water from the water cart. This dust management procedure has not been included in calculating the emission factor so as to remain a conservative (overestimation) assessment.

The emissions for stockpile wind erosion have been modelled as an area source located 3m above ground level. Based on this information it is estimated that the current facility emissions for wind erosion is 2,700 kg/yr and emissions for each of the proposed Stages 1-4 are 3784 kg/yr.

4.4.3 Dump Truck Loading

Loading of trucks by excavator and front-end loader generates 0.025 kg dust per tonne (SPCC et al 1988). The following have been based on 150,000 tpa for current operations and 250,000 tpa for each proposed stage operations. The emissions resulting from excavation have been modelled as an open-pit source. Based on this information we estimate that the current facility emission for excavation is 3,750 kg/yr and emissions for each of the proposed Stages 1-4 are 6,250 kg/yr.

4.4.4 Haulage

Off-highway dump trucks raise dust at the rate of 2 kg per vehicle kilometre travelled (vkt) on roads with normal dust control measures (SPCC et al 1988). For roads watered frequently the emission rate can be reduced to 1 kg/vkt (Shearer, Dougherty and Easterbrook, 1981). For modelling of haulage emissions the value of 2 kg /vkt was used. Haulage has been modelled as two distinct components.

The first is the haul road, which winds its way from the base of the pit to the top. This distance was calculated using the haul road gradient, 1 in 10, and has been modelled as an open-pit source. The second component consisted of the haul road from the top of the pit to the dumping area near the crushing and screening plant and has been modelled as an area source. It was estimated that this distance, including a return trip and manoeuvring of the vehicle to be in the correct dumping position, would be no further than 300 m.

The haulage during this operation is performed by the Caterpillar articulated dump truck D30D (30 tonne capacity). The current output of 150,000 tpa equates to 5,000 trips per year. The proposed output of 250,000 tpa equates to 8,334 trips per year. Based on this information we estimate that the current facility emission for haulage (ie including the haul road from within the pit as well as from the top of the pit to the crushing and screening plant) is 11,400 kg/yr. Total emission for Stage 1 is 19,000 kg/yr, for Stage 3 is 24,000 kg/yr and Stage 4 is 29,000 kg/yr.

4.4.5 *Dumping*

The process of dumping generates dust at the rate of 0.012 kg/t (SPCC et al 1988). The current facility has been calculated based on 150,000 tpa while the proposed Stages 1 - 4 have been based on 250,000 tpa. This emission source has been modelled as an area source with release height of 1.5m. Based on this information we estimate that the current facility emissions for dumping are 1,800 kg/yr and emissions for each of the proposed Stages 1-4 are 3,000 kg/yr.

4.4.6 *Crushing*

Dust generated from crushing depends on the extent of crushing (primary, secondary or tertiary), the moisture content and the dust mitigation measures applied to the process. The crushing and screening plant is equipped with two (2) DCE Vokes dust extraction units in addition to the Hosokawa Mikropul dust extraction unit. The plant also has misting sprays at the primary boot and product discharge points. All screens have dust covers and are sealed. As long as the mist sprays, in particular, are maintained to good working order the emissions from the crushing and screening plant are spasmodic and are typically low concentration in nature. Due to the mitigation equipment installed it is considered that the dust generated by the crushing and screening plant is insignificant under normal conditions, and therefore these emissions were incorporated into the conveyor emissions for the model.

4.4.7 *Exhaust From Vehicles*

Off-highway diesel trucks generate particulate emissions at a rate of 0.12 kg/hr (US EPA, 1995). The current operation runs for ten (10) hours a day five (5) days a week, and uses a sole Caterpillar articulated dump truck (D30D) to transport wastes. For the proposed Stages 1 -4 it is assumed two Caterpillar articulated dump trucks (D30D) will be operating and the operation hours are five (5) twelve (12) hour days a week and one (1) seven (7) hour day (Saturday 6.00 am - 1.00 pm) for fifty-two (52) weeks in a year.

These sources were modelled as both an open-pit and area source, by splitting the emissions and adding these to the haulage and haul road emissions. Based on this information the current facilities dust emissions from exhausts are 312 kg/yr, while emissions for each of the proposed Stages 1-4 are 418 kg/yr.

4.4.8 *Conveyor Transfer Points*

The emission rate for conveyor transfer points is 0.006 kg/t (NSW EPA). It has been assumed that all of the 150,000 tonnes (for the current operation), and all 250,000 tonnes (proposed operation) travels via the conveyor to transfer points. This emission has been modelled as an area source, released at a height of 1.5m. Based on this information the current facilities emissions are 900 kg/yr, while emissions for each of the proposed Stages 1-4 are 1,500 kg/yr.

4.4.9 *Product Handling*

Product handling is undertaken using front-end loaders and includes stockpiling and loading sales trucks. Dust generated from the action of front-end loaders is at a rate of 0.025 kg/hr (SPCC et al 1988). For the current operation it has been assumed that two front-end loaders are active for ten (10) hours per day, five (5) days a week. For the proposed operation it has been assumed that two front-end loaders are active for twelve (12) hours per day, five (5) days a week, with seven (7) hours of operation on a Saturday. These emissions are being modelled as an area source. Based on this information the current facilities emissions are 7,500 kg/yr, while emissions for each of the proposed Stages 1-4 are 12,500 kg/yr.

4.5 EPISODIC IMPACTS; DRILLING AND BLASTING

Drilling and blasting have the potential to cause significant impacts on the neighbouring areas. Their episodic nature allows this impact to be avoided. Drilling usually occurs over a period of two to five days, as a precursor to blasting. Three different blast designs have been proposed based on different geology (eg. solid or weathered rock) as well as for different bench heights, either 12 or 15 metres (Brodbeck, 1999). In terms of the different blast designs they differ in number of blast holes (41 - 54), blast hole depth (13 m - 16 m) and spacing between blast holes (3.7 - 4.1m). These figures are based on an approximate blast size of 20,000 tonnes and a calculated with a rock density of 2.6 g/cc. These blast designs are typical only and the particular blast design will be determined to achieve the optimum result based upon local geology and achievement of blast overpressure and ground vibration EPA criteria.

Based on 20,000 tonnes per blast, there would be an average twelve (12) drilling episodes per year (ie. monthly), each of which last for two to five days. The current blast design typically involves drilling 900 holes per year (75 per episode), while the highest number of holes that all proposed stages (1-4) will drill are, 648 per year (54 per episode).

In accordance with the proposed drilling design, blasting will occur on average monthly, however blasting occurs on one day per episode. For each blasting episode capping (stemming) is placed over blast holes to minimise dust and to maximise blast success. The capping is used to ensure that the pressure generated from the blast will be forced down the hole, opening seams for extraction.

The holes drilled for the blast are often drilled in rows of three or four, roughly the width of the desired bench. Drill rigs are fitted with dust extractors. During blasting these rows are detonated separately, but in rapid succession. The main emissions generated from these activities are emitted during this 1 - 3 second interval. Dust emanates from the entire area of the blast, averaging 400 m^2.

Due to the episodic nature of these impacts, their short, infrequent nature and the standard implementation of dust mitigation measures such as adequate stemming and not drilling and blasting in adverse weather conditions, dust generated during drilling and blasting is assumed to be insignificant for dispersion modelling which is run for a minimum period of 365 days. Therefore, drilling and blasting has not been included as a source in the model.

4.5.1 Asphalt Plant

It is proposed that a mobile asphalt plant capable of producing around 100 tonnes an hour will be located on-site on an as needed basis. An area 100 m by 50 m will be allocated south-west of the existing weighbridge and site office to accommodate this plant.

In the asphalt making process the aggregates are fed into the plant. After screening they pass through the drier to reduce moisture. Individual sized aggregates, together with filler are mixed with hot bitumen to form asphalt, which is then transported by truck to the required site.

The loading of aggregates will be undertaken by the front-end loaders used for product stockpiling and whose dust emissions are accounted for in Section 4.4.9. The asphalt plant has one stack fitted with a wet scrubber to reduce odour and dust emissions. It is expected that emissions will be minimal and stack height release high enough to reduce ground level effects.

4.5.2 Pugmill

It is proposed that a mobile pugmill be added to the facility to mix lime or cement (stored in filler silos) and aggregate together which is then loaded into trucks for delivery. Loading for this process will be undertaken using the product stockpile front-end loaders. Usage of the pugmill will be based on market demand. It is

anticipated that the market volume required will be minor. As such, there are no expected additional dust or odour emissions of considerable consequence and the pugmill has not been considered in the model.

4.5.3 *Summary*

A summary of dust emissions for area and open-pit sources to be used in the ISC model is given in *Table 4.3* and *Table 4.4* respectively.

Table 4.3 SUMMARY OF INPUT EMISSIONS (AREA SOURCES)

Source /Quarry Stage	Emission (kg/yr)	Emission ($g/s/m^2$) TSP	Emission ($g/s/m^2$) PM_{10}
Dumping			
Current	1,800	0.002	0.001
Stages 1 –4	3,000	0.001	0.0005
Haul road			
Current	3,081	0.0003	0.0002
Stages 1 – 4	5,109	0.0004	0.0002
Conveyor			
Current	900	0.002	0.001
Stages 1 –4	1,500	0.002	0.001
Product handling			
Current	7,500	0.0003	0.0002
Stages 1 –4	12,500	0.0002	0.0001
Stockpiles			
Current	2,700	3.4E-5	2.4E-5
Stages 1 – 4	3784.3	2.9E-5	2.0E-5

Table 4.4 SUMMARY OF INPUT EMISSIONS (OPEN-PIT SOURCES)

Source /Quarry Stage	Emission (kg/yr)	Emission ($g/s/m^2$) TSP	Emission ($g/s/m^2$) PM_{10}
Wind erosion			
Current	15,768	9.4E-7	6.6E-7
Stage 1	26,280	2.9E-7	2.0E-7
Stage 3	26,280	1.2E-7	8.5E-8
Stage 4	26,280	1.0E-7	7.1E-7
Loading			
Current	3,750	7.5E-7	4.2E-7
Stage 1	6,250	1.7E-7	1.0E-7
Stage 3	6,250	7.3E-8	4.2E-8
Stage 4	6,250	6.0E-8	3.4E-8
Haulage			
Current	8,631	1.7E-6	1.0E-6
Stage 1	14,310	3.9E-7	2.3E-7
Stage 3	19,311	2.3E-7	1.4E-7
Stage 4	24,311	2.3E-7	1.4E-7

Chapter 5

DUST IMPACT ASSESSMENT

5.1 IMPACT ASSESSMENT

The results from the ISC model are summarised below. Stage 2 development has not been modelled separately because it is in effect an intermediate stage between 1 and 3. Stage 1 has been modelled as the westernmost point of extraction, and Stage 3 has been modelled as the eastern and northern most point of extraction, with emissions from the pit originating closer to the surface than during Stage 4. It was necessary to model Stage 4 because of the increase in haulage emissions (approximately 5,000 kg/yr more than Stage 3). The location of discrete receptors and sources modelled is shown in *Figures 5.1 to 5.3*.

All of the regular quarry activities have been included in the model. Emissions relating to blasting and drilling have not been included due to the short duration of impacts and their episodic nature.

Contours have been developed for PM_{10} 24 hour concentrations. Contours of averaging periods longer than this are not supplied due to the relatively lower impacts of the longer term (ie. annual) averaging periods. TSP 24 hour contours are not provided, as there are no applicable criteria for TSP over short-term averaging periods.

5.2 DUST DEPOSITION

Table 5.1 to *Table 5.4* summarise the highest monthly dust deposition concentrations predicted at discrete receptors from modelling. These predictions do not include drilling and blasting as an emission source due to its episodic nature being incompatible with the model inputs.

