Noise and Vibration Assessment

Appendix H

Environmental Acoustics Assessment
Munmorah Power Station Rehabilitation EA
Delta Electricity

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aurecon

Document prepared by:

Aurecon Australia Pty Ltd
ABN 54 005 139 873
116 Military Road
Neutral Bay
New South Wales 2089 Australia

T: +61 2 9465 5599
F: +61 2 9465 5598
E: sydney@ap.aurecongroup.com
W: aurecongroup.com

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aurecon

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1. Introduction and Background

1.1 Introduction

The Delta Electricity's Munmorah Power station located on the NSW Central Coast near Doyalson was constructed as a 1,400MW four unit coal fired power station in 1967. Units one and two ceased operating in the early 1990s, while units three and four have continued to generate electricity in the National Electricity Market (NEM).

Delta Electricity is proposing to rehabilitate the unit three and four generating plant to replace worn and obsolete components with the currently available technology. The purpose of the rehabilitation is to improve the reliability and efficiency of the generating units, returning unit output to the original 350MW such that they are able to continue to generate electricity for the NEM in the short to medium term (up to 20 years) while reducing the carbon footprint per unit of electricity generated.

Noise generated by the refurbished plant is a key environmental issue raised in the Director General's Requirements (DGRs). This report details the noise assessment conducted to predict the effect of the refurbished plant on the noise levels in the surrounding environment and addresses the Key Assessment Requirements.

1.2 Background

The location of Munmorah Power Station and Munmorah – Vales Point (MV) coal conveyor can be seen in Figure 1.1.

The proposed rehabilitation of the power station will not involve any significant changes to the current layout of the site as the majority of the works will occur within the existing plant area. The rehabilitation works are largely concerned with the upgrade of worn components and outdated technology. In addition to the rehabilitation of the plant, it is proposed that the MV conveyor is also rehabilitated and replaced with a new conveyor.

Many aspects of the power station operations, such as the fabric filters, flue gas and cooling water systems will not be affected by the proposed rehabilitation. Accordingly, the environmental impacts associated with these aspects of the plant would not alter the currently approved operations.

The proposed rehabilitation will involve the following changes:

- Main steam turbine upgrade
- Circulating water system debris filter and ball cleaning system upgrade
- Attemperation pump rehabilitation
- Feed pump upgrade
- Replacement of existing auxiliary cooling water system arrangement
- Air heater upgrade
- Economiser upgrade
- Furnace rehabilitation
- Increase capacity of the MV conveyor or alternative fuel delivery arrangement
- Upgrading of the electrical and controls system
- Other minor rehabilitation or upgrades to related ancillary plant and equipment

The proposed upgrade of the MV coal will largely follow the current conveyor route, deviating slightly on parts of Delta land. Technical studies for the development of the new conveyor show that it is likely that some transfer stations can be eliminated which will reduce noise emissions when compared to the existing conveyor. The preferred conveyor option is driven from the head–end and tail–end and therefore does not incorporate a mid–section drive minimising the environmental noise impact to surrounding residents adjacent to the conveyor route.

It is understood that the plant will be designed to be "carbon capture ready" as part of the rehabilitation. At this stage, final preferred technology and configuration are still unknown; therefore accurate sound power level data for this equipment is not available. A detailed assessment of the noise emissions from this equipment will be conducted during the design stages of the project to ensure that noise emissions from the Carbon Capture Plant will not lead to exceedances of the developed project specific noise goals.

Figure 1.1 – Location of rehabilitation site and conveyor

2. Regulations and Standards

2.1 Construction noise

The NSW Department of Environment, Climate Change and Water (DECCW) have published Interim Construction Noise Guidelines in 2009 which specify allowable noise emissions from construction works.

The standard hours of operation for the construction works are specified as follows:

Monday to Friday: 7.00am to 6.00pm

Saturdays: 8.00 am to 1.00pm

No work is to be conducted on Sundays or public holidays.

During the standard hours of operation, the Interim Construction Noise Guideline specifies that the predicted noise level at a noise sensitive receiver (residential) should be less than the noise management level ($L_{Aeq15\ min}$). The noise management level is calculated based on the Rating Background Level (RBL) + 10 dBA. The rating background level is based on noise survey data, collected in accordance with the procedures defined in the NSW Industrial Noise Policy.

The Noise Management Level for construction outside of these standard hours is calculated based on RBL+5dBA

Noise monitoring has not been conducted by Aurecon for this stage of the project as comprehensive monitoring has recently been conducted at Munmorah Power Station in relation to the development of the Colongra Gas Turbine Power Station (also known as Munmorah Gas Turbine) and the Noise Management Plan for the existing Munmorah Power station; this information has been used to develop noise criteria for the proposed rehabilitation.

2.2 Existing environment

Wilkinson Murray acoustic consultants were commissioned to conduct a noise assessment for the proposed Munmorah Gas Turbine Facility by Parsons Brinkerhoff in 2005 (Wilkinson Murray, 2005). As part of the assessment, unattended noise monitoring was conducted at four indicative sites from 19 to 29 August 2005. The locations of the monitoring can be seen in Figure 2.1, with the results from noise monitoring given in Table 2.1.

Approximate distances between the power station and the nearest sensitive receivers are shown in Table 2.2.

The noise monitoring equipment used for these measurements consisted of environmental noise loggers set to A-weighted, fast response, continuously monitoring over 15-minute sampling periods. The equipment calibration was checked before and after the survey and no significant drift was noted. Data with extraneous wind and periods of rainfall have been excluded from the data in accordance with the INP.

Definitions and methods for calculating the Rating Background Level (RBL) and Assessment Background Level (ABL) can be found in the INP.

Table 2.1 – Previous unattended noise monitoring results (Wilkinson Murray, 2005)

Noise catchment area	Noise monitoring location	Rating background noise level RBL (dBA)			Lowest ABL (dBA)
		Day	Evening	Night	
A	14 Kamilaroo Ave, Lake Munmorah	38	38	37	35
B	127 Woolana Rd, Budgewoi	36	33	34	32
C	32 Barega Cl, Buff Point	37	40	36	33
D	83 Perouse Ave, San Remo	39	38	34	33

Where: Day: 7.00am to 6.00pm
Evening: 6.00pm to 10.00 pm
Night 10.00pm to 7.00am

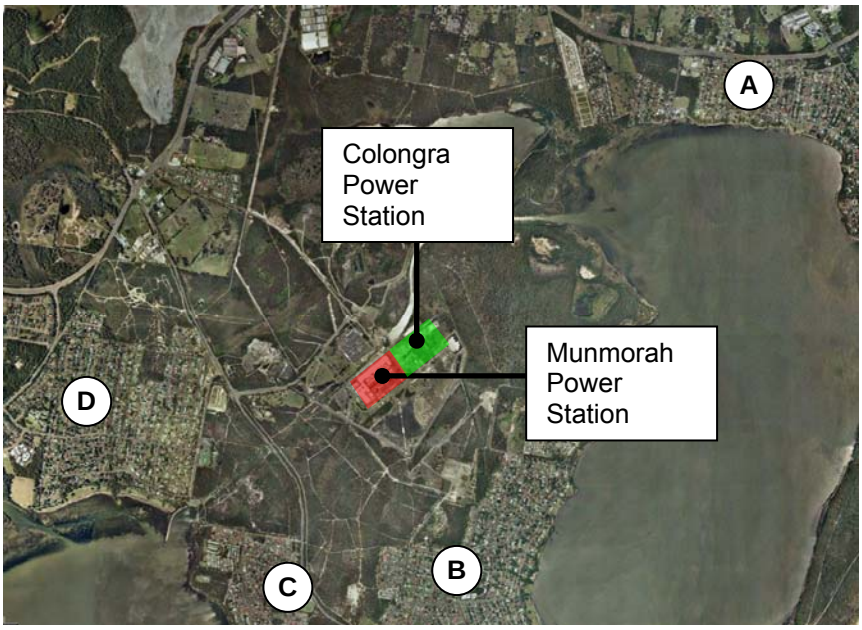


Figure 2.1 – Locations of previous unattended noise monitoring

Table 2.2 – Distance to Colongra gas turbine site (Wilkinson Murray, 2005)

Noise catchment area	Noise monitoring location	Approximate distance to Colongra gas turbine site
A	14 Kamilaroo Ave, Lake Munmorah	2.8 km
B	127 Woolana Rd, Budgewoi	1.2 km
C	32 Barega Cl, Buff Point	1.5 km
D	83 Perouse Ave, San Remo	1.4 km

2.3 Construction noise criteria

Based on the Wilkinson Murray monitoring results, the construction noise management levels in are calculated. Although the monitoring was conducted for the Colongra gas turbine project, it is proposed that these criteria can be directly applied to the Munmorah Power Station Rehabilitation project due to the proximity between the two sites.

