HEGLEY ACOUSTIC CONSULTANTS

# LYTTELTON PORT OF CHRISTCHURCH

# COAL STOCKYARD EXPANSION PROJECT

# ASSESSMENT OF NOISE EFFECTS

**Report No 8479**

**Prepared for**:
Lyttelton Port of Christchurch
Lyttelton
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## 1 INTRODUCTION

Lyttelton Port Company Limited (LPC) is proposing to expand coal storage facilities at Lyttelton Port to cater for increased coal throughputs. As part of the proposed expansion LPC is seeking resource consents to reclaim approximately 10 hectares of Te Awaparahi Bay, Lyttelton Harbour for port activities. The proposed reclamation would extend into Te Awaparahi Bay from the existing coal stockyard as shown on **Figure 1**.

The additional space would accommodate a projected long-term increase in coal from West Coast mines, particularly additional coal from Pike River Coal Ltd. The expansion would also allow for a larger number of stockpiles, of differing coal products. , This assessment of noise effects is therefore based on the reclaimed being used as a coal handling and stockpile area.

It is possible the approximately 10ha reclamation footprint will not be constructed in one stage. Initial expansion of coal stockyard is likely to include the redesigning of the existing yard (i.e. introducing new loading and unloading conveyors) and the initial construction of a smaller reclamation.

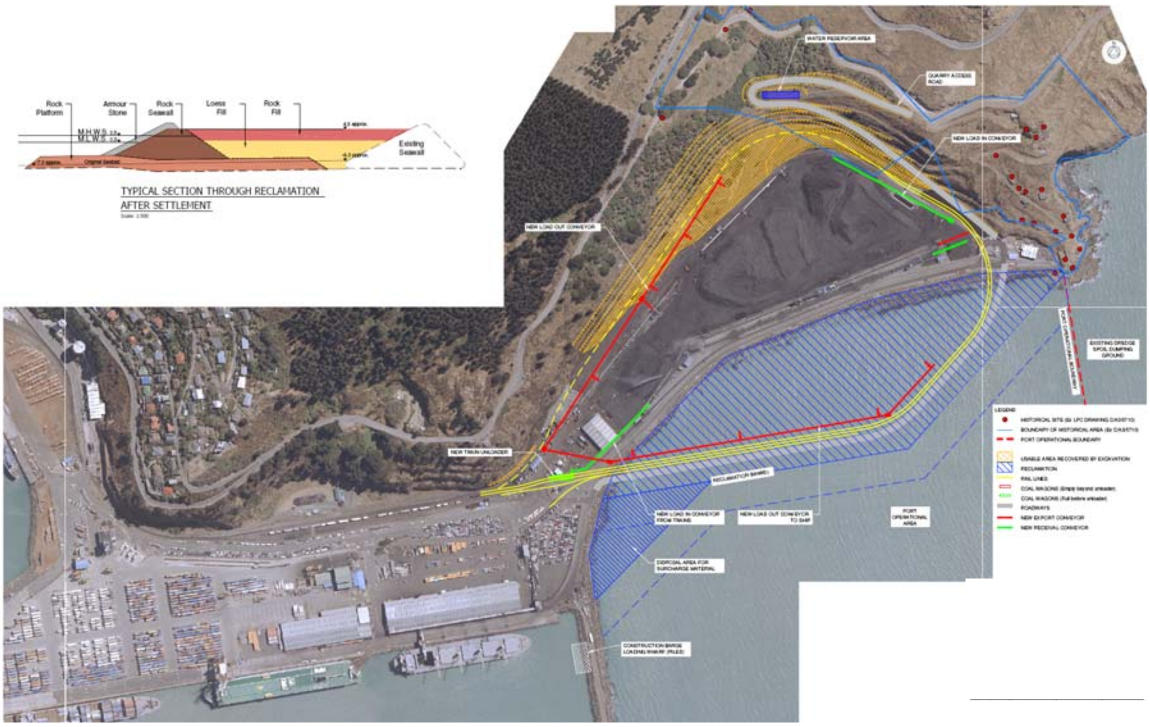



**Figure 1. Proposed Reclamation Area**

The material to be used for the reclamation will predominantly come from the Gollans Bay quarry. However, the Te Awaparahi Bay hillside may also be excavated to provide more area for coal storage (about 2ha) and also to provide some of the material for the 10ha reclamation.

This report considers the noise[1] and vibration effects from the proposal and how the site will be designed and managed to ensure the noise is controlled to within the noise requirements of the Banks Peninsula Proposed District Plan.

[1] See Appendix A for a Glossary of Noise Terms

## 2 DESIGN REQUIREMENTS

The existing coal stockyard at Te Awaparahi Bay is zoned Lyttelton Port under the Banks Peninsula Proposed District Plan (now administered by the Christchurch City Council Plan). Port activities, including coal handling, are a permitted activity in terms of the requirements of the District Plan. However, the reclaimed land will require a land use consent as it is outside the district boundary and does not currently have a zone. Reclamation will take place within the Operational Area of the Lyttelton Port of Christchurch, as defined in Environment Canterbury's Regional Coastal Environment Plan.

Rule 33.2.1 Port Noise Management Plan (Updated April 2007) requires that a Port Noise Management Plan be prepared to include (amongst other things) the following:

- *Lyttelton Port Company Limited in conjunction with the Port Liaison Committee*

- *Develop noise modelling, monitoring and measurement procedures that follow the concepts in NZS 6809: 1999, for the purpose of preparing a Port Noise Contour Map that shows each individual contour line above the 65dBA $L_{dn}$ contour inland of the Lyttelton Port Zone (e.g. 65, 66, 67dBA $L_{dn}$ contours etc.). This Port Noise Contour Map is to be attached to the Port Noise Management Plan and is to be regularly updated as required by the Port Liaison Committee and at the expense of the Lyttelton Port Company Limited.*

**Figure 2** shows the current Port Noise Contour Map.

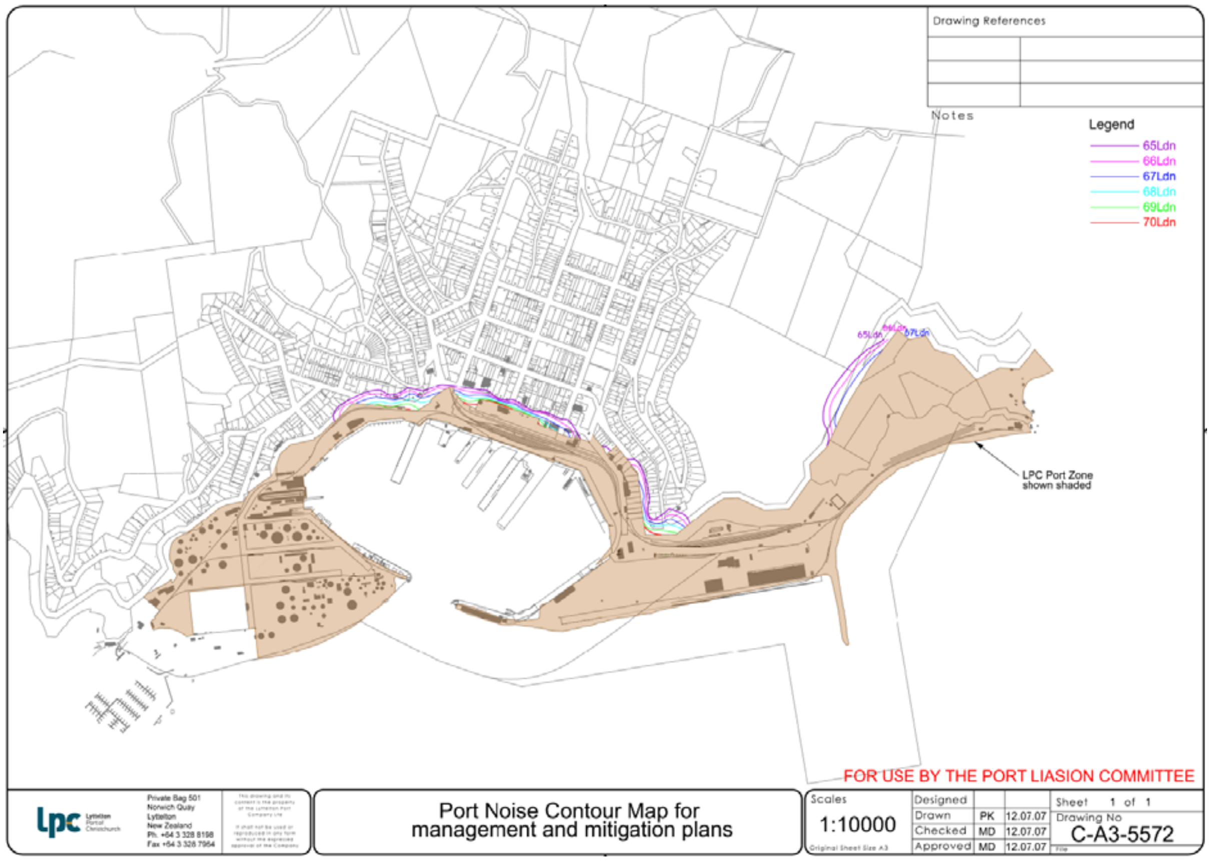



**Figure 2. Port Noise Contour Map**

The quarry site is located in the Rural Zone above a closed refuse disposal site as shown on **Figure 3**.

