2.3.2 *Interference with Fauna Movement*

A potential wildlife corridor currently extends in a north to south direction between the existing quarry area and the semi-cleared farmland in the east of the study area. The proposed development would progressively remove a proportion of this potential wildlife corridor over a minimum 66 year period. Fauna movement between these areas would then be restricted to either semi-cleared vegetation east of the study area, or to a relatively long narrow strip of remnant vegetation between the quarry and the Pacific Highway.

Therefore, in order to minimise the loss of wildlife corridor function in this area, the strip of semi-cleared vegetation retained in the east of the study area would be revegetated (minimum width 220 metres). The first stage of the quarry expansion would be in the western portion of the subject site, hence the revegetation program would be at an advanced stage prior to the existing potential habitat corridor being reduced in size.

2.3.3 *Road Strike*

The roads within the existing quarry site are unlikely to have a significant level of impact on the major fauna groups due to the low speed of traffic utilising the roads, and limited operating hours of the quarry, which are proposed to be from 6.00 am to 6.00 pm. No new roads would be constructed within the study area.

Bats and most bird species are highly mobile and can usually cross roads with minimal chance of injury from moving vehicles. A very small number of bird mortalities could potentially result from individuals being attracted to additional food sources associated with the roads (eg. seeding grasses) (Bennett 1991). However, the incidence of road strike is unlikely to significantly increase due to the proposal.

Arboreal mammal species that do not travel on the ground would still be capable of crossing roads (in forest areas) within the study area due to relatively narrow road widths, retention of mature trees and limited hours of quarry operation (no night traffic). Some species of small terrestrial mammals may already be incapable of crossing existing quarry roads due most likely to fear of predation (Hunt *et al.* 1987). However, no additional roads are proposed to be built, hence there is unlikely to be an increased risk of road strike.

High rates of amphibian mortality have been recorded when local populations are isolated from breeding sites by roads (Gibbs 1998). The proposed quarry expansion would not result in further isolation of potential breeding sites within the study area.

Due to the low speed of quarry traffic and limited hours of operation very few medium to large terrestrial mammals are likely to be struck on the quarry roads.

2.3.4 Noise

There is little relevant information relating to the effects of noise on Australian wildlife. The majority of published data refers to American or domestic fauna, and are frequently inconclusive and even contradictory (Shaw, 1978). Few, if any of the suggested effects of noise benefit animals or increase the chances of species' survival (Shaw, 1978).

Lee and Griffith (1978) report that the main effects of noise on American wildlife are behavioural changes leading to modifications in mating, loss of food supply for predators, changes in inter-specific relationships (predator/prey) and competition for shelter. The main reasons these impacts occur are due to impacts on hearing, communication, non-auditory physiological effects and behavioural changes.

A large number of fauna species seem to adapt well to human presence and associated noise (Busnel 1978). In fact, some species of rats, mice, crows, pigeons, starlings and seagulls have been known to take advantage of human activities by tolerating extremely loud human noise (Busnel, 1978). Nevertheless, threatened fauna species could potentially be sensitive to such human disturbances. Very little research has been carried out on the impacts of noise on Australian fauna species, which is an issue worthy of further investigation.

Noise associated with the existing quarry operation (eg. machinery, blasting) may have already caused a significant reduction in the utilisation of habitats in the immediate vicinity of the quarry by shy individuals or species. Noise could potentially disrupt species while feeding, thus reducing their foraging times within noise-affected areas.

The effects of noise on habitats further away from the quarry are unknown. It is possible that they are more of a temporary nature due to species becoming habituated to background noises.

The proposed quarry expansion would result in slightly increased noise levels due mainly to the proposed increase in utilisation of existing machinery on-site. However, such increases are unlikely to cause a significant disruption to the lifecycle of any species utilising habitats within the study area.

2.3.5 *Direct Blasting Effects*

Blasting may have the potential to cause an impact upon fauna through injury or death caused by flyrock. However, if the charge is set correctly and properly managed there should be no, or very minimal, flyrock resulting. This impact is therefore expected to be negligible on species survival. Direct blasting effects will be minimised due to all blasting occurring during daylight hours, as the majority of fauna species are nocturnal, sheltering under rocks or in hollows during the day.

2.3.6 *Water Quality*

Increases in sediment loads can affect a stream ecosystem far downstream from the actual site of erosion (Bennett 1991). Aquatic communities are sensitive to sedimentation as it blankets rocky crevices and stream beds and alters microhabitats of invertebrates and the spawning sites of fish (Bennett 1991). However, the quarry operations will meet the current EPA requirements for creek sediment loads.

The network of drainage lines within the study area ultimately lead to the Wallamba River. Five main dams exist in the study area, two of which currently act as sediment control dams. One of these is located just south of the primary crusher, and the other just north of the weighbridge. The latter one is the main sediment control dam for all runoff from the stockpile area. Stormwater from this dam overflows in a controlled fashion into the creek. From the dam, water flows through the creek for approximately 300 metres before it leaves the site. Water discharge off company owned land currently complies with EPA requirements.

As part of the proposed quarry expansion, additional measures would be implemented to maintain required water quality standards. Proposed measures would include the construction of a sump in the floor of the quarry pit to catch all water from the disturbed areas, and an increase in the size (retention time) of the main sediment control dam.

The water quality of water discharged off company owned land would continue to comply with current EPA requirements.

2.4 MITIGATION MEASURES

Mitigation measures have been formulated to minimise or prevent the potential impacts of the proposed development on the subject species and their habitats.

i. Revegetation of Disturbed Areas

Ongoing revegetation of benches visible to travellers on the Pacific Highway will be conducted after each stage is complete. Although this is being undertaken primarily to reduce the visual impact of the quarry, it will also contribute to replacing some of the fauna habitat removed during quarry expansion. Furthermore, after the life of the quarry has expired all site facility areas, stockpile areas and overburden areas will be revegetated.

ii. Sediment Control

A series of mitigation measures to address pollution control would be implemented to ensure that any disruption to viable local fish populations would be minimised. These mitigation measures are detailed in section 3.10.3 of the EIS and include:

- installation of erosion and sediment controls prior to any soil disturbance, including clean water diversion drains and sediment dams downstream of disturbed areas;
- installation of erosion and sediment controls around the overburden stockpile area; and
- the stockpiling of vegetation removed during construction activities for later use in erosion control and stabilisation of disturbed areas.

iii. Enhancement of Potential Wildlife Corridors (ie. revegetation program)

Semi-cleared land east of the eastern quarry boundary will be revegetated in order to enhance a potential movement corridor for fauna between forested communities north and south of the study area (refer to EIS *Figure 3.10*). The area to be revegetated will consist of a 220 metre (minimum width) wide strip of vegetation running north to south. The plant species used for revegetation will be based on those occurring naturally within surrounding undisturbed areas of vegetation. The plant species used will vary within the rehabilitation site depending on elevation and aspect to simulate any natural changes evident in surrounding areas of natural vegetation.

A dam site located within the proposed wildlife corridor, approximately 100 metres south-east of the eastern quarry boundary, will be incorporated into the rehabilitation site. Emergent aquatic vegetation will be planted in suitable areas of the dam, and terrestrial shelter (ie. rocks and logs) will be placed around the dam edges to provide suitable habitat resources for amphibians, reptiles and small terrestrial mammals.

A strip of cleared land (approximately 200m x 20m) along the southern edge of the access road would also be revegeted at the beginning of the proposed quarry expansion to enhance the potential wildlife corridor function of remnant vegetation between the Pacific Highway and the study area.

iv. Limited hours of operation

The operating hours of the Jandra quarry would be 6.00 am to 6.00 pm Monday to Friday, and 6.00 am to 3.00 pm on Saturday. The limited operating hours would significantly reduce the likelihood of roadstrike on nocturnally active species within the study area due to their low activity levels during the operating periods.

Chapter 3

EIGHT PART TESTS OF SIGNIFICANCE

3.1 TERRESTRIAL EIGHT PART TEST OF SIGNIFICANCE

The TSC Act commenced on 1 January 1996, and replaced the legislative scheme introduced by the *Endangered Fauna (Interim Protection Act)* (1991). The TSC Act made substantial amendments to the *National Parks and Wildlife Act* (1974) (NPW Act) and the *Environmental Planning and Assessment Act (1979)* (EP&A Act). Section 5A of the EP&A Act sets out eight factors to be considered in deciding whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats.

When undertaking the eight part test, a number of flora and fauna species have been considered. *Table 3.1* lists these species and their likelihood of occurrence based on habitat preference, known occurrence in the locality and NPWS Atlas of Wildlife recordings for the Bulahdelah and Wingham 1:100,000 topographic map sheets.

Table 3.1 THREATENED TERRESTRIAL FLORA AND FAUNA SPECIES POTENTIALLY OCCURRING IN THE STUDY AREA

Common Name	Scientific Name	Likelihood of Occurrence in the Subject Site	Likely Sensitivity to Disturbance from Proposal
Koala	*Phascolarctos cinereus*	Moderate to high. Has been recorded within the locality (3 km from site) and limited suitable habitat exists in the subject site.	Low - no levels of activity recorded during surveys. Better quality habitat in surrounding areas.
Tiger Quoll	*Dasyurus maculatus*	High. Has been recorded in the locality and suitable foraging habitat exists within the subject site.	Low - den sites unlikely to occur on site, extensive suitable habitat to be retained in locality.
Brush-tailed Phascogale	*Phascogale tapoatafa*	High. Has been recorded within the locality and suitable habitat for the species exists within the subject site.	Low to Moderate - potential foraging habitat would be removed.
Squirrel Glider	*Petaurus norfolcensis*	High. Has been recorded within the locality and suitable habitat for the species exists within the subject site.	Low to Moderate - potential foraging and roosting habitat would be removed.
Long-nosed Potoroo	*Potorous tridactylus*	Moderate. Has not been recorded in the locality and only sub-optimal habitat exists within the subject site.	Low - potential foraging habitat would be removed.
Common Bent-wing Bat	*Miniopterus schreibersii*	Moderate to high. Has not been recorded in the locality, but suitable habitat exists within	Low - small portion of potential foraging

Table 3.1 THREATENED TERRESTRIAL FLORA AND FAUNA SPECIES POTENTIALLY OCCURRING IN THE STUDY AREA

Common Name	Scientific Name	Likelihood of Occurrence in the Subject Site	Likely Sensitivity to Disturbance from Proposal
		the subject site.	and roosting habitat would be removed.
Little Bent-wing Bat	*Miniopterus australis*	High. Has been recorded within the locality and suitable habitat for the species exists within the subject site.	Low - small portion of potential foraging and roosting habitat would be removed.
Eastern Freetail-Bat	*Mormopterus norfolkensis*	Moderate to high. Has not been recorded in the locality, but suitable habitat exists within the subject site.	Low - small portion of potential foraging and roosting habitat would be removed.
Greater Broad-nosed Bat	*Scoteanax rueppellii*	Moderate to high. Has not been recorded in the locality, but suitable habitat exists within the subject site.	Low - small portion of potential foraging and roosting habitat would be removed.
Yellow-bellied Sheathtail Bat	*Saccolaimus flaviventris*	Moderate. Has not been recorded in the locality, however suitable habitat for the species potentially exists within the subject site.	Low - small portion of potential foraging and roosting habitat would be removed.
Large-footed Myotis	*Myotis adversus*	High - has been recorded in the locality, suitable foraging habitat in study area.	Low - small loss of potential roosting habitat.
Masked Owl	*Tyto novaehollandiae*	High. Has been recorded within the locality and the subject site contains suitable	Low - minor loss of potential foraging

Table 3.1 THREATENED TERRESTRIAL FLORA AND FAUNA SPECIES POTENTIALLY OCCURRING IN THE STUDY AREA

Common Name	Scientific Name	Likelihood of Occurrence in the Subject Site	Likely Sensitivity to Disturbance from Proposal
		foraging habitat.	habitat.
Powerful Owl	*Ninox strenua*	High. Has been recorded within the locality and the subject site contains suitable foraging habitat.	Low - minor loss of potential foraging habitat.
Barking Owl	*Ninox connivens*	Moderate to high. Suitable foraging habitat exists within the subject site.	Low - minor loss of potential foraging habitat.
Glossy Black-cockatoo	*Calyptorhynchus lathami*	High. The species has been recorded in the locality and suitable foraging habitat exists within the subject site.	Low - minor loss of potential foraging habitat
Square-tailed Kite	*Lophoictinia isura*	High - previously recorded in the locality suitable foraging habitat exists on site.	Low - minor loss of potential foraging habitat.
Black Bittern	*Ixobrychus flavicollis*	Moderate. The species has been recorded within the locality, however only sub-optimal habitat exists within the subject site.	Low - no loss of breeding habitat, minimal loss of potential foraging habitat.
Stephen's Banded Snake	*Hoplocephalus stephensii*	Low to moderate - sub-optimal habitat on site, not previously recorded in the locality.	Low - small area of potential habitat to be removed.