As the proposed construction (rehabilitation) period will be greater than three weeks, a quantitative noise assessment is required under the Interim Construction Noise Guidelines. The quantitative noise assessment involves the evaluation of likely construction activities and the prediction of the noise level from the activities at the sensitive receivers surrounding the activity.

As the development of construction noise emissions criteria are based on previous noise monitoring not specific to the Munmorah rehabilitation project, it is proposed that the strictest of the calculated noise management levels established for the Colongra gas turbine project be used to provide a conservative assessment. It is therefore proposed that the following noise limits shall be used for the construction noise assessment:

Standard hours: $L_{Aeq\ 15min}$ **46 dBA**
Outside of standard hours: $L_{Aeq\ 15min}$ **39 dBA**

Table 2.3 – Construction noise management levels

Noise catchment area	Construction Noise Management Levels $L_{Aeq15min}$ dBA	
	Standard hours (Day RBL + 10dBA)	Outside of standard hours (Night RBL + 5dBA)
A	48	42
B	46	39
C	47	41
D	49	39

2.4 Construction and Operational Vibration Criteria

Acceptable levels of vibration are set out by the NSW DECCW in their Guideline *Assessing Vibration* (February 2006) (Ref 9). The guideline gives recommendations regarding the preferred and maximum allowable vibration levels in three axes for human comfort in building interiors.

An excerpt from the guideline is shown in Table 2.4. It should be noted that the allowable levels are only specified in the 1 – 80 Hz frequency region.

The German Standard DIN 4150 1999-02 gives guidelines for allowable levels of vibration for building structures to minimise superficial damage. Long term periods of vibration may lead to damage to building structures (either superficial or structural) and should therefore be kept within allowable limits. If the limits for superficial damage specified in DIN4150 are adhered to, it is highly unlikely that structural damage will occur. A summary of the allowable vibration levels is provided in Table 2.4.

When reviewing the vibration criteria, it is important to note the difference in units – the DIN standard specifies vibration in terms of velocity across all frequencies, whereas the NSW DECCW guideline specifies vibration in terms of acceleration in the frequency range of 1 – 80 Hz only

Table 2.4 – Allowable vibration acceleration levels 1–80 Hz (DECCW website)

Location	Assessment Period	Preferred Values m/s^2		Maximum Values m/s^2	
		Z Axis	X and Y Axis	Z Axis	X and Y Axis
Continuous vibration					
Residences	Daytime	0.01	0.0071	0.02	0.014
	Night–time	0.007	0.005	0.014	0.01
Offices, schools, educational institutions and places of worship	Daytime or Night–time	0.02	0.014	0.04	0.028
Impulsive vibration					
Residences	Daytime	0.3	0.21	0.6	0.42
	Night–time	0.1	0.071	0.2	0.14
Offices, schools, educational institutions and places of worship	Daytime or Night–time	0.64	0.46	1.28	0.92

Table 2.5 – DIN Vibration level recommendations (DIN 4150 1999-02)

Line	Type of Structure	Guideline values for velocity V_i in mm/s			
		Vibration at the foundation at a frequency of			Vibration at horizontal plane of highest floor for all frequencies
		1Hz to 10Hz	10Hz to 50Hz	50Hz to 100Hz*	
1	Buildings used of commercial purposes, and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design or occupancy	5	5 to 15	15 to 20	15
3	Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2 and are of great intrinsic value (eg listed buildings under preservation order)	3	3 to 8	8 to 10	8

(*)At frequencies above100Hz, the values given in this column may be used as minimum values

2.5 Operational Noise Criteria

The existing Munmorah Power Station Noise Management Plan, developed by Parsons Brinckerhoff in September 2008 for Delta Electricity (Parsons Brinckerhoff, 2008) specifies allowable noise emissions for the existing plant. The rehabilitated plant will be required to comply with the noise emission targets of the existing plant.

The operational noise criteria developed by Parsons Brinckerhoff are based on site specific noise monitoring conducted for a sufficient period so as to characterise the local noise environment. This allows the noise emissions criteria from the project to take emissions from adjacent industry and noise sources into consideration and minimise the risk of noise creep (gradual increase of ambient noise levels in an area due to additional developments).

2.5.1 Existing environment

Unattended noise monitoring was conducted by Parsons Brinckerhoff to determine the existing noise levels and to develop operating noise criteria as part of the Munmorah Power Station Noise Management Plan at the nearest sensitive locations to the boundary of the plant. The distances between the plant and the monitoring sites can be seen in Table 2.6 (Parsons Brinckerhoff, 2008) and Figure 2.2.

The noise survey noted that noise generated by the power station was inaudible at the measurement sites during the daytime due to the influence of local noise sources (eg the Central Coast Highway, local fauna, residential activity and aeroplanes) however measurements taken at night-time indicated that the noise from the power station was audible during periods of low background noise.

The Parsons Brinckerhoff Noise Management Plan did not develop Rating Background Levels for the noise survey data as specified in the New South Wales Industrial Noise Policy. A summary of the data can be seen in Table 2.7.

Table 2.6 – Location of noise monitoring sites (Parsons Brinckerhoff, 2008)

Location	Direction	Distance to Plant
Mackleay Drive (Sunnyvale Caravan Park), Halekulani	East	1.5 km
Kalele Avenue, Halekulani	South–East	1.1 km
Alpine Avenue, San Remo	West	1.0 km

Table 2.7 – Unattended noise measurements 10 – 17 September 2008 (Parsons Brinckerhoff, 2008)

Location	L_{Aeq} dBA			L_{A90} dBA		
	Day	Evening	Night	Day	Evening	Night
Macleay Drive (Sunnyvale Caravan Park), Halekulani	49	41	44.5	35	35	35
Kalele Avenue, Halekulani	61.5	51.5	50	38	38	39
Alpine Avenue, San Remo	60	55	49.5	44.5	42.5	34.5

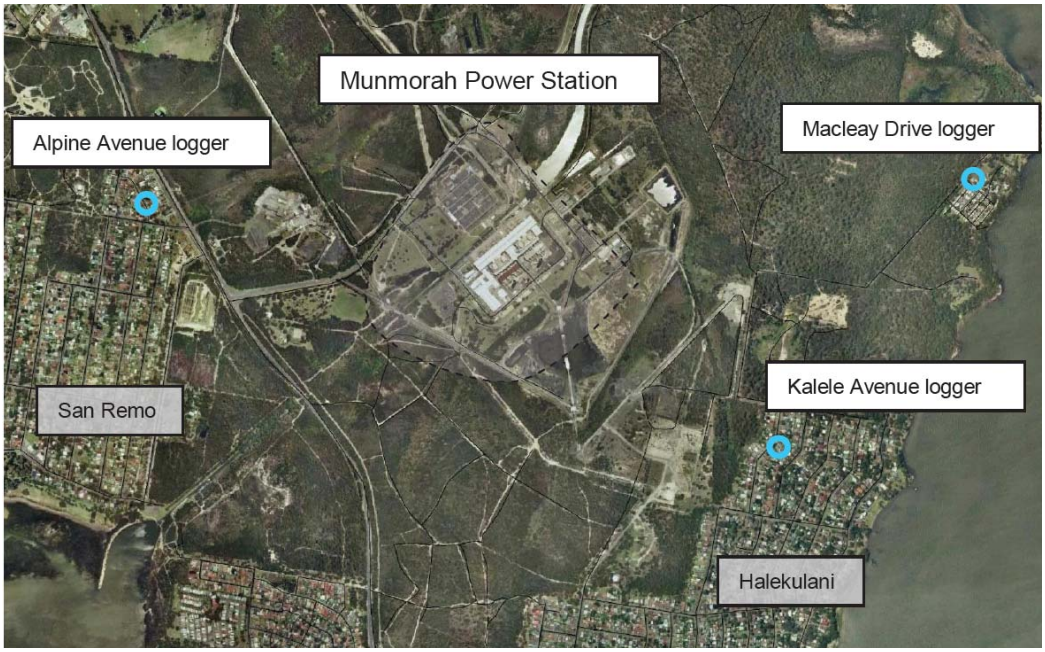


Figure 2.2 – Location of unattended noise monitoring (Parsons Brinckerhoff, 2008)

2.6 Regulations

The NSW Industrial Noise Policy sets out two criteria that are used to assess potential off site noise levels. The first aims to control intrusive short–term noise levels for residences (intrusive criterion), while the second aims to maintain the long term amenity of particular land uses (amenity criterion). The more conservative of the two limits is established as the project–specific operational noise goal.