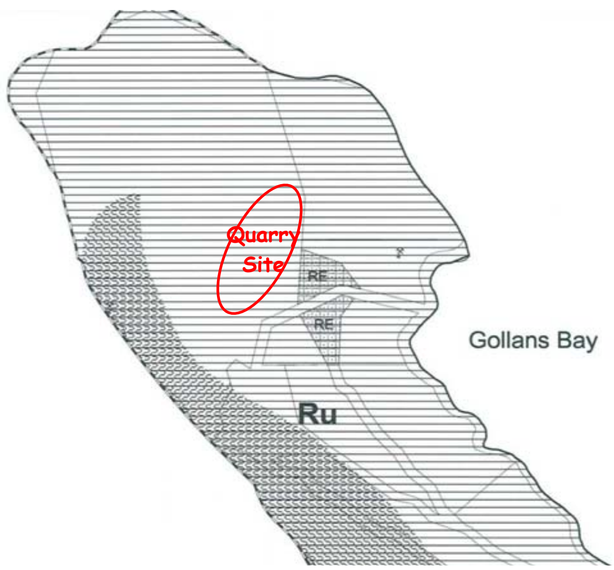



**Figure 3. Existing Quarry Location**

Across the Lyttelton Harbour there is a residential and rural zone at and around Diamond Harbour as shown on **Figure 4**.

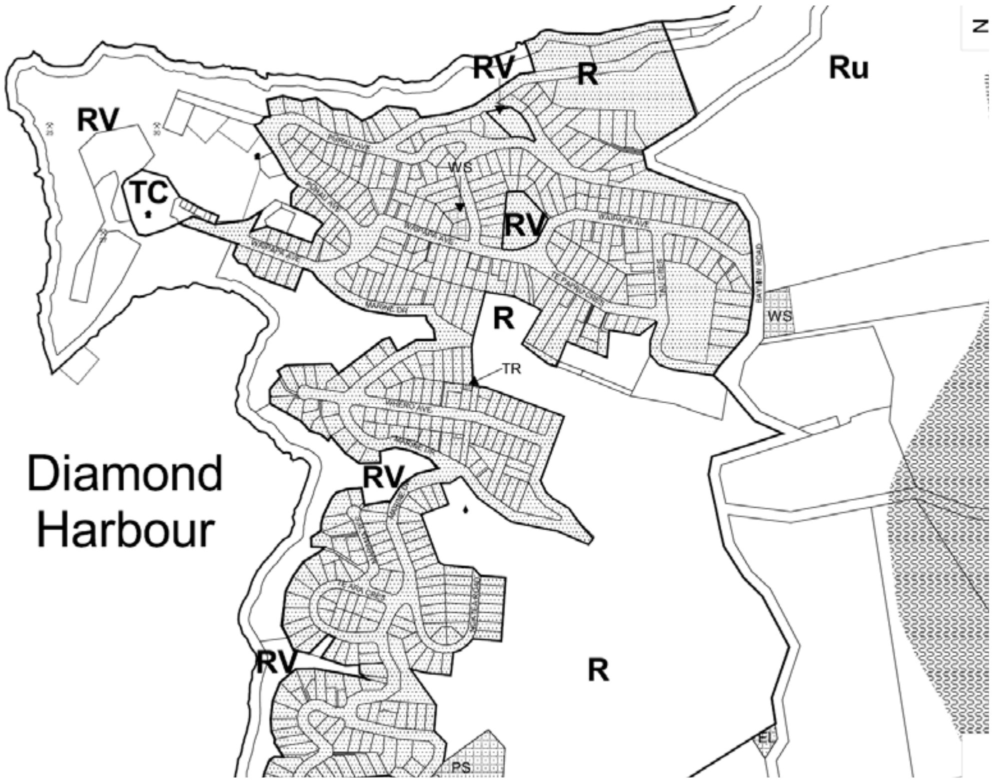



**Figure 4. Zoning in the Diamond Harbour Area**

Rule 33.1.4 of the Banks Peninsula Proposed District Plan sets the following noise requirements for an activity carried out in the Rural Zone.

> *All activities shall be designed and conducted so as to ensure that the following noise limits are not exceeded at any point within the notional boundary of any dwelling, other than a dwelling on the same site:*
>
> - *At night-time - 40dBA ($L_{10}$)*
>   *70dBA ($L_{max}$)*
> - *At all other times - 50dBA ($L_{10}$)*

Blasting at the quarry will be required to fracture the rock. Rule 33.1.6 Blasting, of the Banks Peninsula Proposed District Plan sets the following noise limits for any blasting activities:

*Where blasting is undertaken as part of a permitted or controlled activity, vibration from the site shall not exceed a peak particle velocity of 5 mm/sec, provided that this level may be exceeded on up to 5% of the total number of blasts over a period of 12 months. The level shall not exceed 120dB (Lin peak) at any time.*

*Airblast overpressure from blasting on any land shall not exceed a peak non-frequency weighted (linear or flat) level of 115dB provided that this level may be exceeded on up to 5% of the total number of blasts over a period of 12 months. The level shall not exceed 120dB (Lin Peak) at any time.*

Rule 33.1.5 of the Proposed District Plan sets the following noise controls to be complied with in all parts of the District not referred to in Rules 1.1 to 1.4 above.

*Any activity shall be designed and conducted so as to ensure that the following noise limits are not exceeded at any point outside the site boundary:*

- *At night-time -* 40dBA ($L_{10}$)<br>70dBA ($L_{max}$)
- *At all other times -* 50dBA ($L_{10}$)

*Where blasting is undertaken as part of a permitted or controlled activity, vibration from the site shall not exceed a peak particle velocity of 5 mm/sec, provided that this level may be exceeded on up to 5% of the total number of blasts over a period of 12 months. The level shall not exceed 120dB (Lin peak) at any time.*

*Airblast overpressure from blasting on any land shall not exceed a peak non-frequency weighted (linear or flat) level of 115dB provided that this level may be exceeded on up to 5% of the total number of blasts over a period of 12 months. The level shall not exceed 120dB (Lin Peak) at any time.*

Rule 33.1.8 of the Plan requires the measurement and assessment of noise to be undertaken in accordance with the following requirements:

- *Where standards for noise are specified the measurement of noise shall be in accordance with NZS 6801:1991, 'Measurement of Sound' and assessed in accordance with NZS 6802:1991, 'Assessment of Environmental Sound'.*

- *For the purposes of administering the rules of this section of the Plan the following meanings shall apply:*
    - *dBA means the A-frequency weighted sound pressure level in decibels relative to a reference sound pressure of 20 micro pascals.*
    - *$L_{10}$ means the $L_{10}$ exceedance level set in A-weighted decibels which is equalled or exceeded ten percent of the total measurement time.*
    - *$L_{max}$ means the maximum A-frequency-weighted sound level (dBA $L_{max}$) during a stated time period.*
    - *Night-time means the period of time between 10 pm and 7 am the following day.*
    - *Long-term average sound level shall be the time-average sound level (day-night level) $L_{dn}$ and shall be determined from the inverse-logarithmic mean of the measured Ldn level for each day over any five day period within a week.*
    - *The 'notional boundary' of any dwelling shall be 20 metres from the façade of that dwelling, or the legal boundary of the site where this is closer to the dwelling.*

Rule 33.1.7 of the Banks Peninsula Proposed District Plan sets the following noise control for construction noise.