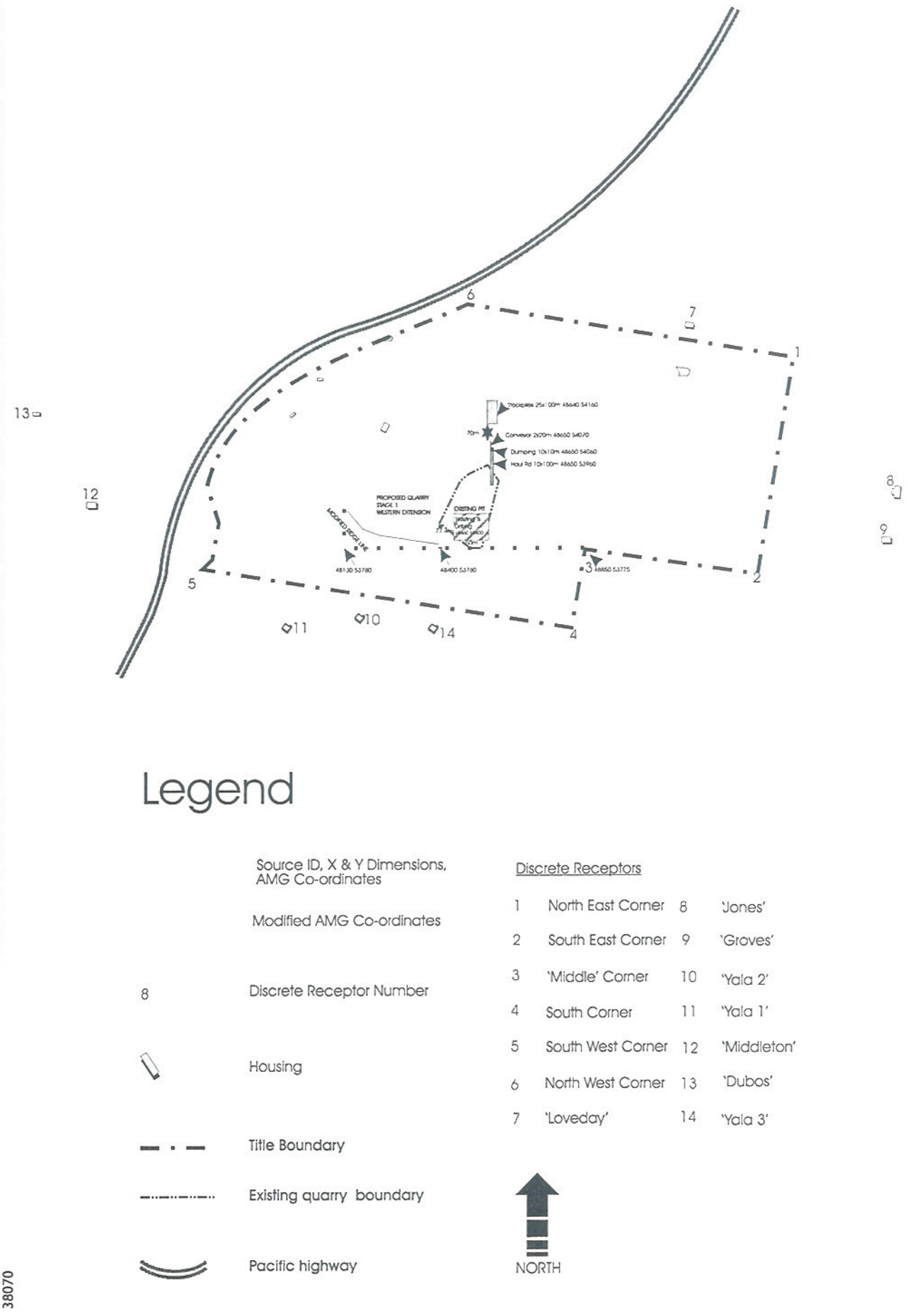

Figure 5.1 CURRENT STAGE LOCATIONS OF DISCRETE RECEPTORS AND SOURCES MODELLED

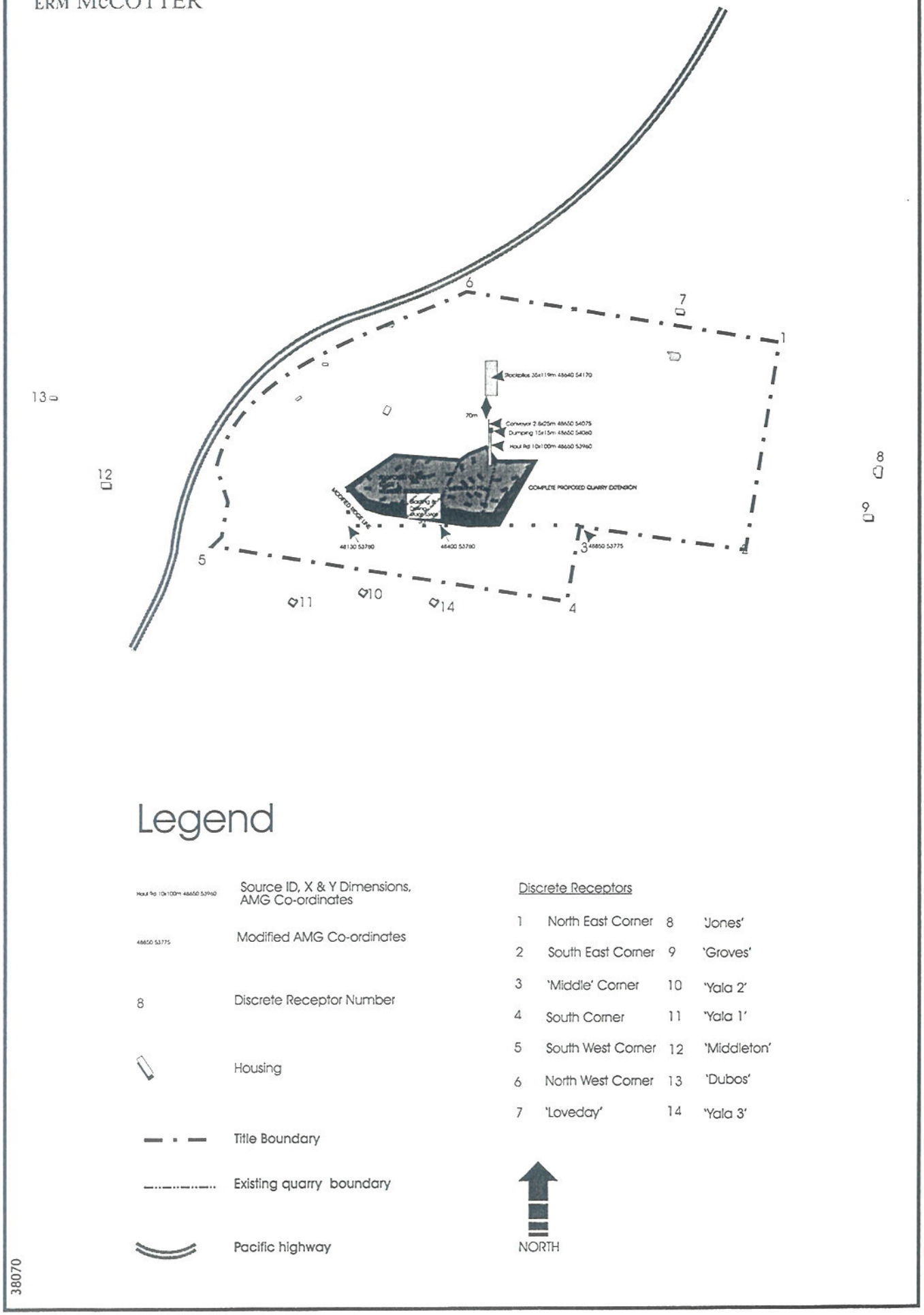

Figure 5.2 STAGE 1 LOCATIONS OF DISCRETE RECEPTORS AND SOURCES MODELLED

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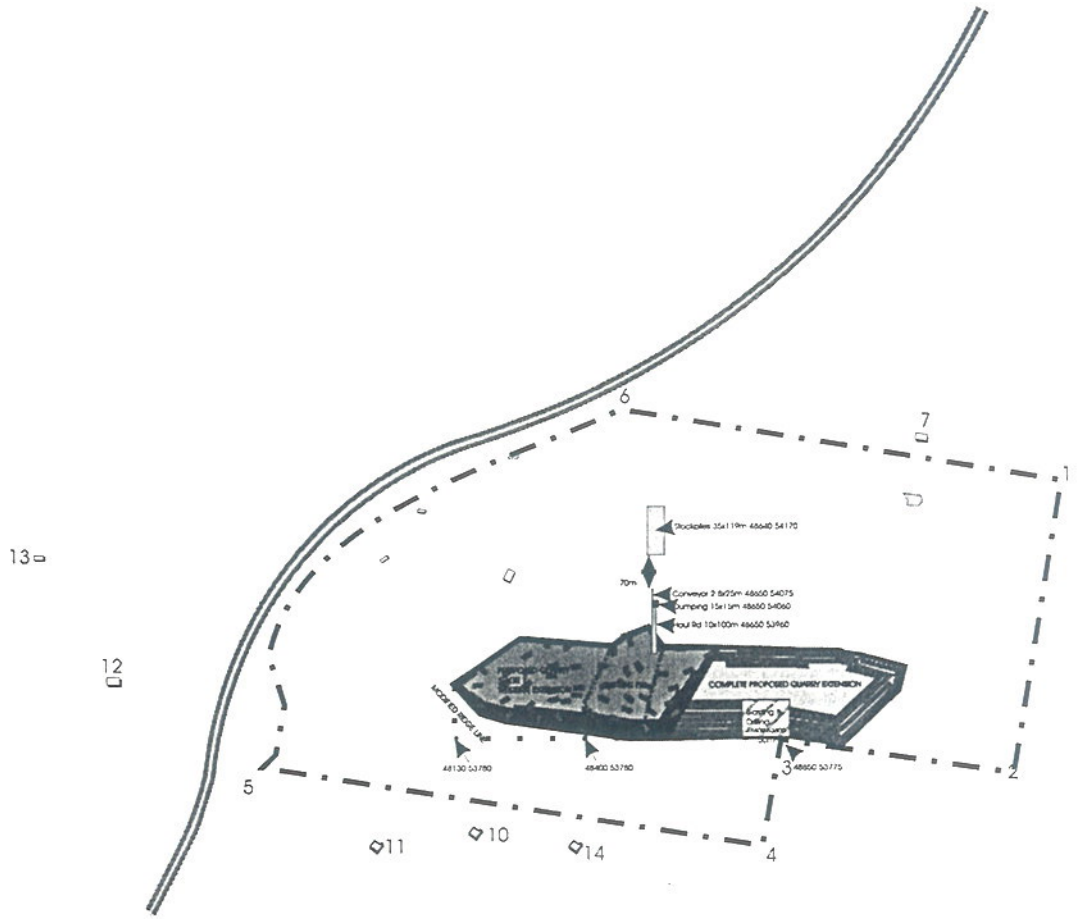


Legend

Haul Rd 10x100m 48650 53960	Source ID, X & Y Dimensions, AMG Co-ordinates
48650 53775	Modified AMG Co-ordinates
8	Discrete Receptor Number
	Housing
	Title Boundary
	Existing quarry boundary
	Pacific highway

Discrete Receptors

1	North East Corner	8	'Jones'
2	South East Corner	9	'Groves'
3	'Middle' Corner	10	'Yala 2'
4	South Corner	11	'Yala 1'
5	South West Corner	12	'Middleton'
6	North West Corner	13	'Dubos'
7	'Loveday'	14	'Yala 3'

NORTH

38070

Figure 5.3 STAGES 3 AND 4 LOCATIONS OF DISCRETE RECEPTORS AND SOURCES MODELLED

Table 5.1 DUST DEPOSITION RATES FOR THE EXISTING DEVELOPMENT

Discrete Receptor	Deposition (g/m²/mth)
1. north east corner of property	0.20
2. south east corner of property	0.94
3. 'middle' corner of property	2.85
4. south corner of property	0.29
5. south west corner of property	0.46
6. north west corner of property	2.47
7. 'Loveday' house to north	0.72
8. 'Jones' house to east	0.32
9. 'Groves' house to east	0.16
10. 'YALA 2' house to south	0.44
11. 'YALA 1' house to south	0.65
12. 'Middleton' house to west	0.15
13. 'Dubos' house to west	0.33
14. 'YALA 3' house to south	2.19

Table 5.2 DUST DEPOSITION RATES FOR STAGE 1

Discrete Receptor	Deposition (g/m²/mth)
1. north east corner of property	0.30
2. south east corner of property	1.17
3. 'middle' corner of property	3.69
4. south corner of property	0.47
5. south west corner of property	0.65
6. north west corner of property	2.88
7. 'Loveday' house to north	1.01
8. 'Jones' house to east	0.45
9. 'Groves' house to east	0.22
10. 'YALA 2' house to south	0.69
11. 'YALA 1' house to south	0.94
12. 'Middleton' house to west	0.20
13. 'Dubos' house to west	0.42
14. 'YALA 3' house to south	2.64

Table 5.3 DUST DEPOSITION RATES FOR STAGE 3

Discrete Receptor	Deposition (g/m²/mth)
1. north east corner of property	0.31
2. south east corner of property	1.18
3. 'middle' corner of property	3.95
4. south corner of property	0.46
5. south west corner of property	0.65
6. north west corner of property	2.90
7. 'Loveday' house to north	1.03
8. 'Jones' house to east	0.47
9. 'Groves' house to east	0.23
10. 'YALA 2' house to south	0.60
11. 'YALA 1' house to south	0.87
12. 'Middleton' house to west	0.20
13. 'Dubos' house to west	0.42
14. 'YALA 3' house to south	2.55

Table 5.4 DUST DEPOSITION RATES FOR STAGE 4

Discrete Receptor	Deposition (g/m²/mth)
1. north east corner of property	0.31
2. south east corner of property	1.18
3. 'middle' corner of property	3.89
4. south corner of property	0.45
5. south west corner of property	0.65
6. north west corner of property	2.90
7. 'Loveday' house to north	1.02
8. 'Jones' house to east	0.46
9. 'Groves' house to east	0.23
10. 'YALA 2' house to south	0.58
11. 'YALA 1' house to south	0.87
12. 'Middleton' house to west	0.19
13. 'Dubos' house to west	0.42
14. 'YALA 3' house to south	2.53

5.3 DUST CONCENTRATION

Tables 5.5 to 5.8 give annual and 24 hour concentrations predicted for different stages of the quarry. These concentrations do not include blasting and drilling practices as part of the emissions due to their episodic nature. Contours of the highest 24 hour PM_{10} dust concentrations due to quarry operations (excluding drilling and blasting) are shown in *Figures 5.4 to 5.7.*

Table 5.5 COMPARISON OF DUST CONCENTRATIONS FOR ALL SOURCES EXCEPT DRILLING & BLASTING FOR EXISTING QUARRY

Discrete Receptor	Max 24 hour PM_{10} (μ/m^3)	Annual Average PM_{10} (μ/m^3)	Annual Average TSP (μ/m^3)
1	4.97	0.30	0.46
2	19.84	0.76	1.21
3	54.38	2.62	4.25
4	4.51	0.35	0.55
5	20.42	0.40	0.60
6	57.27	2.56	3.99
7	16.84	0.87	1.42
8	6.93	0.26	0.41
9	2.12	0.14	0.22
10	12.06	0.39	0.60
11	20.33	0.48	0.79
12	5.38	0.14	0.21
13	15.89	0.30	0.47
14	69.76	1.65	2.50

Table 5.6 COMPARISON OF DUST CONCENTRATIONS FOR ALL SOURCES EXCEPT DRILLING & BLASTING FOR STAGE 1

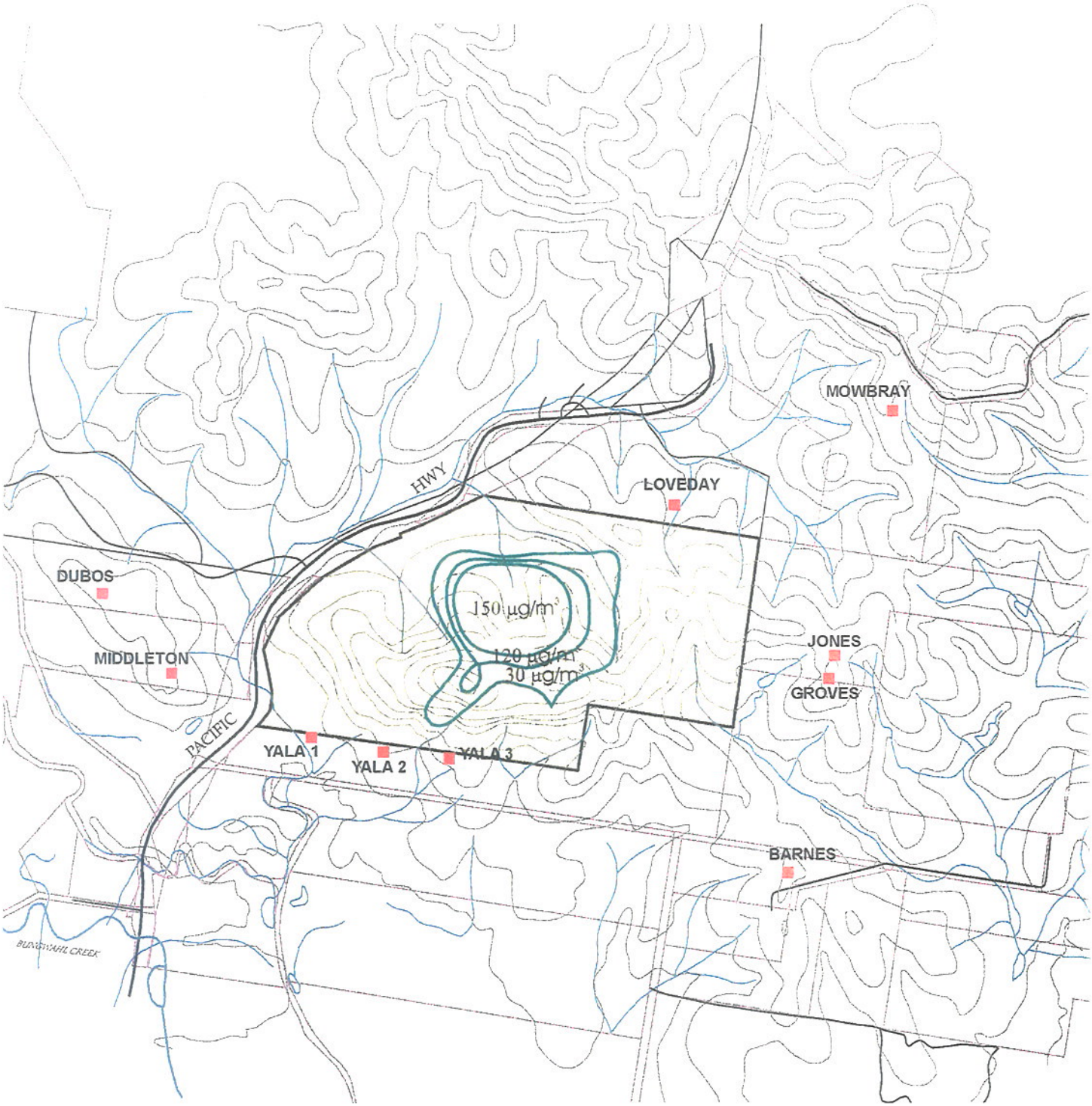
Discrete Receptor	Max 24 hour PM_{10} (μ/m^3)	Annual Average PM_{10} (μ/m^3)	Annual Average TSP (μ/m^3)
1	3.89	0.35	0.67
2	17.72	0.79	1.52
3	54.34	2.80	5.41
4	4.41	0.48	0.87
5	23.49	0.47	0.86
6	45.32	2.40	4.56
7	21.02	1.03	1.97
8	7.20	0.30	0.58
9	1.85	0.17	0.31
10	9.49	0.56	0.97
11	24.62	0.61	1.14
12	5.69	0.16	0.30
13	14.43	0.32	0.60
14	59.94	1.77	3.16

Table 5.7 COMPARISON OF DUST CONCENTRATIONS FOR ALL SOURCES EXCEPT DRILLING & BLASTING FOR STAGE 3

Discrete Receptor	Max 24 hour PM_{10} (μ/m^3)	Annual Average PM_{10} (μ/m^3)	Annual Average TSP (μ/m^3)
1	4.96	0.39	0.72
2	17.79	0.80	1.53
3	56.30	3.26	6.03
4	4.86	0.55	0.98
5	23.45	0.47	0.85
6	46.17	2.40	4.56
7	19.82	1.04	1.98
8	7.52	0.31	0.60
9	2.28	0.19	0.33
10	9.39	0.43	0.0
11	21.43	0.53	1.03
12	5.40	0.15	0.29
13	14.45	0.32	0.60
14	58.77	1.67	3.02

Table 5.8 COMPARISON OF DUST CONCENTRATIONS FOR ALL SOURCES EXCEPT DRILLING & BLASTING FOR STAGE 4

Discrete Receptor	Max 24 hour PM_{10} (μ/m^3)	Annual Average PM_{10} (μ/m^3)	Annual Average TSP (μ/m^3)
1	4.82	0.38	0.71
2	17.78	0.80	1.52
3	55.94	3.14	5.79
4	4.82	0.53	0.93
5	23.45	0.47	0.85
6	46.09	2.40	4.54
7	19.75	1.03	1.96
8	7.35	0.31	0.59
9	2.06	0.18	0.31
10	9.04	0.41	0.75
11	21.21	0.52	1.02
12	5.21	0.15	0.28
13	14.45	0.32	0.82
14	58.58	1.65	2.56