Table 3.1 THREATENED TERRESTRIAL FLORA AND FAUNA SPECIES POTENTIALLY OCCURRING IN THE STUDY AREA

Common Name	Scientific Name	Likelihood of Occurrence in the Subject Site	Likely Sensitivity to Disturbance from Proposal
Pale-headed Snake	*Hoplocephalus bitorquatus*	Low to moderate - sub-optimal habitat on site, not previously recorded in the locality.	Low - small area of potential habitat to be removed.
Green-thighed Frog	*Litoria brevipalmata*	Low to moderate. No records in the sub-region, suitable habitat on site.	Low - minimal impact on potential habitat for this species.
Rudder's Box	*Eucalyptus rudderi*	Moderate - suitable habitat on site, previously recorded in the locality, however, not recorded during current survey.	Low - the species was not recorded during the current survey, hence if it does occur, very few individuals would be removed. The species would be used during revegetation programs.

a ***in the case of a threatened species, whether the lifecycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction;***

No threatened plant species were recorded during the ecological investigations, however suitable habitat does exist in the study area for the RoTAP species rudder's box (*Eucalyptus rudderi*). The subject site has been thoroughly surveyed in order to detect this plant species, however, none have been observed. If this species does occur on the subject site, it is unlikely that the activity would cause the extinction of a viable local population due to the extent of similar vegetation communities and habitats in the locality, particularly within Kiwarrak State Forest.

The ecological investigations revealed that limited areas of potential koala habitat exist in the study area. Furthermore, despite the level of survey effort (ie. spotlighting and scat searches) no koalas (*Phascolarctos cinereus*) were observed, and no other evidence of the species (ie. scratches or scats) was located during the current survey. Furthermore, the proposed development would remove only a relatively small proportion of the potential feeding resources for this species from the locality. Therefore, the proposed development is unlikely to disrupt the lifecycle of this species such that a viable local population would be placed at risk of extinction.

The tiger quoll (*Dasyurus maculatus*) could potentially utilise the habitats in the subject site as a foraging resource within an extensive home range. Potential den sites are unlikely to occur within the subject site due to a paucity of hollow logs or caves that the species requires for breeding (State Forests of NSW 1995). It is unlikely that the proposed quarry expansion would remove or isolate significant areas of foraging habitat for the species. Furthermore, *D. maculata* has been recorded within Kiwarrak State Forest, which is likely to contain extensive areas of suitable habitat for the species. Therefore, the proposed development is unlikely to contribute to the extinction of a viable local population of the species.

The proposed quarry expansion would remove approximately 10.5 hectares of potential foraging habitat from the study area for the brush-tailed phascogale (*Phascogale tapoatafa*). Research by Rhind (1996) in Western Australia indicates that the preferred nesting trees of the species are usually dead, or have a diameter of more than 85 centimetres. Nesting females also require hollows with spacious internal cavities (nest is over 30 times larger than the female) (Rhind 1996; Soderquist 1995). Very few dead or large trees (more than 85 centimetres diameter) are located in the subject site. Therefore, the proposed quarry expansion would be unlikely remove a significant proportion of suitable roosting or breeding hollows for the species. Furthermore, large tracts of relatively undisturbed forest containing known habitat for the species would be retained within Kiwarrak State Forest, where

the species has been recorded at several locations including Cow Hill, Turragurry Gully and Dennes Creek. Therefore, the proposed quarry expansion is unlikely to have a significant impact on viable local populations of this species.

The squirrel glider (*Petaurus norfolcensis*) prefers mature forests or mixed aged stands of eucalypts with an abundant supply of nectar, pollen, eucalypt sap, *Acacia* gum, honeydew and arthropods (State Forests of NSW 1995). The forest types within the subject site are unlikely to represent a significant foraging resource for the species due to the presence of relatively immature forest (resulting from previous logging practices), and a lack of dense stands of acacias or banksias within the subject site to provide additional food resources.

There is very little data available regarding preferred den characteristics of squirrel gliders (Gibbons & Lindenmayer 1997). However, the species has been recorded using living trees, dead trees and hollow stumps as den sites (Gibbons & Lindenmayer 1997). Very few large living trees, dead trees or hollow stumps occur in the subject site, hence there appears to be a paucity of suitable sheltering resources for the species. Therefore, habitats within the subject site are unlikely to represent significant habitat for the species, hence the proposed development would be unlikely to cause the extinction of a viable local population of the squirrel glider.

In NSW the long-nosed potoroo (*Potorous tridactylus*) has been recorded in rainforest, moist hardwood forest, woodland with dry heath understorey, wet heaths, dense coastal scrubs and mixed species open-forest (Seebeck *et al.* 1989). The denser vegetation types are utilised as a sheltering resource, while the surrounding wet sclerophyll forests and open vegetation types are utilised as foraging resources (Seebeck *et al.* 1989). The species appears to avoid virgin rainforest in preference for the ecotone between rainforest and moist open forest (Seebeck *et al.* 1989). The species may utilise the subject site as part of its floristically diverse foraging habitat. Although suitable sheltering habitat exists within the southern portions of the study area, only limited sheltering habitat exists within the subject site. The proposed development is therefore likely to result in the removal of a small portion of potential roosting and foraging habitat for the species. However, the long-nosed potoroo is a highly mobile species, and extensive areas of suitable habitat exist within the locality. Therefore, it is unlikely that the impacts associated with the proposed development would disrupt the lifecycle of the species to the extent that a viable local population of the species would be placed at risk of extinction.

Habitat within the study area may provide a foraging resource for a variety of threatened bat species including the yellow-bellied sheathtail bat (*Saccolaimus flaviventris*), large bent-wing bat (*Miniopterus schreibersii*), little bent-wing bat (*Miniopterus australis*), greater broad-nosed bat (*Scoteanax rueppellii*), large-footed myotis (*Myotis adversus*) and the eastern freetail-bat (*Mormopterus norfolkensis*). The

bent-wing bats and the large-footed myotis are primarily cave-dwelling species that require caves or similar structures for breeding (Churchill 1998), hence the study area does not contain suitable breeding habitat for these species. However, suitable roosting habitat for all species does exist on site in the form of small tree hollows and trees with decorticating bark (Churchill 1998). All of these species appear to utilise a wide variety of habitat types ranging from rainforest to dry sclerophyll forest and open woodland (Churchill 1998). All of these species are highly mobile, and extensive suitable roosting and foraging resources are likely to exist in surrounding areas. Therefore, the proposed development has the potential to modify a relatively small area of suitable foraging habitat and remove some roosting resources for these species, however, not the extent that viable local populations would be placed at risk of extinction.

There are very few hollow bearing trees within the study area that represent suitable roosting or nesting resources for the masked owl (*Tyto novaehollandiae*), barking owl (*Ninox connivens*) or the powerful owl (*Ninox strenua*). These threatened owl species may however utilise the habitats of the subject site as a foraging resource within an extensive home range. Furthermore, large areas of suitable foraging habitat are likely to exist within adjacent forests and woodlands. Therefore, the proposed quarry expansion is likely to remove only a small portion of foraging habitat hence it is unlikely to contribute to the extinction of a viable local population of these species.

Although potential foraging resources for the glossy black-cockatoo (*Calyptorhyncus lathami*) exist within the study area, these resources represent only a small fraction of the potential foraging resources available for this species in the locality. Due to there being a lack of medium to large hollows over the study area, the site is unlikely to be utilised for breeding purposes by the species. Nevertheless, the proposed development could potentially degrade the quality of foraging habitat for this species within the study area, but not to the extent that a viable local population of the species would be placed at risk of extinction.

The square-tailed kite (*Lophoictinia isura*) appears to utilise a wide variety of structurally diverse habitat types including eucalypt forest and woodland, mallee, heath and scrubby habitats (Garnett 1993; State Forests of NSW 1995). The species does not seem to have any specific nesting requirements, other than living trees within tall eucalypt forest. Therefore, extensive areas of potential foraging and nesting habitat in the form of dry open forest and woodland exist within the locality for the species. The subject site represents only a very small fraction of potential foraging and roosting habitat for this species in the locality. The proposed development could potentially degrade the quality of foraging and roosting habitat for the species within the subject site, however, not to the extent that a viable local population of the species would be placed at risk of extinction.

The black bittern (*Ixobrychus flavicollis*) occurs in thick vegetation at margins of watercourses, swamps, billabongs, mudflats and mangroves in tidal creeks and rivers. Denser vegetation along the margins of the ephemeral watercourses in the north of the study area may provide suitable foraging habitat for the species. The proposed quarry expansion would not encroach on these denser vegetated areas. Critical breeding habitat for the black bittern usually consists of mangrove belts along coastal waterways and densely vegetated wetlands (State Forests of NSW 1995). Habitats within the study area are unlikely to represent suitable breeding habitat for the species, nevertheless, areas of dense riparian vegetation would not be subject to direct disturbance by the proposed quarry expansion.

The stephen's banded and pale-headed snakes (*Hoplocephalus*) inhabit a variety of habitat types including dry rainforest, sub-tropical rainforest, wet sclerophyll forest, dry sclerophyll forest and rock outcrops (Gilmore and Parnaby 1994). In terms of sheltering resources, these species utilise gaps underneath decorticating bark on trees, hollow trunks and limbs of dead trees, or gaps within exfoliating rock outcrops (Gilmore and Parnaby 1994; State Forests of NSW 1995). The subject site does not contain significant areas of exfoliating rock or trees (living or dead) with hollow trunks and limbs. There are some trees with decorticating bark within the subject site that may provide sheltering resources for these species. However, other areas containing suitable sheltering and foraging resources exist within the study area and surrounding areas. Therefore, although the proposed quarry expansion would remove a relatively small portion of potential sheltering habitat from the study area, the impacts of this removal would be unlikely to have a significant impact on viable local populations of these species.

In terms of foraging resources, the *Hoplocephalus* species are nocturnally active, and hunt for tree frogs, lizards, birds and small mammals usually within the dense shrub understorey and groundcover layers. Potential foraging habitat for these species is likely to occur within the relatively dense riparian vegetation along the ephemeral watercourses in the north of the study area. These areas of dense riparian vegetation would not be disturbed by the proposed quarry expansion, hence no significant impact on local populations of these species is expected.

The green-thighed frog (*Litoria brevipalmata*) is known to inhabit primarily rainforest and wet sclerophyll forest (Cogger 1996). However, it has also been recorded in dry open forest and coastal swamp forest. Studies by Lemckert *et al.* (1997) suggest that the species prefers to live in areas of moist forest with both a deep and moist leaf litter and a complex and dense understorey. Potential habitat for this species in the study area is likely to be associated with dense vegetation around the two large permanent dams. It is proposed to use these two dams for emergency water supplies primarily for dust suppression on quarry roads. Access to these dams by water trucks and pumps would be restricted to existing tracks, hence there would be

minimal disturbance to the vegetation around the dams. Furthermore, water would be retained in these dams at all times. Therefore, the proposed quarry expansion would be unlikely to disturb the lifecycle of the green-thighed frog to the extent that a viable local population would be placed at risk of extinction.

b ***in the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised;***

No relevant endangered populations of native fauna and flora (as listed on Part 2 of Schedule 1 of the TSC Act) occur within the study area.

c ***in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed;***

Other than the possible recording of the eastern falsistrelle (*Falsistrellus tasmaniensis*), the study area does not currently represent known habitat for any threatened species. Nevertheless, formal conservation reserves and State Forests make up approximately 39 percent (2.4 million hectares) of land contained within the NSW North Coast region (6 million hectares). A large proportion of this 39 percent consists of habitat types dominated by eucalypt species such as those within the study area. Hence, in a regional context the habitats within the subject site are relatively common and widespread. Within the locality there is approximately 9400 hectares of forest contained in Kiwarrak State Forest alone. Extensive areas of forest also occur on private land within the locality. The proposed quarry expansion would remove approximately 8.8 hectares (16.3 percent) of dry open forest and 1.7 hectares (five percent) of moist open forest from the study area. The study area contains approximately 54 hectares of dry open forest and 34.5 hectares of moist open forest. The proposed clearing would amount to a cumulative loss of forest habitat of less than 0.1 percent within the locality. The area of habitat to be removed is unlikely to represent a significant area of habitat for threatened flora or fauna species.

d ***whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;***

A potential wildlife corridor currently extends in a north to south direction between the existing quarry area and the semi-cleared farmland in the east of the study area. Although the potential corridor has been completely cut by a light vehicle access track and powerline easements, it is likely to still function as a corridor for a variety of more mobile species such as birds, flying mammals and medium to large terrestrial fauna.