*1.7 Exceptions*

*The noise limits set out in Rules 1.1 to 1.6 (above) shall not apply in the following circumstances:*

- *On any site where construction activity is taking place. In this circumstance construction noise in any management area shall comply with the provisions of the New Zealand Standard NZS 6803P:1984 - The Measurement and Assessment of Noise from Construction, Maintenance and Demolition Work. Any discretionary adjustments provided for in clause 6.1 of this standard shall be mandatory within the District.*

It is noted that NZS 6803P:1984 Measurement and Assessment of Noise from Construction, Maintenance, and Demolition Work has been updated with NZS 6803:1999 Acoustics – Construction Noise. The main difference between the two

Standards is that the 1999 update of the Construction Standard is that the ambiguities have been removed, the $L_{10}$ has been replaced with $L_{eq}$ levels and the $L_{95}$ limit has been deleted as it did not offer any acoustic protection in practice. For the type of construction work proposed at this site compliance with one of the Standards will also achieve compliance with the other Standard.

It is recommended that the 1999 Standard is adopted for construction work at this site and that Standard (NZS 6803:1999 Acoustics – Construction Noise) has been used in the following.

**Table 2** of NZS6803:1999 sets the following noise limits for construction work to be complied with at all times.

***Table 2 - Recommended Upper Limits for Construction Noise Received in Residential Zones and Dwellings in Rural Areas***

| *Time of week* | *Time period* | *Typical duration (dBA)* | | *Short term duration* | | *Long term duration* | |
|---|---|---|---|---|---|---|---|
| | | $L_{eq}$ | $L_{max}$ | $L_{eq}$ | $L_{max}$ | $L_{eq}$ | $L_{max}$ |
| *Weekdays* | *0630-0730* | *60* | *75* | *65* | *80* | *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* | *80* | *55* | *85* | *55* | *85* |
| | *1800-2000* | *45* | *75* | *45* | *75* | *45* | *75* |
| | *2000-0630* | *45* | *75* | *45* | *75* | *45* | *75* |

Clause 7.2.1 of NZS6803 states

*(a) "Short-term" means construction work at any one location for up to 14 calendar days;*

*(b) "Typical duration" means construction work at any one location for more than 14 calendar days but less than 20 weeks; and*

*(c) "Long-term" means construction work at any one location with a duration exceeding 20 weeks.*

For this project it is expected the total construction work would exceed 20 weeks so the long term requirements of **Table 2** above has been adopted for the duration of the project.

# 3 PROPOSED PROJECT WORK

The proposed project involves three basic work areas. These are as follows:

i. The construction of the reclamation and the subsequent operation of the expanded coal stockyard at Te Awaparahi Bay;

ii. The possible quarrying/earthworks of the hillside by the coal stockyard; and

iii. The quarrying/earthworks at the Gollans Bay Quarry and the associated haul road.

These are discussed in turn.

## 3.1 Construction of the Reclamation

### 3.1.1 Wharf Piling

Prior to the reclamation taking place, preparatory works would be undertaken. This includes the building of a small piled wharf. The purpose of the wharf is to enable a barge to transport some of the rock protection for the reclamation. The development of the wharf will require some piling. The noise from this work has been based on piling undertaken when driving piles at a marina to construct the marine berths.

The predicted noise from the piling has been based on field measurements taken of driving timber piles with a 2½t drop hammer during the construction of a marina as shown on **Figure 5**. The noise levels were 73dBA $L_{max}$ when 100m from the piling. A similar noise level will be experienced if using a concrete pile with a timber dolly.

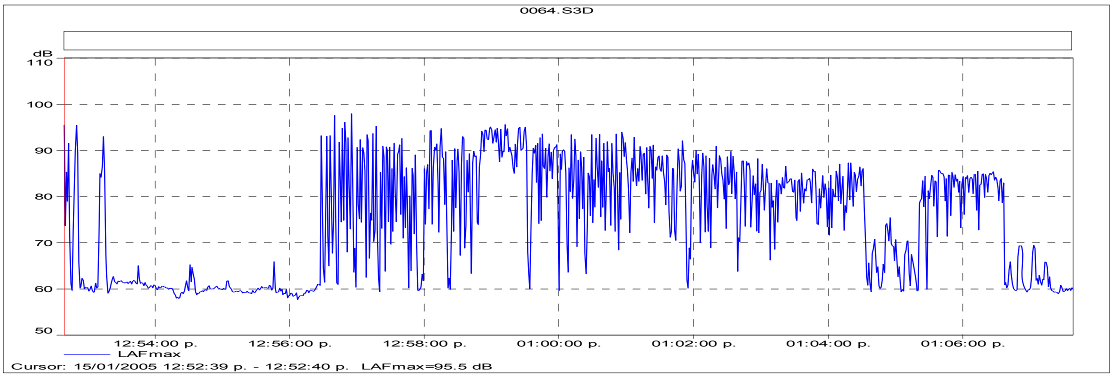



**Figure 5. Example of Piling Noise at 8m**

### 3.1.2 Reclamation Work

The initial works to establish the construction site for the reclamation and the subsequent preparation of the geotextile, to be laid prior to the placement of the fill material, are secondary to the noise from the reclamation work itself. On the basis that the construction of the reclamation must be managed so as not to cause a noise nuisance, and the noise from the secondary activities will be quieter than the main reclamation work, these earlier and secondary phases of work have not been addressed further.

Once the geotextile matting is laid, an initial 500mm thick layer of river-run gravel will be brought to site and placed by barge. The next layer of fill material, rock from the quarry, will be transported to site using 50 - 100 tonne off road dump trucks and stockpiled before being loaded onto the barge with an excavator or by conveyers. **Figure 6** shows the largest size excavator likely to be used (Cat 345c). The noise from this excavator measured 74dBA $L_{eq}$ and 90dBA $L_{max}$ when at 20m as shown on **Figure 7**.


**FIGURE 6. EXCAVATOR LOADING SCRAPER**

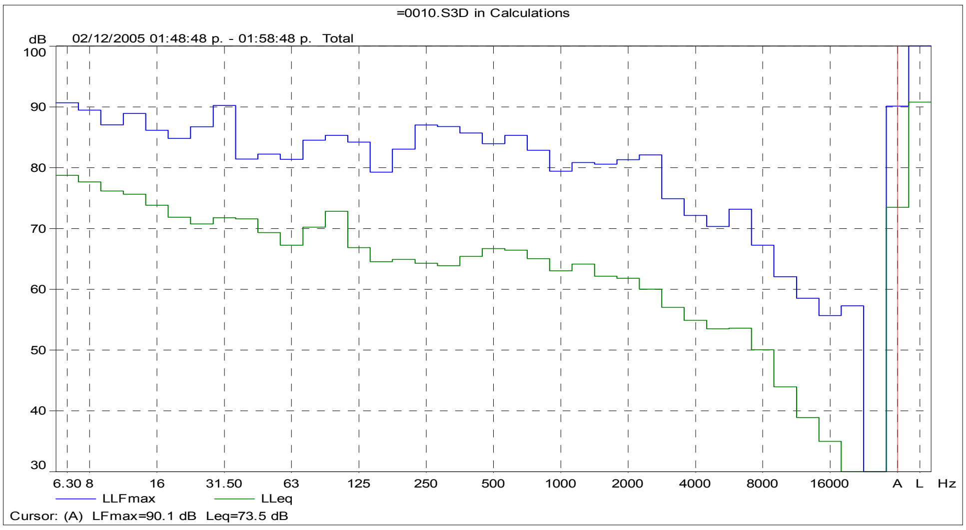



**Figure 7. Excavator Spectrum**

The noise from the barge will be controlled by the noise from the tug being used. With the tug operating at 1,700rpm the noise measured 80dBA $L_{eq}$ and 81dBA $L_{10}$ when at 3m from the exhaust, which is the main noise source, as shown on **Figure 8**.

