43. The operation has been carried out for many years. It is classed as long-term duration and is therefore required to meet 70 dBA between 7.30am and 6pm, and 45 dBA between 8pm and 6.30am with intermediate limits applying between these times, depending on the day of the week. During the day the measured noise level from this dredge (or a dredge of similar capacity) would comply with the construction noise limits at all houses. At night this dredge (or similar equipment) would be able to operate within the noise limit of 45 dBA provided it was no closer than 590 metres to any house. A significant proportion of the channel falls outside this restriction and no specific mitigation would be required in these areas.

Large TSHD Dredge

44. The predicted noise contours for the large TSHD were shown in Figure 2 of paragraph 25 of my evidence. These contours (which are worst case) indicate that very few if any dwellings are likely to be subject to above 60 dBA. Therefore, by reference to Table 2 of the Construction Noise Standard, it can be seen that the dredging activity would be within the recommended upper limits for long duration projects from 7.30 am to 8.00 pm weekdays, and 7.30 am to 6.00 pm Saturdays. Therefore dredging could be undertaken at these times in compliance with the standard. Exceptions are small areas (at Rocky Point, Acheron Point, Pulling Point and Tayler Point) for periods between 7.30 am and 6.00 pm on Sundays and Public Holidays where

the more stringent limits applying at these times are predicted to be exceeded.

45. However, dredging activity would in general be a 24 hour activity, and there would be periods when some dwellings would be exposed to noise levels at night which exceed the construction noise night-time limit of 45 dBA, albeit intermittently. I note that the draft consent conditions provide a limited exemption to complying with the 45 dBA limit for work on weekdays (8.00 pm – 7.30 am), Saturdays (6.00 pm – 7.30 am) and all of Sundays with the following provisos:

    i) where the residential dwelling has been acoustically treated;

    ii) where the occupier of the residential dwelling has consented in writing to the work taking place;

    iii) for vessel movements between the dredging area and disposal sites which form part of normal port operation vessel movements.

46. While there is some ability to carry out work at night on areas which are well away from residential areas, there would be periods when dredging activity at night time near residences is unavoidable. Based on estimates provided by Port Otago of the total duration of dredge for the Major Capital dredging for a 10,800m3, the durations are as follows:

    a. Harington Point/Otakou Community – 14 days;
    b. Te Ngaru/Waipuna Bay – 17 days;
    c. Deborah Bay – 35 to 30 days;
    d. Careys Bay/Port Chalmers – 50 days.

    Note that within these periods the noise levels would vary cyclically (as previously described) and would not be continuous. If a smaller TSHD dredge such as a 6,000m3, was to be the dredge to undertake the works, these durations would be longer, but as noted noise standards would be complied with.

47. Over a full week the Construction Noise Standard places a 45 dBA limit on about 50% of the total hours available. But I am informed by Port Otago that there is only a limited available volume required to be dredged in the channel that is further than 750 metres from any residence, at which distance a dredge would be below 45 dBA at all times (see fig 9). Of this available volume some is restricted or unproductive due to being contained within a short distance (which would require excessive turning movements) or it is within the entrance channel which will be unworkable at times due to swell. Therefore there are insufficient areas of the channel available to dredge at night during the 50% of the hours when the 45 dBA limit applies.

48. During the day, while the noise would be audible at coastal areas closest to the dredge, the noise levels are unlikely to cause any significant effects as noise levels would be similar to noise levels experienced in that environment already. For instance, noise levels from dredging would be unlikely to interfere with conversations outside or listening to a radio while gardening. Indoors the noise, while audible under some conditions, is unlikely to be disturbing.

49. During the periods when night-time noise levels from major capital works are in excess of 45 dBA (as per the draft consent conditions) there is the potential for some intermittent effects from the noise. This would depend on weather conditions at the time and the noise emission from the actual dredge used. But in the event of still conditions and the noisiest equipment, then noise levels of 45 – 50 dBA could be experienced at times for residences at Harington Point and Otakou, Waipuna, Deborah Bay and Careys Bay. Noise levels between 50 - 55 dBA could be experienced at times at Rocky, Acheron, Pulling and Tayler Points and the Spit.