- The relevant intrusive criterion can be summarised as follows:

  $L_{Aeq(15\ min)} \leq$ RBL + 5 dBA
- The amenity criterion is determined based on guidelines presented in the INP (EPA 2000). The acceptable amenity limits for an urban area are listed in Table 2.8.

The amenity criterion is established with reference to the L_{Aeq} noise levels for the area and the existing industrial noise influence. The amenity criterion is then corrected with reference to Table 2.2 of the INP.

A background noise level of 33 dBA L_{A90} was adopted in the Parsons Brinckerhoff Noise Management Plan (Parsons Brinkerhoff, 2008) for the most sensitive night time period for the determination of the intrusive operational noise goals. This was based on the minimum background noise level measured over the noise survey period. It is important to note that the short term L_{A90} descriptor should not be interchanged with the averaged RBL (the calculation procedure of which is described in the NSW INP) therefore criteria based on this measurement are not strictly adhering to the NSW INP.

Monitoring conducted by Wilkinson Murray for the Colongra Gas Turbine Facility (Wilkinson Murray, 2005) showed a night time RBL of 34 dBA for sites B and D (see
Table 2.1), therefore the adoption of an RBL of 34 dBA is seen to be the correct measurement to determine the allowable operational noise emissions.

Table 2.8 – NSW INP amenity criteria – suburban environment

Type of receiver	Period of day/day of week	Acceptable noise level (L_{Aeq} dBA)	Recommended Maximum Noise level (L_{Aeq} dBA)
Residential – daytime	7 am to 6 pm, Monday to Sunday	50	55
Residential – evening	6 pm to 10 pm	45	50
Residential – Night time	10 pm to 7 am	40	45
Industrial premises	When in use	70	75
Urban/Industrial Interface – Daytime	7 am to 6 pm, Monday to Sunday	65	70
Urban/Industrial Interface – Evening	6 pm to 10 pm	55	60
Urban/Industrial Interface – Night time	10 pm to 7 am	50	55

Based on the noise survey results and the procedure described in the INP, the following criteria are developed for the site:

Amenity night–time goal:

Acceptable: 40 dBA $L_{Aeq\ 15min}$

Maximum: 45 dBA $L_{Aeq\ 15min}$

Intrusive night–time noise goal: 39 dBA $L_{Aeq15\ min}$

The night–time intrusive criterion is the most conservative of the noise goals and as such should be adopted as the project specific design noise goal.

To assess the cumulative impacts from surrounding noise sources (such as the adjacent Colongra Power Station), the Amenity criteria should apply.

Project specific design noise goal: 39dBA $L_{Aeq\ 15min}$

As the plant is expected to be a continuous operation, it is considered that where compliance with the night time noise goal is achieved, relevant day time and evening goals would also be met.

At the power station boundary, noise levels should not exceed 70 dBA (Table 1.8) to maintain the acoustic amenity of the surrounding environment.

Predicted noise emission levels should be corrected for annoying characteristics (tonality, impulsiveness, low frequency noise, intermittent noise, etc) as recommended in the INP, up to a maximum of 10 dBA.

It should be noted that the NSW INP has specific criteria for existing industrial premises, covered in Section 10 of the Policy. This section may be used where the industrial noise source was designed to achieve a higher noise criterion than that provided in the current INP. In reviewing this section, it is noted that if an industrial facility is found to be in excess of the applicable project specific design noise goal, a schedule of possible mitigation measures to be implemented should be developed and incorporated into an agreed pollution reduction program.

Although the project is a rehabilitation of an existing facility, it is proposed that an aim of the project should be to achieve the project specific design noise goal (39 dBA) as calculated by the procedure specified by the INP. However as significant portions of the existing facility will be maintained as part of the rehabilitation, and that a large amount of the equipment being replaced will be highly specialised (eg the replacement of the fan blades), obtaining accurate information regarding the noise emissions from this equipment may be difficult. For this reason, it is proposed that all feasible and practical measures be taken at the design stage to ensure that operational noise emissions from the site achieve the project specific noise goal of 39 dBA. Noise monitoring will be conducted at part of the commissioning stage of the project. If commissioning noise monitoring shows that noise emissions from the Munmorah Power Station at the nearest receiver exceed 39 dBA, a schedule of possible mitigation measures to be implemented will be developed and incorporated into an agreed pollution reduction program to reduce noise emissions to the project specific noise goal of 39 dBA.

2.7 Director General's and Department of Planning Requirements

A summary of the Director General's and the Department of Planning requirements is reproduced below.

- Operational noise impact under worst case operating scenarios and meteorological conditions
- Cumulative impact from Munmorah (Colongra), Vales Pt and Eraring Power Stations
- Vales Point to Munmorah Power Station Conveyor
- Low frequency noise
- Peak noise impacts – Sleep disturbance
- Construction noise in accordance with DECC construction noise guideline
- Vibration from construction and operation
- Traffic generated during construction and operation in accordance with ECRTN

3. Assessment

3.1 Construction noise

At this stage, exact construction details are still being finalised, however it can be assumed that the total construction period shall be greater than three weeks. For this reason, a quantitative construction noise assessment is required.

Heavy construction is not expected to be required as the project largely involves rehabilitation or replacement of existing plant and control systems, and therefore the impact from construction noise on nearby residents is expected to be minimal. Typical construction noise sources will include the following:

- Traffic noise relating to equipment transport trucks
- Operation of mechanical equipment such as cranes, oxyacetylene equipment and loaders for dismantling the turbine and new turbine installation
- Other on-site equipment maintenance

There will be variable noise levels depending on the stage of the works, however potential construction noise impact is considered to be minimal as the main construction activities will be conducted within the existing plant area. The existing overhead crane within the turbine hall building will be used for much of the heavy lifting associated with removing and replacing plant. The turbine hall will also provide some attenuation for the construction noise.

For the purposes of this assessment, construction noise source sound power levels have been taken from the NSW RTA Environment Noise Management Manual V1.0, supplemented by additional information as required.

The nearest residential receiver is located to the west of the plant, approximately one kilometre from Munmorah Power Station. Table 3.1 below provides example construction activities and the associated sound pressure levels at various distances from the noise source. Note that these levels are indicative only; a detailed assessment of noise emissions from specific items of equipment should be conducted as part of the Construction Noise Management Plan.

Table 3.1 – Predicted construction sound pressure levels

Item of Equipment	Noise Criteria dBA $L_{Aeq\ 15\ min}$		Sound Power Level dBA	Predicted Sound pressure level at distance dBA					
	Standard hours	Outside standard hours		10m	50m	100m	500m	1km	1.5km
Scraper	47	39	110	82	68	62	48	42	38
Bulldozer			110	82	68	62	48	42	38
Grader			109	81	67	61	47	41	37
Front end loader			110	82	68	62	48	42	38
Vibrating roller			107	79	65	59	45	39	35
Backhoe			108	80	66	60	46	40	36
Excavator			105	77	63	57	43	37	33
Compressor			100	72	58	52	38	32	28
Concrete vibrator			112	84	70	64	50	44	40
Concrete pump			109	81	67	61	47	41	37
Dump truck			108	80	66	60	46	40	36
Water tanker			109	81	67	61	47	41	37
Compactor			110	82	68	62	48	42	38
Concrete saw			118	90	76	70	56	50	46
Transport Truck			108	80	66	60	46	40	36

3.1.1 Construction noise mitigation

The staging, timing and detail for the construction activities will be determined at the detailed design stage of the project by the appointed design and construction contractor for the project. However, based on the predicted sound pressure levels at one kilometre, the majority of activities will meet the standard construction noise criterion. Consideration of the construction methodologies will be required to control construction noise emissions in the event that non–standard working hours are proposed.

Best practice construction methodologies should be implemented to minimise environmental noise emissions from the construction activities. Such methodologies should include but are not limited to:

- Minimising tonal reversing alarms with the implementation of broadband reversing alarms
- Using a “forward working procedure” minimising reversing trucks, forklifts etc, wherever possible
- Using low noise construction practices where possible
- Locating noisy machinery as far from sensitive receivers where possible
- Using existing topology and buildings on site as noise barriers between noise sources and sensitive receivers
- Consideration of noise emissions from heavy vehicle routes delivering equipment to site and removing waste from site to sensitive receivers
- Limiting noisy activities to daytime hours where possible

A Construction Noise Management Plan would be developed when details of the construction activities are finalised. The construction noise management plan would need to address the requirements outlined above.