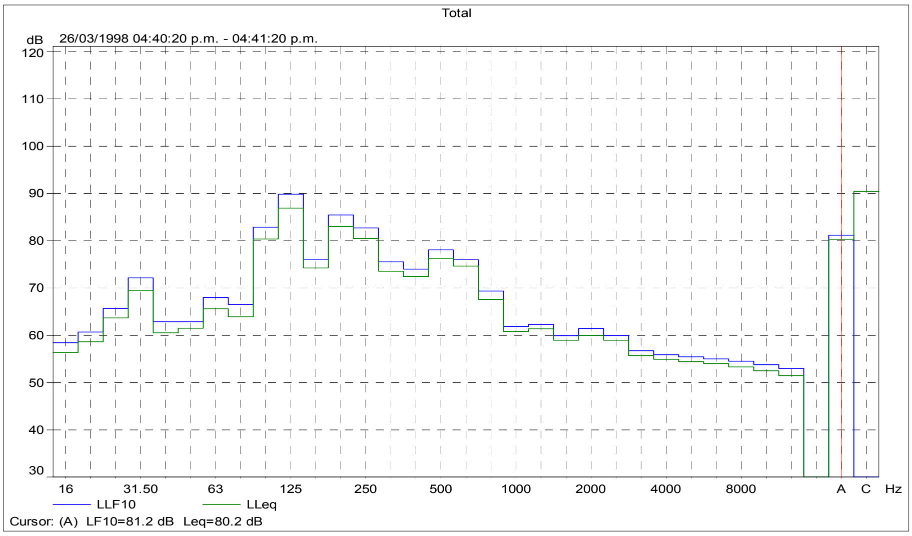



**Figure 8. Tug Sound Spectrum**

Armour rock will be placed on the seaward face of the reclamation by either end dumping or dumped from a barge then put into place using an excavator such as shown on **Figure 6**.

The geotextile to be used in the construction of the reclamation may need to be weighted with run of river gravel to prevent folds forming in the fabric and to reduce damage due to the smoothness of the gravel. The gravel would be transported via pubic roads to Cashin Quay. This would result in noise from an additional 50 heavy vehicles per day (hvpd) on the road network over a 12-hour day for a temporary period.

Irrespective of whether the major excavations into the hillside adjacent to the existing coal stockyard are carried out (discussed later), some minor excavation work is likely to proceed in order to optimise coal storage. This would involve excavating approximately 50,000m³ of loess from the hillside and this may be transported off-site if a purchaser can be found. This would result in noise from an additional 72hvpd on the road network over a 12 hour-day.

### 3.2 Operation of the Expanded Coal Stockyard

The existing coal stockyard has five stockpiles. The amount stored at any time varies depending on the shipping timetable and the number and type of coal grades stored at the time. A range of equipment is required to shift the coal and includes:

- Loaders and Bulldozers
- Coal Conveyors
- Coal Stacker

The same equipment is proposed for management of the expanded coal stock yard. A Komatsu W600 loader is shown on **Figure 9**. The noise measured from a single loader was 75dBA $L_{eq}$ and 78dBA $L_{10}$ with the loader operating between 20 – 50m from the monitoring point as shown on **Figure 10**.


**Figure 9. Komatsu Coal Loader**

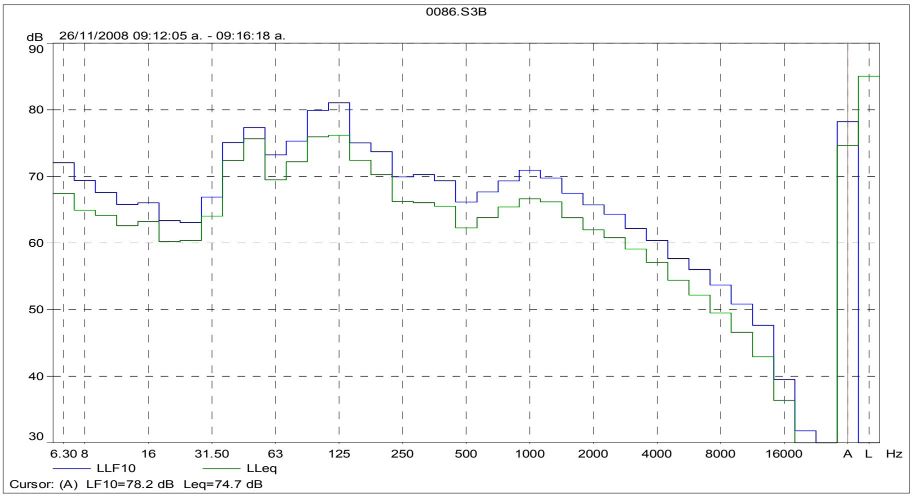



**Figure 10. Coal Loader at 20 – 50m**

A Komatsu D375A bulldozer is shown on **Figure 11**. The bulldozer is 76dBA $L_{eq}$ and 78dBA $L_{10}$ when measured at 10 - 15m as shown on **Figure 12**.


**Figure 11. Komatsu D375A Bulldozer**

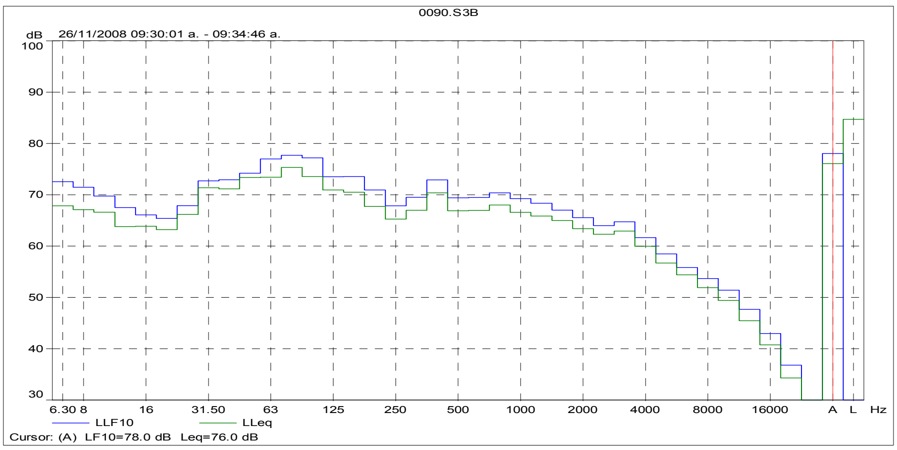



**Figure 12. Komatsu Bulldozer at 10 - 15m**

The conveyor operating was measured at 76dBA $L_{eq}$ and 76dBA $L_{10}$ when at 30m from the conveyor as shown on **Figure 13**.

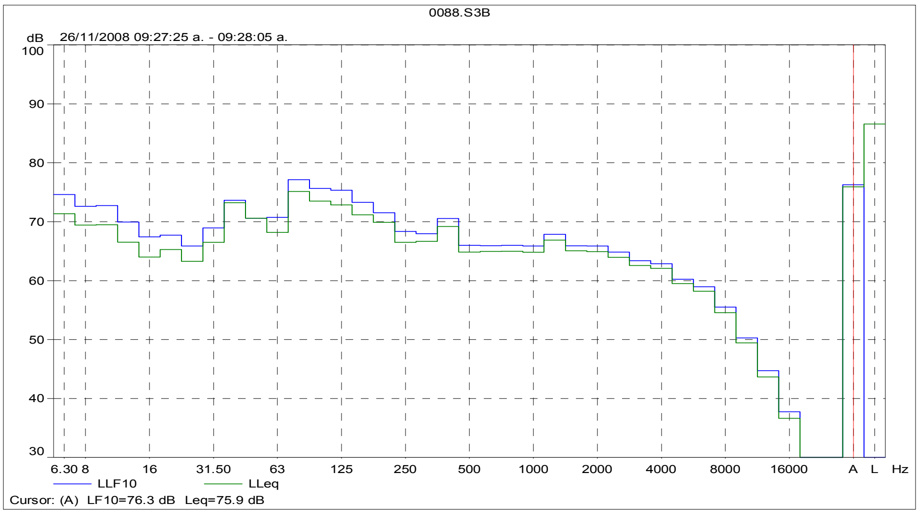



**Figure 13. Conveyor Noise at 30m**

The Stacker is shown on **Figure 14**. The noise measured 77dBA $L_{eq}$ and 79dBA $L_{10}$ when 20m from the stacker operating as shown on **Figure 15**. Also shown on **Figure 15** is a tonal component to the sound at 2.5kHz. The tone is not present all of the time but it has been taken into account in the analysis, as this tone attracts a 5dBA penalty due to the special audible characteristics of the sound. This is accordance with the requirements of clause 4.4 of NZS 6802:1991 - Assessment of Environmental Sound.