50. These noise levels could disturb sleep and might cause annoyance and community complaints. While in many instances acceptable sleeping conditions could be achieved inside the dwelling with closed windows for external noise levels up to 50 dBA or more, it may not be practical or acceptable to have windows closed on all affected nights.

With open windows there may be disturbance to some residents at times Later in my evidence I will discuss mitigation measures that can be taken to address these issues.

Backhoe Dredge And Blasting

51. Noise from Backhoe operations off Acheron Head, Rocky Point and in the Port Chalmers Swinging Basin could produce noise levels at nearest dwellings above the construction night time noise limit of 45 dBA L_{eq} but below the day time limit of 70 dBA. The worst case Backhoe (118 dBA) could generate noise levels of up to 55 dBA at the closest houses in Careys Bay under neutral or favourable meteorological conditions. Therefore 24 hour operation of this type of dredge would be likely to cause adverse noise effects, except when weather conditions such as high winds, either cause a very high level of background masking noise, or moderate off shore winds cause a sound shadow in the landwards direction. Hence a dredge of this noise emission would be limited to day time operation to comply with the draft consent conditions.

52. For quieter Backhoe dredges (112 dBA) noise levels are predicted to be 45-48 dBA at the closest houses for typical work areas, and some parts of the operation at the eastern side of the Port Chalmers swinging basin could be carried out at night without exceeding the 45 dBA limit.

Underwater Noise

53. I was asked by Port Otago Ltd to make predictions of the underwater sound levels for both the blasting operation and the dredging operation.

Blasting

54. I have used the blasting records from the Beach St wharf in 1992/93 to derive a worst case relationship between underwater pressure and charge weight, using the basic relationships from other blasting documents. In short $Pc = 3{,}800\ (W^{1/3}/R)$ in kPa (where W is the weight per delay in kg) and R is the distance from the blast. I have derived a table below for a 5 kg charge and a 20 kg charge. The table

shows how far away you must be for the blast pressure to have reduced to a given level. I have prepared this table so that other people with expertise in marine animal behaviour can assess the effects of dredging and blasting noise on marine animals. Note my understanding is that we can have greater charges in total so long as there is an adequate delay between firing, so ten 5 kg charges could be used and if the detonation is delayed between them the effect will be as for a 5 kg charge. Note that this relationship gives lower blast pressures than the Australian Standard formula, but since it is based on an extensive set of measurements in the actual conditions and location concerned, and because I have used the upper limit of the blast pressures, it is reasonable to use this relationship.

Blast pressure (kPa)	Sound level (dB re 1 µPa)	Distance from blast in metres for 5 kg charge per delay	Distance from blast in metres for 20 kg charge per delay
3 kPa	190	2000	3000
10 kPa	200	600	1000
30 kPa	210	200	300
100 kPa	220	60	100

55. Circles of appropriate diameter could be drawn around the blast location to give us each sound contour level. These should be conservative as they are based on hemi-spherical spreading throughout the harbour. It is likely that there will be a significant reduction in blast pressure for propagation out of the channel, especially at lower tides. Given that the harbour is relatively shallow and the bottom is covered in sand it is unlikely I think that there would be any entrapment of blast energy in a narrow layer. Therefore hemi-spherical spreading should be a reasonable assumption.

56. I think it is unlikely that a significant pressure wave would travel past Aramoana, the attenuation involved in the 90° turn would be large.

Therefore it is unlikely that any effect could be detected past the heads.