3.2 Construction Vibration

Vibration levels are dependent on both the source level and the transmission path attenuation. Increased distance and higher levels of ground attenuation will reduce the impact on sensitive receivers. A detailed geological survey has not been completed to determine ground attenuation for the prediction of vibration levels, however, the RTA Environmental Noise Management Manual (ENMM) gives estimations of the vibration levels of various items of equipment. This information has been reproduced in Table 3.2

Considering the category of “dwellings” under the DIN4150 Standard, the maximum allowable vibration velocity is 5 mm/s (seen in Section 11.4). This value is to be measured in the horizontal plane of the highest floor of the building. It is expected that some attenuation will be provided due to the connection between the building structure and the ground.

In addition, British Standard BS7385 for cosmetic damage, and BS6472 for human response provide recommendations concerning the safe working distances between vibration sources and various receivers. Based on this information, the safe working distances shown in Table 3.3 should be met to avoid adverse comment from residents and or cosmetic damage to buildings. It should be noted that these distances may differ based on the equipment specific vibration levels and the site specific geological conditions, for this reason, the distances should be taken as indicative only.

Given that the closest residence is approximately one kilometre from the proposed rehabilitation site, any vibration impact on the residence is expected to be negligible.

Table 3.2 – Example equipment and activity generated vibration levels (RTA ENMM 2001)

Item	Vibration Levels peak Particle Velocity at 10 m (mm/s)
Loader Breaking Kerbs	6–8
15 Tonne Roller	7–8
7 Tonne Compactor	5–7
Roller	5–6
Pavement Breaker	4.5–6
Dozer	2.5–4
Backhoe	1
Jackhammer	0.5

Table 3.3 – Safe working distances for vibration equipment

Plant Item	Rating/description	Safe Working Distance	
		Cosmetic damage (BS7385)	Human Response (BS6472)
Vibratory Roller	<50 kN (typically 1-2 tonnes)	5 m	15 m to 20 m
	<200 kN (typically 4 – 6 tonnes)	12 m	40 m
	<300 kN	25 m	100 m
Medium Hydraulic Hammer	900 kg (12 – 18 tonnes excavator)	7 m	23 m
Large Hydraulic Hammer	1600 kg (18 – 34 tonnes)	22 m	73 m
Vibratory Pile Driver	Sheet piles	2 to 20 m	20 m
Pile boring	<800 m	2 m	N/A
Jackhammer	Hand held	1 m	Avoid contact with structure

3.2.1 Construction vibration mitigation

Predicted vibration levels from the construction activities of the rehabilitation project are expected to be significantly below the relevant allowable criteria and therefore no specific construction vibration mitigation is required. It is recommended however, that best practice methods are employed to mitigate any possible impacts.

3.3 Operational Noise

The proposed project involves the rehabilitation of an existing facility where worn and technically obsolete equipment is refurbished or replaced. Generally this kind of rehabilitation will lead to a decrease in the operational noise emissions from a development to the surrounding environment. This section assesses the individual proposed upgrades with respect to predicted noise emissions relative to the existing.

Noise from the power station is primarily from three sources:

- Air intake
- Noise from turbine/generator hall (including steam driven air ejectors)
- Noise from exhaust stack

It is understood that a redesign of the stack particulate sampling system may be conducted as part of the rehabilitation to ensure that sampling methods comply with the standard testing methodology. This may involve the redesign of the fabric filter ductwork which may impact stack noise emissions. At this stage, any new stack particulate sampling system is at concept design stage, and therefore acoustic design of silencers etc has not been conducted. A detailed assessment of stack noise emissions will be conducted at the detailed design stage to ensure that

noise emissions comply with the developed noise criteria.

In addition, noise is also generated by the MV coal conveyor. The route of the conveyor remains essentially unchanged and therefore the noise impacts from the conveyor are expected to be reduced. If technically feasible, some of the existing transfer stations may be eliminated with slight deviations from the existing conveyor route, further reducing conveyor noise. The operating hours of the conveyor are not proposed to be altered.

The three main noise generating items of equipment are currently operating on site, and no significant changes to the equipment sound power levels are expected. The Parsons Brinkerhoff Noise Management Plan developed for the Munmorah Power station in September 2008 (Parson Brinckerhoff, 2008) conducted short–term, attended noise monitoring between 11.40pm and 12.30 am on the eastern, south eastern and western boundaries of the power station to assess the existing environmental noise emissions. The noise survey results are summarised in Table 3.4. It is noted that the measurements were taken at night time, when minimal extraneous noise sources were present, and the noise emissions from the power station were discernable from ambient noise during periods of low background noise.

A review of the historical operational data of the power station revealed that both turbines were operational during measurements, with a combined power generation of 480MW. A review of the meteorological conditions (measured at the on site weather station) was conducted for the period in which noise levels were measured. Meteorological conditions affect noise levels, especially due to wind effects and temperature inversion. The review indicated a high likelihood of temperature inversion conditions at the time of measurement. Note that in Table 3.4. Stability Class A covers moderate wind conditions and Stability Class F refers to temperature inversion conditions.

The total output of the current plant is 600 MW, therefore the plant was operating at approximately 80% capacity during the noise survey.

Current noise emissions from the site, measured at the residential receivers during the worst case (temperature inversion) conditions, are marginally compliant with the noise goals, and the sound power levels of the equipment after the proposed rehabilitation to the facilities are expected to be equal to, or below the current levels. The predictions of operational noise have been calibrated to the existing measured noise levels.

Table 3.4 – PB noise survey results (PB 2008)

Receiver	Munmorah Power Station	
	Stability Class A Power Station Influence (dBA)	Stability Class F Power Station Influence (dBA)
Alpine Ave	<45 (inaudible)	40-42
Kalele Ave	<37 (inaudible)	39-40
Sunnyvale Caravan Pk	<36 (inaudible)	38-39

3.4 Traffic Noise Assessment

An assessment of the possible impacts from traffic movements through the construction period and operations following rehabilitation has been conducted to determine the effect of traffic noise on sensitive receivers.

The site is accessed via The Central Coast Highway, which from previous traffic flows recorded for the Colongra Gas Turbine Environmental Assessment (Parsons Brinckerhoff 2008), has an average weekday traffic volume of approximately 13,000 vehicles (combined north and southbound traffic).

For assessment against the Environmental Criteria for Road Traffic Noise (ECTRN) the road has been classified as freeway/arterial road due to the characteristically heavy and continuous traffic flows.

An assessment of existing road traffic noise has not been conducted at this stage, however the ECTRN recommends target noise levels of 60 dBA (LAeq15hr) for the daytime period and 55 dBA (LAeq9hr) for the night time period for residential receivers adjacent to existing freeway/arterial roads and that noise arising from traffic generated by a development should not increase existing noise levels by more than 2 dBA. In all cases, traffic arising from the development should not lead to an increase in existing noise levels of more than 2 dBA.

The operation of the proposed development is not expected to create additional traffic flows to the area, however additional heavy vehicle access is expected to be required during the construction phase.

3.4.1 Construction Traffic

It is expected that the potential traffic impacts would primarily occur during the construction phase of the project where heavy vehicles may be used to transfer goods to and from the site. Construction traffic may temporarily impact normal traffic flow, however based

on the construction traffic estimates, potential impacts on the local traffic conditions are likely to be extremely low.

Construction staff travelling to and from the site would occur during peak hours in the early morning and afternoon. The indicative average workforce numbers at any time during the rehabilitation programme would be in the order of 100 employees.

This represents an insignificant increase in overall traffic volumes on the Central Coast Highway and will lead to minimal noise increase. Construction traffic noise impacts would be mitigated by limiting heavy vehicle movements to the daytime period, where practicable. These issues would be addressed in detail in the construction noise and vibration management plan.

3.4.2 Operational Traffic

Traffic associated with the operation of the plant is expected to be similar to existing operations, as the workforce is expected to be effectively the same. As no coal would be transported by road, there would be a slight reduction in heavy vehicle movements and hence noise from such operations, as this has occurred in the past.