**Figure 14. Stacker**

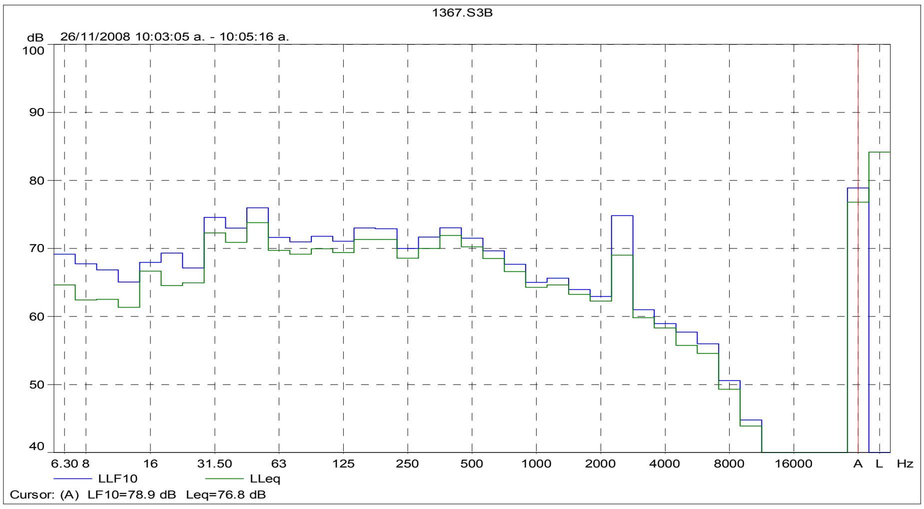



**Figure 15. Sound Spectrum of Stacker at 20m**

The only other sound of any significance in the coal yard is the train unloading. As shown on **Figure 16**, the train noise was 77dBA $L_{eq}$ and 76dBA $L_{10}$ when 8m from the wagons, 15 – 30m from the two locomotives and 35m from the recieval hopper grizzly.

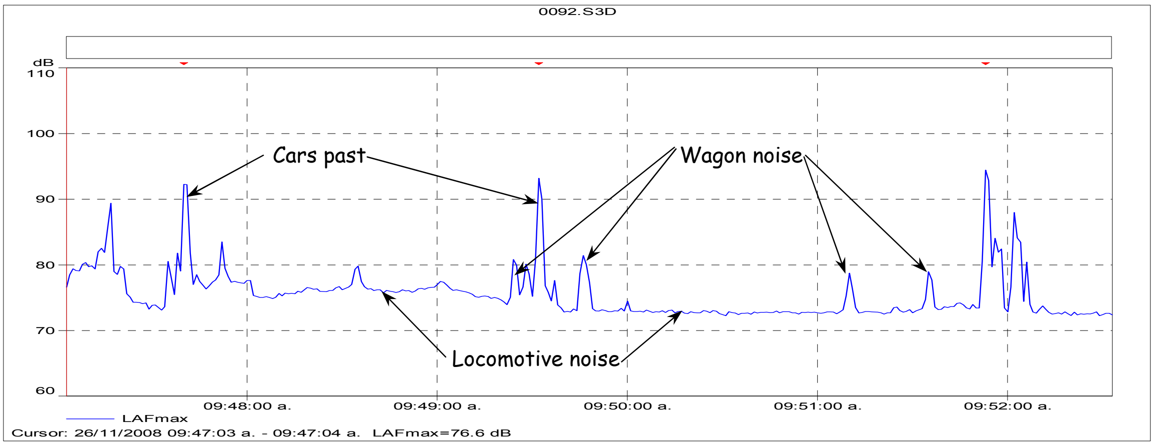



**Figure 16. Train Unloading at 8m**

There will be water carts used to control dust although this noise will be well below the noise generated by of the loaders and bulldozers operating so will not generate any cumulative noise effects for the residential neighbours. For this reason no additional analysis has been undertaken on the water carts.

### 3.2 Possible Excavation of the Hillside Adjoining the Existing Coal Stockyard

Should it be decided to expand the coal storage facility landward, it will be necessary to blast the existing rock in the hillside on the north-west side to the existing coal stockpile area. Where blasting is required it will be necessary to drill to place the explosives and this will be done using a top of the hole drilling rig. The noise from this type of drill operating is typically 89dBA $L_{10}$ at 10m as shown in **Figure 17**.

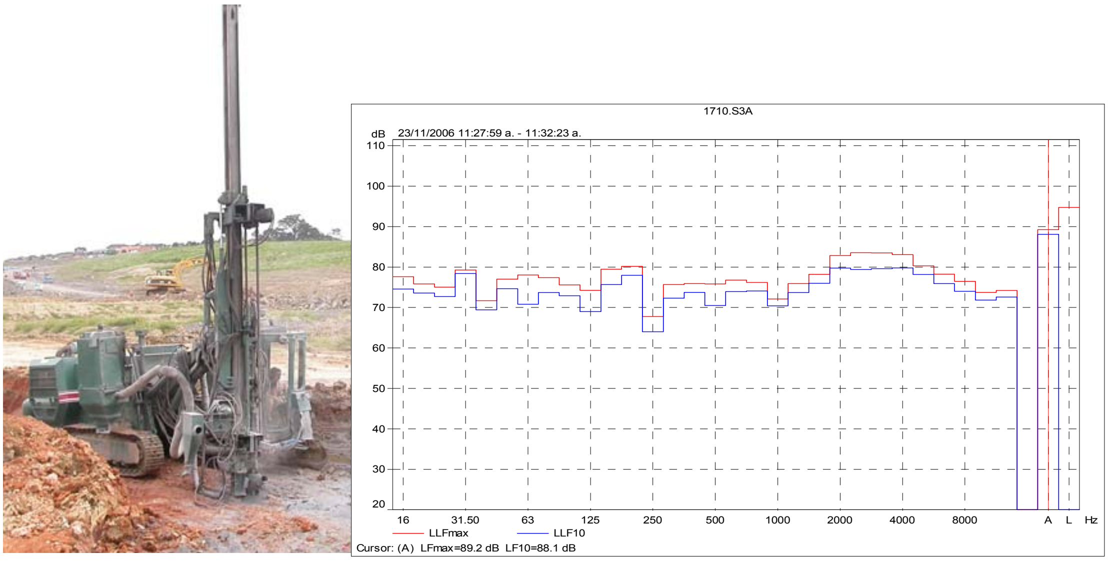



**Figure 17. Rock Drill at 10m**

Once drilled, the charges will be kept relatively small and by using a delayed blast technique so that any noise to the closest residential neighbours, who are on the eastern edge of Lyttelton, is kept to a minimum. Noise and vibration predictions from blasting in the quarries are based on the noise as measured at an existing hard rock quarry.

The expansion of the stockyard into the hillside will be undertaken using similar equipment to that used during the construction of the reclamation so the noise will be similar for the neighbours.

It is possible that the rock being extracted from the hillside could be crushed and screened using a portable crusher at a rate of approximately 200 tonnes/hour. The reason for this is that smaller crushed rock maybe able to used as an alternative to the “imported” river-run gravel to be placed on the geotextile described earlier. Measurements undertaken of portable crusher (**Figure 18**) shows the noise level is typically 83dBA at 17m as shown in **Figure 19**.