Dredging

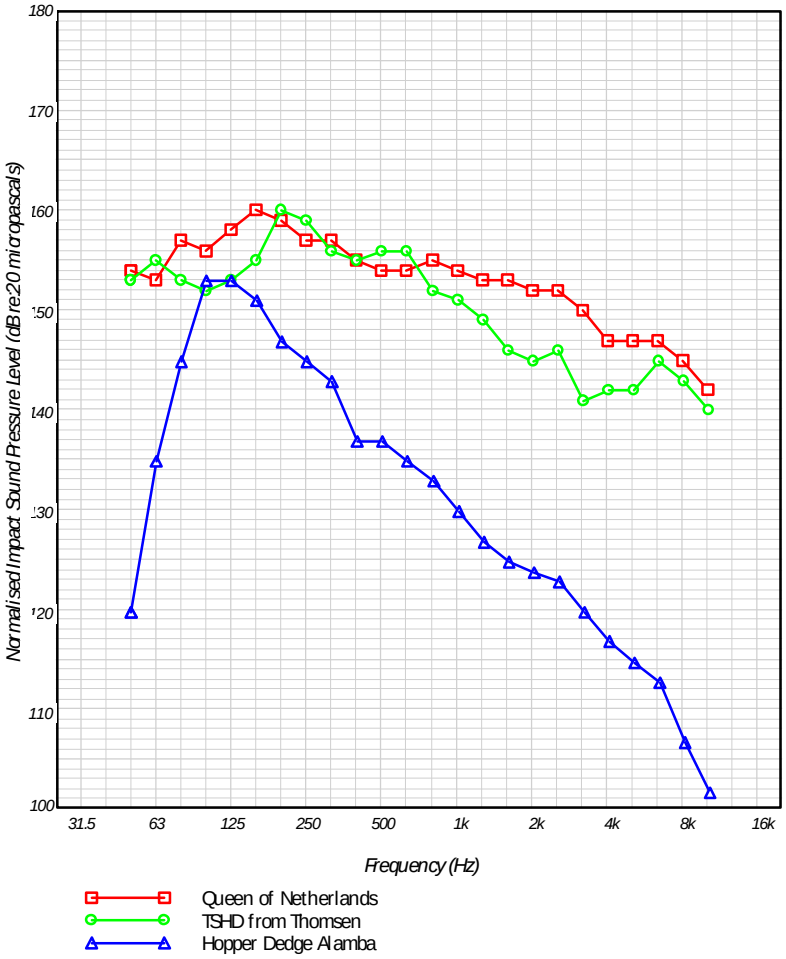
57. I have based my calculations of underwater dredging noise on information contained in Thomsen's survey of British data on marine dredging on underwater sound of TSHD dredges and the Melbourne project. I have used a level of 170 dB at 1 metre based on the New Era being at the lower end of dredge sizes (based on relative sizes of engine powers one would expect a dredge the size of the New Era to be 13 dB quieter than a dredge of the size of the Volvox Asia) and because the dredging material is sand (which is likely to produce less noise on the pipe walls compared to gravel). As comparison the Melbourne dredging data gives a level of 169 - 180 dB at 1 metre for the Queen of the Netherlands, a much bigger vessel. Based on the source level of 170 dB I have produced a table of underwater sound levels at given distances from the New Era.

Distance from acoustic centre of New Era (while dredging) (metres)	Sound level (dB re 1 µPa)
1	170
5	160
20	150
100	140
500	130
2000	120

58. Circles of appropriate diameter could be drawn around the dredge location to give us each sound contour level. These should be conservative as they are based on reduction with distance half way between hemi-spherical and cylindrical. This effectively allows for some reflection off the bottom of the sea, or some sound refraction off a warmer layer at greater depths in the open sea. In the harbour the distances are more realistic up and down the channel. Outside the channel the sound levels are likely to be less than expected for a

given distance because there will be some attenuation of sound as it travels out of the channel. Thus the distances quoted should generally be conservative.

59. In order for marine biologists to ascertain or assess effects on marine life it is necessary to know the relative frequency spectrum of the noise. Three representative spectra are given in the graph below. The spectra for Queen of Netherlands and the spectra from Thomsen are similar with the most acoustic energy between 50 Hz to 1000Hz, peaking around 200 Hz but with appreciable acoustic energy down to 30 Hz and up to 5 kHz. The hopper dredge from Alabama (USACE document) is however quite narrow band with significant energy only between 80 Hz to 300 Hz. To be conservative it would be best to assume a spectrum shape similar to the 2 upper curves (red and green lines)



Date: 25/03/2011

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Steaming

60. Note that the table above is applicable for the New Era while it is dredging. While it is motoring to the disposal grounds and back the noise levels is expected to be the same as similar sized normal vessels as it will be engine and propeller noise that are dominant and the dredging equipment is not operating. Thomsen gives a range of source levels for normal shipping of 160-180 dB at 1 m for small boats and ships, and 180 – 190 dB at 1 metre for large vessels. It would be reasonable to assume that the New Era is 5 dB quieter while motoring and therefore the table below could be used to give the expected level versus distance when disposing outside the heads.