RESIDENCE/NOISE RECEPTOR

150 µg/m³ PM_{10} DUST CONTOUR

CSR PROPERTY BOUNDARY

CADASTRAL BOUNDARIES

EXISTING QUARRY

57106/38070fg5.4rev.CDR

SOURCE: CMA 1:25,000 TOPO NABIAC SHEET

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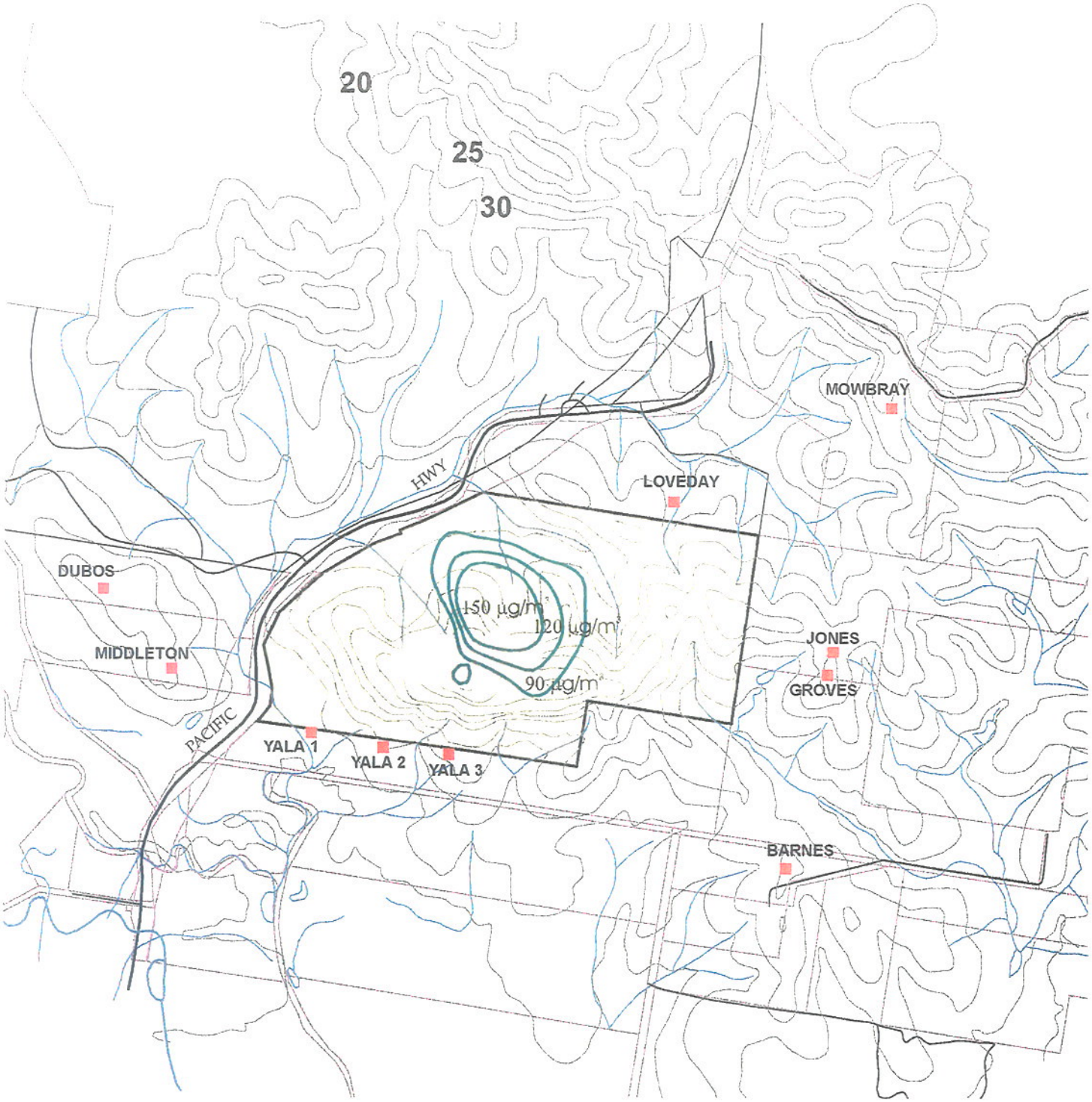
Figure 5.4 MAXIMUM 24 HOUR PM_{10} DUST CONTOURS - EXISTING QUARRY

N

0 400m



RESIDENCE/NOISE RECEPTOR

CSR PROPERTY BOUNDARY

150 µg/m³ PM_{10} DUST CONTOUR

CADASTRAL BOUNDARIES

STAGE 1 QUARRYING

57106/380/70APPfg5.5nest1.CDR

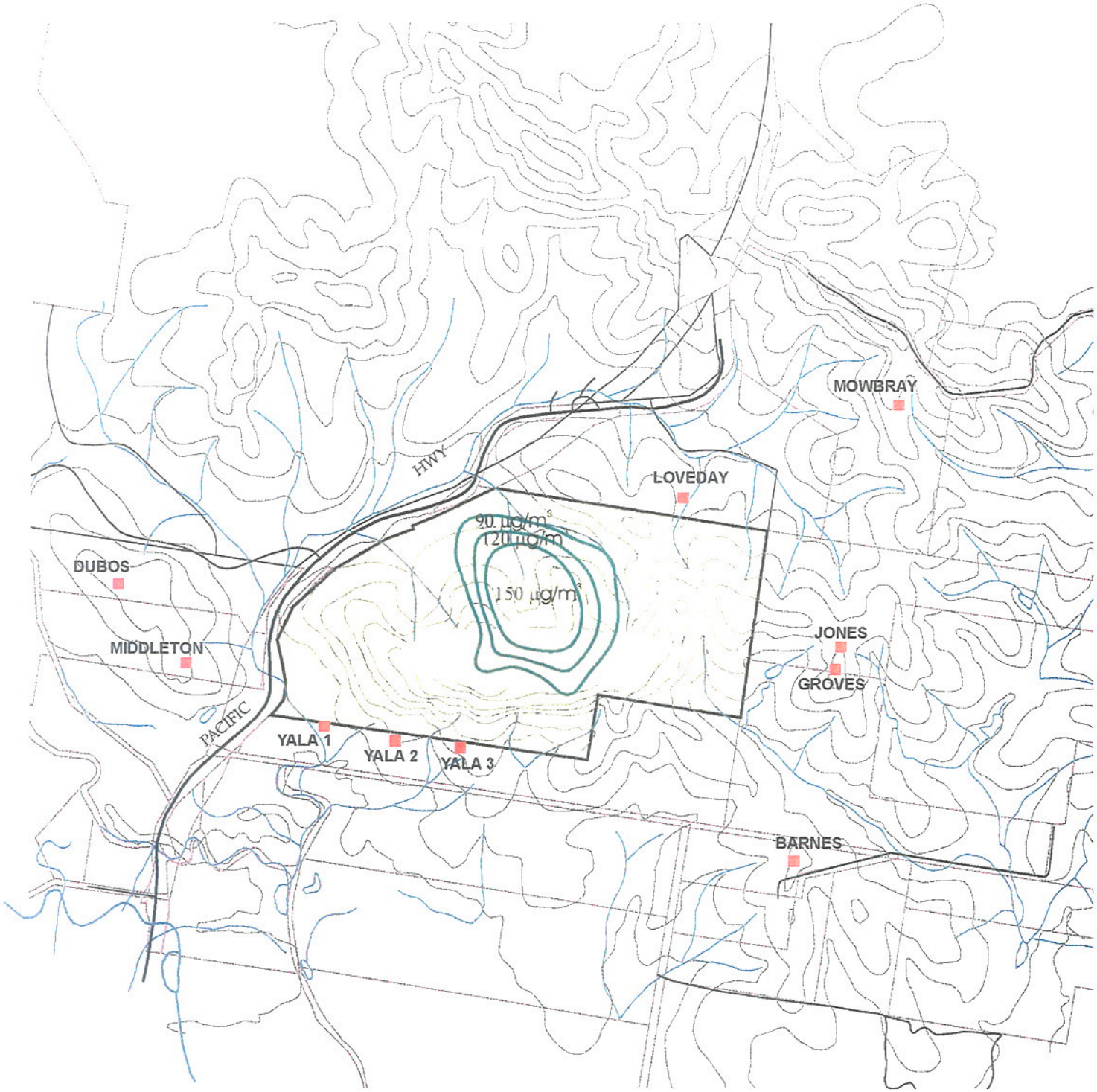
SOURCE: CMA 1:25,000 TOPO NABIAC SHEET

ERM MITCHELL MCCOTTER

Figure 5.5 MAXIMUM 24 HOUR PM_{10} DUST CONTOURS - STAGE 1 QUARRYING

N

0 400m



RESIDENCE/NOISE RECEPTOR

150 µg/m³ PM_{10} DUST CONTOUR

CSR PROPERTY BOUNDARY

CADASTRAL BOUNDARIES

STAGE 3 QUARRYING

57106/38070APPfg5.6dst3.CDR

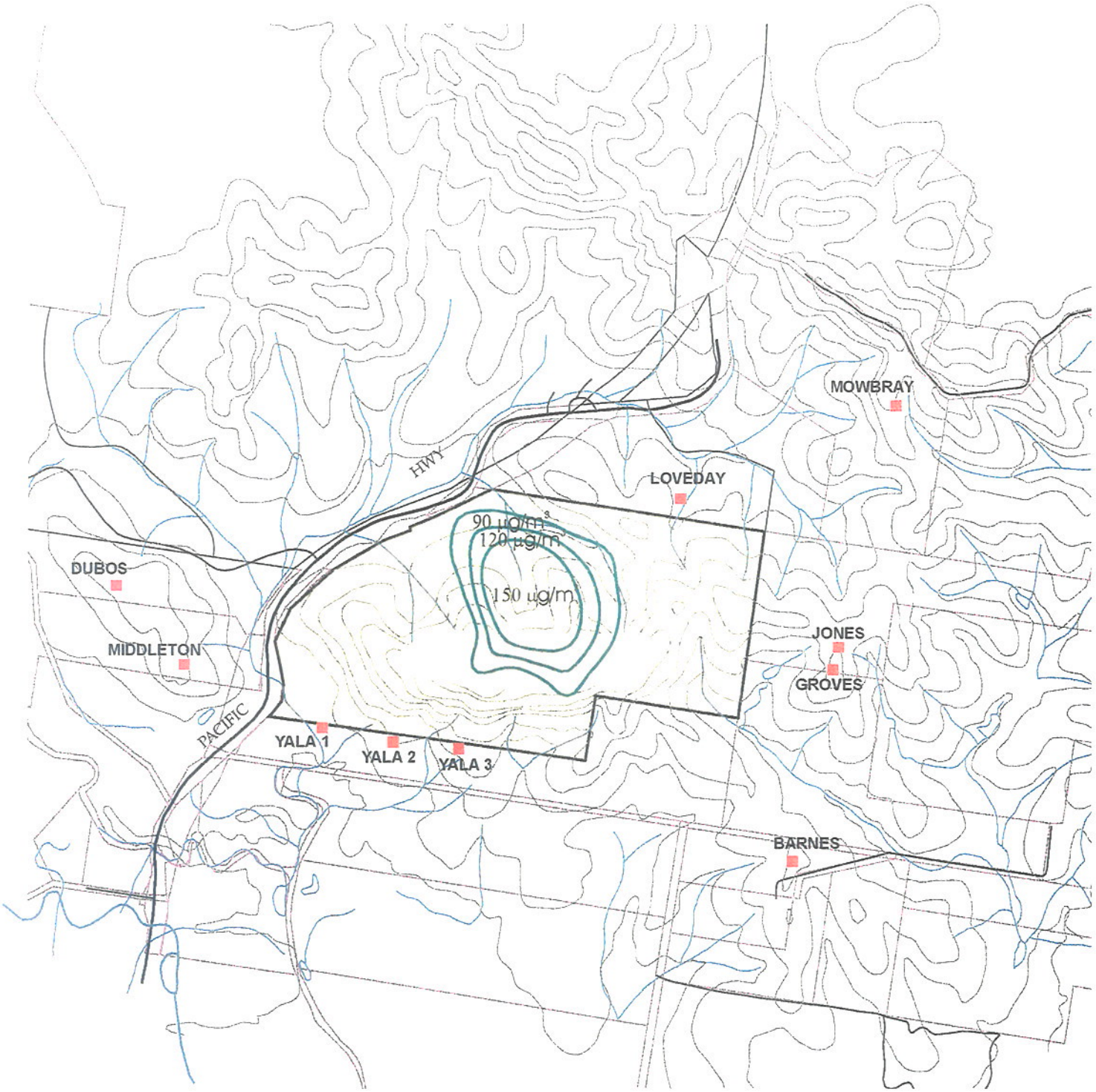
SOURCE: CMA 1:25,000 TOPO NABIAC SHEET

ERM MITCHELL McCOTTER

Figure 5.6 MAXIMUM 24 HOUR PM_{10} DUST CONTOURS - STAGE 3 QUARRYING

N

0 400m



RESIDENCE/NOISE RECEPTOR

150 µg/m³ PM_{10} DUST CONTOUR

CSR PROPERTY BOUNDARY

CADASTRAL BOUNDARIES

STAGE 4 QUARRYING

57106/38070APPJg5.7dgn4.CDR

SOURCE: CMA 1:25,000 TOPO NABLAC SHEET

ERM MITCHELL McCOTTER

Figure 5.7 MAXIMUM 24 HOUR PM_{10} DUST CONTOURS - STAGE 4 QUARRYING

N

0 400m

Chapter 6

DISCUSSION

6.1 DUST DEPOSITION

The current dust deposition values have been correlated against existing measurements. They show that predicted concentrations are within the range of the measured concentrations. The concentrations of dust deposition predicted by the model for Stages 1,3 and 4 show that concentrations will not significantly change.

Dust deposition will not exceed EPA criteria under the conditions modelled. All discrete receptors will have a maximum increase of less than 1.1 kg/m^2/month, well below guideline criteria for air quality amenity, 2 g/m^2/month.

6.2 DUST CONCENTRATION DUE TO NORMAL QUARRY OPERATIONS

6.2.1 PM_{10}

i. 24 hour Average

Modelled PM_{10} concentrations are highest at YALA 3 residence (69.76 µg/m^3), still well below the NSW EPA adopted USEPA guideline level of 150 µg/m^3 for a 24 hour concentration.

The emissions originating from quarry operations (including various open-pit sources) have a negligible effect on the surrounding discrete receptors as concentrations predicted at these locations differ only slightly between Stages 1-4. This is primarily because the emission which dramatically increase between Stages 1-4, are open-pit sources (see *Table 4.4*). Lower values have been predicted at receptors from these sources as the pit walls act as wakes (thus minimising PM_{10} emission from the cavity), as opposed to area sources, where there are no wakes (and more dispersion occurs).

The concentrations predicted at discrete receptors for all stages are primarily due to area emissions which do not emanate from the actual quarry pit.

ii. Annual Average

Modelled PM_{10} concentrations taken as an annual average are also well below the NSW EPA adopted USEPA criteria of 50 $\mu g/m^3$. The highest concentrations calculated at the YALA 3 residence and at the southern and north-western quarry property boundary were below 3 $\mu g/m^3$. It is not expected that impacts from the proposed increase in quarry area will have a significant effect on amenity or health relating to PM_{10} dust concentrations.

6.2.2 *Total Suspended Particulate*

For total suspended particulate (TSP) the NSW EPA adopt only an annual criteria being the National Health and Medical Research Council's recommended maximum annual concentration of 90 $\mu g/m^3$. The predicted concentrations for TSP between each of the proposed quarry stages also do not vary significantly and are well below this criteria. As for PM_{10} the highest concentrations calculated were at the YALA 3 residence and at the southern and north-western quarry property boundaries (less than 6.03 $\mu g/m^3$). It is not expected that impacts from the proposed increase in quarry area will have a significant effect on amenity or health relating to TSP dust concentrations.

6.3 EPISODIC IMPACTS

Episodic impacts relate to drilling and blasting as emission sources. Due to their nature it is difficult to accurately assess their impact with the ISC model. These impacts relate only to emissions which will typically occur around once or twice a month.

Impacts from drilling and blasting can be reduced through standard blasting and drilling mitigation measures as outlined in Chapter 7 - *Mitigation Measures* and CSR's guidelines *'Drilling and Blasting Procedures for Jandra Quarry'*. Primarily, it is important to consider the meteorological conditions, in particular wind speed and direction and any inversion layer before conducting drilling and blasting. Consideration must be made with all available meteorological information before each session occurs. Particular attention is required when blasting near the southern and eastern extent of the quarry where blast locations are close the property boundary and some nearby residences.

Depending on the meteorological conditions at the time of the blast, the volume of dust emanated may settle in the surrounding area in a very short period of time, travel via 'plug flow' downwind or in high wind conditions may be dispersed

rapidly. As the duration of the blast is extremely short, these factors can be assessed on-site and significant impacts off-site can be avoided.

As a precursor to minimising the impact of the dust generated, blast holes can be capped with stemming, which restricts the upward emission of dust. In addition, shot rock is moistened with water sprays prior to loading into dump trucks.

Therefore, as long as standard drilling and blasting practices are followed it is anticipated that blasting and drilling will not have a significant impact on dust levels at nearby residences.

Chapter 7

ODOUR ASSESSMENT

7.1 ODOUR SOURCES

It is anticipated that most activities at the quarry will not produce odours that may have off-site effects. This is because of the relatively low concentrations of odour produced combined with the large area for dispersion to occur. The exclusion of this is the asphalt plant, which has the potential to cause off-site effects.

7.2 ASPHALT PLANT

A mobile asphalt plant is to be located on-site on an as needs basis, based on market demand. The plant will be capable of producing approximately 100 to 200 tonnes an hour. Air emissions from the asphalt plant will be directed though a wet scrubber to remove both particulate and odour emissions. The plant will be fitted with a wet scrubber flow meter with an audible and visual alarm. Lime or flyash will be contained in a filler silo reducing the potential for fugitive air emissions from these process inputs.

The process of producing hot mix asphalt involves drying and heating the aggregate before addition of the bitumen. The drying process involves the aggregate moving through a rotating, slightly inclined, direct fired drum drier. After drying the aggregate is generally heated to temperatures ranging from 150°C - 200°C and then coated with bitumen. Odour emissions from this process are associated with volatile organic compounds (VOC's) from the bitumen.