**Figure 18. Portable Crusher**

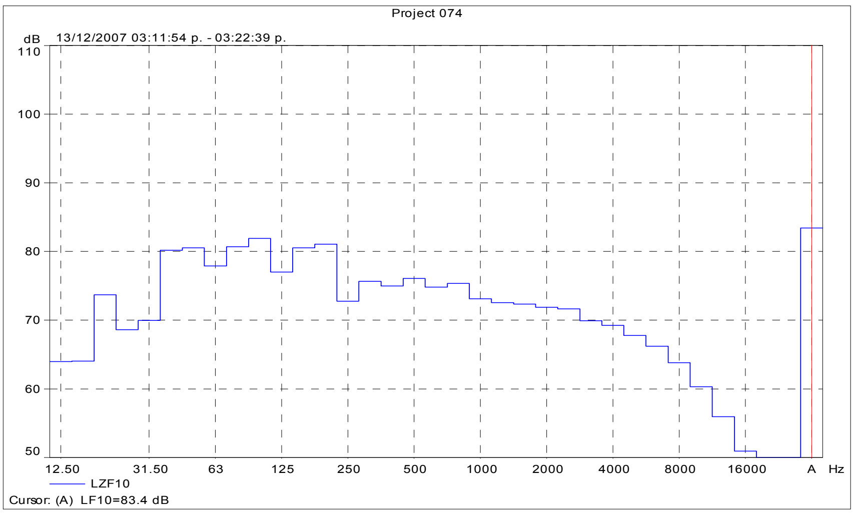



**Figure 19. Portable Crusher Noise at 17m**

### 3.3 Gollans Quarry Development and Operation

The majority of the rock will be excavated directly using a bulldozer, such as the Komatsu D375A as shown on **Figure 11**, to rip the rock. In some parts of the quarry it may be necessary to drill and blast to fracture the rock. This rock will then be loaded into a dump truck using an excavator such as a Cat 345C as shown on **Figure 6**. Dump trucks, such as shown on **Figure 20**, will be used to haul the excavated material from the quarry to the reclamation area for up to 24 hours of the day seven days of the week. These trucks have are typical 68dBA $L_{eq}$ and 70dBA $L_{10}$ at 65m.


**Figure 20. Dump Truck**

As described earlier for the possible excavation of the hillside, blasting will be required in the quarry to fracture the rock a top of the hole drill is expected to be used as set out in **Figure 17** for the blasting in the coal stockpile area.

It is noted that overburden will need to be removed as the quarry progresses. This is expected to be undertaken using an excavator and dump trucks. It has been assumed the same equipment used in the quarry will be used for this work.

As part of the quarry development it will be necessary to upgrade the existing haul road. This will be undertaken using equipment such as a bulldozer, excavators, trucks and compactors. The analysis has assumed a similar sized bulldozer and excavator will be used as in the coal stockpile area and set out above. Measurements of a compactor show the noise will be typically 68dBA at 15m so will not have any significant additive noise effects on the other equipment operating during the construction of the haul road.

Again, rock extracted from the quarry could be crushed and screened using a portable crusher at a rate of approximately 200 tonnes/hour as an alternative to the “imported” river-run gravel. Once more refer to the measurements undertaken for a portable crusher shown in **Figure 18** and **Figure 19**.

### 3.4 Vibration

Piling is one potential source of vibration to residents. However, experience with piling at the port has shown there are negligible vibration effects from piling in the harbour and any vibration is unlikely to exceed a peak particle velocity of 1- 1.5mm/s, well within the District Plan limit of 5mm/sec. The proposed small wharf is not expected to generate any adverse effects for the closest residents to the proposed wharf.

Blasting typically creates some associated vibration. However the delayed blasting during the excavation of the hillside adjacent to the existing coal stockyard at Te Awaparahi Bay or at Gollans Bay quarry is not expected to be any noticeable vibration at the closest houses.

## 4 NOISE PREDICTION TECHNIQUES

As a general rule, sound from a localized source spreads out uniformly in all directions as it travels away from the source, and the sound level drops off at the rate of 6dB for each doubling of distance. Additional variables of outdoor sound transmission and attenuation are set out below with respect to the 'source-path-receiver' concept of evaluation with the complete analysis including the following effects:

Source:

- Sound power levels for all equipment
- Frequency distribution of noise sources
- Other variations with time; day/night, summer/winter, construction phases.
- Composite source, decibel summation of contributing sources.
- Point, line, area sources
- Combined multiple source locations.

Path:

- Distances, elevations
- Molecular absorption
- Wind effects
- Temperature
- Terrain
- Barriers

Receiver:

- Nearby receiver positions - point calculation
- Remote receiver positions - point calculation
- Statistical distribution of received sound

Because many of these individual items are interrelated and have tie-ins at various stages of the analysis, the step by step procedure does not necessarily follow the above list sequentially. Nevertheless, all the items must be considered.

### 4.1 Geometric Spreading

A point source can be defined as a source whose dimensions are small compared to the measurement distance.

The sound pressure of spherical waves decreases in inverse proportion to the distance from the source. In terms of sound pressure, this is a decrease of 6dB for each doubling of distance from the source.

### 4.2 Atmospheric Absorption

A certain amount of airborne sound energy is absorbed by molecular absorption which has a small effect at short distances and at low frequencies, but has a significant effect at large distances and high frequencies. The effect is dependent on the temperature and moisture content (relative humidity) of the air. The American National Standard, Methods for the Calculation of the Absorption of Sound by the Atmosphere, ANSI S1.26-1978 is adopted for predicting atmospheric absorption.

### 4.3 Ground Effects

There are two relative mechanisms for the reduction of transmitted sound above or near the earth's surface; the effect of ground reflection and effect of absorptive ground covers. These mechanisms are sufficiently interrelated to be considered as one total effect.

### 4.4 Meteorological Effects

The two meteorological conditions that will affect sound transmission are wind velocity and temperature gradients.

A steady, smooth flow of wind, equal at all altitudes would seemingly have no noticeable effect on sound transmission because the wind speed is typically low compared to the speed of sound. In practice, however, wind speeds above the ground are slightly higher than wind speeds near the ground and the resulting wind speed gradients tend to 'bend' sound waves over large distances (>≈300m). Sound travelling with the wind is bent downward to the ground and sound travelling against the wind is bent upward above the ground.

### 4.5 Barrier Effects

A barrier, either natural or artificial, may be any solid body (which is relatively opaque to sound) that blocks the line of sight from source to receiver. For example, a solid timber fence, earth berm or intervening topography.

### 4.6 Effects of Rain and Fog

Propagation of sound through light rain or fog can produce scattering and attenuation of sound waves. However, the likely excess attenuation is only about 1dB/km.

### 4.7 Atmospheric Conditions

Higher wind speeds (>5m/s) will increase the down wind noise and decrease up wind noise levels considerably for distances >≈3 - 400m. However, the real change in the environment will be from the wind raising the overall noise levels due to the rustling of leaves etc.

Calculations assume there is a mild temperature inversion. Without an inversion levels would be slightly lower and when there is a strong inversion levels may rise by up to 8 - 10dBA.

### 4.8 Cumulative Effects

The analysis includes the cumulative noise effects of all equipment operating at a given time. As the cumulative effects are added logarithmically two equal noise sources increase the received noise compared to one source by 3dBA and for three equal noise sources the level increases by 5dBA above a single source.

# 5 PREDICTED NOISE LEVELS

## 5.1 Reclamation and Hillside Excavation

Rock drilling to place the charges to fracture the rock on the northern side of the coal stockyard area will be 47dBA $L_{10}$ at the closest houses in Lyttelton when taking into account the screening effects of the topography to these houses. The crushing of rock in this area using a portable crusher will be 39dBA $L_{10}$ in neutral meteorological conditions.

Even though the District Plan standards on blasting do not apply to activities within the Lyttelton Port Zone, the adoption of a delayed blasting technique would mean the level of noise can be kept to an upper limit of 95dB linear, which is well within the 115dB linear peak as set out in the District Plan anyway.

Similarly, the vibration effects from the blasting to develop the coal stockyard area are not expected to exceed *a* peak particle velocity of 2.0 mm/sec based on a conservative prediction and should generally be lower. This is well within the peak particle velocity of 5 mm/sec limit as set out in Rule 33.1.6.

The Battery Point Gun emplacement concrete structures are potentially sensitive to vibration effects. The predicted ground vibration is unlikely to have any significant adverse effects at all on the structures. However, to ensure this is the case the vibration will be initially monitored and in the unlikely event there is any possibility of a vibration effect the blasting will be modified by a combination of charge size and the delays.

The vibration effects from trucks using the proposed haul road will be well within a reasonable limit providing the haul roads are well maintained and the road surface is kept in good condition.