As there is no increase in operational vehicle numbers, the predicted operational traffic noise emissions of the proposed plant will be equivalent to, or slightly reduced in comparison to the existing emissions. Parking of staff vehicles occurs on site which is significantly removed from adjoining residential receivers.

4. Operational Noise Predictions

SoundPLAN Version 6.5 was used to predict the noise emissions from the site in order to assess the noise emissions against the applicable criteria. As the majority of the equipment on site will be retained in the refurbished plant, sound power levels of the existing plant were used as a basis of the computational noise model. The predicted noise emissions from the two power stations were calibrated against the previous noise studies for the plants, for both neutral and adverse meteorological conditions, with agreement between the predictions generally within +/- 3dBA at the sensitive residential receivers.

In addition to prediction of noise emissions from the Munmorah Power Station, noise emissions from the adjacent Colongra Gas Turbine facility were incorporated into the simulation in order to assess the cumulative impact of the two industrial sources. Vales Point Power Station has not been included in the simulation due to the large separation distance between the two sites (approximately 6km).

A detailed three dimensional computational noise model was generated for each site which included the main noise generating sources on the sites, the surrounding buildings and terrain contours at 2 metre intervals.

The generation of the calibrated computational noise model allowed the cumulative impact of the two power station sources to be assessed against the relevant criteria under the worst case meteorological conditions.

4.1 Meteorology

4.1.1 Meteorological Data

Meteorological data from the MMPS on site weather station from 2004 was analysed to examine the incidence of two noise enhancing meteorological conditions:

- Source-receiver winds
- Temperature inversions

These conditions may increase noise levels at a receiver by up to 10 dB.

For source to receiver winds, observed meteorological data in 2004 was obtained from the Delta MMPS Weather Station. The year 2004 was deemed be a representative year for future wind conditions.

For temperature inversions, prognostic data from CSIRO's The Air Pollution Model (TAPM) was obtained for the site area during the winter months of 2004. TAPM data was deemed to be suitable for use as temperature inversions occur over long distances (>400m) and observed data at a single meteorological station will not accurately reflect the occurrence of temperature inversions.

4.1.2 Source-to-receiver winds

Source-to-receiver winds need to be assessed when wind is a feature of the site. The *NSW Industrial Noise Policy (INP) 2000* indicates that wind is a feature when source-to-receiver wind speeds below 3m/s occur for more than 30% of the time during any assessment period in any season. It can be seen from Figure 4.1 that source-to-receiver winds occur for less than 30% of the time in any of the eight intermediate cardinal directions for the representative year of 2004. Therefore, no further analysis of noise enhancing source-to-receiver winds is deemed to be necessary for this assessment.

4.1.3 Temperature Inversions

The *NSW Industrial Noise Policy (INP) 2000* states that temperature inversions are a feature of the site when temperature inversions occur for more than 30% of the winter months (June, July and August) during the night period (6pm to 7am).

The site is located in a non-arid site where rainfall typically exceeds 500mm a year. Therefore, the site is susceptible to moderate F-class Pasquill Stability Class inversions.

Figure 4.1 indicates that the moderate F-class inversions occurred for 30% of the time during the winter months of 2004. Therefore, temperature inversions should be considered in this assessment.

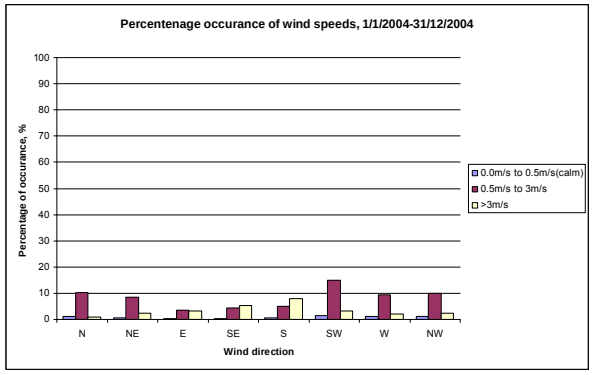


Figure 4.1 – Wind speed analysis

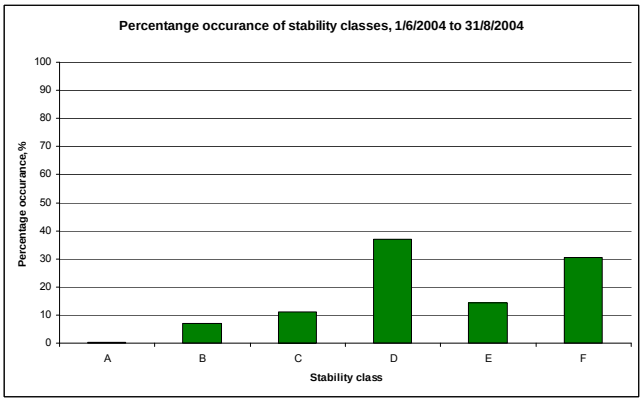


Figure 4.2 – Temperature inversion analysis

A moderate F-class inversion incorporates a 3 °C/100 m temperature inversion for all receivers, plus a 2 m/s source-to drainage-flow wind which is the localised drainage of cold air under the influence of the local topography, and travels in one direction only (direction of decreasing altitude). The drainage-flow wind is not to be confused with gradient wind which is the regional wind determined by synoptic factors (high and low-pressure systems), and may originate from any direction. Gradient wind is not a feature of this site.

For more information regarding the local metrology, please refer to the Air Quality Assessment Report.

4.2 Computational Model

The computational noise model was developed using SoundPLAN Version 6.5, and includes the site buildings and noise sources for the Munmorah Power Station, the MV Conveyor and the Colongra Gas Turbine facility. A 450 metre × 2.4 metre noise barrier has been installed adjacent to the MV conveyor as a measure to reduce the Denman Street residents from noise which has also been included in the simulation.

The site layouts for the two power station sites were used as a template for the geometry in the simulation. The building layout for the Munmorah Site is shown below in Figure 4.3. The sensitive receivers adjacent to the site can be seen in Figure 4.4.