Distance from acoustic centre of New Era (while steaming) (metres)	Sound level (dB re 1 µPa)
1	165
2	160
10	150
50	140
220	130
1000	120

Wharf Construction

61. Construction of the multi-purpose wharf extension would involve normal construction operations and would include piling, trucking of fill material, concreting and paving. Piling is likely to be the loudest activity and might be carried out by a variety of techniques; however the noisiest method is understood to be “top driving”. The nearest house is approximately 350 metres away in Careys Bay and calculations of the noise level at the nearest residence due to piling, using this method, predict a noise level of 65 -70 dBA L_{eq}. Thus all wharf construction activities are predicted to comply with the construction noise limits of NZS 6803:1999 for weekdays and Saturdays between the hours of 7.30 am and 6.00 pm.

Operational Noise

62. Port operational noise levels have been predicted for two different scenarios for the new 6000 TEU class vessel. If the vessel were to berth bow out and be worked at the George St wharf (Container Wharf) then noise levels would be insignificantly different from current noise levels for both Port Chalmers and Careys Bay. No change in noise effects currently experienced would be expected. If the new vessels were to be berthed bow out and worked at the multi-purpose berth then the noise levels in Port Chalmers are predicted to decrease by 1 dB which is insignificant, but are predicted to increase in Careys Bay by up to 3-4 dBA. Of course the increase would be gradual as the volume of cargo would only increase over a number of years . The increase in noise over time would be just discernable and is predicted to bring about ten or twelve houses inside the 55 dBA L_{dn} contour and perhaps two or three houses of them inside the 60 dBA L_{dn} contour. These houses would then be Noise Affected Properties according to Rule 21.5.2 in the Dunedin City District Plan and would be subject to the provisions for noise insulation in the Port Noise Management Plan.

NOISE MANAGEMENT AND MITIGATION

63. In accordance with Sections 16 and 17of the RMA it is recommended that in addition to all practicable steps being taken to reduce the noise levels and its effects through careful management of the activity, where this is not possible, that some form of mitigation of the effects is undertaken.

Construction Noise

64. There are a number of mitigation measures that have been developed and included in the proposal. These include the selection and use of the quietest practicable equipment that is capable of carrying out the work, and the programming of work in particular areas to limit night-time exposure to residences. The maximum sound power level emitted by the dredges for the major capital dredging, and the backhoe would be specified in the tender documents as based on noise levels used in the modelling work, and incentives would be investigated to further reduce the sound power level as far as

practical. These factors would be an essential component of the tendering process and the noise levels of equipment and the management of the contractors work programme to minimise disturbance of residential areas would be a key factor in evaluating tenders. If it is possible to achieve a sound power level lower than 112 dBA for the large TSHD dredge then the areas that could be dredged at night without exceeding 45 dBA Leq15min would increase significantly.

65. In addition there could be opportunities to take advantage of meteorological conditions that either mask the noise from the dredge, or that reduce noise propagation in a particular direction.

66. A noise monitoring programme would be carried out at the beginning of the major capital dredging programme to confirm actual noise levels compared with the predictions contained in this report and indicate when it might be possible to take advantage of favourable weather conditions to minimise noise at certain sensitive locations. This would allow more precise identification of the houses that could be exposed to noise levels over 45 dBA, the likely extent of the exposure and how it might be minimised. Once the exposed dwellings are identified then individual owners would be consulted.

