# Stage 2 Kerosene Vale Ash Repository

# Technical Report 5 - Noise and Vibration

April, 2008

Delta Electricity

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# Executive summary

This report has been prepared by Parsons Brinckerhoff (PB) on behalf of Delta Electricity to assess the potential noise impacts of the proposed Stage 2 Fly Ash Placement at the Kerosene Vale Ash Repository (KVAR), Lithgow.

The proposed Stage 2 project is the expansion of the placement area, providing capacity to continue the placement of ash over KVAR for a further 11 – 15 years. Stage 2 operations include the transportation of fly ash from the Wallerawang Power Station to the KVAR using semi trailer trucks on the existing haul road and the progressive capping of the deposited fly ash at KVAR to reach the design height of 940 Australian Height Datum.

Coal delivery for the Wallerawang Power Station occurs on the haul road concurrently with Stage 1 operations. This noise assessment has assumed that coal truck delivery movements will continue the same operations during Stage 2 works.

In order to provide space for the fly ash, construction works are required for the re-alignment or Sawyer Swamp Creek and the strengthening of the Kerosene Vale existing bund wall where excavated material would be used for capping of Stage 2 areas.

This noise impact assessment for the potential noise impact from the construction and operation activities associated with the Stage 2 proposal has been undertaken in accordance with the DECC's Industrial Noise Policy (EPA 1999) and associated Industrial Noise Policy Application Notes and with consideration to the NSW Environmental Criteria for Road Traffic Noise (EPA 1999) and Chapter 171 Noise Control Guideline, Construction Site Noise, Environmental Noise Manual 1994.

Baseline conditions measured and predictions carried out for existing and proposed noise emission profiles have been used to prepare a statement of noise impact potential and associated recommendations.

The noise monitoring undertaken for this assessment at the nearest potentially impacted receptor and an indicative background location was applied to NSW Industrial Noise Policy guidance in determining intrusive noise design goals for the Stage 2 proposal. Noise design goals of 42 dB(A) $L_{Aeq,\ 15\ min}$ (day time), 43 dB(A) $L_{Aeq,\ 15\ min}$ (evening ) and 38 dB(A) $L_{Aeq,\ 15min}$ (night time) have been established. An $L_{A1}$ noise criteria of 49 dB(A) has also been determined for the assessment of potential sleep disturbance.

Noise predictions for the Stage 2 fly ash truck and existing coal truck movements were modelled. The prediction of the noise impact was carried out applying haul road truck flows determined from Wallerawang weighbridge data for fly ash trucks and known delivered coal volumes for coal trucks. The hourly number of events for each vehicle type (fly ash semi trailer and coal rigid) were included to determine contributing noise sources on the haul road. Daytime, evening and night time noise impacts were determined and a potential worst case 15 minute scenario was modelled accounting for intensification of truck movements potentially occurring as a result of coal demand and fly ash production.

Model validation exercises indicated that the predictive methods were within acceptable limits of error.

Comparison of Stage 1 and predicted Stage 2 noise impacts determine that the day time (7 am – 6 pm) period demonstrates an increase in noise level of up to 1.5 dB(A) and evening time (6 pm – 10 pm) periods an increase in noise level of up to 2.5 dB(A).

The Stage 2 fly ash truck and existing coal truck operations on the haul road are not expected to occur during the night time (10 pm – 7 am) period. Therefore, in comparison to the existing Stage 1 scenario, no noise impacts have been predicted for the night time period; the introduction of a second silo at WPS is predicted to manage fly ash truck movements within the day time and evening periods.

The predicted worst case, determined over a 15 minute period, of 6 fly ash trucks in cumulative operation with 6 coal trucks have been predicted to be the peak of operations to achieve compliance with the NSW INP noise design goal of 42 dB(A) $L_{Aeq,\ 15\ mins}$.

Consideration has been provided for emergency and abnormal fly ash truck operations which may occur during the night time period (10 pm – 2 am). In order to be compliant with the NSW INP night time noise design goal of 38 dB(A) $L_{Aeq,\ 15\ mins}$ recommended peak fly ash truck movements should be 5 trucks per 15 minute period.