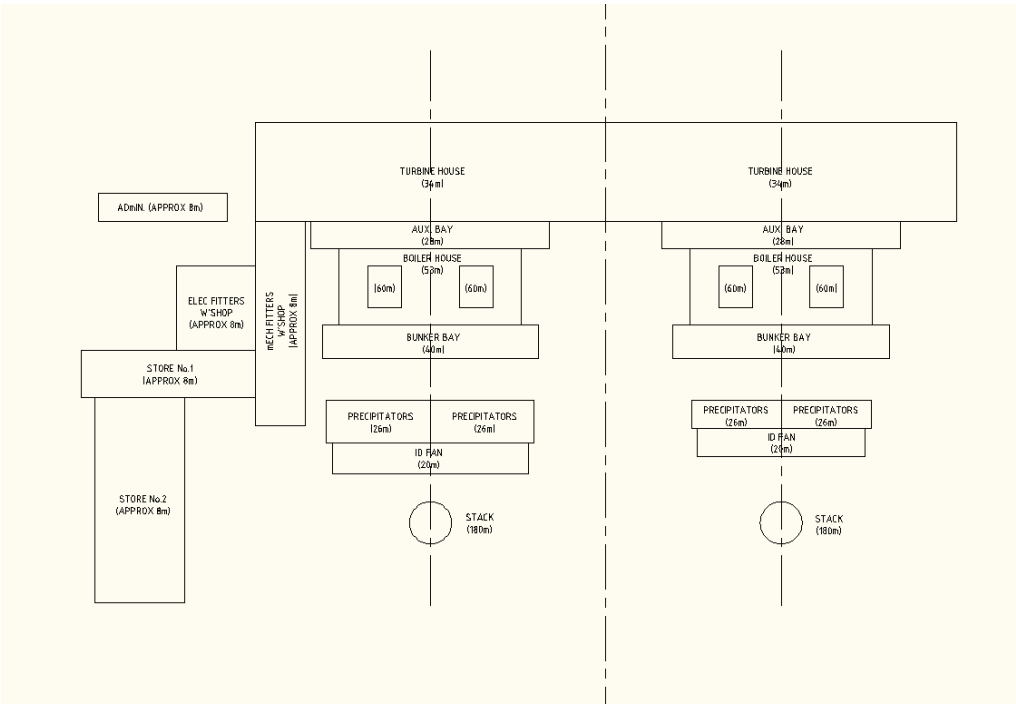


Figure 4.3– Munmorah Power Station layout and building heights

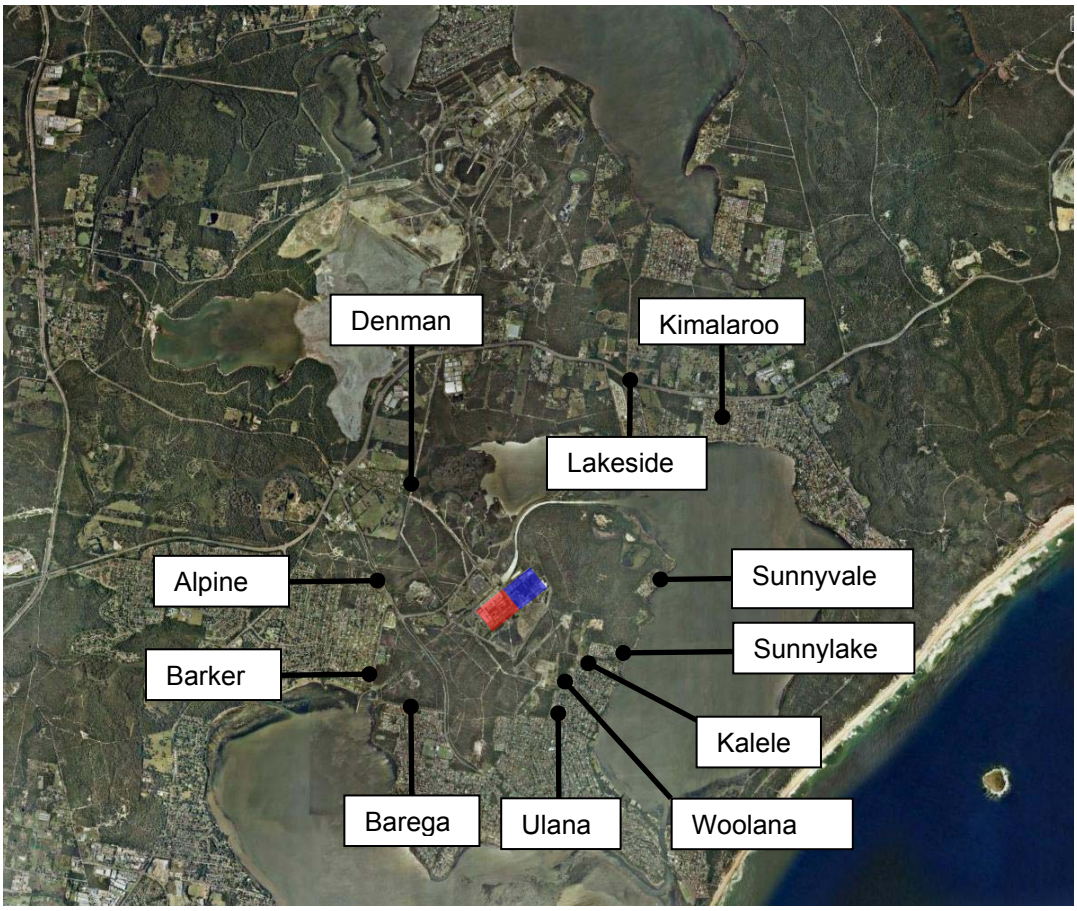


Figure 4.4 – Locations of sensitive receivers relative to site

Table 4.1 – Calibration against measured data – Munmorah Power Station

Receiver	Munmorah Power Station			
	Stability Class A		Stability Class F	
	Predicted 2009	Measured Power Station Influence (PB 2008)	Predicted 2009	Measured Power Station Influence (PB 2008)
Alpine Ave	36	<45 (inaudible)	40	40-42
Kalele Ave	39	<37 (inaudible)	44	39-40
Sunnyvale Caravan Pk	36	<36 (inaudible)	42	38-39

Table 4.2 – Calibration against previous modelling – Munmorah Power station

Receiver	Munmorah Power Station			
	Stability Class A		Stability Class F	
	Predicted 2009	Predicted (PB 2008)	Predicted 2009	Predicted (PB 2008)
Alpine Ave	36	37	40	37.5
Kalele Ave	39	40.5	44	41.5
Sunnyvale Caravan Pk	36	36	42	40

Table 4.3 – Calibration against previous modelling – Colongra Gas Turbine Facility

Receiver	Colongra Gas Turbine Facility			
	Stability Class A		Stability Class E	
	Predicted 2009	Predicted (WM 2005)	Predicted 2009	Predicted (WM 2005)
Barega CL	27	28	30	31
Barker St South	15	18	18	21
Barker St North	30	30	33	32
Denman St	27	24	29	29
Ulana Ave	31	32	34	35
Woolana Ave	33	34	36	37

4.2.1 Model Calibration

In order to quantify the accuracy of the noise model, the predicted values were compared against the measured and predicted levels developed in the Munmorah Power Station Noise Management Plan (Parsons Brinckerhoff, September 2008) and the Munmorah Gas Turbine Facility Noise Assessment (Wilkinson Murray, September 2005).Calibration of the predicted values was within agreement of +/- 3dBA of previous noise emission predictions, and compare well to previous noise monitoring conducted on site.

4.2.2 Simulation Results

Plant emissions

The noise emissions from both the Proposed Munmorah Rehabilitated Plant and the adjacent proposed Colongra plant were predicted and calibrated against previous noise emission modelling documented in the Noise Management Plant (in the case of the Munmorah plant) or the predicted noise levels as part of the Development Application (in the case of the Colongra plant). An analysis has been conducted for both the neutral (Stability Class A) and temperature inversion (Stability Class F) conditions.

Full noise contours from the simulations can be seen in the Attachment.

Table 4.4 – Munmorah Power Station predicted levels

Receiver	Criterion (dBA)	Munmorah contribution dB(A)	
		Stability Class A	Stability Class F
Alpine Ave	39	36	40
Barega Cl		32	35
Barker St South		32	36
Barker St North		37	40.5
Denman St		33	37
Kalele Ave		39	44
Kimalaroo Ave		29	34
Lakeside Village		28	32
Sunnylake Caravan Park		36	41.5
Sunnyvale Caravan Park		36	42
Ulana Ave		40	45
Woolana Ave		40	45

Table 4.5 – Colongra Power Station predicted levels

Receiver	Criterion (dBA)	Colongra contribution dB(A)	
		Stability Class A	Stability Class F
Alpine Ave	39	30	38
Barega Cl		27	35
Barker St South		15	22
Barker St North		30	37
Denman St		27	34
Kalele Ave		33	40
Kimalaroo Ave		26	34
Lakeside Village		24	33
Sunnylake Caravan Pk		29	35
Sunnyvale Caravan Pk		35	41.5
Ulana Ave		31	38
Woolana Ave		33	40

Table 4.6 – Combined Munmorah and Colongra Power station predicted levels

Receiver	Criterion (dBA)	Combined contribution dB(A)	
		Stability Class A	Stability Class F
Alpine Ave	40 – 45	37	42
Barega Cl		33	38
Barker St South		32	36
Barker St North		38	42
Denman St		34	39
Kalele Ave		40	45
Kimalaroo Ave		31	37
Lakeside Village		29	36
Sunnylake Caravan Pk		37	42
Sunnyvale Caravan Pk		38	45
Ulana Ave		41	46
Woolana Ave		41	46

Conveyor emissions

Two groups of properties are potentially affected by conveyor noise: those located along Denman Street and those located adjacent to the Pacific Highway at Doyalson Welding. The locations are identified in Figure 4.5. The properties located on Denman Street are approximately 100 metres from the conveyor, and the properties located adjacent to Doyalson welding are located approximately 200 metres from the conveyor.

Previous measurements conducted by PB for the MV conveyor surveyed two sites; 1 and 17 Denman Street between 12.00 am and 1.00 am on 14 March 2008. The measurements showed that the contributions from the MV conveyor at two sites were 39 dBA at 1 Denman Street and 44 dBA at 17 Denman Street. No previous monitoring results for the Doyalson site were available. It is understood that a noise barrier was installed adjacent to the conveyor to shield the Denman Street residences prior to the measurements.

The noise emissions to the Denman St and Doyalson receivers were calculated to assess the cumulative impact of the MV conveyor, The Munmorah Power Station and the Colongra Gas Turbine Facility.

The results from the conveyor noise predictions can be seen in Table 4.7. The results show that under neutral conditions, the predicted levels marginally comply with the maximum Amenity criterion, with exceedances expected under Adverse Conditions. The addition of a noise barrier adjacent to the Doyalson Welding site would be expected to decrease the noise emissions by 6 – 8 dBA which would reduce the noise exposure to the Doyalson site to within the maximum amenity criterion.