A number of process modifications such as drum rearrangement, adjustment of the asphalt injection point and optimising the combustion process will reduce the VOC's and therefore odour.

Fugitive VOC emissions from the asphalt tanks will be routed back to the combustion unit which will serve as an afterburner reducing the concentration of fugitive VOC's to atmosphere.

In addition to these mitigation measures, the exhaust stack will ensure that adequate dispersion of the emission plume takes place. It is expected that with the distance to the nearest receptor from the proposed asphalt plant site being approximately 600

metres, adequate dispersion will occur. Plume dispersion will be enhanced by the heavily vegetated nature of the area.

Plume dispersion in conjunction with the appropriate control technologies will ensure that odour emissions from the asphalt batching plant will not have a significant impact on nearby discrete receptors.

Chapter 8

MITIGATION MEASURES

As part of standard CSR's quarrying practices mitigation measures are conducted during daily activities. These have been developed through CSRs long association with quarrying. Mitigation measures to control air quality at the quarry include:

- regular watering of haul roads and stockpiles;
- limiting speeds of vehicles on unsealed surfaces to 40 kph;
- minimising vehicle kilometres travelled on unpaved roads;
- rehabilitating disturbed areas;
- where practical/possible conduct drilling and blasting during suitable meteorological conditions (ie. not during high winds or temperature inversions);
- adequate stemming of drill holes;
- dust extraction units on drill rigs and crushing and screening plants to be well maintained;
- seals and mist sprays on quarry equipment to be well maintained;
- dust displaced during silo filling to be controlled by an appropriate filter (ie a reverse pulse silo filling filter or equivalent);
- wet scrubber on asphalt bathing plant to be maintained regularly including the regular servicing of the recycling interceptor trap; and
- stack emissions from the asphalt batching plant to be monitored for:
  - VOCs;
  - semi VOCs;
  - CH_4, H_2, N_2, CO, CO_2 and O_2;
  - particulate;
  - Stack gas moisture, velocity and temperature; and
  - mass flow rate of exhaust gases, water, particulates, N_2, CO, CO_2 & O_2.

Chapter 9

CONCLUSION

The proposed extension of Jandra quarry from 150,000 tpa to 250,000 tpa should not significantly impact on the air quality of the surrounding area. The proposed impacts have been predicted using the ISC model.

The predictions show that a minimal increase in PM_{10} concentrations may occur over 24 hour averaging periods. Predicted annual concentrations of PM_{10} and TSP are also expected to raise slightly however all are expected to be well below the criteria nominated by the NSW EPA. It is anticipated that dust deposition criteria nominated by the NSW EPA will be complied with.

Potential short-term dust impacts due to drilling and blasting, whilst only predicted to occur once or twice a month, can be mitigated through the use of standard mitigation measures which are detailed in this assessment. CSR needs to be especially prudent when drilling and blasting practices occur near their southern property boundary during Stage 3.

Odour impacts emanating from the asphalt plant are proposed to be mitigated through the use of appropriate control technologies and an exhaust stack to produce sufficient dispersion.

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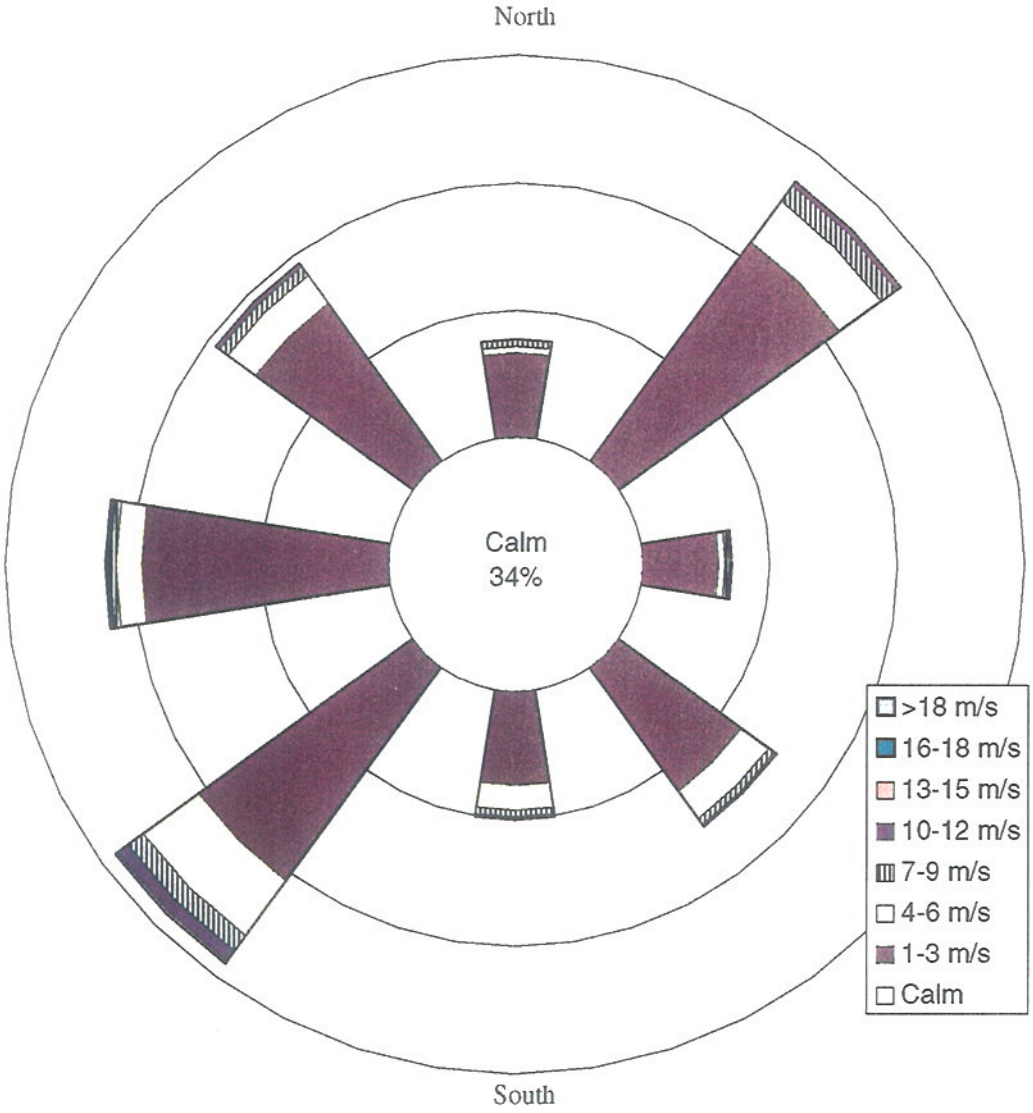
APPENDICES

Appendix A

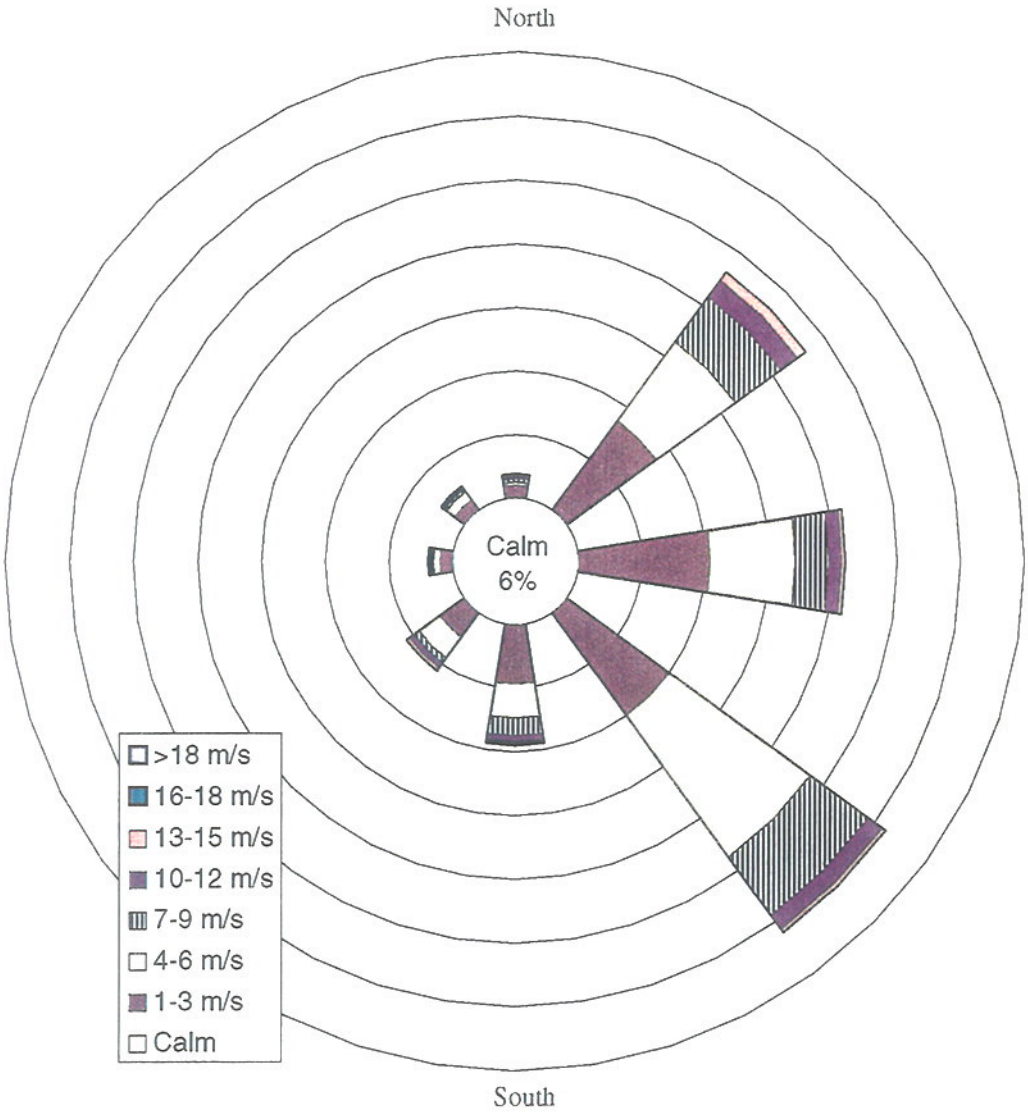
WINDROSES

Windrose for Summer
9am



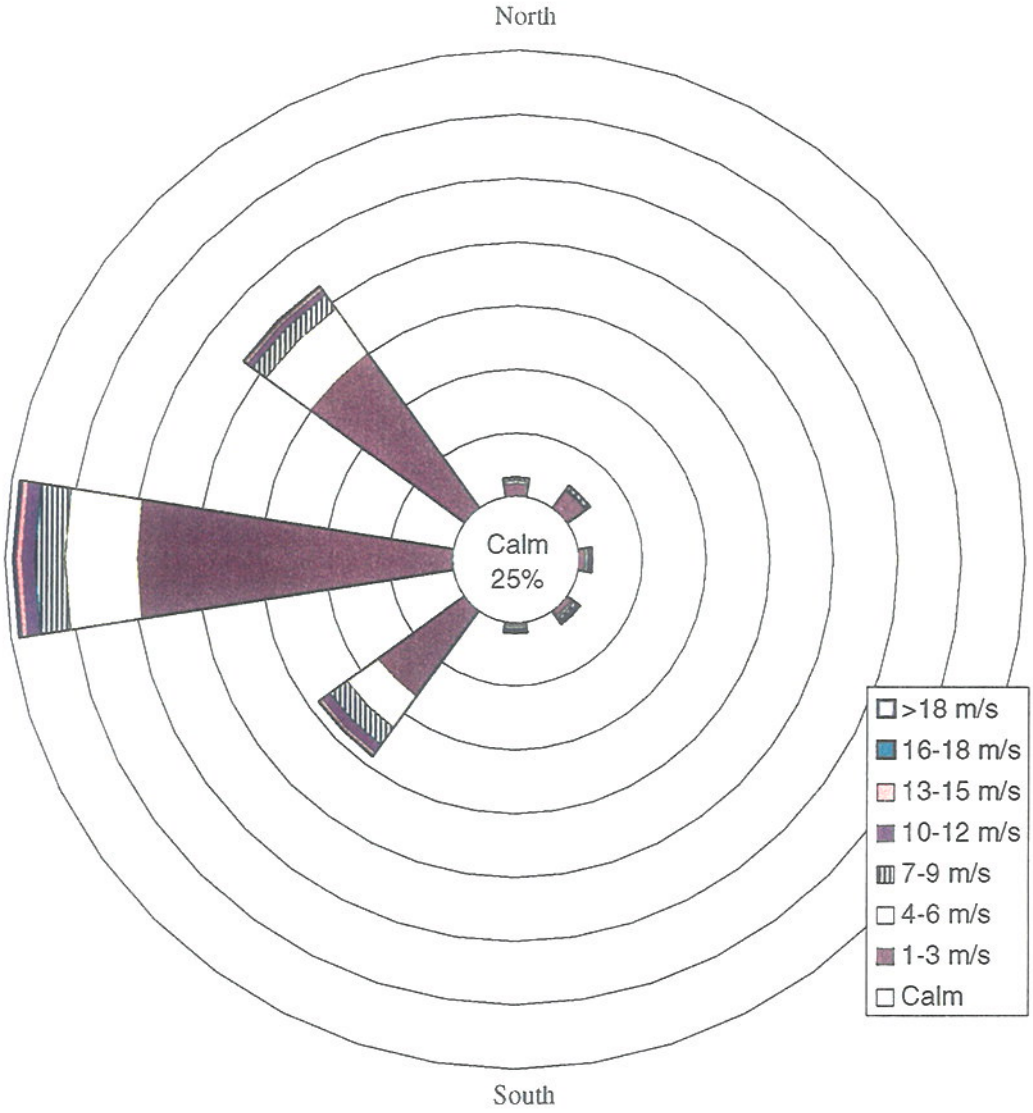
The segments of each arm represent the seven wind speed classes, with increasing windspeed from the centre outwards.The length of each arm represents the proportion of the total wind that blew from that direction. The value in the central circle represents the proportion of calm conditions. The circlular grid represents a contour interval of five percent.

Windrose for Summer
3pm



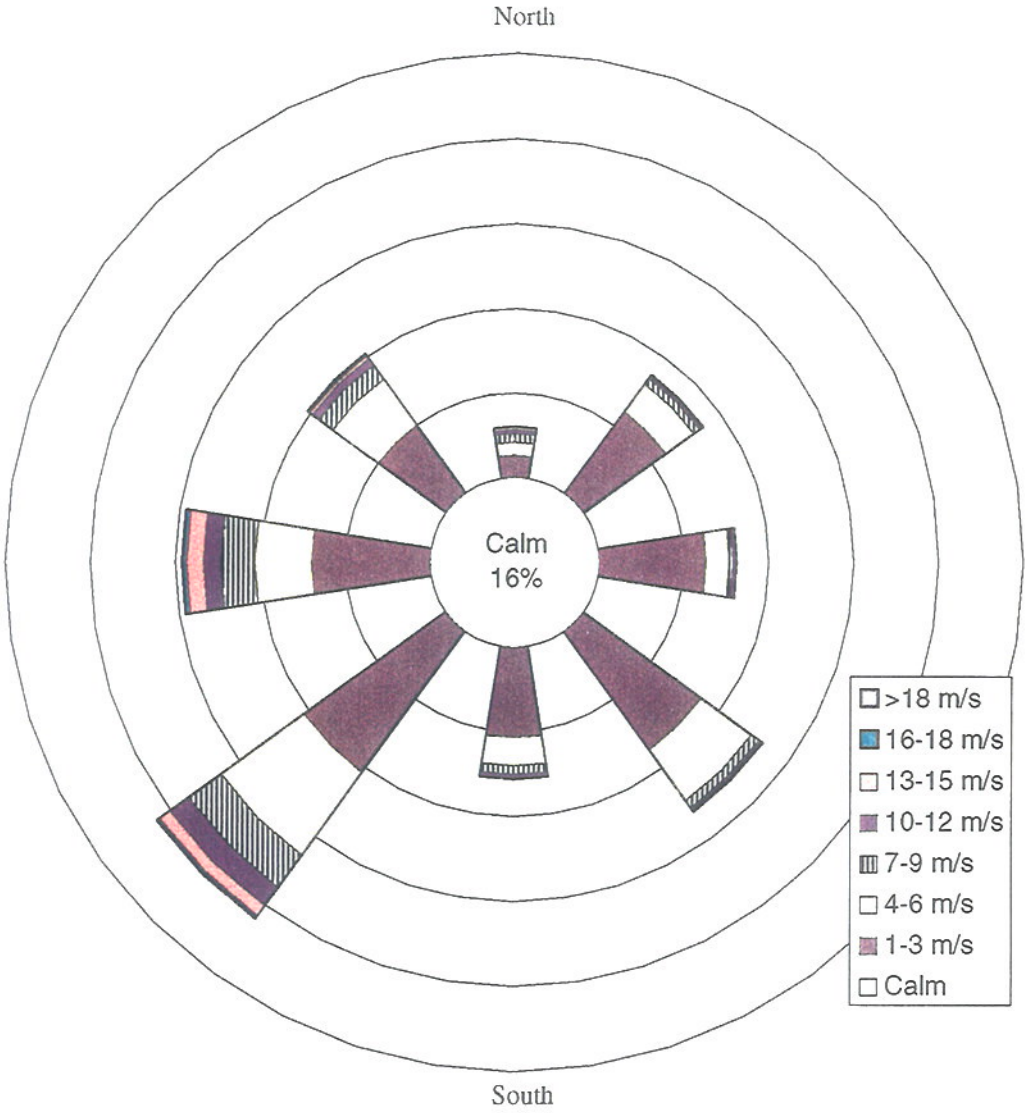
The segments of each arm represent the seven wind speed classes, with increasing windspeed from the centre outwards.The length of each arm represents the proportion of the total wind that blew from that direction. The value in the central circle represents the proportion of calm conditions. The circlular grid represents a contour interval of five percent.