67. A range of mitigating options would be investigated in consultation with each resident. In some cases the location of bedrooms may be such that they are shielded to some degree, and actual exposure of the bedrooms could be within acceptable limits. This might be the case when bedrooms are located at the rear of a house facing away from the harbour. In other situations it may be possible to offer temporary measures to improve the sound insulation of bedrooms. People's response to noise is variable, and the best option for mitigation will vary accordingly. In some cases re-location to a motel for a few nights might be an acceptable mitigation measure, while in other cases this may be seen by a resident as more disruptive than the noise.

68. In addition to the mitigation measures discussed above, a continuing programme of communication with the local communities will be invaluable in keeping residents informed. This would include making the dredging schedule public on Port Otago's website on a monthly basis so that residents would be aware of expected dredging activity and know the likely extent and duration. It is generally found that the degree of community disturbance is reduced when the duration and extent of noisy activities is well communicated and understood. In addition communication with residents would include contact numbers for registering complaints or feedback, and there would be a defined procedure for registering and responding to complaints. These mitigation measures have been addressed in Port Otago's proposed Environmental Management Plan.

BACKHOE DREDGE AND BLASTING

69. The Backhoe dredge would involve similar considerations as discussed above for the large TSHD dredge such as selection of tenders to minimise noise output of equipment, programming of work, and community consultation. For a noisy Backhoe dredge (118 dBA) however, additional mitigation options such as temporary treatment of bedrooms or temporary relocation of occupants would be unlikely to be practical because of the large number of dwellings involved. For a quiet Backhoe dredge (112 dBA) the mitigation options would essentially be similar to that of the large TSHD and so work in some areas at night may be able to be carried out within the 45 dBA limit.

70. Blasting work would be carried out during the day time only and this contract would have conditions to require compliance with the Construction Noise Standard.

Noise Monitoring During Construction

71. In addition to the initial monitoring of the noise emission of the large TSHD dredge to define the 45 dBA contour, spot noise monitoring would be carried out in response to residents requests where there is evidence of potential exceedance. A contact point would be given in the material distributed to local communities, so that people wanting to

have the noise exposure at their house monitored can request that someone come to their house and measure the noise level. This would act as a check on any variations to conditions or assumptions that might occur, and would provide reassurance that work is being undertaken in accordance with what has been outlined in this report.

Operational Noise

72. For operational noise following the berth extension it is anticipated that noise mitigation would be required for about ten or twelve houses in Harbour Terrace in Careys Bay. This may not be required immediately as the initial lower loadings would not increase noise levels significantly. Results from the permanent noise monitor at Careys Bay and annual noise contour predictions based on forward projections would be provided to the Port Noise Committee to decide on the timing of this work. The mitigation would involve individual assessment of each house, design of walls, floors, ceilings, roofs, windows, doors and ventilation in order to meet an internal noise level of 40 dBA L_{dn} in all habitable spaces of the house when exposed to the noise level predicted by the contours (plus a 3 dB margin). This work would become part of the programme overseen by the existing Port Noise Liaison Committee and as with current work in Port Chalmers once work is complete would require a certificate of compliance with the noise mitigation plan requirements.

SUBMISSIONS

73. I have read the submission on these applications. There are twenty five submissions that have concerns with noise. These include the submission from the Careys Bay Association (CBA) [submitter 174] with 40 signatures, some of whom may have also made a personal submission. I would like to respond to the submissions.

Careys Bay Association

74. In broad terms the submissions consider that the existing noise environment is already unsatisfactory (with particular mention made of container impacts), and that extension of the multi-purpose wharf will

inevitably lead to increased noise spill into Careys Bay and Deborah Bay.

75. CBA are concerned that the existing level of Port noise (which they consider unreasonable) would increase significantly. They identify a number of factors that would lead to this. These factors include general increase in Port activity, the larger ships, and ships berthing closer to Careys Bay. I have taken into account all the factors they have identified and so I am confident the noise model I have used to predict noise levels is well founded and covers their area of concern.