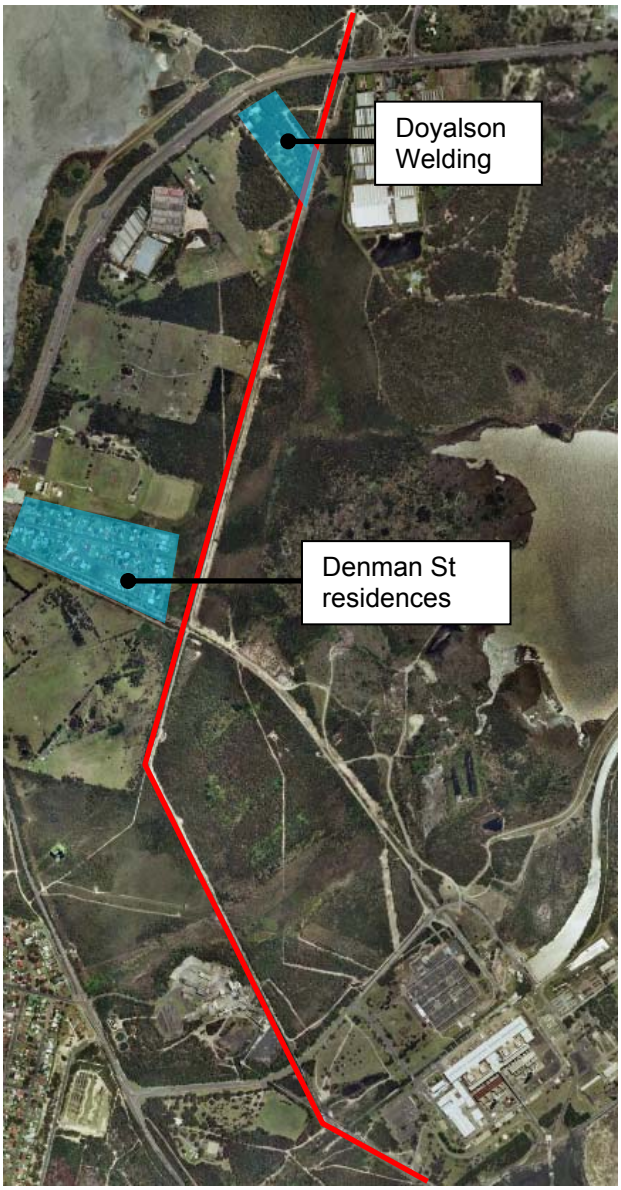


Figure 4.5 – Sites potentially affected by conveyor noise

4.2.3 Assessment of results

It can be seen from the results that the predicted noise emissions from the Munmorah Site are exceeding the night time noise criterion by up to 2 dBA during neutral and 6 dBA during adverse conditions. The inclusion of noise emissions from the adjacent Colongra Power station increases noise levels by up to 2 dBA when compared to noise emissions from Munmorah Power station alone however the maximum exceedance remains at 5 dBA at the worst case receiver during worst case meteorological conditions.

It is proposed that the combined noise emissions from the Colongra and Munmorah Sites should comply with the INP Amenity criteria, which aims to set a maximum average noise level for various types of receivers. The acceptable amenity criterion for a suburban/rural receiver is 40dBA, with a recommended maximum of 45dBA. It can be seen that the maximum exceedance of the criteria is 1 dBA during the worst case meteorological conditions.

4.3 Future noise predictions

A primary aim of the rehabilitation of the facility is to return the capacity of the plant from the current reduced capacity of 600MW to the original design of 700MW. Although manufacturer's data is not available for the new items of equipment to be installed, it is possible to make predictions regarding the increase in noise levels generated by the upgrading of the plant with the increase in capacity. The key upgrade to the facility is the replacement of the turbines to allow for more efficient energy generation, the turbines/halls are therefore a major noise source on site.

Engineering Noise Control (*Bies and Hanson, Third Edition)* proposes a set of formulae for calculating the sound power level for gas turbines. Three equations (based on Army, Air Force and Navy, USA 1983a) are provided to predict the sound power levels of the casing, inlet and outlet.

Casing: $L_w = 120 + 5\times\log_{10}(MW)$

Inlet: $L_w = 127 + 15\times\log_{10}(MW)$

Exhaust: $L_w = 133 + 10\times\log_{10}(MW)$

It is proposed that these formulae are used to determine the possible increase in sound power level associated with the increase in capacity of the turbines only. Note that the sound power levels of the equipment incorporated in the computational noise model have been calibrated to noise measurements taken on site and therefore represent a more accurate set of source data than the above approximations.

Based on these formulae, assuming an increase in capacity from 600MW to 700MW, the following sound power level increases are expected:

Casing: 0.3dB

Inlet: 1.0 dB

Exhaust: 0.7 dB

Given that the upgrading of the turbine involves the replacement of old equipment with current technology, it is expected that the noise levels associated with the increase in capacity will be offset by new, low noise turbine technology.

4.3.1 Proposed Plant Upgrades

Table 4.8 shows the components that will be rehabilitated as part of the proposed project. As discussed, the major upgrades to the plant involve the rehabilitation of the turbine blades, which is likely to slightly reduce noise emissions from site.

Table 4.7 – Conveyor Predicted noise levels

Receiver	Criteria (dBA)	Predicted Sound Pressure Level dBA	
		Stability Class A	Stability Class F
Denman St	40 – 45	40	49
Doyalson Welding		46	53.5

Table 4.8 – Noise impacts from proposed modifications

Modification	Noise Impact
Main steam turbine blade replacement	Marginal decrease in noise emission levels with the installation of up to date technology is expected. Upgrade of turbine is likely to decrease environmental noise emissions. Noise increase due to Increase in capacity is likely to be offset by the replacement of old technology
Circulating water system debris filter and ball cleaning system upgrade	Nil impact to noise emissions.
Attemperation pumps rehabilitation	Rehabilitation of Attemperation Pumps is likely to result in a marginal decrease in the contribution from these sources. In comparison to other noise sources on site the contribution from attemperation pumps will be minimal.
Feed pump and turbine upgrade	Upgrade of feed pump is likely to reduce the noise emissions from the plant due to upgrade of worn equipment.
Replacement of existing auxiliary cooling water system arrangement	Nil impact to noise emissions.
Air heater upgrade	Nil impact to noise emissions.
Economiser upgrade	Nil impact to noise emissions.
Furnace refurbishment	Nil impact to noise emissions
Other minor upgrades to related ancillary plant and equipment	Nil impact to noise emissions; no changes to major noise emitting equipment

4.3.2 Upgrading of the electrical and controls system

The upgrading of the electrical system will have negligible impact on the noise emissions. Upgrading of the control systems is likely to lead to a slight decrease in noise emissions due to increased control of equipment and therefore noise emissions. Continuous noise monitoring has been implemented on site (Parsons Brinkerhoff, 2008), which is connected to a noise alarm in the Power Station Control Room. This can trigger a series of manual noise management actions to reduce the propensity for adverse community response. It is possible that control systems could be integrated with the on site ambient noise monitoring to automatically control noise events on site further automating this process.

4.3.3 Impulsive noise events

The safety valve release causes a maximum noise event which may lead to sleep disturbance in the local community. The boiler safety valve release is an automated event which may occur at any time, and therefore an assessment of possible sleep disturbance must be conducted. The Parsons Brinkerhoff Munmorah Power Station Noise Management Plan (Parson Brinckerhoff, 2008) also assessed the noise emissions from the boiler over pressure release valve, where a short burst of pressure is released to the environment. Measurements conducted on the over pressure valve revealed that the sound power level of the safety release valve and the over pressure valve were both approximately 120dBA.

The Noise Management Plan adopted a sound power level of the valve release event as 120 dBA, and using computational noise modelling, predicted the noise level at the nearest receptor as 28 dBA. The NSW INP specifies a +5 dBA correction for noise sources with impulsive characteristics, therefore the predicted level, when corrected for the impulsive nature of the safety valve release event is 32 dBA.

Assuming a 10 dBA transmission loss through a façade with an open window to allow for natural ventilation, an internal sound pressure level in the worst affected bedroom will be 22 dBA. Based on these predicted values, an awakening response to this event is not expected.

However it is proposed that best practice measures be implemented to control noise emissions from the steam release. It is therefore proposed that silencers should be installed to the steam release valves as a matter of best practice.