Windrose for Winter
9am



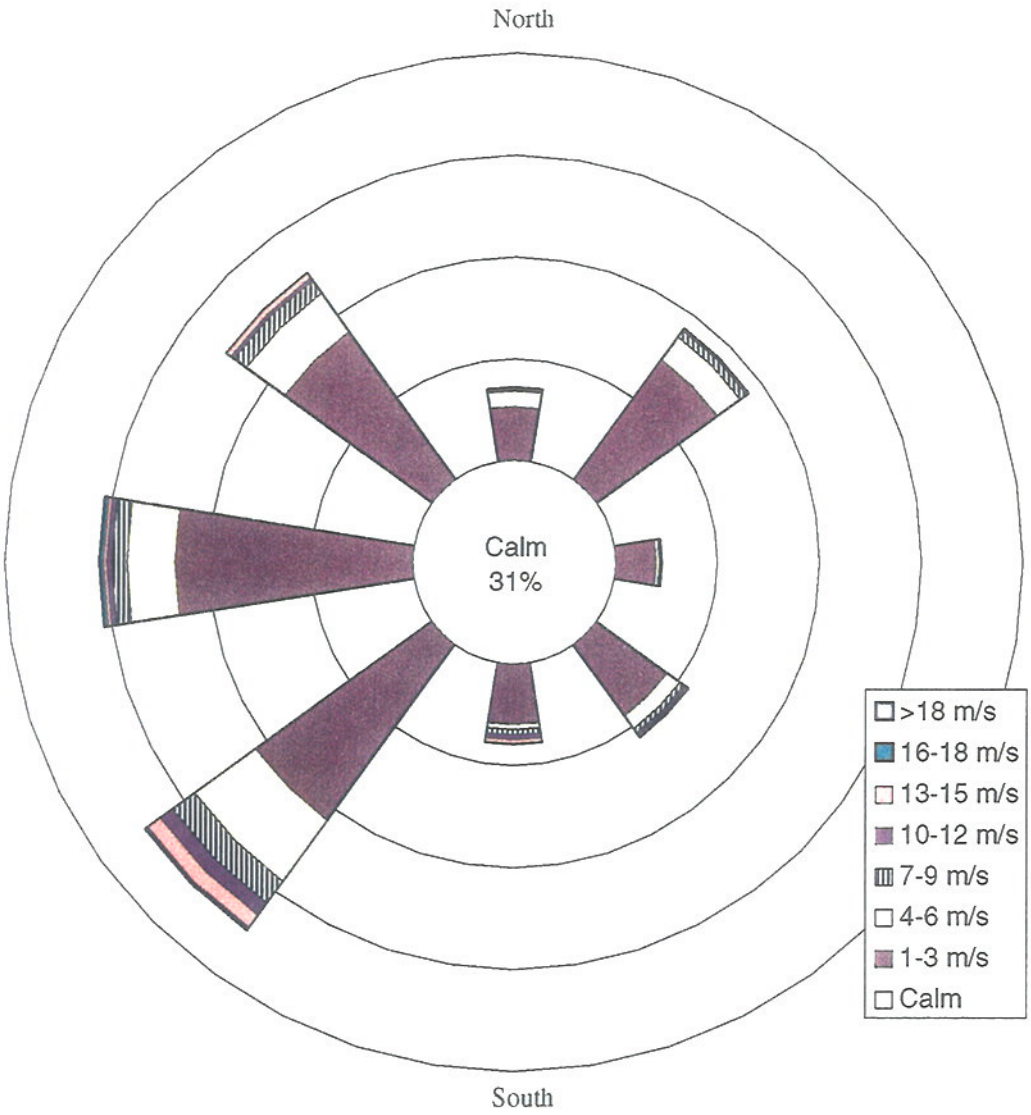
The segments of each arm represent the seven wind speed classes, with increasing windspeed from the centre outwards.The length of each arm represents the proportion of the total wind that blew from that direction. The value in the central circle represents the proportion of calm conditions. The circlular grid represents a contour interval of five percent.

Windrose for Winter
3pm



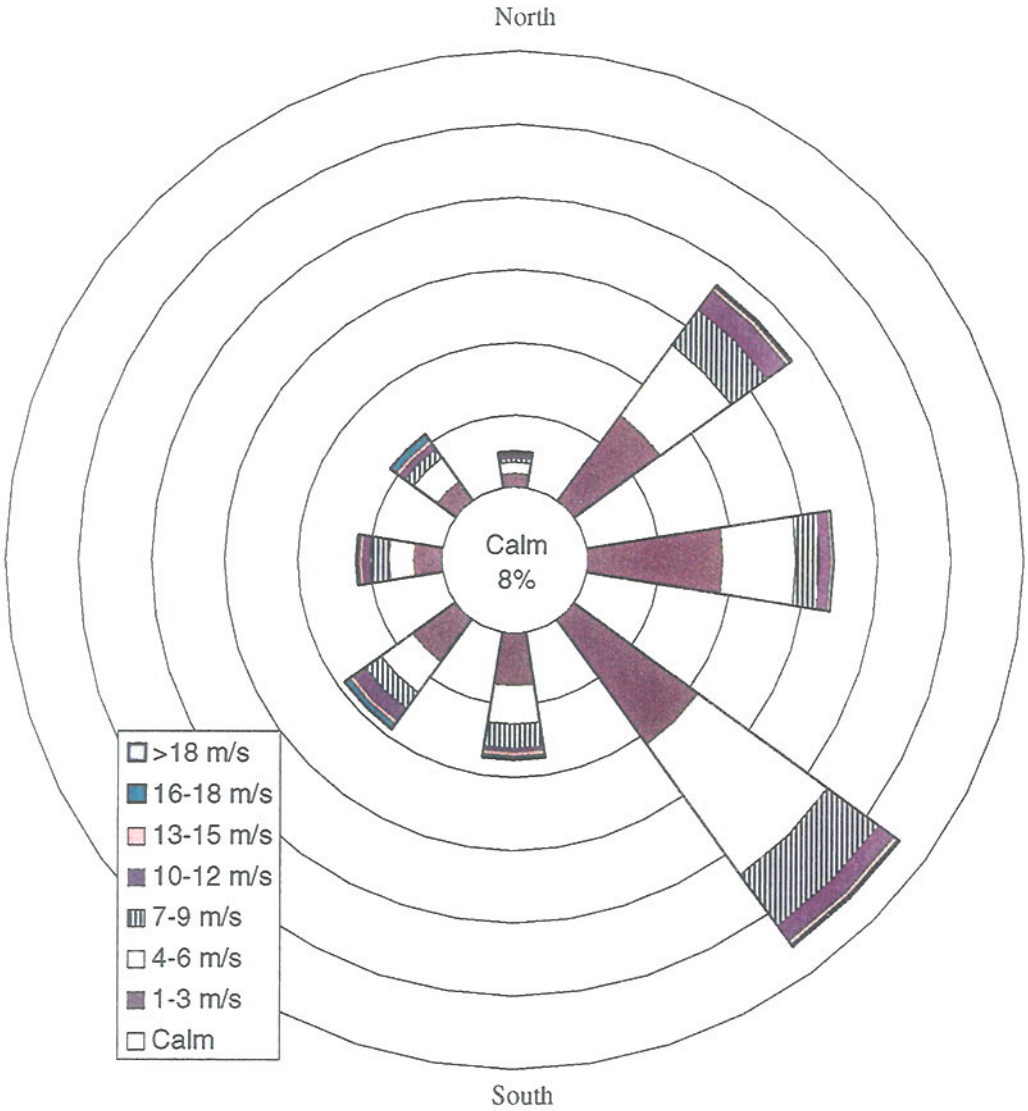
The segments of each arm represent the seven wind speed classes, with increasing windspeed from the centre outwards.The length of each arm represents the proportion of the total wind that blew from that direction. The value in the central circle represents the proportion of calm conditions. The circlular grid represents a contour interval of five percent.

Windrose for Spring
9am



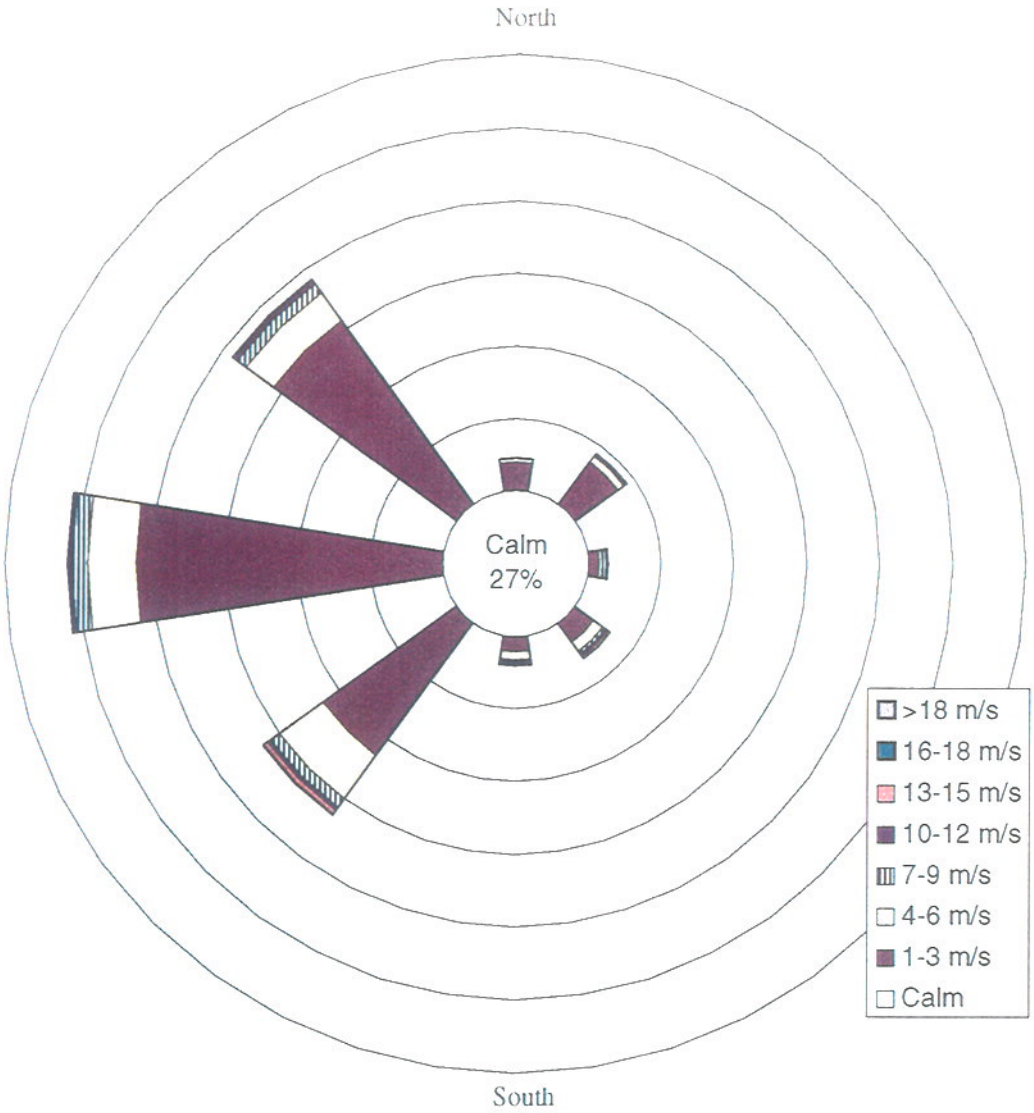
The segments of each arm represent the seven wind speed classes, with increasing windspeed from the centre outwards.The length of each arm represents the proportion of the total wind that blew from that direction. The value in the central circle represents the proportion of calm conditions. The circlular grid represents a contour interval of five percent.

Windrose for Spring
3pm

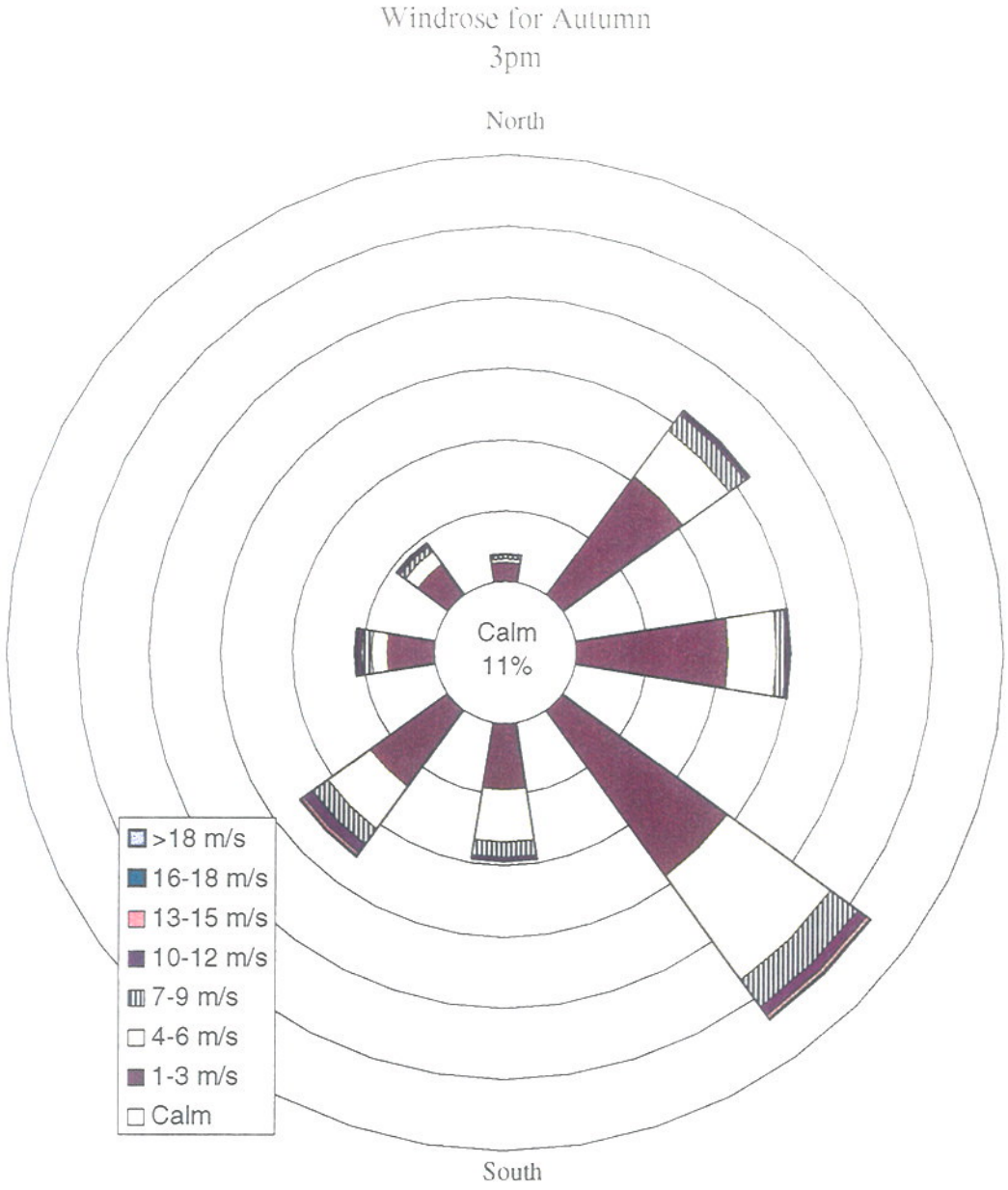


The segments of each arm represent the seven wind speed classes, with increasing windspeed from the centre outwards.The length of each arm represents the proportion of the total wind that blew from that direction. The value in the central circle represents the proportion of calm conditions. The circlular grid represents a contour interval of five percent.

Windrose for Autumn
9am



The segments of each arm represent the seven wind speed classes, with increasing windspeed from the centre outwards.The length of each arm represents the proportion of the total wind that blew from that direction. The value in the central circle represents the proportion of calm conditions. The circlular grid represents a contour interval of five percent.