76. As I have noted in my evidence, with the 6000 TEU vessel at the George Street wharf (Container Wharf) no discernable difference in noise is predicted. With the 6000 TEU vessel at the multi-purpose berth the noise in Careys Bay is predicted to increase generally by 3 – 4 dB while the ship is being worked compared to the current situation of a 4100 working at the George St berth. This would be an appreciable increase for that period of time, and would require 10 – 12 houses to be included in the sound insulation programme. Houses not included in the sound insulation programme, because they are outside the 55 dB L_{dn} contour would also experience increased noise levels of 3 – 4 dB for this period. At times at night, these noise levels could exceed normal District Plan noise levels, which is undesirable. However, the complex and difficult issues involved in the setting of a noise regime for Port Otago were canvassed at great length during hearings in 2003 and subsequent Environment Court decision on April 2004, leading to the current Noise Management regime within the district Plan I will touch on the history of the regime shortly. This has been in operation for a number of years and appears to have been successful in dealing with long standing noise issues arising from the container operation that affects the Port Chalmers residences

77. The Noise Management Plan places responsibilities on the Port Company to reduce noise at source as far as practicable, and I understand that noise issues are taken very seriously when purchasing new equipment. The current fleet of straddle carriers are fitted with hush kits which have reduced noise very considerably

compared to the earlier generation of straddle carrier. The Port has an ongoing programme of training to ensure operators appreciate the need for care when carrying out potentially noisy operations such as picking up or putting down containers. The Port operates two continuous real time noise monitors, the results from which are reviewed daily and summary reports provided to the Noise Liaison Committee on a regular basis. In my experience the Port Company takes its responsibility to reduce noise very seriously.

78. The CBA submission has several comments on the adequacy of the noise modeling. I note that a peer review of our noise model has recently been carried out by Hegley Acoustic Consultants and the conclusion of this review was:

> *"Based on the above I am of the opinion that the method adopted to predict the port noise, and the calibration of the noise model undertaken has provided noise contours that are as reliable as any noise predictions can be expected to be and as such may be accepted with a good level of confidence".*

79. The CBA criticises the ambient noise measurements applying to Careys Bay, as they include noise from the Port, and assert that because the noise levels were obtained before 2003, they do not provide a true representation of the existing environment. Therefore, they say predicted noise levels based on old data are under-estimated.

80. The ambient noise surveys are used only to establish the noise climate of an area, and are not used in the predictive model. Therefore, no under-estimate of future noise levels is possible. The comprehensive noise surveys in Careys Bay undertaken before 2003 showed it to be a relatively quiet area, similar to areas on the southern end of Port Chalmers. I have no reason to consider that this has changed significantly between 2003 and 2009. It is worth noting that a change of ambient levels of 2 – 3 dB either up or down would have no effect on my assessment. I also note that Port Otago has recently installed a permanent noise monitor near the cemetery that is

positioned to monitor noise that would be heard in Careys Bay. This monitor has been in operation since mid 2009 and will provide a valuable tool for monitoring noise at this end of the Port. It provides a 24 hour record of the noise levels (summarised in 15 minute blocks) on an ongoing basis.

81. Another issue raised by CBA is that the larger 6000 TEU vessels could be louder than the current 4100 TEU vessels. In my view this is unlikely. The noise emission of the 4100 vessels was quite unexpected when they arrived, and was out of all proportion to the increased capacity of the vessel. In my opinion, they were badly designed (from a noise point of view) and no consideration had been given to noise emission. This is confirmed by noise measurements on the new series of 4100 class vessels which are 3-4 dB quieter than the same size of earlier 4100 vessels. I think it is likely that the 6000 TEU vessels will be no louder than the new series of 4100 vessels.

Deborah Bay Residents Association

82. I have read the Deborah Bay Residents Association (DBRA) submission [submitter 152]. They are concerned that noise effects from the Port, which can already be heard in Deborah Bay will significantly increase with this proposal, leading to increased sleep disturbance and affect health and wellbeing.

83. I have carefully considered this and my opinion is that absolute noise levels are unlikely to increase in Deborah Bay. If, as I consider likely, the 6000 vessels are quieter than the current 4100 vessels, then some small reduction of noise levels may be achieved. There would, over time, be a longer duration of noise as the 6000 vessel would be in port for longer periods of time as the cargo volumes increase, but overall I do not think that there will be an increase in effects of noise in Deborah Bay.