4.3.4 Operational noise mitigation

It is expected that the combination of the rehabilitation activities proposed for the Munmorah Power Station Rehabilitation project will result in an overall reduction in the operational noise emissions from the plant, therefore, additional mitigation measures are not proposed at this stage.

Due to the custom nature of the equipment involved in the rehabilitation of the plant, obtaining accurate sound power level data from the manufacturer may be difficult. In order to minimise operational noise emissions, it is therefore recommended that where low noise options exist for equipment, these should be specified, as a matter of best practice.

Commissioning measurements will be taken once rehabilitation works are complete to assess the environmental impact from the rehabilitation works. If the noise emissions are found to be excessive when compared to the developed operational environmental noise emissions criteria, mitigation measures should be developed to reduce the noise emissions to within the noise emission criteria.

Should commissioning measurements reveal an unreasonable noise level at the nearest residential receivers, remedial work should be considered. The scope of the remedial acoustic treatment would depend on the source of the offending noise and may include the increase of building envelope construction, installation of silencers, or the installation of noise barriers etc.

4.3.5 Operational Vibration

Operational vibration from the plant is expected to be negligible, and significantly below the vibration level criteria at the nearest residences.

No new vibration sources are to be introduced on site and therefore no additional impact is expected.

5. Conclusion

Noise emissions from the proposed rehabilitation of the existing Munmorah Power Station have been assessed and compared to the existing noise sources on site. The proposed rehabilitation works are not expected to introduce additional operational noise or vibration sources and therefore nil additional operational impact is expected when compared to existing operations on site. Increases in efficiency and the replacement of worn and damaged items of equipment are expected to slightly reduce the operational noise emission level of the power station.

At this stage, construction requirements and techniques have not been confirmed, however preliminary assessment of noise and vibration impact from construction indicate that minimal construction noise and vibration impacts are expected. A construction noise and vibration management plan will be developed to assess in detail the impact of construction noise on the local community and ensure noise criteria are met once a detailed construction schedule is developed.

Potential traffic noise impacts of the project for both construction and operational traffic, consistent with the Environmental Criteria for Road Traffic Noise. have been considered. No significant noise impact is predicted from a very minor increase in heavy vehicle movements along the Central Coast Highway during the construction phase. The operation of the rehabilitated power station is not expected to create additional traffic flows to the area. Previous occasional coal deliveries by road would also no longer occur. Construction traffic noise impacts would be mitigated by limiting heavy vehicle movements to the daytime period where practicable. These issues would be addressed in detail in the construction noise and vibration management plan.

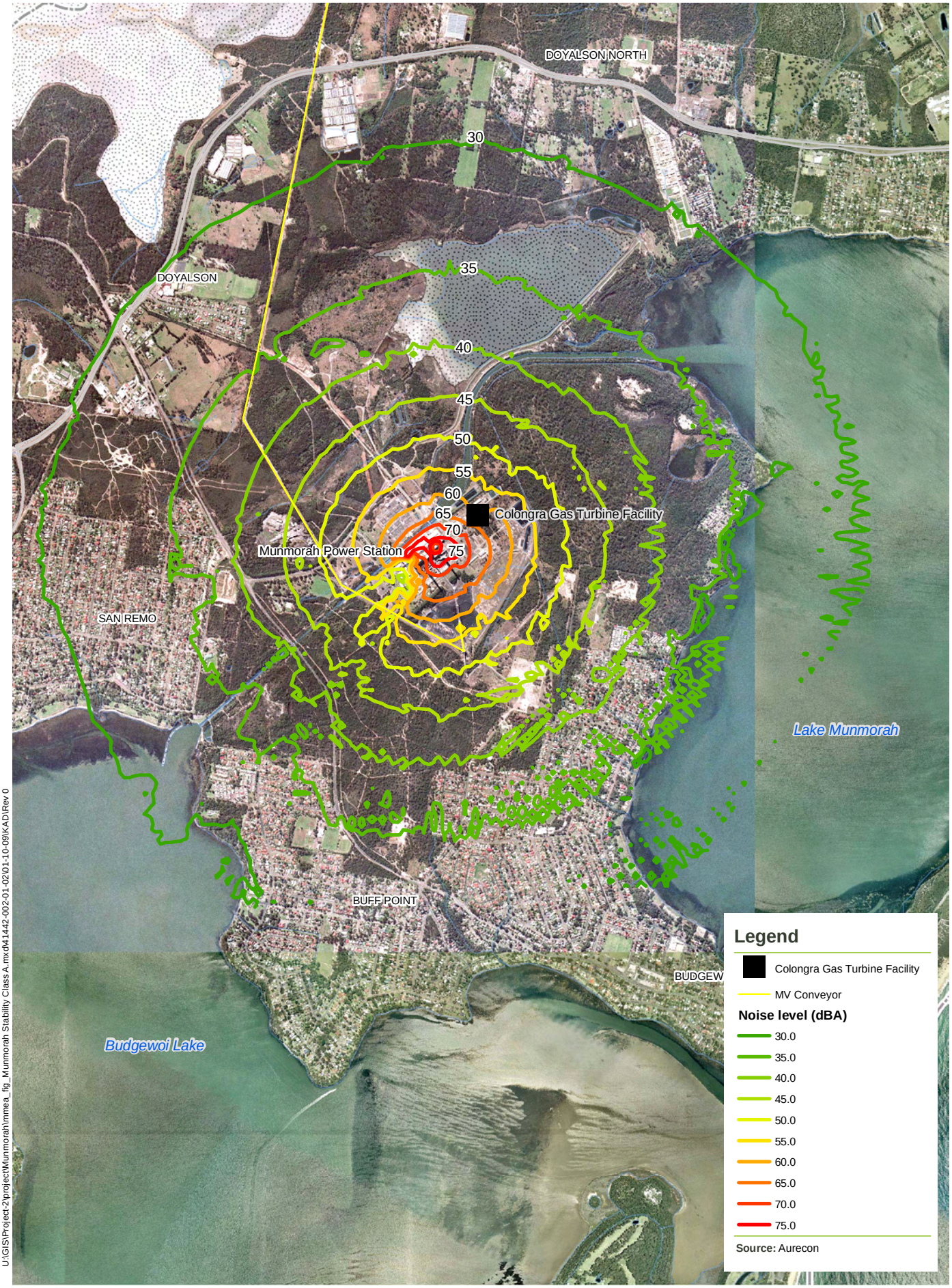
Noise emissions from the proposed rehabilitated Munmorah Power Station have been predicted at the surrounding residences based on information regarding the existing noise emissions from the plant. Predictions show that under adverse meteorological conditions, some exceedances of the criteria are expected. However, as accurate data of the sound power levels of the proposed refurbished equipment is not to be available, all feasible and reasonable noise control measures will be implemented during the design stage to reduce the noise emissions from the plant.

It is proposed that commissioning measurements will be conducted after completion of the rehabilitation project, and, if found to be excessive, remedial action will be implemented to reduce noise emissions. Such action may include additional treatment of building facades, installation of acoustic barriers etc. When final design options for the plant are confirmed preferred suppliers should provide acoustic data for review against modelling inputs and final comparison against existing noise emissions.

6. References

1. Parsons Brinkerhoff “Munmorah Power Station Noise Management Plan” September 2008
2. Aurecon “Munmorah Power Station Rehabilitation Preliminary Environmental Assessment” 22 April 2009
3. Director General’s Requirements (project Application: MP 09_0117)
4. Department of Water and Energy letter from Jeff Hunt to Dinuka MacKenzie, File Ref MP ER20655
5. Department of Planning letter from Joe Woodward to Scott Jeffries, Ref DOC09/30449, LIC09/664
6. SKM Report “Munmorah Units 3&4 Rehabilitation Studies” Report 8 July 2009
7. Munmorah Gas Turbine Facility Noise Assessment, Wilkinson Murray, September 2005
8. NSW Department of Environment and Climate Change, Interim Construction Noise guidelines 2008
9. NSW Department of Environment and Climate Change, Assessing Vibration – a Technical Guide
10. German Standard DIN 4150–02, Structural Vibration – Effects of Vibration on Structures
11. Laing O’Rourke – Delta MV Conveyors, Overland Conveyor Concept Study Report, 12 December 2008

Attachment A
Noise contours from simulations



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SCALE 1:30,000 @ A4

0 500 1,000 Meters

Projection: MGA

Munmorah Power Station **Rehabilitation Environmental Assessment**

FIGURE 1: Munmorah Power Station - Stability Class A (Neutral)