During the reclamation the noise level at the closest residential site in Lyttelton will be 32dBA $L_{eq}$ in slightly positive meteorological conditions, which is well within the night time requirements of NZS6803. Across the water in Diamond Harbour and assuming a slightly positive meteorological effect the noise from the reclamation work will be 30dBA $L_{eq}$ with all equipment operating.

At 32dBA $L_{eq}$ at the closest house in Lyttelton the cumulative effects of the noise from the reclamation work to the existing port noise as shown on the Port Noise Contour map (**Figure 2**) will be negligible. That is, there will not be any adverse effects for the residents due to work on the reclamation.

The noise level across the water in Diamond Harbour will be a predicted 32dBA $L_{eq}$, which is well within the night time limit of 45dBA $L_{eq}$ as set out in the Construction Standard.

During the construction of the wharf the piling noise could be as high as 66dBA $L_{eq}$ with a maximum level ($L_{max}$) 74dBA. This is well within the upper limit of 70dBA $L_{eq}$ and 85dBA $L_{max}$ as set out in the Construction Standard for a project that exceeds 20 weeks work.

As discussed earlier in the report, river gravel will potentially be transported to the site over the external road network, generating approximately 50hvpd during the period when the gravel is transported. Loess material from excavations at the rear of the site may also be transported via the road network to fill sites if there is demand, creating approximately 72hvpd.

A set out in the traffic engineers report the current daily traffic volume on Norwich Quay (SH74) east of Tunnel Road is 7,832vpd with 1,184 heavy vehicles. Taking the maximum number of heavy vehicles likely to be generate by any transporting of material on the external road network (70 trucks per day) will increase the existing traffic noise by a predicted 0.3dBA (from 66.8dBA 24 hour $L_{eq}$ to 67.1dBA 24 hour $L_{eq}$ at 20m from the edge of the carriageway), which is insignificant and unlikely to create any adverse noise effects for the neighbours.

While the traffic noise effects have been evaluated it is noted that there are no noise controls at all in the District Plan with respect to traffic noise and this is typical of all District Plans. The only traffic criteria currently available for use in New Zealand are the New Zealand Transportation Authority (NZTA) Guidelines. These guidelines were developed for new and improved works, which the above does not address. Even if they did there would need to be an increase of 3dAB in order to warrant any noise control treatment to reduce the noise.

### 5.2 Coal Stockpile Operation

The activities in the coal stockpile area will be greater than those undertaken during the reclamation although there will be some minor screening of the plant due to small bunds around the outer fringe of the site. Screening effects due to coal stockpiles have not been included in the analysis as there will be periods when there will not be any screening.

The predicted noise at the closer houses in Lyttelton will be 34dBA $L_{10}$ in slightly positive meteorological conditions and 32dBA $L_{10}$ across the water in Diamond Harbour.

The noise at the Lyttelton house from the reclamation work will not have any cumulative effects to the existing noise levels and in the Diamond Harbour area the noise will be well within the District Plan night time limit of 40dBA $L_{10}$.

### 5.3 Quarry Noise

With the above equipment working in the quarry the predicted operation noise level at the closest houses in Lyttelton will be 24dBA $L_{10}$ with slightly positive meteorological conditions, which are the design conditions adopted for the analysis. On the rural land immediately across Lyttelton Harbour and assuming a slightly positive meteorological effect, the noise from the quarry operating will be 30dBA $L_{10}$.

Blast noise is partly dependent on the size of the charge in the hole. Based on measured blast noise of a similar quarry it is predicted the blast noise from the

Gollans Bay quarry will not exceed a level of 85dB at the closest dwelling (which is in Lyttelton). This level is well within the 115dB (Lin peak) requirement of Rule 33.1.6.

The vibration effects from the blasting are not expected to exceed *a* peak particle velocity of 1.0 mm/sec and should generally be lower. This is well within the peak particle velocity of 5 mm/sec limit as set out in Rule 33.1.6.

At 24dBA $L_{10}$ from the Gollans Bay quarry noise at the closest house in Lyttelton the cumulative effects of the noise to the levels as shown on the Port Noise Contour map (**Figure 2**) will be negligible. Therefore there will not be any adverse effects for those residents due to the quarry operating.

The noise level in the rural area across the harbour will be typically 28dBA $L_{10}$, which is well within the District Plan limit of 40dBA $L_{10}$ during the night time.

## 6 CONCLUSIONS

It is proposed to develop the existing coal stockpile area at Lyttelton Port of Christchurch. As part of this development, fill material will be taken from the existing quarry site to the reclamation area as shown on **Figure 1**. The cumulative noise from the quarry or the possible hillside excavation, reclamation area and subsequent operation of the coal stockpile area, will not have any adverse cumulative effects to the current port operation and comply with the requirements of the City District Plan. The noise across Lyttelton Harbour will be well within the noise requirements of the District Plan at all times.

Based on the analysis, the noise from the proposed reclamation and associated activities will be no more than minor in terms of the requirements of the Resource Management Act.

* * *

# APPENDIX A

## Guide to Noise Terms

The following sets out an explanation of the acoustic terms that will be referred to throughout this report. The aim is not to necessarily provide technical definitions, but to enable a basic understanding of what is meant.

The setting of specific noise levels to control any adverse effects does not necessarily mean that noise will not be heard. Audibility depends on the level of a sound, the loudness of the background sound and any special frequency composition or characteristics that a sound may have.

Research suggests that a small number of people (approximately 10%) will find any noise not of their own making unacceptable. Conversely, there are approximately 25% of the population that are essentially immune to any noise. Neither of these two extremes is normally designed for. In establishing the appropriate noise levels the aim is to try and represent the typical expected community reaction, this will generally be approximately 90% of the people.

In order to reflect community response to noise it is necessary to establish a measure that reflects our attitude to the sounds that we hear. Due to the variability of many sounds (level, tone, duration, intrusiveness above the existing sound, etc) no single descriptor will totally describe the potential community reaction to a sound. For this reason there are a number of terms that need to be understood.

### dBA

The basic unit to quantify a sound is the decibel. The A-weighted sound level, or dBA, is a good environmental noise descriptor because of the similarity between A-weighting and the frequency response of the human ear at moderate sound levels. It can also be measured easily. However, it provides no indication of tonal frequency components or unusual frequency distributions of sound that may be the cause of annoyance. Where appropriate, this must be assessed separately.

We can hear a change in sound pressure that varies from 1 (taken as the threshold of hearing) through to 1,000,000,000,000 (taken as the threshold of pain). In order to bring these numbers to a more manageable size a logarithmic scale is normally adopted. This reduces the above values to 0 and 12 respectively. The decibel is then described as 10 times the logarithm of the ratio of the pressure level of interest, to a reference pressure level. Thus the scale becomes 0 to 120dBA.

Some typical subjective changes in noise levels are:

A change of 3dBA is just perceptible
A change of 5dBA is clearly perceptible
A change of 10dBA is twice (or half) as loud

Because we use a logarithmic scale care must be taken when adding sound levels. Two equal noise sources raises the level of one source by 3dBA. It takes 10 equal noise sources to raise the level of one source by 10dBA. ie 60dBA + 60dBA = 63dBA and 60dBA x 10 = 70dBA.

**Maximum Sound Level ($L_{max}$)**

This unit equates to the highest (maximum) sound level for a defined measurement period. It is adopted in NZS6802:1991 Assessment of Environmental Sound, mainly as a method of protecting sleep.

**$L_{10}$**

The sound level which is equaled or exceeded for 10% of the measurement time. This level is adopted in NZS6802:1991 Assessment of Environmental Sound to measure intrusive sound. This level may be considered as the average maximum sound level.

**Background Sound $L_{95}$**

The sound level which is equaled or exceeded for 95% of the measurement time. This level is adopted in NZS6802:1991 Assessment of Environmental Sound to measure the background sound. This level may be considered as the average minimum sound level and is the component of sound that subjectively is perceived as continuously present.

**Equivalent Sound Level ($L_{eq}$)**

The $L_{eq}$ may be considered as the continuous steady noise level that would have the same total A-weighted acoustic energy as a fluctuating noise over the same time period.