84. A number of submissions find current noise levels unacceptably high and have a number of criticisms of our noise assessment report, primarily for the aspects dealing with operational noise.

85. I think it would be helpful to briefly summarise the background to the control of operational noise from the Port Chalmers Industrial Area, the area where the operational noise would be generated. Noise from the operation of the Port had been an issue for a number of years with a history of disagreement and litigation. The many complex issues were thoroughly canvassed in an appeal to the Environment Court in 2003, which after hearing all the evidence, decided upon the current noise management regime. From an acoustical point of view there are a number of very difficult factors involved: port operations are conducted outside, with large and powerful machinery, which can only be quietened to a certain degree; the Port has no effective control over ship noise, trucks or rail noise: there is a necessity to load and unload ships at night when sensitivity to noise is heightened; and the Port is bound by geography to be where it is and cannot practicably be moved. The situation is made more difficulty by the dynamic nature of the Port scene, with changes to trades, shipping lines and vessel happening very quickly, and with little lead time and driven by the shipping companies not the Port Company. On the other hand the noise levels experienced by residents are higher than desirable levels for residential areas, and can lead to adverse effects, the most serious being disturbance to sleep at night.

86. The solution decided upon by the Environment Court was essentially to provide a means for the Port and the nearby community to co-exist, even if it was not ideal for either party. It was accepted that the outdoor environment could not be reduced to desirable residential levels, but that an acceptable indoor environment, including the affected bedrooms, could be created by upgrading the sound insulation of houses. The internal noise environment was set at 40 dB L_{Adn} for the worst 5-day period of the year. This was accepted as a good internal noise design level. The houses were divided into four categories or levels of noise exposure: above 65 dB L_{Adn}; between 65 – 60 dB; 60 - 55 dB and below 55 dB. For the highest level of noise exposure residents were offered the choice of purchase of the property by the Port, or acoustic treatment to the required standard, to be provided by the Port. For exposure between 60 - 65 dB L_{dn} the

Port is required to contribute to the costs of acoustic treatment but may also make an offer to purchase. For exposure between 55- 60 dB L_{Adn} the Port is required to offer technical advice to noise affected properties and may offer to contribute to the cost of acoustic treatment.

87. The Acoustic Treatment programme has now been operating for a number of years, starting with the most affected properties. I have been involved with the acoustic design for a large number of properties, and with issuing Acoustic Certificates when work is complete and the testing has shown that the design level has been achieved in all rooms. The testing of each completed property provides assurance that the acoustic work has been installed correctly and the design was sound. The programme appears to be successful and I am not aware of any complaints from people who have had the acoustic treatment carried out.

88. A number of submissions [29,67,125,172 specifically] note that the noise which affects them the most is neither ship noise or straddle carrier noise, but rather the impact noise from handling of containers. Now this noise often does not affect the overall daily average noise (L_{dn}) on which the Noise Management Plan acoustic treatment classifications are based. A better method of dealing with the effects of this impact noise could lie in better training and use of equipment by the Port Company, and is the type of issue that the Port Noise Committee is intended to address and, as I have already noted, is an issue that the Port Company takes very seriously.

89. A number of submissions [128,140,172] are critical of the noise modeling as it pertained to Careys Bay. I have already noted that the noise model has been independently peer reviewed by Hegley Acoustic Consultants, who were satisfied that it provided reliable results and the calibration of the model was satisfactory. I would like to comment on the simple analysis undertaken by Dr Hall [Submitter 172] using a 460m radius *"noise impact buffer".* This approach is a reasonable approximation to the way noise propagates over a flat hard

surface, such as water. However, there are several very significant drawbacks when applying it to the situation of Port Chalmers and Careys Bay. The most important is that noise tends to travel in more or less straight lines, and where there is an obstacle between source and receiver, that a large amount of the noise is blocked. Sound waves do bend around an obstacle to some extent, and so the acoustic shadow is not complete, but nevertheless 10 dB or more attenuation can be experienced. In this case the very substantial hill between much of the Port and Careys Bay shelters much of the noise. The noise model takes this into account by drawing a line between each source on the Port (of which there are many scattered up and down the wharf) and a grid of receiving positions, calculating the effect of the hills for each path. This is a complex and time consuming procedure best undertaken by a computer. Another secondary effect is that sound is absorbed by grassland or forested areas and the noise model also takes this into account. Thus it is not useful in this situation, where there are many noise sources with a complex topography, to draw simple circles to represent noise affected areas, and the noise contour derived from the noise model I have developed are a more accurate and realistic basis for assessment.