Fly ash trucks maybe operational during the night time period for emergency assessment of potential sleep disturbance has been undertaken. An ENCM sleep disturbance goal of 49 dB(A) $L_{A1}$ has been adopted. Individual truck pass by events have been predicted at the nearest sensitive receptors to be 57 dB(A) $L_{A1}$. Where sleep disturbance is to be considered as an assessment parameter or for establishment of noise management or mitigation purposes noise design goals should be established considerate of further sleep disturbance criteria as sleep disturbance is a subjective response.

A range of noise management and mitigation recommendations have been provided for consideration in an operational noise management plan to incorporate and address impact profiles for all potentially affected receivers and to provide procedures, mitigation measures and management practises through out the works program.

# 1. Introduction

This report has been prepared by Parsons Brinckerhoff (PB) on behalf of Delta Electricity to assess the potential noise and vibration impacts of the proposed construction and operation of the Stage 2 Kerosene Vale Ash Repository (KVAR) fly ash placement works. The study has been prepared for inclusion within the Environmental Assessment being prepared by PB.

## 1.1 Background

This assessment has been completed in accordance with the guidelines presented in the *Industrial Noise Policy* (NSW EPA INP 2000), the *Environmental Noise Control Manual* (NSW EPA ENCM 1994) and other relevant guidelines.

The report presents an assessment of off-site noise issues from the proposed construction and operational activities for the Project. Predictive noise modelling has been carried out for a number of varying scenarios for the proposed ash placement works.

Detailed assessment has been made to noise associated with the proposed haulage of ash generated from the current operation of Wallerawang Power Station (WPS) along the private haul road.

## 1.2 Scope

The scope of work for this study was to prepare a noise and vibration impact assessment for the proposed construction and operation of the Project. This required completion of the following tasks:

- assess the existing ambient noise environment in the study area
- establish reasonable and feasible noise design objectives and assessment criteria for the study area
- provide a detailed assessment of potential noise impacts associated with the development (construction, operational and sleep disturbance)
- provide a qualitative assessment of potential vibration impacts associated with the development
- assess potential impacts against relevant legislation and guidelines
- provide a concise statement of potential noise and vibration impact
- develop noise and vibration impact mitigation measures.

Supporting documentation has been included in the Appendices of this report. Limitations to the scope and use of this assessment are provided in Section 14 of this report.

# 2. Site description and proposal details

## 2.1 Site location

The KVAR is located approximately 2.5 kilometres north-east of the WPS and approximately 10 Kilometres north-west of the city of Lithgow. The nearest residential community is Lidsdale which lies approximately 1.5 kilometres to the west of the KVAR. The nearest properties are approximately 200 metres from the haul road which operates between the WPS and KVAR.

Residential properties at Lidsdale are between 15 and 40 metres below the haul road which runs on a ridge separating the existing and proposed ash storage locations from Lidsdale. The storage areas have been engineered from a previous quarry site and is 20 and 40 metres below the level of the haul road to the west.

The local region is a suburban environment of residential properties accessed by local roads from the Castlereagh Highway which connects Lidsdale and WPS with Lithgow and the Great Western Highway.

The KVAR study area is shown in the regional context as Figure 2-1.

## 2.2 Description of proposal

In 2002 approval was attained for the storage of dry ash by product from WPS at the KVAR. Since 2002 an area identified as Stage 1 has been utilised at KVAR to store the ash. Stage 1 areas have now reached their design height and it is now required that the Stage 2 area be utilised to continue to storage programme.

Stage 2 is the expansion of the placement area, and has the capacity to continue the placement of ash over KVAR for a further 11 – 15 years. This would allow the WPS operations to continue beyond the completion of Stage 1 activities.

A conceptual site layout diagram is provided as Figure 2-1. A summary of the Stage 2 construction works requirements and associated operational activities follow.

### 2.2.1 Construction works

Key construction activities for Stage 2 would include:

- re-alignment of Sawyer Swamp Creek
- Kerosene Vale existing bund would be buttressed and strengthened to contain the ash storage
- material from the pine plantation area would be excavated to provide space for the fly ash, excavated material would be used for capping of Stage 1 and Stage 2 areas.