The proposed development would progressively remove a large proportion of this potential wildlife corridor over a period of 60 years. The main impact on the potential corridor would during Stage 3 of the quarry expansion, which would take place in at least 40 years time. If the proposed mitigation measures were not

implemented then fauna movement between these areas may then be restricted to either semi-cleared vegetation east of the study area, or to a relatively long narrow strip of remnant vegetation between the quarry and the Pacific Highway.

In order to minimise the potential loss of wildlife corridor function in this area a strip of semi-cleared vegetation retained on the farmland in the east of the study area (minimum width 220 metres) would be revegetated. The revegetation program for this area would commence at the beginning of the proposed quarry expansion. Stage 1 of the proposed expansion would take at least 20 years to complete, and would not encroach upon the potential wildlife corridor. Stage 2 would take at least an additional 20 years to complete, and would remove approximately half of the potential wildlife corridor. Therefore, the proposed revegetation corridor would have at least 40 years to establish prior to the potential habitat corridor being cut, hence the revegetated area would be at an advanced (mature) stage prior to the potential loss of corridor function.

Furthermore, a strip of cleared land (approximately 200m x 20m) along the southern edge of the access road would also be revegeted at the beginning of the proposed quarry expansion to enhance the potential wildlife corridor function of remnant vegetation between the Pacific Highway and the study area.

e *whether critical habitat will be affected;*

At the time of report production no relevant "critical habitat" had been declared by the Director General of NSW NPWS. Therefore, the impact associated with the proposed activities on critical habitat could not be assessed.

f *whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region;*

In 1997, conservation reserves covered an area of approximately 5,752,738 hectares within the NSW North Coast region (EPA 1997). Extensive areas have since been dedicated as conservation reserves in the region, however, the total size of these new areas was not available during the preparation of this report. All of the potentially occurring threatened species within the study area would be represented within existing conservation reserves (and other similar protected areas). However, due to particular habitat requirements, large home ranges and/or sparse distributions a significant proportion of these species cannot be considered to be adequately represented within existing conservation reserves (and other similar protected areas).

g *whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process;*

The proposed activity is not specifically recognised as a key threatening process on Schedule 3 of the TSC Act. However, the removal of habitat is an activity that is likely to be recognised by the scientific community as potentially detrimental to certain species or their habitats. Nevertheless, given the disturbed nature of habitats within the subject site, the extent of proposed habitat removal and the types of mitigation measures proposed, the impact of the proposed quarry expansion is unlikely to have a significant impact on threatened species or their habitats.

h ***whether any species, population or ecological community is at the limit of its known distribution.***

None of the threatened species potentially occurring within the study area would be at the limit of their known distribution.

3.1.1 Conclusion

The study area does provide suitable habitat for a number of threatened species. However, the vegetation communities within the study area have been degraded through previous disturbances from quarry activities, timber harvesting, rural residential development and road and powerline easement construction. The extent of proposed habitat removal on site is unlikely to significantly impact on threatened species likely to occur. Part of the study area could potentially represent a fauna movement corridor between forest areas to the north and south of the study area. However, the proposed revegetation program and staged expansion of the quarry from the western side of the subject site should ensure the maintenance of the potential corridor function between these forest areas.

Based on the eight factors considered above, it is highly unlikely that the proposed development would cause a significant impact on threatened species potentially occurring within the study area.

3.2 AQUATIC EIGHT PART TEST OF SIGNIFICANCE

3.2.1 Background

NSW Fisheries legislation has recently been strengthened with the inclusion of Threatened Species Conservation provisions to declare and list threatened species of fish and marine vegetation, endangered populations and ecological communities and key threatening processes. These provisions mirror those in the *Threatened Species Conservation Act* (1995) (administered by NSW NPWS), and must be

considered when referring to Section 5A of the *Environmental Planning and Assessment Act* (1979) (EPA Act).

The Fisheries Management Act 1994, as amended by the Fisheries Management Amendment 1997, has the following objectives in terms of the protection of threatened species and their habitats:

a. to conserve biological diversity of fish and marine vegetation and promote ecologically sustainable development;

b. to prevent the extinction and promote the recovery of threatened species, populations and ecological communities of fish and marine vegetation;

c. to protect the critical habitat of those threatened species, populations and ecological communities that are endangered;

d. to eliminate or manage certain processes that threaten the survival or evolutionary development of threatened species, populations and ecological communities of fish and marine vegetation;

e. to ensure that the impact of any action affecting threatened species, populations and ecological communities of fish and marine vegetation is properly assessed; and

f. to encourage the conservation of threatened species, populations and ecological communities of fish and marine vegetation by the adoption of measures involving cooperative management.

ERM has undertaken an Eight Part Test of Significance as defined in Section 5A of the *Environmental Planning and Assessment Act*, 1979 (EP&A Act). The Eight Part Test was undertaken to specifically assess whether the proposed extensions to the Jandra Quarry is likely to have a significant effect on threatened fish species, populations or ecological communities, or their habitats that may occur within the study area.

3.2.2 *Factors for Consideration*

a in the case of a threatened species whether the lifecycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction;

None of the species currently listed as Endangered or Vulnerable in the *Fisheries Management Amendment Act* (1997) are likely to occur in the ephemeral drainage lines surveyed. Therefore, the lifecycle of any threatened fish species is highly unlikely to

be disrupted by the proposed development such that a viable local population of the species would be placed at risk of extinction.

A series of mitigation measures to address pollution control would be implemented to ensure that any disruption to viable local fish populations would be minimised. These mitigation measures include:

- installation of erosion and sediment controls prior to any soil disturbance, including clean water diversion drains, sediment basins in gully systems and catch drains to divert runoff from disturbed areas to the basins;
- construction of diversion drains along the ridge lines around and beside the excavation site to ensure that clean rainfall runoff drains around the zone of disturbance;
- the provision of sedimentation basins and controls on all diversion drains;
- the establishment of sedimentation drains down slope of the excavation area to retain all runoff from disturbed areas;
- installation of erosion and sediment controls around the site of the stockpiled excavation material; and
- the mulching and stockpiling of vegetation removed during construction activities for later use in erosion control and stabilisation of disturbed areas.

b ***in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised;***

There are currently no endangered fish populations listed on the *Fisheries Management Amendment Act* (1997).

c ***in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed;***

No known habitat for species currently listed as Endangered or Vulnerable on the *Fisheries Management Amendment Act* (1997) exists within the watercourses located in the study area.

d ***whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;***

The ephemeral watercourses within the study area are not recognised as known habitat for any species currently listed as Endangered or Vulnerable on the *Fisheries Management Amendment Act* (1997). Furthermore, the proposed development would remove a small section of the initial headwaters of Bungwahl Creek, hence, in effect, shortening the waterway rather than cutting it.

e ***whether critical habitat will be affected;***

There are currently no areas of critical habitat listed on the *Fisheries Management Amendment Act* (1997).

f ***whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region;***

At present, NSW Fisheries have declared eight Aquatic Reserves, and one marine protected area within NSW (NSW Fisheries 1998). However, these reserves cover predominantly marine and estuarine habitats and are unlikely to adequately represent threatened species, populations or ecological communities, or their habitats in the region.

However, there are extensive numbers of waterways similar to that within the study area existing within State Forests in the region. For the purposes of this report waterways within State Forests are considered to be *other similar protected areas* due to the level of protection offered to these forested areas and associated waterways under current State Forests of NSW management practices. Therefore, aquatic habitat to be removed by the proposed development is likely to be adequately reserved in the region.

g ***whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process;***

The proposed activity is not specifically recognised as a threatening process on the *Fisheries Management Amendment Act* (1997). However, if the proposed activity is not conducted in accordance with adequate mitigation measures it is likely to be recognised by the scientific community as potentially detrimental to certain species and their habitats.

h ***whether any threatened species, population or ecological community is at the limit of its known distribution.***

The study area is not within the known distribution of any of the species currently listed as Endangered or Vulnerable on the *Fisheries Management Amendment Act* (1997).

3.3 CONCLUSIONS

Based on the eight factors considered above, it is highly unlikely that the proposed development would cause any adverse effect on threatened fish species, fish populations or their habitats.

The best practice methods available would be used to mitigate the potential water quality impacts of the proposed quarry extension. The adoption of best practice methods effectively promotes ecologically sustainable development and minimises processes that threaten the survival or evolutionary development of threatened species, populations and ecological communities of fish and marine vegetation.

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APPENDICES

Appendix A

FLORA SPECIES LIST

APPENDIX A: FLORA SPECIES RECORDED

Family	Scientific Name	Common Name
Asclepiadaceae	*Gomphocarpus fruticosa*	Balloon Cotton Plant
Asteliaceae	*Cordyline stricta*	Palm Lily
Asteraceae	*Ageratina adenophora*	Crofton Weed
	Bidens pilosa	Farmer's Friends
	Cirsium vulgare	Scotch Thistle
	Olearia viscidula	Wallaby Weed
	Senecio madagascariensis	Fireweed
	Tagetes minuta	Stinking Roger
Bignoniaceae	*Pandorea pandorana*	Wonga Wonga Vine
Cactaceae	*Opuntia stricta*	Prickly Pear
Caesalpinioidaceae	*Senna coluteoides*	Cassia
Casuarinaceae	*Allocasuarina littoralis*	Black She Oak
	Allocasuarina torulosa	Forest Oak
Commelinaceae	*Commelina cyanea*	Wandering Jew
Dennstaedtiaceae	*Pteridium esculentum*	Bracken Fern
Dicksoniaceae	*Calochlaena dubia*	False Bracken Fern
Dilleniaceae	*Hibbertia dentata*	Twining Guinea Flower
	Hibbertia diffusa	

APPENDIX A: FLORA SPECIES RECORDED

Family	Scientific Name	Common Name
Epacridaceae	*Leucopogon juniperinus*	
Euphorbiaceae	*Breynia oblongifolia*	Breynia
	Phyllanthus gunnii	Spurge
Fabaceae	*Daviesia genistifolia*	
	Glycine tabacina	Love Creeper
	Glycine sp.	
	Hardenbergia violaceae	
	Indogofera australis	
	Jacksonia scoparia	Dog Wood
	Kennedia rubicunda	Running Postman
	Oxylobium cordifolium	Native Holly
	Oxylobium ilicifoliim	Native Holly
Haloragaceae	*Gonocarpus tetragynus*	Poverty Raspwort
Iridaceae	*Patersonia glabrata*	Purple Flag
Lamiaceae	*Plectranthus parviflorus*	Cockspur Flower
Lobeliaceae	*Pratia purpurascens*	White Root
Lomandraceae	*Lomandra longifolia*	Mat Rush
Luzuriagaceae	*Eustrephus latifolius*	Wombat Berry

APPENDIX A: FLORA SPECIES RECORDED

Family	Scientific Name	Common Name
	Geitenoplesium cymosum	
Menispermaceae	*Sarcopetalum harveyanum*	
Mimosaceae	*Acacia binervata*	Two-veined Hickory
	Acacia longifolia	Sydney Golden Wattle
	Acacia sp.	Wattle
Myrtaceae	*Callistemon salignus*	Willow Bottlebrush
	Corymbia intermedia	Pink Bloodwood
	Corymbia maculata	Spotted Gum
	Eucalyptus acmenoides	White Mahogany
	Eucalyptus microcorys	Tallowwood
	Eucalyptus propinqua	Grey Gum
	Eucalyptus saligna	Sydney Blue Gum
	Eucalyptus placita	Grey Ironbark
	Eucalyptus umbra	Broad-leaved White Mahogany
	Lophostemon confertus	Brush-box
	Melaleuca sieberi	Sieber's Paperbark
	Syncarpia glomulifera	Turpentine
Nymphaceae	*Nymphaea sp.*	Water Lillies
Oxalidaceae	*Oxalis* sp.	