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JANDRA QUARRY
EXTENSION

CSR

L. ECOLOGICAL ASSESSMENT

JANDRA QUARRY EXTENSION

Ecological Investigations

For:
CSR CONSTRUCTION MATERIALS

October 1999

38070ECORP2

Report No. 38070ECORP2

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. To the best of our knowledge, the proposal presented herein accurately reflects the CSR's 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 THE PROPOSED DEVELOPMENT

CSR Construction Materials Limited (referred to below as CSR) purchased Jandra Blue Metal Quarries Pty Ltd in late 1996 and commenced full scale production at the site in early 1997. The site was originally established following development consent granted by Greater Taree City Council in December 1984. A further development consent in July 1991 increased the production limit of the quarry to 150,000 tonnes per annum (tpa). The existing site is described as Lots 2, 11 ,12 ,13 ,14 and 15 in DP 790056.

The quarry is located on the eastern side of the Pacific Highway at Possum Brush, approximately 18 kilometres south of Taree. The present operation crushes and screens material and provides a pre-coating facility for sealing aggregates. The location of the quarry is shown in *Figure 1.1*.

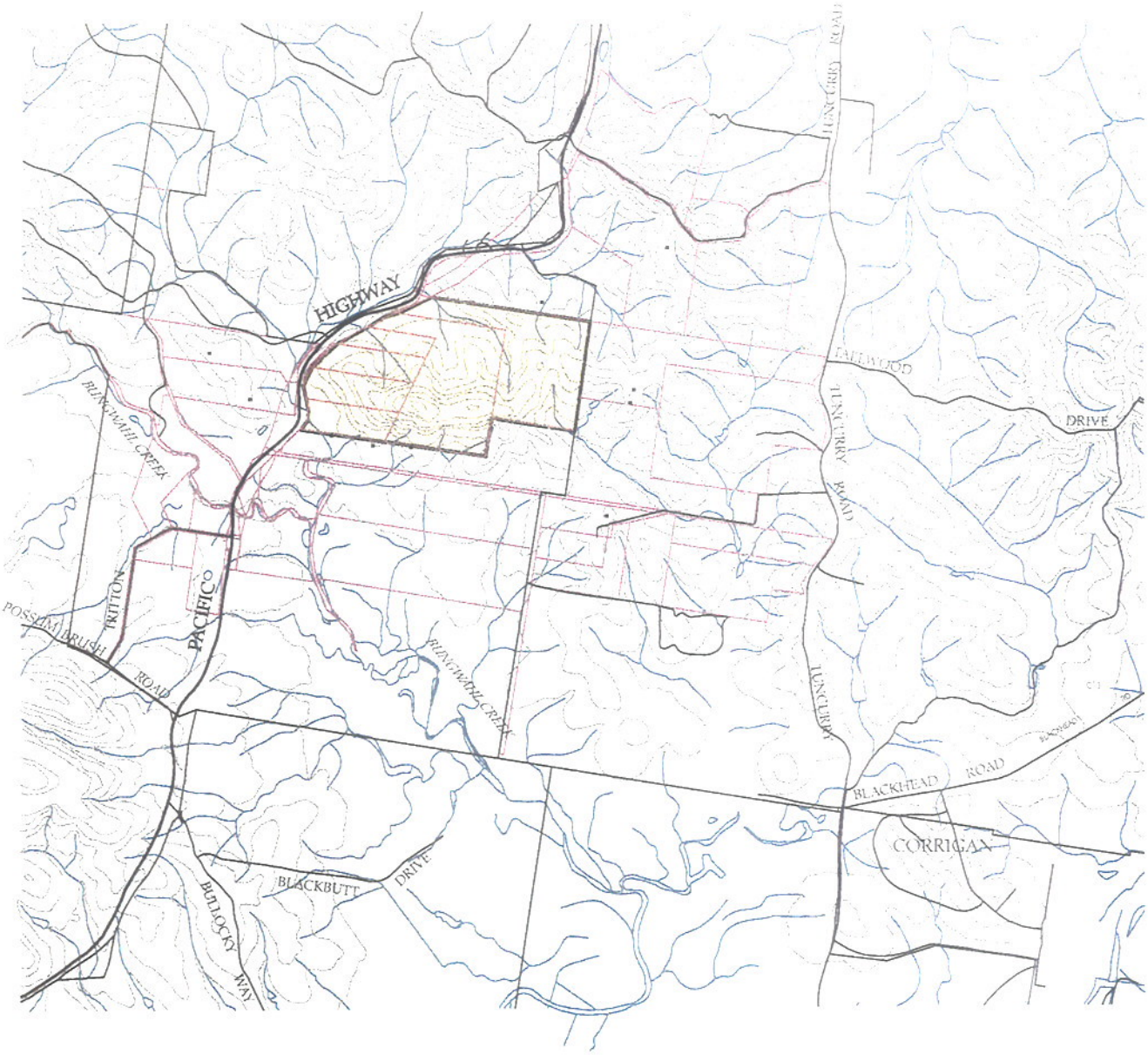
At the time of acquisition CSR calculated that reserves of legally extractable rock contained within the 5 ha approved area totalled 960,000 tonnes. Since then the company has extracted some 400,000 tonnes of material. At the current extraction rate the remaining 560,000 tonnes will last just over four years.

Geological investigations have shown a substantial available resource of at least 19 hectares (ha) on the site that is underlain by greywacke. This resource is contained with a CSR owned area of 118 ha. The company is seeking approval to increase the quarry area to allow extraction of sufficient rock that would secure the economic viability of its investment.

Approval to increase the existing quarry area would significantly expand reserves. A four staged process is proposed involving extraction down to RL 20 and providing 16 million tonnes of fresh rock.

In this application CSR also seeks to gain approval to alter its current operating conditions (1984 and 1991 approvals), as follows:

- expand operating hours from 6.00 am to 6.00 pm Monday to Friday and 6.00 am to 3.00 pm Saturdays. Ancillary operations such as refuelling, servicing and maintaining plant will be undertaken between 6.00 am and 9.00 pm Monday to Saturday;



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CSR PROPERTY BOUNDARY

RESIDENCES

CADASTRAL LINES

N

ERM MITCHELL McCOTTER

Figure 1.1 SITE LOCALITY

- expand the existing site facilities area;
- lift approved production levels from 150,000 tpa to 250,000 tpa;
- significantly expand reserves to allow planning for the companies future. This includes extraction down to RL 20 and will provide 16 million tonnes of fresh rock;
- remove the restrictions on blasting to enable the adoption of normal commercial blasting practices;
- locate on site, from time to time on an as needed basis, a mobile pugmill and or a mobile asphalt batching plant; and
- construct a new weighbridge and office complex west of the current weighbridge.

There will be no change to the processing operations at the quarry. This report on Ecological Investigations forms *Appendix J* to the Environmental Impact Statement for the proposed development. It describes existing threatened flora and fauna species and fauna habitat known or likely to occur in the study area, assesses likely impacts and provides mitigation measures. Eight Part Tests of Significance are provided for terrestrial and aquatic species in accordance with the requirements of Section 5A of the *Environmental Planning and Assessment Act* (1979) and the *Fisheries Management Amendment Act* (1997).

1.2 DEFINITIONS

The following definitions are applicable to these ecological investigations.

- ***activity*** has the same meaning as in the *Environmental Planning and Assessment Act 1979;*
- ***affected species*** means those species likely to be affected by the proposal;
- ***conservation status*** is regarded as the degree of representation of a species or community in formal conservation reserves;
- ***development*** has the same meaning as the *Environmental Planning and Assessment Act 1979;*
- ***Director-General*** means the Director General of National Parks and Wildlife;
- ***locality*** means the area within a ten kilometre radius of the study area;

- *region* means, for the purposes of the provision in which it is used, a bioregion defined in a national system of bioregionalisation that is determined (by the Director General by order published in the Gazette) to be appropriate for those purposes. The study area lies within the North Coast bio-region as documented by Thackway and Cresswell (1996).

- *significant species* means species not listed in the Threatened Species Conservation Act 1995 (TSC Act) but considered to be of regional or local significance;

- *study area* is the subject site and any additional areas which are likely to be affected by the proposal, either directly or indirectly;

- *subject site* means the area which is proposed for development/activity; and

- *subject species* means those threatened and significant species which are considered known or likely to occur in the study area.

All other definitions are the same as those contained in the TSC Act.

1.3 THE STUDY AREA

1.3.1 Climate

Meteorological data has been compiled from the nearest official meteorological station at Taree, approximately 20 kilometres from the study area. The Taree district is located in the sub-humid temperature zone where the climate is influenced by topography, latitude, the local differences in altitude, the proximity of the ocean and the effect the ocean has on temperature and precipitation patterns.

The following climatic characteristics have been determined:

- Mean annual rainfall of the area is 1,183.9 millimetres. Rainfall is seasonally distributed with a late summer/early autumn peak. March is the wettest month, with a mean monthly rainfall of 149.3 millimetres. August has the lowest mean monthly rainfall of 36.5 millimetres. In winter the westerly influences bring most of the rain.

- Mean daily pan evaporation rates range from 1.8 to 2.8 millimetres per day during the winter months, increasing to between 5.3 and 6.2 millimetres in summer.

- The highest temperatures are reached in January, when the mean temperature range is 17°C to 28.8°C. The lowest temperatures are recorded during July, with the range being 5.8°C to 18.3°C.

1.3.2 *Geology and Soils*

The area is underlain by an undifferentiated sequence of Devonian sediments that is approximately 345 to 395 million years old. The sequence consists of interbedded mudstone, sandstone, conglomerate, tuff and chert, with local greywacke beds.

A major greywacke bed is present in the quarry area. It is up to 190 metres thick and has a strike length of at least 1,000 metres. Diamond drilling has confirmed that there is at least 30 metres of greywacke below the current floor of the quarry. Physically the greywacke bed is a very hard durable dark grey rock with little apparent differentiation across the bed. Scattered throughout the bed are relict brachiopod shells and clasts of granitic material up to 10 cm in diameter.

No structural analysis has been carried out, but wedge type failures are evident in the upper weathered benches.

The soil overlying the study area was found to have low erosion and good rehabilitation potential. Generally, the topsoil layers were found to be suitable for rehabilitation depending on the depth of stripping and extent of stockpiling (ie. minimise stripping of inferior rocky subsoil and minimise the time frame soils are stockpiled thus reducing nutrient leaching).

1.3.3 *Regional Biogeography*

A biogeographic region is a complex land area composed of a cluster of interacting ecosystems that are repeated in similar form throughout (Thackway & Cresswell 1995). Region descriptions seek to describe the dominant landscape scale attributes of climate, lithology, geology, landforms and vegetation (Thackway & Cresswell 1995).

The study area falls within the NSW North Coast (NNC) biogeographic region, which covers 60,794 square kilometres (Thackway & Cresswell 1995). The Queensland component accounts for 2,604 square kilometres of this area, while the NSW component amounts to 58,189 square kilometres. In the NNC region, reserved areas account for 5-10% of the total area.

In the NNC region, the dominant ecosystem condition of the Queensland component is characterised by 'modified ecosystems with very few indigenous ecosystems remaining'. The NSW component is documented as 'having indigenous ecosystems

present but co-existing with pastoral/timber industries'. Dominant limiting factors to conservation management in the Queensland component are documented as being urbanisation and horticulture. In the NSW component, the major limiting factors to conservation management are documented as being agriculture, clearing, cropping, feral animals, wildfire, forest timber production/harvesting, grazing and pastoral use, horticulture, mining, tourism, urbanisation and weeds. Thackway and Cresswell's assessment indicates that there is an inadequate representation of reserves in the NNC region.

Chapter 2

ECOLOGICAL INVESTIGATIONS

2.1 METHODOLOGY

2.1.1 Literature Review and Database Search

Investigations involved a review of relevant literature including reports, topographic maps and interpretation of 1:25,000 aerial photographs. A National Parks and Wildlife Service data search was conducted for the Bulahdelah and Wingham 1:100,000 map sheets.

2.1.2 Flora Survey

The primary objectives of the flora survey were:

- to map and describe the vegetation communities and to subsequently determine habitats on-site; and
- to identify the likelihood of any threatened plant species occurring on the site, and consequently to assess the potential impacts of the proposed activities on identified species.

Vegetation analysis consisted of a general description of the plant communities using qualitative field observations and interpretation from aerial photographs. The random meander technique was used to identify plant species, vegetation communities and habitats. This technique involves walking in a random manner through the study area, identifying the full range of potential habitats and plant communities (Cropper 1993).

Significant flora species potentially occurring within the study area were targeted by visiting the community type in which they may occur.

Terrestrial vegetation communities were classified according to the scheme proposed by Walker and Hopkins (1990). Texts used for plant identification included Harden (1990, 1991, 1992, 1993), Brooker *et al.* (1997), Auld and Medd (1996), Tame (1992), Robinson (1994) and Leonard (1996).

The conservation status of the communities occurring within the study area was determined using a variety of texts including Forestry Commission (1989), Hager and Benson (1994) and Specht *et al.* (1995).

2.1.3 *Fauna Habitat Assessment*

Vegetation communities reflect differences in community structure and plant species composition. The majority of fauna species select habitat based primarily in structural characteristics of vegetation communities rather than their composition of plant species. One notable exception is the koala, which selects habitat based on the presence of particular species suitable for feeding. Structural characteristics of vegetation communities include the height of the dominant layer, the number of distinctive layers and the density of vegetation.

Many specialised faunal groups may also rely upon the availability of water, the presence of particular tree or shrub species, or specific micro-climatic characteristics in order to survive. Human activities, particularly those that alter the structure or cover of vegetation, have the potential to change faunal habitat characteristics, which, in turn, may result in modifications to the composition of fauna within an area.

Investigations sought to identify and assess the type and quality of fauna habitats occurring within the study area. Assessment of fauna habitat types and quality was derived from a qualitative assessment of:

- dominant vegetation type;
- structural vegetation characteristics;
- presence/abundance of hollow-bearing trees;
- level of disturbance;
- density of ground litter (ie logs, leaf litter); and
- presence/absence of standing or flowing water (modified from SWC 1994).

2.1.4 *Fauna Survey*

i. Spotlighting

Spotlighting surveys were undertaken in an effort to determine the assemblage of arboreal mammals occupying the study area. They were conducted primarily to

detect the squirrel glider (*Petaurus norfolcensis*) and brush-tailed phascogale (*Phascogale tapoatafa*). A total of two hours of spotlighting on foot was conducted by two ecologists walking at approximately one kilometre per hour over three nights (total 12 person hours of spotlighitng). A further half hour of spotlighting from a slow moving vehicle (moving at approximately five kilometres per hour) was undertaken over three nights (an additional one and a half hours of spotlighting).

A total transect distance of 4.5 kilometres was covered during the spotlighting surveys, as illustrated in *Figure 2.1*. Spotlighting was only undertaken during suitable weather conditions, characterised by mild to warm temperatures, low wind and no rainfall.

ii. Avifaunal Surveys

Diurnal bird surveys were conducted in an effort to detect the black bittern (*Ixobrychus flavicollis*) and the square-tailed kite (*Lophoictinia isura*). Surveys were conducted in habitats deemed suitable for these species, primarily at dam sites with emergent vegetation for the black bittern and within the dry open forest communities for the square-tailed kite.