SUMMARY AND CONCLUSIONS

90. I have carried out an assessment of the effects of the proposal to deepen and develop the shipping channel in Otago Harbour and extend the multi-purpose wharf. Ambient noise surveys have been undertaken at representative locations and the noise environment has been found to be typical of a rural coast environment. During calm periods the environment is quiet, with low noise levels. During periods with high winds the environment can be noisy, with ambient levels of 50 dBA or more.

91. An examination of the relevant District and Regional Plan rules indicates that there are no specific noise limits that would apply to the dredging and other construction activities, although the Regional Plan notes that regard should be had to the Construction Noise Standard and I have used this as the basis of assessment. The operational

aspects of the wharf extension are covered by the Noise Mitigation Plan for Port Chalmers.

92. Noise levels have been predicted for the small and large TSHD dredging activity. Worst case noise emission and sound propagation have been assumed. Dredging would be a 24 hour activity with similar noise levels at night as during the day. The noise levels at any one receiver would be intermittent, with effects experienced for only a small proportion of the duration of the dredging contract, and only at times within any particular period. The predicted noise levels indicate that during the daytime significant noise effects are not expected, and compliance with the Construction Noise Standard should be achieved. At night, noise levels could be at times above the 45 dBA limit of the Construction Noise Standard provided that the mitigation work specified in the draft conditions is undertaken. The times when the noise exceeds 45 dBA is likely to be only at a limited number of locations and for a few periods at night (of up to an hour and half each as shown in my earlier figure 1) and only for a limited number of nights (14 – 50 depending on location and whether a large or small TSHD is used) and spread over many months of the project.

93. Mitigation measures that would be used to achieve compliance with the night time noise limit of 45 dBA include programming of night-time activity away from residential areas, reduction of dredge noise as far as practicable, taking advantage of weather conditions that either raise the background noise, or reduce sound propagation in particular directions, and reducing internal noise levels in bedrooms where possible (e.g. by enabling windows to be closed without reducing necessary ventilation). An active consultation programme would be undertaken to inform people of the extent and duration of the dredging activities as it might affect them. I have read the Environmental Management Plan and draft consent conditions and support the provisions as they relate to noise.

94. Overall it is considered that noise effects from small and large dredging are likely to be minor. The draft conditions provide mitigation measures that must be in place for those situations where the night-

time limit of 45 dBA cannot be achieved. The times when noise would exceed 45 dBA at night would be limited to a few periods and at any particular location would occur for a limited number of nights. The nature of the noise would be similar to existing noise sources such as shipping and is therefore, less likely to be disturbing.

95. I have carried out calculations of underwater noise from both blasting and dredging activities and this information has been provided to other members of the team to assess the effects on marine animals.

96. Operational noise from the wharf extension has been predicted for two scenarios. For the scenario in which the new 6000 TEU class vessel uses the George Street Container Terminal wharf there would be no discernable change in noise effects compared to the current situation and no adjustments would be required to the programme of house insulation that is currently in progress. For the scenario where the new vessel is berthed and worked at the extended multi-purpose berth there is a small, probably insignificant reduction in noise at Port Chalmers, but a gradual increase in noise in Careys Bay over time as port cargo volumes increase. This would require up to 12 houses in Harbour Terrace to be included in the sound insulation programme, with 2-3 of these being in the 60 - 65 dBA zone which could involve upgrading of the dwellings or an offer to purchase properties as set out in the Port Noise Management Plan.

Keith Orsbourn Ballagh