APPENDIX A: FLORA SPECIES RECORDED

Family	Scientific Name	Common Name
Passifloraceae	*Passiflora subpeltata*	Wild Passionfruit
Philydraceae	*Philydrum lanuginosum*	Woolly Frogmouth
Phormiaceae	*Dianella caerulea*	Blue Flax Lily
Pittosporaceae	*Billardiera scandens*	Apple Dumplings
	Bursaria spinosa	Blackthorn
	Pittosporum revolutum	Rough Fruited Pittosporum
	Pittosporum undulatum	Sweet Pittosporum
Platyzomataceae	*Adiantum aethiopicum*	Maiden Hair Fern
Poaceae	*Chloris truncata*	Rhodes Grass
	Danthonia sp	Wallaby Grass
	Echinopogon sp	Tufted Hedgehog Grass
	Imperata cylindrica	Blady Grass
	Themeda australis	Kangaroo Grass
	Andropogon virginicus	Whisky Grass
Proteaceae	*Persoonia linearis*	Narrow-leaved Geebung
Rhamnaceae	*Emmenosperma alphitonioides*	Bonewood
Rosaceae	*Rubus hillii*	Blackberry
Rutaceae	*Zieria smithii*	Sandfly Zieria
Santalaceae	*Exocarpos cupressiformis*	Cherry Ballart

APPENDIX A: FLORA SPECIES RECORDED

Family	Scientific Name	Common Name
Smilaceae	*Smilax glyciphylla*	Climbing Sarsparilla
Solanaceae	*Solanum mauritianum*	Wild Tobacco Tree
	Solanum prinophyllum	Forest Nightshade
Typhaceae	*Typha orientalis*	Bull Rush
Thymelaceae	*Pimelea linifolia*	Rice Flower
Verbenaceae	*Lantana camara*	Lantana
	Verbena bonariensis	Purple Top
Violaceae	*Viola hederaceae*	Native Violet

Appendix B

AQUATIC HABITAT ASSESSMENT RESULTS

APPENDIX B: AQUATIC HABITAT ASSESSMENT RESULTS.

Criteria	Site 1	Site 2	Site 3	Site 4	Site 5
Location	E448300; N6453650	E448600; N6453650	E448800; N6453600	E448550; N6454400	E448200; N6454300
Waterbody Type	ephemeral drainage line	ephemeral drainage line	ephemeral drainage line	ephemeral creek with permanent dam	ephemeral drainage line
Pool/Riffle Sequence	no	no	no	pools, no riffles	no
Substratum Type	rock	rock	rock	clay loam	clay loam
Snag Abundance	sparse	sparse - moderate	sparse - moderate	moderate	moderate
Instream Vegetation	no aquatic species (ie. lantana, grasses)	no aquatic species (ie. lantana, bracken fern, grasses)	no aquatic species (ie. fishbone fern, grasses)	*Gahnia* sp. emergent veg.	nil
Water Depth	nil	nil	nil	0 to 60 cm	nil
Waterbody Width	nil	nil	nil	2.5m	nil
Streamflow Present	no	no	no	no	no

APPENDIX B: AQUATIC HABITAT ASSESSMENT RESULTS.

Criteria	Site 1	Site 2	Site 3	Site 4	Site 5
Deep Pools Present	nil	nil	nil	dam	no
Impediments to Fish Passage	no flow	no flow	no flow	dam structure, lack of streamflow	no flow
Riparian Zone Veg. Type	dry open forest	moist open forest		moist open forest	moist open forest
Water Clarity	n/a	n/a	n/a	<10 cm	n/a
Stream Classification	1	1	1	3	2

Note: *Stream classification is explained in Section 2.1.5.*
Stream site locations are shown on Figure 2.1.

Appendix C

SEPP 44 KOALA HABITAT ASSESSMENT RESULTS

APPENDIX C: RESULTS OF SEPP 44 INVESTIGATION

Plot Number	Lower Canopy Tree Species	No. Individuals	Upper Canopy Tree Species	No. Individuals
1	*Eucalyptus microcorys*	1	*E. microcorys*	6
	E. propinqua	1	*E. propinqua*	2
	Corymbia resinifera	2	*E. acmenoides* *	5
	C. gummifera	1	*C. resinifera*	3
	Allocasuarina torulosa	3	*Syncarpia glomulifera*	1
			A. torulosa	3
2	*E. propinqua*	3	*E. propinqua*	2
	E. acmenoides *	3	*E. acmenoides* *	6
	C. maculata *	8	*C. maculata* *	17
	E. placita *	3	*E. placita* *	9
	A. torulosa	8		
3	*C. maculata* *	5	*C. maculata* *	11
	E. placita *	4	*E. placita* *	6
	E. acmenoides *	1	*E. acmenoides* *	3
	A. torulosa	15		
4	*E. microcorys*	1	*E. microcorys*	1
	E. propinqua	1	*E. propinqua*	1

APPENDIX C: RESULTS OF SEPP 44 INVESTIGATION

Plot Number	Lower Canopy Tree Species	No. Individuals	Upper Canopy Tree Species	No. Individuals
	E. acmenoides *	7	*E. acmenoides* *	6
	C. maculata *	15	*C. maculata* *	15
	E. crebra	1	*A. torulosa*	1
	A. torulosa	5		

Note: Highlighted text indicates preferred koala feed tree species, including primary species of locally preferred koala food trees as identified by Evans and Fitzpatrick (1996).

Plot locations shown on *Figure 2.1* in main document.

* These species have been identified as secondary koala food tree species in the Manning Valley Catchment (Evans & Fitzpatrick 1996).

JANDRA QUARRY

EXTENSION

CSR™

M. NOISE AND BLASTING ASSESSMENT

JANDRA QUARRY EXTENSION

Noise And Blast Assessment

For:
CSR CONSTRUCTION MATERIALS

October 1999
38070NOISERP2

Report No. 38070NOISERP2

This report was prepared in accordance with the scope of services set out in the contract between ERM Mitchell McCotter Pty Ltd ACN 002 773 248 (ERMMM) and CSR Construction Materials. To the best of our knowledge, the proposal presented herein accurately reflects the CSR intentions when the report was printed. However, the application of conditions of approval or impacts of unanticipated future events could modify the outcomes described in this document. In preparing the report, ERMMM used data, surveys, analyses, designs, plans and other information provided by the individuals and organisations referenced herein. While checks were undertaken to ensure that such materials were the correct and current versions of the materials provided, except as otherwise stated, ERMMM did not independently verify the accuracy or completeness of these information sources.

Approved by:	*Tony McNamara*
Position:	Project Director
Signed:	
Date:	

ERM Mitchell McCotter Quality System

Prepared by:	*Murray Curtis*
Position:	Project Manager
Signed:	
Date:	14/10/99

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Chapter 1

INTRODUCTION

1.1 BACKGROUND

ERM was commissioned by CSR Construction Materials to undertake a noise and blasting assessment for the proposed expansion of Jandra Quarry. The quarry is located approximately 20 kilometres south of Taree on the mid north coast of NSW. The quarry locality is shown on *Figure 1.1*.

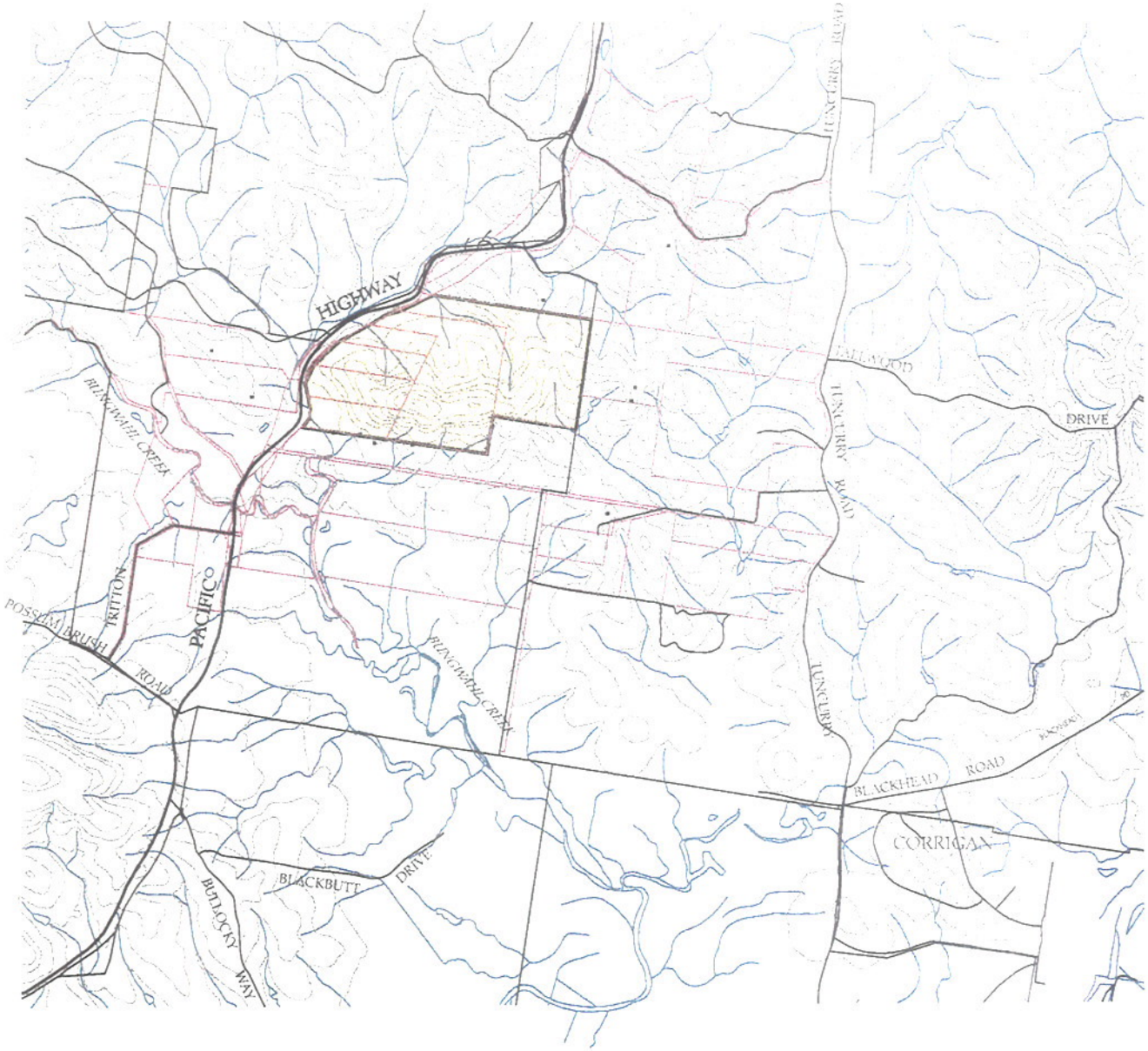
1.1.1 Quarry Development Plan

A figure showing the contour plan of the existing quarry is provided in *Appendix A*. Future quarry development is planned to take place in four stages. The following summaries of quarry development have been provided by CSR.

- Stage 1 comprises the westerly development of the quarry towards the Pacific Highway. The western limit of extraction is 400 metres from the Highway with the floor level of the quarry remaining at the existing level of RL 50m;
- Stage 2 involves the easterly development of the RL 50, 62, 74, 86 and 98 metre faces half way to the proposed eastern limit of the quarry and developing a cut to RL 35 in the latter part;
- Stage 3 sees the continued development east of the RL 35, 50, 62, 74 and 98 metre benches to their most eastern limit. At no stage will the eastern ridge be breached. Towards the end a drop cut to RL 20 will be developed; and
- Stage 4 comprises development of the final bench resulting in a floor level at RL 20, and some peripheral clean up.

Plans showing quarry development stages are also attached in *Appendix A*.