Surveys were conducted for a minimum of 30 minutes at dusk over three nights as well as opportunistically for the duration of the field investigation. All species of avifauna incidentally observed were recorded.

iii. Anabat Detection

Anabat surveys were conducted to detect microchiropteran bat species, particularly the common bent-wing bat (*Miniopterus schreibersii*), little bent-wing bat (*M. australis*), large footed myotis (*Myotis adversus*), eastern free-tail bat (*Mormopterus norfolkensis*), greater broad-nosed bat (*Scoteanax rueppellii*) and the yellow-bellied sheath-tailed bat (*Saccolaimus flaviventris*). Two hours of walking transects were conducted along (walked) spotlighting transects over three nights. Stationary bat detection was also conducted on the southern access road. Anabat detection was undertaken at dusk in suitable weather conditions (mild to warm, little wind and no rain). The Anabat recording path is illustrated in *Figure 2.1*.

iv. Hairtube Sampling

The hairtube sampling targeted the brush-tailed phascogale (*Phascogale tapoatafa*) and the squirrel glider (*Petaurus norfolcensis*). A total of three hairtube transects (two lines of five tubes and one line of six tubes) were set for 15 nights in habitat deemed suitable for the target species (*Figure 2.1*). The hairtubes were set 20 to 50 metres

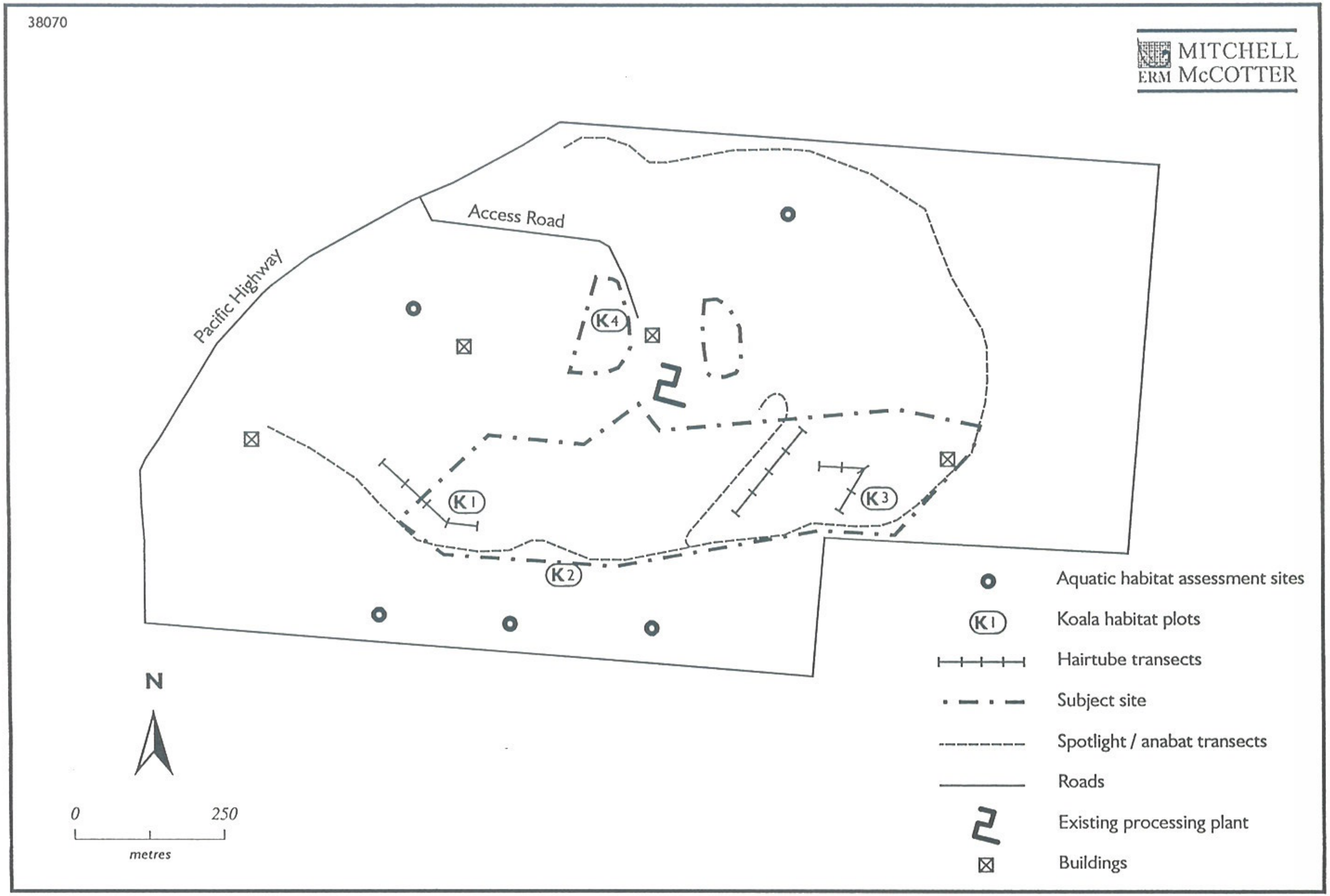

Figure 2.1 LOCATION OF FIELDWORK ACTIVITIES WITHIN THE STUDY AREA

apart. A total of 240 hair tube nights were performed at three transect locations. Hairtubes were baited alternatively with meat (bacon pieces) and a mixture of peanut butter, honey and rolled oats.

v. Amphibian Surveys

Amphibian searches were conducted to determine the assemblage of amphibians in the study area, and specifically to detect green-thighed frog (*Litoria brevipalmata*). Searches were undertaken at three sites within the study area (*Figure 2.1*). Site selection was based on the presence of suitable habitat as determined through the ground truthing. Each site was surveyed at least twice over three consecutive nights.

Each survey consisted of a 30 minute (minimum) visual search (using a spotlight) by two team members, and call playback survey broadcasting calls of amphibian species likely to occur. Each suitable call was played for five minutes, followed by a two minute listening period. Each call playback survey was preceded and followed by a ten minute listening period.

vi. Reptile Surveys

Nocturnal reptile searches were conducted in conjunction with amphibian searches to detect the pale-headed snake (*Hoplocephalus bitorquatus*) and stephen's banded snake (*H. stephensii*). The searching technique included spotlight searching, and searching of fallen logs, decorticating bark, rock outcrops and other likely substrates. Two team members conducted each search for a minimum period of 30 minutes each evening of the field survey. Driving spotlight transects were also used in an effort to detect these species.

Diurnal searches for reptiles were also undertaken and included searches under rocks, fallen logs, decorticating bark and other crevices potentially utilised by reptiles. All reptile species opportunistically sighted were recorded. Diurnal and nocturnal reptile survey sites are illustrated in *Figure 2.1*.

vii. SEPP 44 - Koala Habitat Surveys

The field survey included a search for the presence of *'potential koala habitat'* and *'core koala habitat'* as defined in *State Environmental Planning Policy No. 44 - Koala Habitat Protection* (SEPP 44). In SEPP 44 *'potential koala habitat'* is defined as *'areas of native vegetation where the trees of the types listed in Schedule 2 constitute at least 15 percent of the total number of trees in the upper or lower strata of the tree component'*. In addition to tree species listed in Schedule 2 it is also necessary to consider tree species that are

recognised to be locally significant as feeding resources to koalas. For the purpose of this study the locally preferred koala food trees included the primary koala food trees identified in Evans and Fitzpatrick (1996).

The methodology used for detecting *'potential koala habitat'* was based on that used by the Australian Koala Foundation. Plots of 0.1 hectares (50 x 20 metres) in size were marked out in each vegetation type (*Figure* 2.2). The abundance of each tree species in the upper and lower canopy was recorded to enable an approximate percentage of cover for each species to be calculated. If *'potential koala habitat'* was identified then further investigations were conducted to assess the presence of *'core koala habitat'*.

In SEPP 44 *'core koala habitat'* means *'an area of land with a resident population of koalas evidenced by attributes such as breeding females (that is, females with young) and recent sightings of and historical records of a population'*. Further investigations to assess the presence of *'core koala habitat'* consisted of searching each potential koala food tree for koalas, scratches (consistent with those of a koala) and scats within two metres of each tree bole. In addition, scats and scratch marks were also searched for while undertaking other fieldwork activities.

viii. Opportunistic Fauna Surveys

Field checking for evidence of fauna during the flora survey included:

- mammals: scats, diggings, burrows, footprints, roost sites, tree scratchings and feeding incisions. Habitat features such as groundcover, extent of shrub and tree layers and the presence of mature habitat trees with hollows were also considered;
- birds: incidental bird observations were recorded. Vegetation cover of the canopy, understorey and groundcover were also taken into account; and
- reptiles and amphibians: the availability of cover, basking sites and breeding sites.

2.1.5 *Aquatic Habitat Assessment*

Lincoln-Smith (1998) provides information on how to determine the appropriate level of investigation for aquatic ecosystems. Included in his description is a formula designed to assist in determining the level of detail required for aquatic ecological investigations. The application of this formula to the current proposal indicates that a level one investigation is appropriate. This conclusion is based on the predicted low level of disturbance, the high inertia, high stability and high

Figure 2.2 DISTRIBUTION AND EXTENT OF VEGETATION COMMUNITIES WITHIN THE STUDY AREA

resilience of the subject system (Lincoln-Smith 1998). A level one investigation includes the following:

- use of existing information and consultation with appropriate authorities; and
- site description including habitat inventory of the proposed development.

The impact of the proposed development on aquatic habitats is regarded as minor because it would not:

- create barriers to fish passage;
- significantly change physical properties of water;
- have chemical effects on water quality; or
- have biological effects on the aquatic environment, such as the introduction of new species.

As a consequence of the expected low impact of the proposed development, the impact assessment for fish was limited to a general assessment of the aquatic habitat and a desktop review of fish species likely to occur in the study area.

The evaluation of aquatic habitat involved a descriptive assessment of the habitats available at each potential impact site. The method used was similar to the habitat inventory method described by Lincoln-Smith (1998). The habitat components documented during the field survey include:

- type of waterbody (permanent or ephemeral);
- presence of a pool/riffle sequence;
- dominant substratum type (rock, gravel, silt, sand, organic material);
- abundance of snags;
- presence of and area of water surface covered by aquatic macrophytes;
- species of aquatic plant present;
- water depth range;
- width of waterbody;
- whether the stream was flowing or not; and

- presence of deep pools.

The ephemeral watercourses occurring in the study area were then graded using the criteria outlined in *Table 2.1* to assess the availability of fish habitat.

Table 2.1 PRELIMINARY STREAM CLASSIFICATION AND DESCRIPTION OF CLASSES

Class	Habitat Type	Description
1	Minimal Fish Habitat	Paddocks, escarpments, etc. unlikely to have defined channels or waterways, water will disperse immediately after rainfall.
2	Intermittent	Intermittent streams with no defined channel - not permanently flowing, may dry up completely, may lead to or from a farm dam.
3	Intermittent	intermittent streams with a defined channel - not permanently flowing, may dry up completely, may lead to or from a farm dam.
4	Semi-permanent	Semi-permanent waterway - defined channel, usually flowing, will generally retain pools (except in extreme drought).
5	Permanent	Permanent water.

Source:. S. Carter, pers. comm. cited in The Ecology Lab Pty Ltd (1998).

2.2 SURVEY RESULTS

2.2.1 *Threatened Species Known or Likely to Occur in the Study Area*

The eastern falsistrelle (*Falsistrellus tasmaniensis*) was the only threatened species recorded (tentatively) during the current surveys. Nevertheless, despite the results of the current survey, potential habitat exists within the study area for a variety of threatened species. *Table* 2.2 outlines the threatened species that could potentially occur in the study area based on the presence of suitable habitat and, for some species, previous records in the locality.

Table 2.2 SUBJECT SPECIES POTENTIALLY OCCURRING WITHIN THE STUDY AREA

Common Name	Scientific Name	Preferred Habitat
Koala	*Phascolarctos cinereus*	Tall open forest to open woodland on high nutrient soils along river flats and drainage lines.
Tiger Quoll	*Dasyurus maculatus*	Wet and dry sclerophyll forest and rainforest.
Brush-tailed Phascogale	*Phascogale tapoatafa*	Dry sclerophyll forest and woodlands
Squirrel Glider	*Petaurus norfolcensis*	Dry sclerophyll forest and woodlands in dry upper slopes and ridges.
Long-nosed Potoroo	*Potorous tridactylus*	Coastal heath, dry and wet sclerophyll forests. Requires thick groundcover, prefers light sandy soils.
Large Bentwing Bat	*Miniopterus schreibersii*	Forested areas, including rainforest, particularly in well timbered valleys.
Little Bentwing Bat	*Miniopterus australis*	Forested areas, including rainforest, particularly in well timbered valleys.
Eastern Falsistrelle	*Falsistrellus tasmaniensis*	Sclerophyll forests from the Great Dividing Range to the coast.
Eastern Free-tail Bat	*Mormopterus norfolkensis*	A variety of forest types ranging from rainforest to dry sclerophyll forest and woodland.
Greater Broad-nosed Bat	*Scoteanax ruepellii*	Woodland, wet and dry sclerophyll forest and rainforest at altitudes less than 500 metres.
Yellow-bellied Sheath-tailed Bat	*Saccolaimus flaviventris*	Specific habitat requirements unknown.

Table 2.2 SUBJECT SPECIES POTENTIALLY OCCURRING WITHIN THE STUDY AREA

Common Name	Scientific Name	Preferred Habitat
Masked Owl	*Tyto novaehollandiae*	Roosting habitat - dense vegetative cover in gullies.
Powerful Owl	*Ninox strenua*	Wet and dry sclerophyll forests, particularly tall, dense eucalypt forest with a dense understorey, on hills and mountains.
Barking Owl	*Ninox connivens*	Wet and dry sclerophyll forests, particularly tall, dense eucalypt forest with a dense understorey, on hills and mountains.
Glossy Black-cockatoo	*Calyptorhyncus lathami*	Forests, woodlands, and timbered watercourses.
Square-tailed Kite	*Lophoictinia isura*	Coastal and sub-coastal open forests and woodlands.
Black Bittern	*Ixobrychus flavicollis*	Mangroves, streamside vegetation including small creeks in forests.
Osprey	*Pandion haliaetus*	Mangroves, rivers and estuaries, inshore islands, coastal islands and nearby forest.
Stephen's Banded Snake	*Hoplocephalus stephensii*	Dry and moist hardwood forest, coastal rainforest.
Pale Headed Snake	*Hoplocephalus bitorquatus*	Dry and moist hardwood forest, coastal rainforest.
Green-thighed Frog	*Litoria brevipalmata*	Wet and dry sclerophyll forest.
Rudder's Box	*Eucalyptus rudderi*	Wet and dry sclerophyll forest on sloping soil with medium fertility.

Table 2.2 SUBJECT SPECIES POTENTIALLY OCCURRING WITHIN THE STUDY AREA

Common Name	Scientific Name	Preferred Habitat
	Dodonaea megazyga	Dry sclerophyll forest, rainforest margins.

2.2.2 *Survey Timing and Weather Conditions*

Field investigations were conducted on 19 and 20 January and on 11 March, 1999. The weather conditions experienced were favourable for the undertaking of the survey, being mild to warm with little wind and no rain. A further flora survey was undertaken in early spring (20 September 1999) to enable identification of additional species during flowering.

2.2.3 *Vegetation Communities*

Based on structural characteristics and floristic composition, three plant communities have been identified within the study area. A full list of plant species identified in the study area is provided in *Appendix A*. No flora species of conservation significance were recorded during the ecological investigations.

The flora survey was as comprehensive as possible, however due to seasonality, some plant species could not be identified due to a lack of flowering or fruiting bodies. Therefore, the species list is unlikely to be exhaustive.

i. Corymbia maculata/ Eucalyptus acmenoides very tall open forest

This is the dominant plant community in the study area, extending from the ridgetop to the midslope on all aspects (*Figure 2.2*).

a. Description

Overstorey: The tallest stratum in this community is approximately 25 to 30 metres high, with a vegetative cover of approximately 45 to 50 per cent. The dominant canopy species are spotted gum (*Corymbia maculata*) and white mahogany (*Eucalyptus acmenoides*). Other commonly occurring species include ironbark (*Eucalyptus* sp.) and grey gum (*E. propinqua*). Tallowwood (*E. microcorys*) and broad-leaved white mahogany (*E. umbra*) occur intermittently in this vegetation community.

Midstorey: The midstorey strata is approximately 10 to 18 metres high, with a vegetative cover of approximately 15 to 20 percent. The mid-storey is dominated by forest oak (*Allocasuarina torulosa*) and juvenile overstorey species.

Understorey: The understorey stratum ranges in height from two to six metres, with a vegetative cover of approximately five to 15 percent. The dominant species in the understorey are juvenile forest oak (*Allocasuarina torulosa*), juvenile eucalypts, lantana (*Lantana camara*), sydney golden wattle (*Acacia longifolia*), spurge (*Phyllanthus gunnii*) and narrow-leaved geebung (*Persoonia linearis*). A number of vines and creepers grow amongst the understorey and include wombat berry (*Eustrephus latifolius*), blackberry (*Rubus hillii*), *Desmodium rhytidophyllum*, running postman (*Kennedia rubicunda*) and love creeper (*Glycine tabacina*).

Groundcover: Groundcover vegetation is approximately 50 to 70 centimetres high, with a foliage cover of 40 to 65 percent. The groundcover is dominated by a variety of herbaceous plants and includes wallaby grass (*Danthonia* sp.), kangaroo grass (*Themeda australis*), whisky grass (*Andropogon virginicus*), blue flax lily (*Dianella caerulea*) and purple flag (*Patersonia* sp.).

b. Condition

This community is dissected by a number of tracks and roads, and it appears to have been extensively logged in the past. There is limited evidence to suggest recent fires within this community. Weed species are relatively common, and include lantana (*Lantana camara*), prickly pear (*Opuntia vulgaris*), wild tobacco bush (*Solanum mauritianum*), blackberry (*Rubus hillii*) and scotch thistle (*Cirsium vulgare*). A number of garden varieties of trees have been planted on the periphery of this community including jacaranda, frangipani and pine trees.

c. Conservation Significance

This forest type is considered to be widespread throughout the coastal districts of NSW (Forestry Commission of NSW 1989). Benson and Hager (1994) identified this plant community to be poorly conserved in the north coast region, and suggested that the community would require several additional samples to be conserved before its conservation status could be considered adequate. However, extensive forest areas have recently (since 1994) been added to the NPWS estate, hence an accurate assessment of the plant community's conservation status cannot be determined until the representativeness of this plant community in new reserve areas has been determined.

Furthermore, the area of this plant community within the study area is in relatively poor condition, and is unlikely to be worthy of conservation due to previous disturbances.

ii. Eucalyptus acmenoides/E. umbra/E. microcorys very tall open forest;

This open forest type occurs predominantly on the sheltered lower slopes and valley in the study area (*Figure* 2.2).

a. Description

Overstorey: The tallest stratum in this community is approximately 30 to 35 metres high with a vegetative cover of approximately 60 percent. The dominant canopy species are white mahogany (*Eucalyptus acmenoides*), broad-leaved white mahogany (*E. umbra*) and tallowwood (*E. microcorys*). Other species that occur intermittently include grey gum (*E. propinqua*), Sydney blue gum (*E. saligna*) brush box (*Lophostemon confertus*), turpentine (*Syncarpia glomulifera*) and bloodwood (*Corymbia* spp.).