**Day Night Level, $L_{dn}$**

The day/night level ($L_{dn}$) is defined as the time-average sound level in decibels (re 20µPa) over a 24 hour period from midnight to midnight) with the addition of 10dB to nighttime levels during the period from midnight to 07.00 hours and from 22.00 hours to midnight, to take account of the increased annoyance caused by noise at night.

**Ambient Sound**

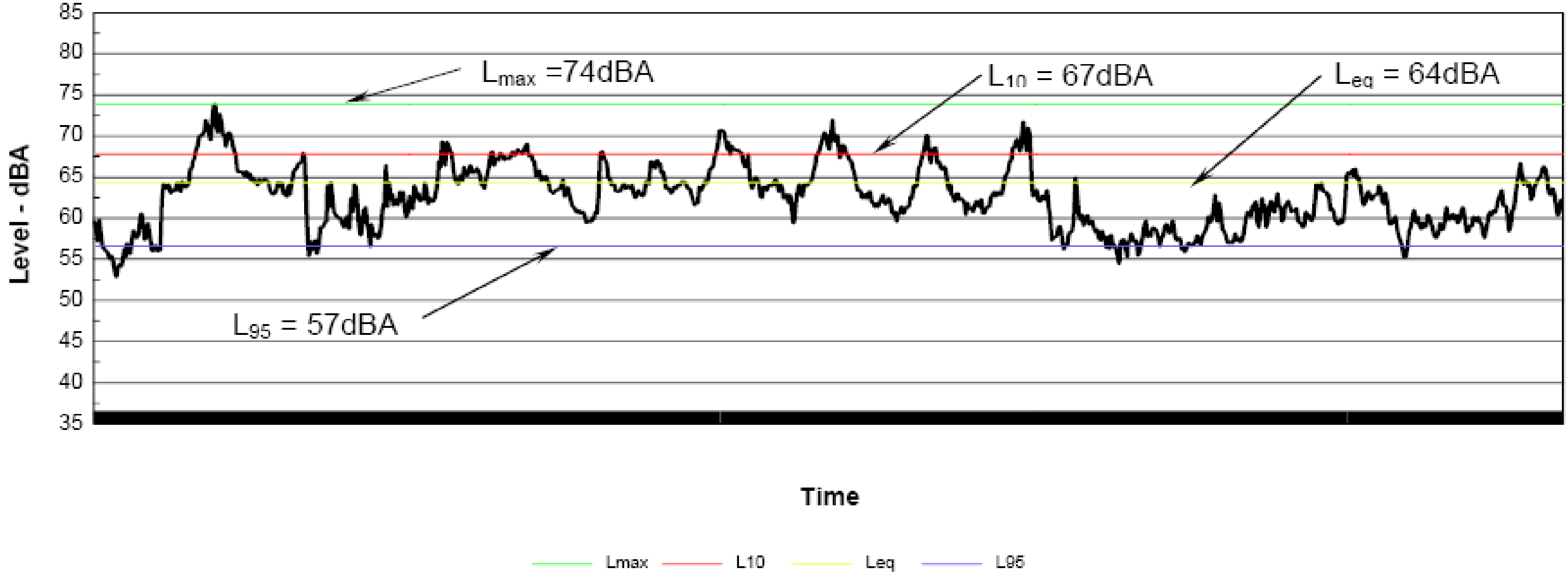
The ambient sound is normally used to describe the total noise environment. The ambient sound is often measured as the 24 hour $L_{eq,}$ which is an average value over the 24 hour period. Shorter times are often used, such as the daytime period

**Notional Boundary**

The notional boundary is defined as a line 20 metres from the facade of any rural dwelling or the legal boundary where this is closer to the dwelling.

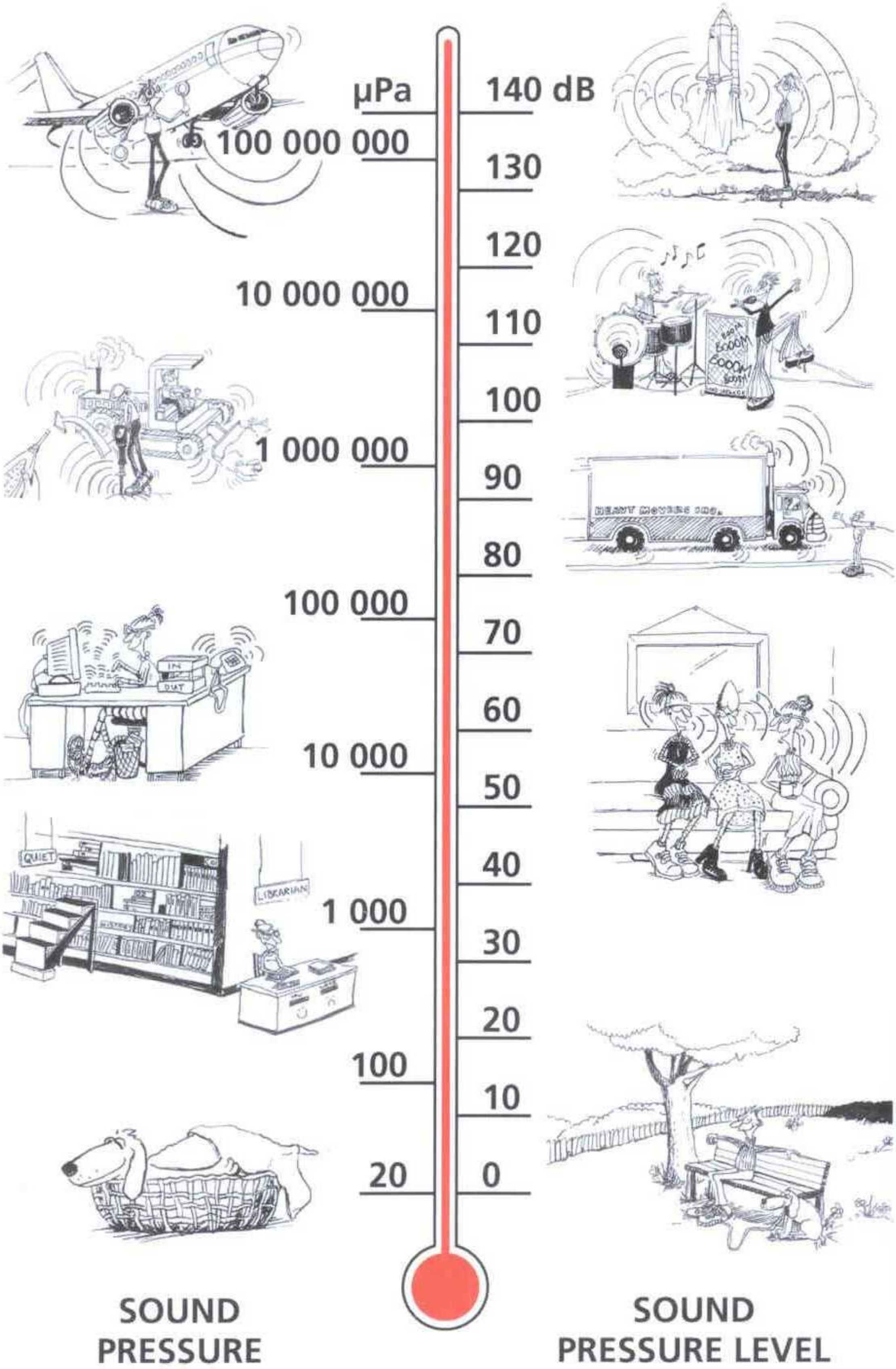
Figure A1 shows a noise trace with the relationship of $L_{max}$, $L_{10}$, $L_{95}$ and $L_{eq}$ values when including all events over the 15 minute measurement period and Figure A2 some typical noise levels.

* * *




$L_{max}$ is the maximum noise level
$L_{10}$ is the noise level that is equaled or exceeded for 10% of the measurement period
$L_{95}$ is the noise level that is equaled or exceeded for 95% of the measurement period
$L_{eq}$ is the noise level that contains the same energy as the time varying noise

**Figure A1**



µPa
140 dB
100 000 000
130
120
10 000 000
110
100
1 000 000
90
80
100 000
70
60
10 000
50
40
1 000
30
20
100
10
20
0
SOUND PRESSURE
SOUND PRESSURE LEVEL


Figure A2