In regard to prediction of noise levels generated by the proposed expansion of the quarry, assessment of Stage 4 is not considered warranted as extraction operations would be on either previously worked benches or on benches below natural ground level and as such any worst case noise and vibration generation scenario would not create noise or vibration levels above those predicted for Stage 1 or Stage 3.



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CSR PROPERTY BOUNDARY

RESIDENCES

CADASTRAL LOTS

N

ERM MITCHELL MCCOTTER

Figure 1.1 SITE LOCALITY

Stage 2 operations have not been assessed as Stage 3 represents worst case noise exposures for residences to the east of the quarry with plant located at the eastern extremity of extraction during Stage 3.

1.2 TERMINOLOGY

Environmental noise levels vary with time, requiring statistical descriptors to characterise the noise environment. The following descriptors are commonly used to assess noise:

- L_{10}, the noise level which is exceeded for 10 per cent of the time and is approximately the average of the maximum noise levels;
- L_{90}, the level exceeded for 90 per cent of the time and is approximately the average of the minimum noise levels. The L_{90} level is often referred to as the "background" noise level and is commonly used to determine noise criteria for assessment purposes;
- L_{eq}, this level represents the average noise energy during a measurement period; and
- dB(A). Noise level measurement units are decibels (dB). The "A" weighting scale is used to describe human response to noise.

Chapter 2

METHODOLOGY

2.1 ACOUSTIC ASSESSMENT

The following methodology was followed for the acoustic assessment of the quarry:

- determine existing background noise level via continuous noise logging at three locations surrounding the quarry;
- obtain plant sound power data from measurements of existing or similar quarry plant items to be used for predictive noise modelling;
- model noise levels from the quarry for various stages of quarry operation with plant items located in worst case scenario locations; and
- compare predicted noise levels to EPA noise criteria.

2.1.1 Background Noise Measurement

Noise levels were measured at three locations using noise data loggers over the period 16 March to 23 March 1999 as shown in *Figure 2.1.* These locations were:

- Proposed residence at rear of YALA property (YALA 3);
- Loveday residence; and
- Jones residence.

The following equipment was used to measure and record environmental noise levels and weather conditions:

- ARL EL215 noise data loggers; and
- Bruel and Kjaer Type 4230 sound level calibrator.

Noise levels were measured over 15 minute intervals with statistical parameters calculated including L_{eq}, L_1, L_{10}, L_{90}, L_{99}, L_{max} and L_{min}.

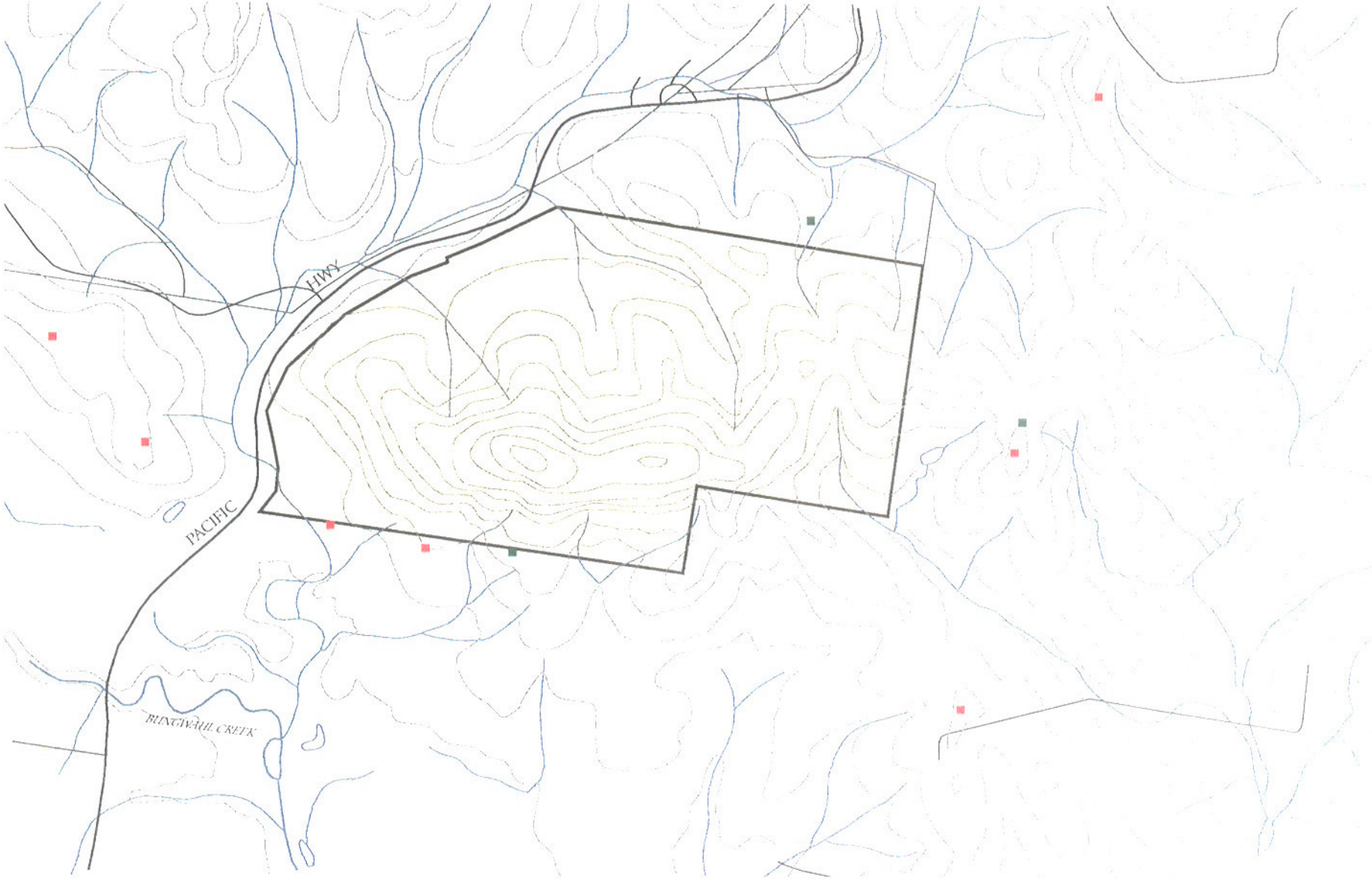

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Figure 2.1 NOISE MONITORING LOCATIONS AND NOISE RECEPTORS

Weather data (hourly wind and rainfall) sourced from Taree Airport allowed correlation of atmospheric parameters and measured noise levels. The weather information was used to filter data where wind speed exceeded five metres per second and/or rainfall occurred.

The EPA recommends minimum repeatable background noise levels be used for determining noise level criteria. The "minimum repeatable" level may be estimated by calculating the 90th percentile of measured L_{90} background noise levels, for the time period of interest.

2.1.2 *Sound Power Level Determination*

Plant sound power levels are required for noise modelling. Third octave sound pressure levels were measured using a SVAN 912 sound level meter and Bruel and Kjaer Type 4230 sound level calibrator. Plant sound power levels were determined generally in accordance with AS 1217 part 7 '*Acoustics - Determination of sound power levels of noise sources - Survey method*'. Sound power of the following plant at the Jandra quarry were determined based on measurements taken on Tuesday 23rd March, 1999.

- CAT 966C Front End Loader;
- CAT 980C Front End Loader;
- Water Cart (International 18t);
- Hitachi EX300-2 Excavator; and
- Komatsu HD325 35t Dump Truck.

Sound power levels of plant items not available on-site at the time have been obtained from previous measurements of similar plant from the ERM database. Data for the Jandra drill rig has been obtained from a noise control report supplied by CSR (Dick Benbow & Associates Pty Ltd, 1998).

2.1.3 *Predictive Noise Modelling*

i. Noise Model

Noise levels from the quarry were calculated using the NSW EPA approved Environmental Noise Model (ENM). This model takes account of noise attenuation due to distance, atmospheric absorption, barriers and the 'ground effect'. It gives

consistently reliable predictions of environmental noise levels. Initial calculations were performed with no wind or temperature gradient (still isothermal conditions or SI conditions), for comparison with the appropriate criteria. Assumed atmospheric conditions were 20 degrees Celsius and relative humidity of 80 percent.

Topographical information was supplied by CSR and the Central Mapping Authority (CMA). CSR provided 2 metre contour maps of Jandra Quarry for the existing site, Stage 1, Stage 2, Stage 3 and the final quarry landform. This was combined with digital contours supplied by CMA of the 1:25000 Nabiac 9333-1-N map sheet. The topographical information together with plant locations and sound power levels and receiver locations were entered into ENM to produce noise contours around the quarry and single point calculations at the nearest ten residences to the quarry. The locations of these residences are shown in *Figure 2.1.*

Output from the model not only provides the total received noise level but also a ranking of noise sources and received level from each. This allows those plant items providing the highest noise levels at the receptor to be targeted for control if required.

The noise model estimates maximum noise levels and assumes all plant and equipment operates simultaneously and at full power. In practice, such an operating scenario would be unlikely to occur. Measurements at similar quarries and mines have indicated that there is a difference of up to 7 dB(A) between the maximum noise level, as predicted by the model, and the L_{10} level generated by quarrying. To estimate the L_{10} level, a conservative value of 5 dB(A) was deducted from the calculated maximum level.

ii. Analysis of Wind Effects

Under various wind and temperature gradient conditions, noise levels may be increased or decreased compared with still-isothermal (SI) conditions, that is, zero wind and temperature gradient. The *Draft Stationary Noise Source Policy* (EPA, 1998) makes significant moves towards accounting for non-neutral atmospheric conditions which affect noise propagation. These include the effects of temperature inversions and wind velocity gradients which can both enhance or reduce noise propagation from source to receiver compared with SI conditions. This is due to refraction of sound propagating through the atmosphere, brought about by a change in sound speed with height. Sound levels are increased when the wind blows from source to receiver or under temperature inversion conditions, and decreased when the wind blows from receiver to the source or under temperature lapse conditions. Assessment of temperature inversions has not been conducted for Jandra Quarry as no night-time operations are proposed.

Bureau of Meteorology data between 1965 and 1999 from Taree Radio Station 2RE was used to determine the prevalent wind vectors for the site. Average monthly data at 9:00 am and 3:00 pm were provided by the Bureau of Meteorology.

The ENM model calculates noise levels under various combinations of wind speed and wind direction. In total, 16 specific meteorological conditions were considered and assigned percentage occurrences. These were categorised as follows:

- wind speed: two categories, zero to three metres per second and greater than three metres per second; and

- wind direction: eight categories in 45 degree increments.

Noise levels for surrounding residences were calculated for the range of possible combinations of wind speed and wind direction. Using the proportion of time when each of these combinations applied, the probable distribution of noise levels was calculated. In calculations, wind speeds greater than 3 metres per second were replaced with 3 metres per second. This is required because the ENM model does not accurately predict turbulence effects associated with higher wind speeds. The cut-off value of 3 metres per second is believed to be conservatively high. Wind speeds in the zero to three metres per second category were modelled using a wind speed of 2 metres per second and the results for still isothermal conditions were used for calm periods.

Noise models, including ENM, are less accurate in predicting noise under adverse conditions than under SI conditions. Hence, any noise level predictions presented under these conditions should be interpreted more carefully than traditional noise contours calculated under SI conditions.

2.1.4 Noise Criteria

i. Neutral Atmospheric Conditions

Noise emissions from the proposed development are compared to criteria determined using the Environment Protection Authority's *Environmental Noise Control Manual* (ENCM) (EPA, 1994). Criteria described in the Environment Protection Authority's recently-released Draft Stationary Noise Source Policy (EPA, 1998) are also considered.

The EPA lists objectives for environmental noise in its Environmental Noise Control Manual (EPA, 1994). These are that:

- noise from any single source should not intrude greatly above the prevailing background noise level, generally by more than 5 dB; and

- background noise should not exceed an appropriate level for the particular locality and land use. Similarly, the Draft Policy discusses maintaining noise level amenity in the long-term.

The "intrusiveness criterion" is designed to achieve the first objective, and is expressed as:

$$L_{A10,15minute} \leq (*L_{90}) + 5$$

where $L_{A10,15minute}$ is the L_{10} noise level from the source, measured over a 15-minute period and $*L_{90}$ is the minimum repeatable background level.