Midstorey: The height of the midstorey stratum varies from eight to 20 metres, with a vegetative cover of approximately 25 percent. It is dominated by forest oak

(*Allocasuarina torulosa*) and juvenile canopy species, particularly brush box and bloodwood species.

Understorey: The understorey stratum is approximately four metres high, with a foliage cover of less than ten percent. The dominant species in the understorey include juvenile forest oak (*Allocasuarina torulosa*), sydney golden wattle (*Acacia longifolia*), narrow-leaved geebung (*Persoonia linearis*), forest nightshade (*Solanum prinophyllum*), *Daviesia genistifolia* and breynia (*Breynia oblongifolia*). Apple dumplings (*Billardiera scandens*), climbing sarsparilla (*Smilax glycophylla*), twining guinea flower (*Hibbertia scandens*) and hardenbergia (*Hardenbergia violaceae*) are common vines or creepers in this community.

Groundcover: Within this community, the groundcover is approximately one metre high, with a foliage cover of 60 percent. The dominant species include mat rush (*Lomandra longifolia*) and bracken fern (*Pteridium esculentum*).

b. Condition

This community is dissected by a number of tracks and roads. Limited evidence exists of recent low intensity burning within this community. Weeds species are common and include bracken fern (*Pteridium esculentum*), purple top (*Verbena bonariensis*), fireweed (*Senecio* spp.) and balloon cotton plant (*Gomphocarpus* sp.).

c. Conservation Significance

This forest type resembles State Forest Type No. 60, which is found to above 300m in the North Coast and Central Coast regions (Forestry Commission of NSW 1989). Benson and Hager (1994) identified this plant community to be inadequately conserved throughout its range. However, extensive forest areas have recently (since 1994) been added to the NPWS estate, hence an accurate assessment of the plant community's conservation status cannot be determined until the representativeness of this plant community in new reserve areas has been determined.

iii. Grassland

The extent of this vegetation community is limited to the powerline easement, the edges of access roads and the area in the south-east portion of the site. The community is dominated by a variety of native and introduced grasses, including wallaby grass (*Danthonia* sp.), kangaroo grass (*Themeda australis*) and whisky grass (*Andropogon virginicus*). This community is in a state of disclimax due to previous clearing activities and regular maintenance slashing. Therefore, it is considered to have low conservation value.

2.2.4 *Habitat Assessment*

i. Terrestrial Habitats

There are four main habitat types within the study area. These consist of dry open forest, moist open forest, aquatic habitats (dams), and grassland. Each of these habitat types are described below according to their habitat elements and degree of naturalness.

a. Dry Open Forest

Vegetation Communities: *Corymbia maculata/Eucalyptus acmenoides* very tall open forest

Habitat Elements: The *Eucalyptus* and *Corymbia* species in the canopy of this habitat type, as well as the *Acacia* species in the understorey would provide a seasonal resource of flowers for nectivorous fauna. The results of the SEPP 44 investigation (Section 2.2.7) indicate that there are few suitable foraging resources for koalas (*Phascolarctos cinereus*) in this habitat type. The presence of *Allocasuarina* species may provide a suitable food resource for glossy black-cockatoos (*Calyptorhynchus lathami*), although no signs of feeding by this species were observed (ie. no chewed cones present).

The study area contains a moderate abundance of leaf litter that may provide suitable shelter for reptiles, as well as suitable foraging habitat for ground-dwelling birds. Rocks and fallen logs are sparse in this habitat type, hence there are minimal sheltering resources for small ground-dwelling mammals and reptiles. The sparse understorey strata would provide limited suitable habitat for small passerine birds. Mature trees with hollows are generally absent, hence there is limited roosting habitat for large hollow-roosting avifauna and arboreal mammals. Nevertheless, the presence of small hollows and decorticating bark may provide suitable roosting resources for microchiropteran bats, small hollow-roosting avifauna and arboreal mammals able to utilise small hollows (eg. squirrel gliders, sugar gliders and eastern pygmy-possums). There is unlikely to be any suitable foraging or breeding resources in this habitat type for amphibians due to a lack of permanent or ephemeral waterbodies in the vicinity.

This habitat type has been disturbed by previous logging and quarrying practices. Access tracks associated with the powerline and residential dwellings along the ridgeline are common within this habitat type. Furthermore, weeds are common throughout.

b. Moist Open Forest

Vegetation Communities: *Eucalyptus acmenoides/E. umbra/E. microcorys* very tall open forest.

Habitat Elements: The *Eucalyptus, Syncarpia, Lophostemon, Melaleuca* and *Callistemon* species in the canopy and midstorey of this habitat type would provide a seasonal resource of flowers for nectivorous fauna. The SEPP 44 investigation revealed some areas of potential koala habitat within this habitat type. However, despite a thorough search for scats and scratches, there was no evidence of this species' presence in the study area.

This habitat type contains a moderate abundance of leaf litter that may provide suitable shelter for amphibians and reptiles, as well as suitable foraging habitat for ground-dwelling birds. Furthermore, there is a moderate abundance of small to medium sized fallen logs that may provide suitable shelter for small ground-dwelling mammals and reptiles. The sparse understorey vegetation would provide limited suitable habitat for small passerine birds. Mature trees with hollows are generally absent, hence there is limited roosting habitat for large hollow-roosting avifauna and arboreal mammals. Nevertheless, the presence of small hollows and decorticating bark may provide suitable roosting resources for microchiropteran bats, small hollow-roosting avifauna and arboreal mammals able to utilise small hollows (eg. squirrel gliders, sugar gliders and eastern pygmy-possums). There are two ephemeral drainage lines that run through this habitat type that would provide suitable foraging and breeding habitat for several amphibian species.

This habitat has been impacted on previously by logging practices and road construction activities. One of the ephemeral creeks has been dammed. Past logging has resulted in canopy thinning and reduction in the density and abundance of hollow logs. Weeds are common on the forest fringe.

ii. Aquatic Habitats

a. Wetlands

There are five main dams within the study area. Two of the dams contain abundant emergent and floating vegetation that provide suitable habitat for a variety of amphibian species. These dams may also provide suitable foraging habitat for a variety of waterbird species.

b. Ephemeral Drainage Lines

When subjected to the preliminary fish habitat classification scheme devised by NSW Fisheries, all of the ephemeral drainage lines on the southern side of the

ridgeline represent only minimal fish habitat. The two ephemeral drainage lines in the northern section of the study area could potentially represent intermittent fish habitat. However, only the drainage line in the north-eastern section of the study area appears to retain pools along the watercourse for any sustained time period. These pools could also provide suitable breeding and foraging habitat for amphibian species. The rocky substrate within the ephemeral drainage lines may also provide suitable shelter for a variety of reptile and amphibian species. The drainage lines assessed are shown on *Figure 2.1* with the results of the aquatic habitat assessment provided in *Appendix B*.

2.2.5 *Fauna Survey*

i. Spotlighting

A total of two native arboreal and one flying mammal species were recorded during the spotlighting surveys undertaken. These were the common brush-tailed possum (*Trichosurus vulpecula*), common ringtail possum (*Pseudocheirus peregrinus*) and the grey headed flying fox (*Pteropus poliocephalus*). Two feral species were observed, these being the fox (*Vulpes vulpes*) and the cat (*Felis cattus*). The only native terrestrial mammal recorded was the red necked wallaby (*Macropus rufogriseus*). One nocturnal bird species was observed, this species was the white-throated nightjar (*Eurostopodus mystacalis*). All of these species are considered to be common and are not listed on the Schedules of the TSC Act (1995).

ii. Avifaunal Surveys

Although the avifaunal surveys were only undertaken at dusk each day (and not sunrise), a total of 31 bird species were recorded during the ecological investigations. *Table 2.3* below lists these species. No species of conservation significance were recorded during the surveys.

Table 2.3 AVIFAUNAL SURVEY RESULTS

Common Name	Scientific Name
Common Koel	*Eudynamys scolopacea*
Pheasant Coucal	*Centropus phasianinus*
Australian Raven	*Corvus coronoides*
Australian Magpie	*Gymnorhina tibicen*
Magpie-lark	*Grallina cyanoleuca*
Laughing Kookaburra	*Dacelo novaeguineae*
White-throated Honeyeater	*Melithreptus albogularis*
Black-faced Cuckoo Shrike	*Coracina novaehollandiae*
Red Browed Finch	*Neochmia temporalis*
Grey Fantail	*Rhipidura fuliginosa*
Eastern Yellow Robin	*Eopsaltria australis*
Noisy Friarbird	*Philemon corniculatus*
Grey Butcherbird	*Cracticus torquatus*
Red Wattlebird	*Anthochaera carunculata*
Masked Lapwing	*Vanellus miles*
Superb Fairy Wren	*Malurus cyaneus*
Sacred Kingfisher	*Todiramphus sanctus*
Yellow-faced Honeyeater	*Lichenostomus chrysops*
Southern Boobook	*Ninox novaeseelandiae*
White-throated Nightjar	*Eurostopodus mystacalis*
King Parrot	*Alisterus scapularis*
Scarlet Honeyeater	*Myzomela sanguinolenta*
Green Catbird	*Ailuroedus crassirostris*
Brown Treecreeper	*Climacteris picumnus*
Noisy Miner	*Manorina melanocephala*
Grey Shrike-thrush	*Colluricincla harmonica*
Willie Wagtail	*Rhipidura leucophrys*
White-browed Scrub Wren	*Sericornis frontalis*
White-throated Needletail	*Hirundapus caudacutus*
Maned Duck	*Chenonetta jubata*
Channel Billed Cuckoo	*Scythrops novaehollandiae*

Table 2.3 AVIFAUNAL SURVEY RESULTS

Common Name	Scientific Name
Pied Currawong	*Strepera graculina*

iii. Bat Detection

The bat call analysis was conducted by Glenn Hoye of Fly-By-Night Bat Surveys Pty. Ltd. None of the calls could be confidently identified, however, four probable identifications and one possible identification were made. The four probable species include gould's wattled bat (*Chalinolobus gouldii*), chocolate wattled bat (*Chalinolobus morio*), eastern broadnosed bat (*Scotorepens orion*) and *Vespadelus* sp.. The possible species was identified as the eastern falsistrelle (*Falsistrellus tasmaniensis*). The eastern falsistrelle is currently listed as vulnerable on Schedule 2 of the TSC Act (1995).

iv. Hairtube Sampling

The hair analysis revealed multiple records of one species, this being the common brushtail possum (*Trichosurus vulpecula*). This species is considered to be common throughout a variety of habitats within the region.

v. Amphibian Survey

Amphibian surveys resulted in the detection of nine species of amphibians. These results are listed in *Table 2.4* below. All species recorded are considered to be common throughout the region.

Table 2.4 AMPHIBIAN SURVEY RESULTS

Common Name	Scientific Name	Method of Detection
Family Myobatrachidae		
Common Eastern Froglet	*Crinia signifera*	Call
Smooth Toadlet	*Uperoleia laevigata*	Call
Brown-striped Frog	*Limnodynastes peronii*	Call
Spotted Grass Frog	*Limnodynastes tasmaniensis*	Call
Family Hylidae		
Bleating Tree Frog	*Litoria dentata*	Call

Table 2.4 AMPHIBIAN SURVEY RESULTS

Common Name	Scientific Name	Method of Detection
Dwarf Tree Frog	*Litoria fallax*	Call; Capture
Broad-palmed Frog	*Litoria latopalmata*	Call
Peron's Tree Frog	*Litoria peronii*	Call; Capture
Tyler's Tree Frog	*Litoria tyleri*	Call

vi. Reptile Surveys

Reptile species recorded during the current survey include the lace monitor (*Varanus varius*) and skinks (*Lampropholis* spp.). Anecdotal evidence (discussions with quarry site manager) suggests that eastern brown snakes (*Pseudonaja textilis*) and red-bellied black snakes (*Pseudechis porphyriacus*) also occur within the study area.

vii. SEPP 44 - Koala Habitat Surveys

The koala habitat assessment results indicate that the moist open forest habitat in the study area contains *'potential koala habitat'* as outlined by Clause 7 of SEPP 44 (refer to *Table 2.5*). The abundance and diversity of tree species recorded during the SEPP 44 investigation is provided in *Appendix C.*

Table 2.5 ASSESSMENT OF POTENTIAL KOALA HABITAT

Plot Number	Koala Food Trees Upper Canopy	% Trees in Upper Canopy	Koala Food Trees Lower Canopy	% Trees in Lower Canopy	Potential Koala Habitat
1	11	55	4	50	yes
2	2	6	3	12	no
3	0	0	0	0	no
4	2	7	2	8	no

Note: *Only locally preferred* primary *koala food tree species were considered in this assessment (Evans & Fitzpatrick 1996).*

Location of plots shown in Figure 2.1.

Although the study area contains areas of *'potential koala habitat'* under the provisions of SEPP 44, no koala scats were found during fieldwork exercises. No scratches resembling those of koalas were identified. Evidence from the fieldwork undertaken for the core koala habitat assessment indicates that the study area does not contain *'core koala habitat'*. Nevertheless, koalas have been recorded within five kilometres of the study area in Kiwarrak State Forest.

2.3 IMPACT ASSESSMENT

The proposed development may have a variety of direct impacts upon threatened flora and fauna that potentially occur in the habitats of study area. These impacts are documented below and include consideration of the cumulative/indirect impact and likely contribution of the proposal to the threatening processes acting on populations of the subject species in the locality. The impact assessment also takes into account existing impacts on the study area, particularly those arising from the existing quarry operations and other activities which have altered the composition of vegetation communities and fauna habitats and ultimately, the composition of flora and fauna within the study area.

2.3.1 *Habitat Loss or Modification*

The direct effect of the quarry extension is the destruction and modification of wildlife habitats. Approximately 14 hectares of dry open forest and 2 hectares of moist open forest would be removed from the study area. The potential impacts of habitat modification and fragmentation on each terrestrial vertebrate class are discussed below.

i. Amphibians and Reptiles

Areas of suitable habitat for amphibians within the study area are likely to be in close vicinity of the ephemeral watercourses and dams. The proposed quarry expansion would not encroach upon the ephemeral drainage lines south of the ridge. However, it would remove approximately eight hectares from the catchment area of Bungwahl Creek (ie. four hectares removed from the two northern ephemeral creeks). One small artificial dam within the existing quarry area would also be removed.

The proposed quarry extension is expected to cause rapid displacement of a variety of common reptile species within the 1.7 hectares of forest to be cleared for the asphalt batching plant and expanded stockpile area. Reptile species would also be progressively displaced from the remainder of the quarry expansion area over a 66 year period (expected life span of the quarry).

The proposed revegetation program would ensure that suitable aquatic vegetation and sheltering resources would be provided in and around existing dam sites to provide some compensatory habitat for these species.

ii. Avifauna

The proposed quarry extension would result in the relatively small loss of habitat for most of the bird species known to occur in the study area. A small proportion of hollow resources would be lost for those bird species capable of utilising small hollows. The proposed development would result in a relatively small extension of edge effect influences into previously unaffected forest areas. The extension of edge effects may lead to changes in bird species composition by creating habitats that favour species with excellent dispersal abilities capable of invading and colonising disturbed habitats (Goosem & Marsh 1997; Laurance 1997; Andrews 1990).

Studies have shown that increased forest edges can potentially increase the rates of nesting failure for some species due to nests being more accessible to predators (eg. currawongs) or nest competitors (eg. cuckoos) (Andrews 1990). Conversely, a study by Taylor and Ford (1998) found that there was no significant increase in the rate of

predation between artificial nests placed near the edges of woodland and artificial nests placed in the centre of fragment habitat. Nevertheless, further research of this issue is required in Australia, hence increases in nesting failure due to edge effects may still be a significant impact depending on the bird species, habitat type and size of remnant vegetation.

iii. Non-flying Mammals

The proposed quarry extension would remove nectar resources for arboreal species, and hollow resources for those species capable of utilising small hollows. Very few large hollows would be removed. The proposal would also remove ground hollow resources for small terrestrial mammals, as well as a small proportion of larger ground hollows used by medium to large terrestrial mammals.

The proposed quarry extension is likely to displace some small terrestrial mammal species with relatively small home ranges. However, the proposed revegetation east of the study area would most likely provide some compensatory habitat for these species. It is recommended that suitable sheltering resources be placed within the proposed revegetated corridor to encourage recolonisation by displaced individuals.

The encroachment of edge effects into previously undisturbed forest areas may cause permanent displacement of some forest species by more competitive edge specialist species. A study by Goosem and Marsh (1997) found that edge effects associated with fragmentation caused by a powerline through tropical rainforest enabled grassland specialist species (*Melomys burtoni* and *Rattus sordidus*) to replace rainforest specialist species (*Uromys caudimaculatus* and *Melomys cervinipes*) within the easement and adjacent forest areas. However, due to the current level of disturbance and open nature of the vegetation communities in the study area such effects are not expected to be significant.

iv. Megachiropteran and Microchiropteran Bats

All habitats within the study area are likely to represent foraging habitat for bats, particularly microchiropteran species. The proposed quarry extension has the potential to cause a very slight reduction in foraging resources for open forest/woodland foragers.

The open forest types in the study area contain a moderate abundance of small tree hollows and bark shedding tree species. The proposed quarry extension would result in the loss of sheltering habitat for those species that utilise tree hollows and shedding bark for roosting purposes.