To satisfy the second EPA objective, background noise levels should be kept within the "maximum acceptable" noise levels suggested in the EPA's Environmental Noise Control Manual. For residences in a rural area these are a night-time background noise level of 35 dB(A) and a daytime level of 45 dB(A).

Similarly, the Draft Policy (EPA, 1998) states that total L_{eq} noise levels from stationary sources should be kept within the "amenity criteria". For residences in a rural area these are L_{eq} levels of 50, 45 and 40 dB(A) for day, evening and night periods respectively.

ii. Adverse Weather Conditions

The "intrusiveness" noise criterion has traditionally been applied under still-isothermal conditions. Experience indicates that if the criterion is met under these conditions, noise under more adverse conditions is generally (but not always) acceptable.

Experience in similar rural areas such as the Hunter Valley, people become more noise sensitive if night-time noise levels exceed about 40 dB(A) on a regular basis. This is 5 dB above the level which would be set as a noise criterion under still-isothermal atmospheric conditions. Hence, one possible formulation for additional criteria would be that noise should not exceed the SI criterion by more than 5 dB on more than ten per cent of occasions throughout a year. This goal would relate to all meteorological conditions.

For this proposal, the following procedure has been used to provide an assessment under the complete range of meteorological conditions, which supplements the assessment under SI conditions:

- an additional "intrusiveness" criterion is used, that under prevailing meteorological conditions, noise levels should not exceed the standard intrusiveness criterion by more than 5 dB(A) for more than 10 per cent of the operating period during a year; and

- additional calculations are performed to define the probability of occurrence of various noise levels accounting for the range of wind speeds and wind directions (and the interactions between these parameters) which are found at the site.

The production of "tenth percentile" noise levels involves detailed and complex noise level calculations. However, this level of detail of the likely noise environment provides regulatory bodies and residents with a more comprehensive and representative understanding of the extent and level of potential noise impacts from the development. This assessment describes the range of noise levels at each potentially affected residence under prevailing meteorological conditions, as well as graphically indicating the tenth percentile noise level.

Using the probability of occurrence of wind speed and wind direction requires more calculation than would a procedure involving a single set of meteorological parameters. This method of assessment represents best available technology and is among the most comprehensive methods to estimate actual noise levels received at a receptor as a percentage of time accounting for atmospheric effects.

Chapter 3

RESULTS

3.1 BACKGROUND NOISE AND INTRUSIVENESS CRITERIA

Minimum repeatable background noise levels were calculated from the logged data at each location. Minimum repeatable background noise levels for the area are used in deriving 'intrusiveness criteria'. Results of background noise measurements are shown in Table 3.1. Graphs of measured noise levels are provided in *Appendix B*.

Table 3.1 BACKGROUND NOISE LEVELS AND INTRUSIVENESS CRITERIA

Location	Minimum Repeatable L_{90} dB(A)	"Intrusiveness" Noise Criteria, L_{10} dB(A)
YALA 3	37.0	42.0
Loveday	36.8	41.8
Jones	35.0	40.0

Notes: 1. *Data where wind speed exceeded 5 m/s or where rainfall occurred not included..*
2. *Minimum repeatable L_{90} over hours of operation. Mon to Fri: 6:00 am to 6:00 pm & Sat: 7:00 am to 3:00 pm.*

The L_{90} criteria for the quarry as defined in the ENCM (EPA, 1994) is dependent upon the existing background noise level as described in Chapter 20 of the ENCM. As existing background noise levels are more than 6 dB(A) below the acceptable maximum level, the L_{90} criterion for the development is 5 dB(A) above background level. The intrusiveness criterion will therefore be the determining factor as the L_{10} intrusiveness criterion is also defined as background plus 5 dB(A). As the L_{10} noise level is by definition not lower than the L_{90} noise level the intrusiveness criterion is the limiting factor and will be considered in this acoustic assessment.

3.2 SOUND POWER LEVELS

Sound power levels for plant items used in noise modelling are shown in *Table 3.2*.

Table 3.2 PLANT SOUND POWER LEVELS

Item	63	125	250	500	1000	2000	4000	8000	Total dB(L)	Total dB(A)
Asphalt Plant	107	113	107	105	101.2	98.9	96.8	94.5	116	108
Crusher	121.2	122.1	112.6	111.3	110.0	111.8	112.0	105.1	126	118
Drill	94.1	94.0	93.5	100.2	101.9	106.7	108.9	103.0	113	113
D8 Dozer	85.0	91.0	101.0	109.0	109.0	107.0	101.0	88.0	114	113
WA420 FEL	107	107	103	106	104	103	97	89	113	109
Cat 966C FEL	107	107	103	106	104	103	97	89	113	109
Cat 980C FEL	105	116	109	111	111	107	100	92	119	115
Water Cart (International 18 t)	106.0	107.0	108.0	109.0	106.0	105.0	100.0	91.0	115	112
Transport Truck	93	96	100	101	103	103	98	88	109	108
Volvo 18t Haul Truck	106.0	107.0	108.0	109.0	106.0	105.0	100.0	91.0	115	112
Hitachi EX300-2	108.0	113.0	104.0	103.0	101.0	97.0	90.0	84.0	115	106
Komatsu HD325	102	106	106	107	106	106	99	91	114	111

Notes: *1. Spectrum dB(Lin).*

3.3 NOISE MODELLING

3.3.1 Neutral Atmospheric Conditions

Noise modelling was conducted under still isothermal meteorological conditions - that is, calm conditions with no temperature gradient. Plant items were located in worst case scenario locations which included stripping topsoil and quarrying and drilling on the topmost benches of the quarry. All plant were operated simultaneously at maximum power. Plant sound power levels are detailed in *Table 3.2* and ISG co-ordinates of plant locations are included in *Appendix C*. Results of single point noise calculations for the closest 10 residences using ENM are shown in *Table 3.3*.

Table 3.3 L_{10} NOISE LEVELS

Residence	Criteria	Existing	Stage 1	Stage 3
YALA 1	42	21.2	36.2	18.4
YALA 2	42	23.9	37.9	20.1
YALA 3	42	27.2	36.4	23.5
Jones	40	25.9	25.6	38.7
Groves	40	24.8	26.4	39.1
Loveday	42	29.5	30.1	32.5
Mowbray	42	31.5	28.7	31.2
Barnes	40	16.5	23.9	35.5
Middleton	42	23.6	31	23.4
Dubos	42	26	29.6	26.3

Notes: *1. All values L_{10} dB(A).*

2. Still isothermal meteorological conditions

3. Adopted criteria for residences not subject to noise monitoring are based on location in regard to monitoring sites and the Pacific Highway

The results given in *Table 3.3* indicate that there are no exceedences of the adopted criteria at any residence during any stage of quarry development.

Noise calculations were not performed for Stage 4 as this stage is primarily the lowering of the pit floor resulting in increased barrier attenuation for workface equipment. Stage 2 has not been modelled as plant in Stage 3 reach the eastern limit of extraction and result in worst case noise exposures for residences to the east. Operations during existing, Stage 1 and Stage 3 represent worst case noise exposures for surrounding residences.

L_{10} noise contours for the existing quarry operations and for Stages 1 and 3 have been calculated and are shown in *Figure 3.1, Figure 3.2* and *Figure 3.3* respectively. Noise levels at all residences are below the adopted criteria.

3.3.2 *Adverse Weather Conditions*

Weather data supplied by the Bureau of Meteorology for Taree Radio Station 2RE between 1965 and 1999 was used to generate seasonal wind roses representing general wind vectors for the area (*Appendix D*). Wind vector percentage occurrence

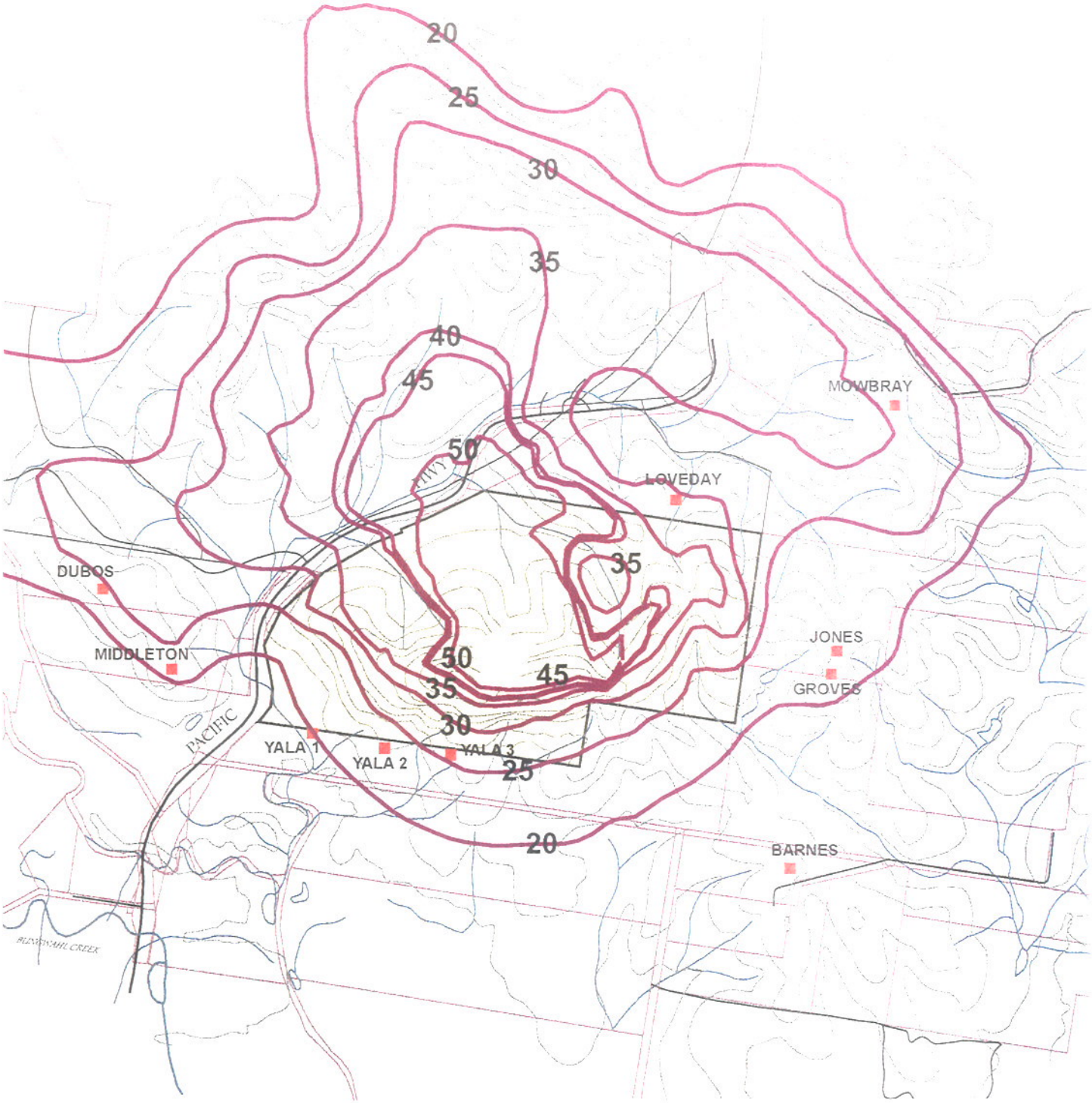
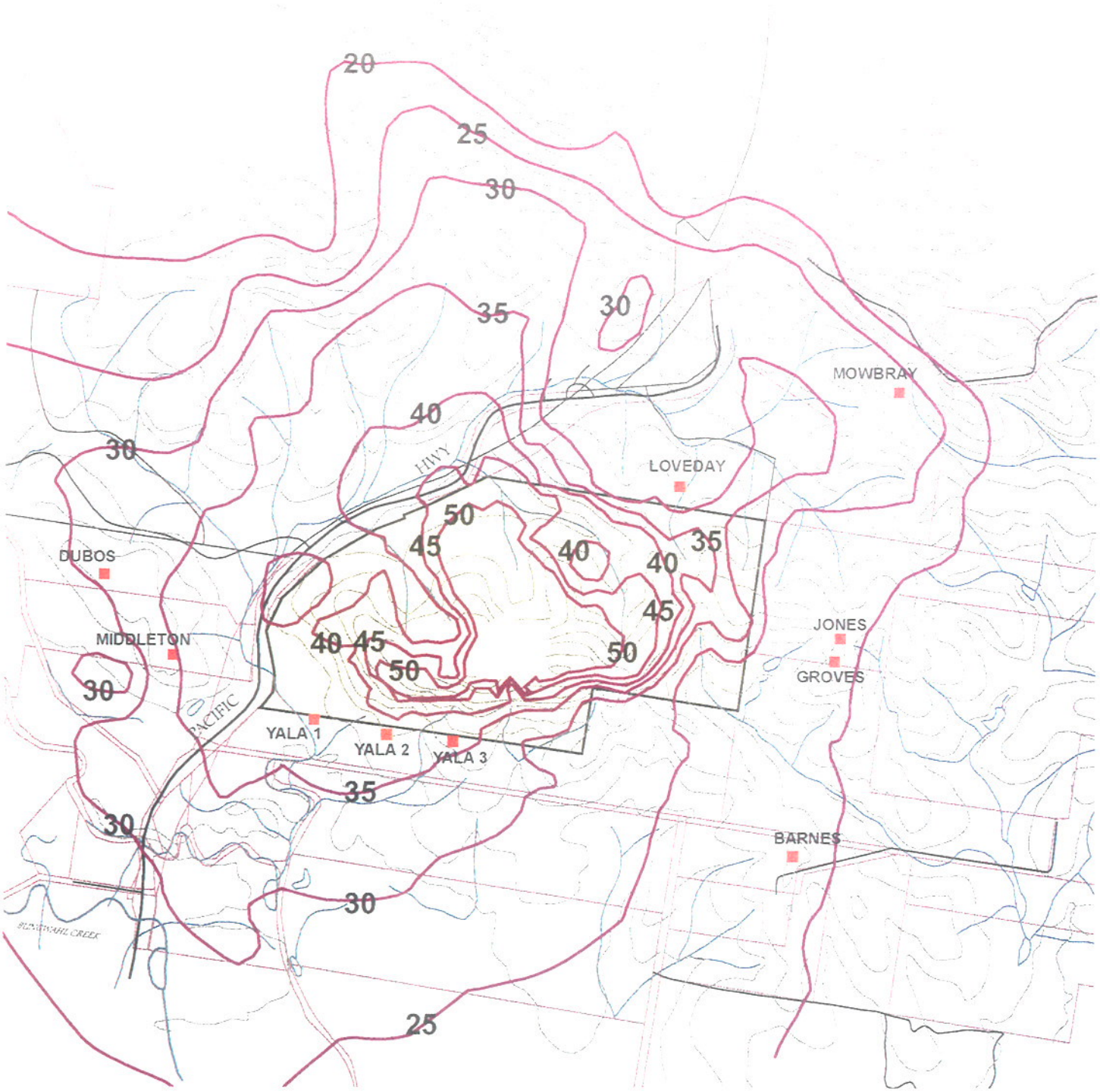


Figure 3.1 STABLE ISOTHERMAL L_{10} NOISE CONTOURS - EXISTING QUARRY

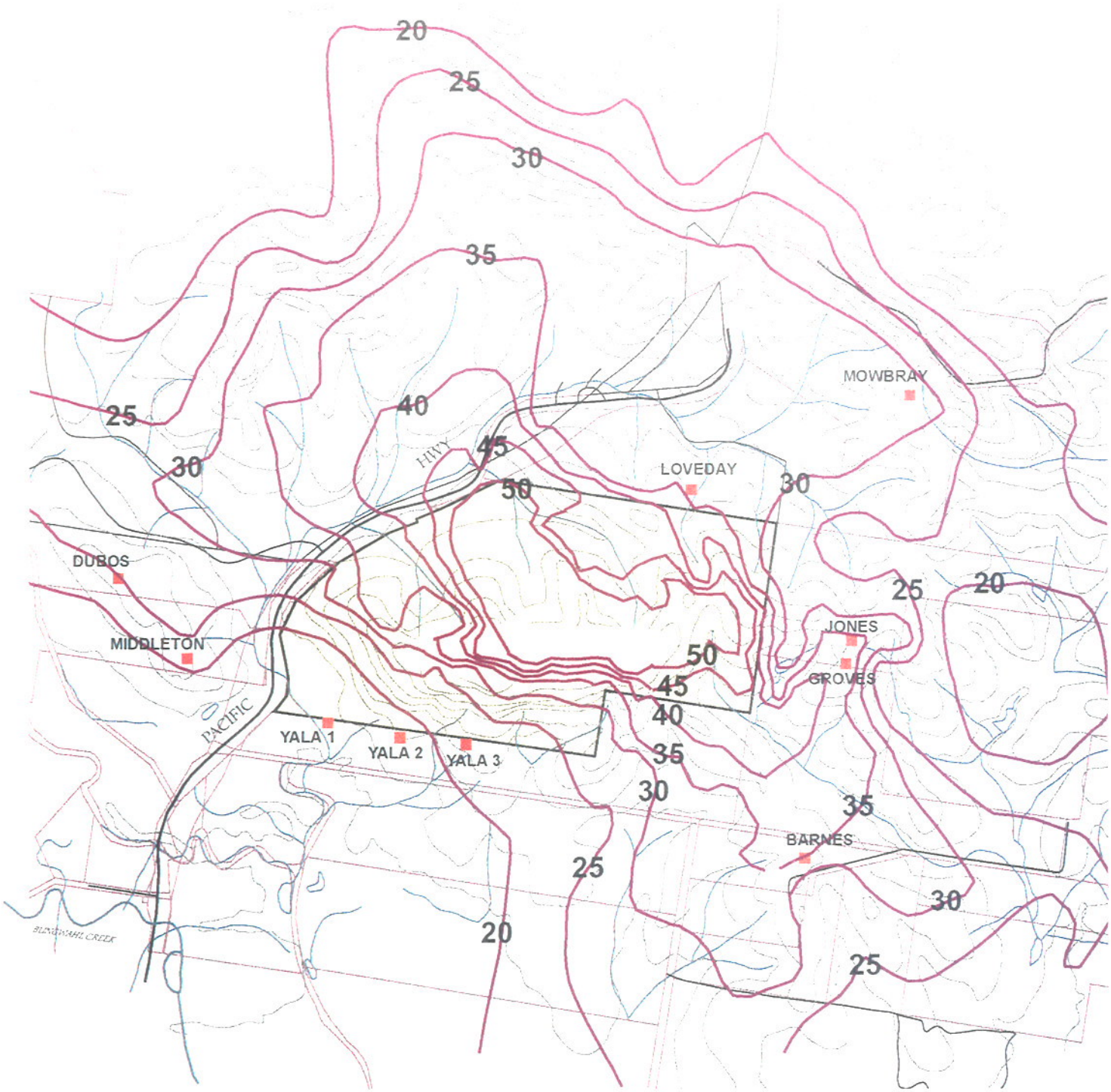


57106/38070APPfg3.2nst1.CDR

SOURCE: CMA 1:25,000 TOPO NABIAC SHEET

ERM MITCHELL McCOTTER

Figure 3.2 STABLE ISOTHERMAL L_{10} NOISE CONTOURS - STAGE 1 QUARRYING



RESIDENCE/NOISE RECEPTOR

30 L_{10} NOISE CONTOUR

CSR PROPERTY BOUNDARY

CADASTRAL BOUNDARIES

STAGE 3 QUARRYING

57106/380070APPfig3.3ncst3.CDR

SOURCE: CMA 1:25,000 TOPO NABIAC SHEET

ERM MITCHELL McCOTTER

Figure 3.3 STABLE ISOTHERMAL L_{10} NOISE CONTOURS - STAGE 3 QUARRYING

N

400m

data was combined with corresponding noise levels for the analysis of the complete set of meteorological conditions as described in Section 2.1.3*ii*.

Calculations were performed for the closest residences to the quarry in each direction. These were:

- YALA 2;
- Groves;
- Loveday; and
- Dubos.

Results have been presented in terms of percentage of time that a given noise level is exceeded and are shown in *Figures 3.4* to *3.6*.

Modelling of noise levels for the range of atmospheric conditions has been conducted for existing, Stage 1 and Stage 3. The criterion adopted for these meteorological conditions is that noise levels should not exceed the standard intrusiveness criterion by more than 5 dB(A) for more than 10% of the specified time period during a year. That is, noise levels should not exceed 45 dB(A) or 47 dB(A) (depending on the location) for more than 10 per cent of the time, see *Table 3.3* for standard intrusiveness criteria applicable to individual residences.

i. Existing Quarry Noise Levels

Noise levels for the existing quarry are within the criteria with no exceedences of the adopted criterion at the 10 per cent level.

Loveday approaches the criterion level for the existing quarry with 45 dB(A) occurring 10 per cent of the time, which remains 2 dB(A) below the adverse weather conditions criterion of 47 dB(A).

ii. Stage 1

Noise levels for Stage 1 are within the criteria with no exceedences of the adopted criteria at the 10 per cent level at any residence.

iii. Stage 3

Noise levels for Stage 3 exceed the criteria level for Groves, which is also representative of Jones, for the worst case scenario modelled. The adopted criterion for these residences is 45 dB(A) which should not be exceeded for more than 10 percent of the time. The 45 dB(A) noise level occurs for 31 percent of the time with noise levels at 47 dB(A) occurring for approximately 8 per cent of the time. Therefore a reduction of 2 dB(A) would result in compliance.

Analysis of the relative contribution to total noise indicates that the dozer removing topsoil is dominant. The dozer is used periodically and is not a permanent plant item. Removal of the dozer results in noise levels approximately 6 dB(A) lower which will result in noise levels complying with the criteria. Use of the dozer for topsoil stripping will need to be co-ordinated not to coincide with adverse wind conditions (west or north west winds), which occur predominantly during winter and autumn mornings.

It should be noted that higher noise levels are often associated with higher wind speeds, and in these cases background noise levels will also be elevated and this may tend to mask quarry noise.

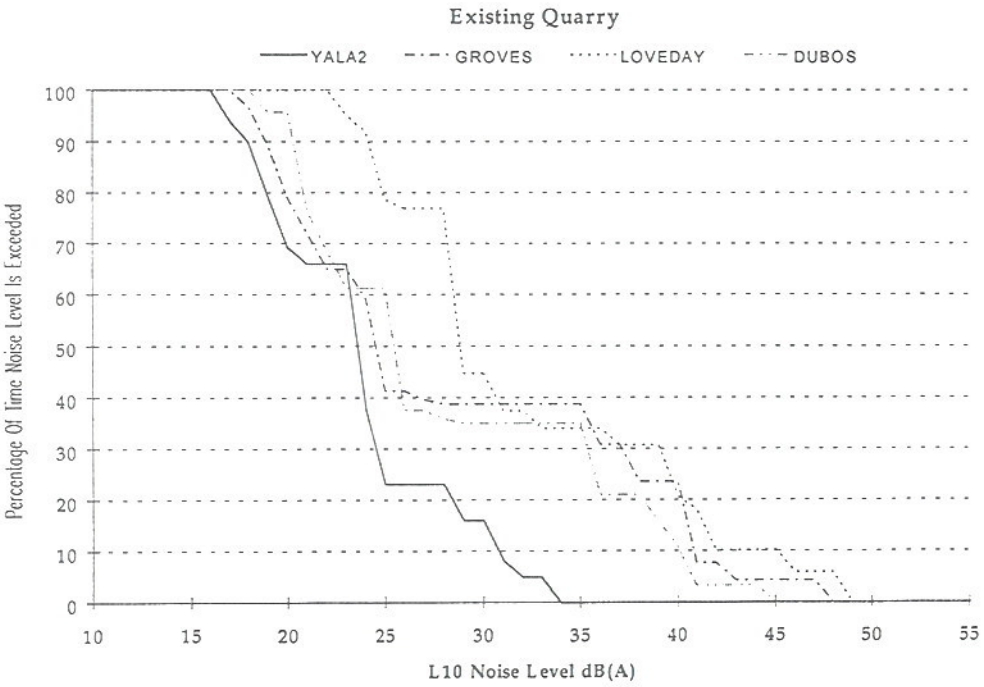


Figure 3.4 NOISE LEVEL DISTRIBUTION, EXISTING QUARRY

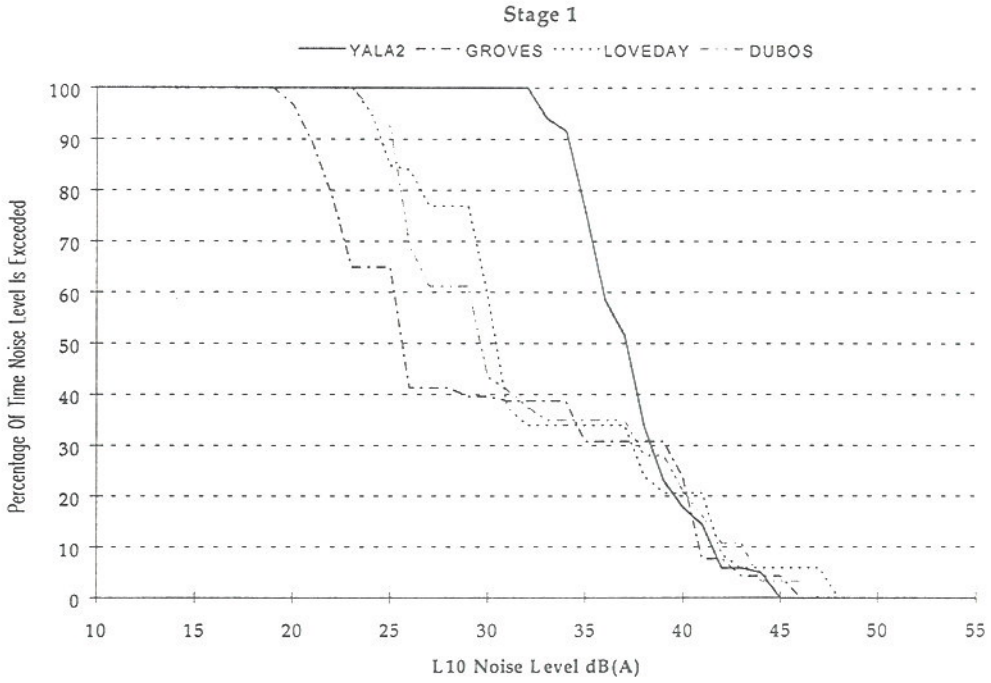


Figure 3.5 NOISE LEVEL DISTRIBUTION, STAGE 1

Figure 3.6 NOISE LEVEL DISTRIBUTION, STAGE 3

Chapter 4

BLASTING

4.1 ASSESSMENT CRITERIA

Noise and vibration criteria for blasting are proposed in the EPA's Environmental Noise Control Manual. However, the EPA has indicated that these have been superseded by values from the Australian and New Zealand Environment Conservation Council's (ANZECC) *"Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration"* (ANZECC, 1990). The ANZECC guidelines are the same as the Environmental Noise Control Manual except for blasting times. Blast overpressure levels should not exceed 115 dB(Lin) at any residence not associated with the quarry, and ground vibration levels should not exceed five millimetres per second (5 mm/s) peak particle velocity. However, it is accepted that some limited exceedence of the criteria may occur on infrequent occasions. This should be limited to not more than 5 per cent of the total number of blasts, and should not exceed 120 dB(Lin) overpressure and 10 mm/s peak particle velocity at any time.

The ANZECC guidelines recommend that blasting should occur only between 9 am and 5 pm, Monday to Saturday, and there should be no blasting on Sundays and public holidays. In addition, it is recommended that blasting occur not more than once a day (Note: occasionally more than one blast per day may be required, for instance, the need for a 'corrective shot').

4.2 BLASTING ASSESSMENT

Blasting impacts can be predicted using a relationship between the maximum instantaneous charge (MIC) and distance from the blast. This form of predictive modelling is of guidance value only as other blast design issues such as blast location, face surveying, length of stemming etc. have a significant influence on blast impacts. Noise and vibration levels due to blasting may be related to the "scaled distance" from the blast, which is defined as:

Scaled Distance = $D/W^{(1/3)}$ for airblast overpressure; and

Scaled Distance = $D/W^{(1/2)}$ for ground vibration.

where D is the distance from the blast to the receptor in metres, and W is the maximum instantaneous charge in kilograms. The formulae for overpressure and ground vibration are site specific.

CSR provided blast monitoring data for 32 blasts over the period 23 April 1997 to 11 November 1998 collected at the former Williams' property (now owned by CSR) located approximately 300 metres to the north-west of the existing quarry face. At this average distance the data show the average overpressure from an MIC 40 kg blast has been 110 dB(Lin). The data is provided in *Appendix E* with a summary given in *Table 4.1*.

Table 4.1 HISTORICAL BLAST DATA SUMMARY

	Approximate Distance metres	Peak particle velocity millimetres per second	Overpressure dB(Lin)
Maximum	390	5	114.5
Minimum	225	0	103.1
Average	300	3	109.8

The historical blast monitoring data at the site were analysed. However, site specific blast and overpressure equations were not developed for the following reasons:

- monitoring location to blast distances did not vary greatly;
- monitoring location to blast distance was not always recorded; and
- the total number of blasts accurately monitored was insufficient.

Instead, standard predictive formulae (those used where no blast monitoring data is available) were used to calculate likely vibration and overpressure levels. Preliminary indications from the blast monitoring data show that actual blast impacts are currently less than those predicted using the standard methods.

4.3 BLASTING IMPACTS

Five recent blasts have been monitored on both the open face side of the quarry (at the site office) and behind the face, on the other side of the southern ridge line, at the nearest residence to any potential blast site (YALA 3). The monitoring data given in *Table 4.2* shows the intervening ridge attenuates blast overpressure to YALA 3 by an

average 12 dB. This attenuation is likely to increase for blasts located on the proposed benches below RL 50.

Although only five blasts have been monitored to date, the results indicate that vibration is likely to be the limiting criteria for determining a suitable design for blasts located along the southern face of the quarry near the YALA residences. The results indicate that blasts at the southern face close to YALA 3 using current blast designs do not exceed the relevant criteria.

Table 4.2 RECENT BLAST MONITORING DATA

Date	Distance metres	Peak particle velocity millimetres per second	Overpressure dB(Lin)
19/04/99	300 shielded side (YALA 3)	4.58	106.1
07/05/99	300 open side (site office)	2.02	118.0
	300 shielded side (YALA 3)	4.65	101.0
15/06/99	300 open side (site office)	4.33	116.9
	300 shielded side (YALA 3)	4.88	108.9
9/08/99	300 open side (site office)	4.9	114.5
30/08/99	300 shielded side (YALA 3)	1.5	97.8

Note: The site office is not a residence and being associated with the quarry EPA criteria is not applicable.

Predicted vibration and overpressure levels for most residences using standard formulae for the proposed typical blast MICs are below the criteria of 115 dB(Lin) and 5 mm/s respectively. These calculations are for unshielded blasts (ie. line of sight between blast and receptor) using a conservative methodology. The criteria is predicted to be exceeded at the nearest residences located on the YALA property which are actually shielded from quarry faces by the ridge line running along the southern boundary of the site. However, as shown by the monitoring data provided in *Table 4.2* above, specific blast designs can be formulated to ensure EPA criteria is not exceeded when blasting close to the YALA residences.

The proposed quarry plans indicate that potential blast locations cover an estimated area of approximately 900 m by 250 m with distances of up to 900 m from the YALA 3 residence. With significant variations in distances to receptors it is extremely inefficient to limit blasts to a specific MIC. It is CSR's intention to monitor several blasts at multiple locations to gather data sufficient for confident impact predictions. The design of blasts nearest the YALA residences can then be optimised to limit the possibility of criteria exceedences and preferred blast designs can be used for blast locations with adequate distances to residences.

CSR has developed a specific set of standard procedures to control blasting at Jandra blasting (CSR Construction Materials, 1999). These procedures are amended by CSR to reflect best management practices as they arise. It should be noted that there will be no secondary blasting.

The primary measure to ensure blast impacts are within acceptable limits is through good design and accurate monitoring. Use of specific blast MIC is only one of a number of tools used in the design process. CSR's experience indicates that current practices such as undertaking face surveys and borehole deviation measurements are an even more important component of the design process. This allows optimisation of blast loading and control of vibration and overpressure.

All blasts will be monitored for both overpressure and vibration levels to ensure statutory limits are not exceeded. If blast overpressure and vibration are found to be in exceedence the cause will be identified and blast design or control procedures modified to prevent recurrence.

4.4 MITIGATION MEASURES

The blasting impact assessment indicates that the quarry can effectively undertake blasting operations such that blasting impacts at nearby receptors will meet ANZECC guideline limits. The following mitigation measures will be implemented to control blasting activities:

- all blasting to be undertaken in accordance with Department of Mineral Resources regulations;
- whenever possible blasting to be limited between 9 am and 5 pm, Monday to Friday and 9.00 am to 3.00 pm Saturday, with no blasting on Sundays and public holidays;
- all blasts to be monitored at the closest residence to ensure that predicted overpressure and ground vibration levels are not exceeded. Blast design to be modified if criteria are exceeded;
- blasting to be avoided in adverse meteorological conditions (ie. not during high winds or temperature inversions); and
- nearby residents on Lot 10 DP 790056 (currently YALA) and Lot 4 DP790058 (currently Loveday) to be advised verbally (or by mutually agreed method) of specific blast times.

Chapter 5

CONCLUSION

Noise modelling was conducted for existing, Stage 1 and Stage 3 phases of operation at Jandra Quarry. For each stage, plant items were located in worst case scenario locations and operated simultaneously at maximum power. Results of single point noise calculations under still isothermal conditions are shown in *Table 3.3*. L_{10} noise levels are below the adopted intrusiveness criteria for all surrounding residences for each stage of quarry development. Natural topographic shielding and distance attenuation result in noise levels below the determining intrusiveness noise criteria.

Modelling for the complete range of meteorological conditions was undertaken for existing, Stage 1 and Stage 3. The analysis gives a comprehensive representation of the range of noise levels likely to occur throughout the year. Noise levels complied with the adopted criteria of still isothermal plus 5 dB for less than 10 per cent of the time under the worst case conditions modelled, except for residences to the east at Stage 3, where an exceedence of approximately 2 dB(A) was found. Analysis of the relative contribution of plant items to noise levels for the Jones and Groves residences to the east revealed that noise levels were dominated by the D8 dozer used to strip topsoil. This operation is temporary and will be planned to coincide with non-adverse weather conditions wherever possible. Removing the D8 dozer results in noise levels complying with the adopted criteria.

It should be noted that noise modelling for both still isothermal and the complete range of meteorological conditions has been conducted for worst case scenarios, which are in reality unlikely to occur with any significant frequency. This has significant implications for the annual distribution of noise levels where it is assumed that worst case plant locations occur for the entire year. This is obviously not going to occur and the assessment is therefore conservative and represents the upper envelope of likely noise levels.

Potential noise impacts at residences surrounding the proposed expansion of Jandra Quarry are within acceptable limits as defined by the EPA. It may be necessary to utilise noise control practices when using the D8 dozer for topsoil stripping. Possible control methods include limiting other plant items simultaneously operating on high or exposed benches, noise control of the dozer or operation in non adverse meteorological conditions.

The blasting impact assessment indicates that the quarry can effectively undertake blasting operations such that blasting impacts at nearby receptors are likely to meet ANZECC guideline limits. Initially, several blasts will be monitored at multiple locations to gather data sufficient for confident impact predictions. The design of blasts for the nearest residences can then be optimised to limit the possibility of criteria exceedences. All future blasts will be monitored for both overpressure and vibration levels to ensure statutory limits are not exceeded. Monitoring will allow refinement of blast design and control procedures. Monitoring along with other specific mitigation measures proposed in Section 4.4 will ensure the amenity of neighbouring residents is not significantly impacted by blasting activities.

REFERENCES

ANZECC, 1990

Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration

CSR Construction Materials, 1999

Drilling and Blasting Procedures for Jandra Quarry

Dick Benbow & Associates Pty Ltd, 1998

EIS Scoping Report CSR Readymix Jandra Quarry

EPA, 1994

Environmental Noise Control Manual

EPA, 1998

Draft Stationary Noise Source Policy

Appendix A

QUARRY DEVELOPMENT PLANS