### 2.2.2 Operation activities

- fly ash would be conveyed from WPS to a storage silo. Semi-trailer trucks and would then collect the ash from the silo and transport it via the existing haul road
- fly ash truck operations on the haul road are proposed to be as those for Stage 1. Normal hours of operation for Stage 2 activities would be limited to between 7am and 10pm, with only emergency and abnormal operations outside of these times. Stage 1 current operations are between 7am – 10pm. Emergency and abnormal operations are known to occur between 10pm – 7am
- fly ash would be deposited at the placement area and raised in 1-2 metre increments by compactors and bulldozers
- ash would be progressively capped until the design height of 940 Australian Height Datum is achieved
- placement would progress in an easterly direction over the pine plantation area and then in a northerly direction towards Sawyers Swamp Creek.


**Figure 2-1: KVAD Study Area and Conceptual Stage 2 Site Layout**

# 3. Noise monitoring methodology

## 3.1 Overview

This section of the report presents the results of background noise measurements carried out in the study area. The results have been used to characterise current background noise profiles and establish project-specific noise design objectives.

Noise measurements were carried out using Acoustic Research Laboratories statistical environmental noise loggers, type EL-316 (long-term unattended noise monitoring) a RION NA27 Precision Sound Level Meter (operator attended noise monitoring). The instrument sets comply with AS 1259.

Instrument sets were calibrated by a NATA accredited laboratory within two years of the measurement period. Copies of the instrument set calibration certificates have been included in Appendix A.

Microphones were positioned at 1.2 m above ground level and were fitted with windsocks. Each instrument was calibrated before and after the measurement period to ensure the reliability and accuracy of the results. No significant variances were observed.

### 3.1.1 Unattended noise monitoring

Unattended noise monitors were established at two key residential locations. Continuous fifteen minute statistical measurements were obtained for a number of descriptors.

Locations were selected with respect to measurements being representative of the existing noise environment, so as not under the influence from extraneous noise and to be secure and accessible.

The background noise levels measured with the environmental noise loggers are influenced by all local noise sources. The noise profiles are to be viewed in conjunction with attended noise measurements and comments.

Unattended noise monitoring was undertaken from Friday 20 July to Friday 27 July 2007.

### 3.1.2 Attended noise monitoring

The instrument was set on A-weighted, fast response and logged noise levels over fifteen minute statistical intervals. Observations were recorded during the measurement interval for attended noise monitoring.

Attended noise monitoring was carried out during the day time of Friday 20 July 2007 and night on 1 August 2007.

## 3.2 Noise monitoring locations

### 3.2.1 Ambient noise monitoring

Locations were chosen following a preliminary site investigation to determine properties in the Lidsdale area potentially impacted by noise from the proposed Stage 2 operations. The monitoring program comprised monitoring at seven locations (refer to Figure 3-1). A description of each noise monitoring location follows.

- Location 1: Site 1 Skelly Road

Skelly Road was identified as containing the nearest potentially impacted receivers, PB were advised by Delta that Site 1 Skelly Road was a site of previous adverse comment in relation to noise from the haul road and had been a site for previous noise monitoring. The location has a separation of approximately 200 metres from the haul road.

Both unattended and day time evening and night time attended noise monitoring were undertaken at this location. Noise logger EL-316-207-009 was established to the front of the property approximately 20 metres from the nearest façade.

- Location: 2: Site 2 Skelly Road

The location was utilised during the attended night time noise monitoring and has a separation distance of approximately 300 metres from the haul road. At this location on Skelly Road the trucks operating on the haul road are on a gradient, preparing to reach the level section of the haul road. Bush woodland separates the haul road from the receiver.

- Location 3: Site 3 Wolgan Road

Wolgan Road is the main residential road in Lidsdale linking to the Castlereagh Highway, attended noise measurements during the night time period were undertaken at this location. The monitoring location is approximately 500 metres from the nearest point on the haul road utilised by fly ash trucks. Attended night time monitoring was carried out at this location.

- Location 4: Site 4 Maddox Lane

Maddox Lane is a residential road located to the north of the KVAR site with an approximate separation distance to the section of the haul road used by fly ash trucks of 1000 metres. Attended night time noise monitoring was carried out at this location.

- Location 5: Site 5 Woodlands (off Castlereagh Highway)

The location is a residential property with a separation distance of approximately 1250 metres from the haul road. This location was chosen as noise influence from the haul road and fly ash placement works were inaudible. The location will serve as indicative background for the Stage 2 assessment.

Both unattended and day time evening and night time attended noise monitoring were undertaken at this location. Noise logger EL-316-207-008 was established to the rear of the property approximately 25 metres from the nearest façade.

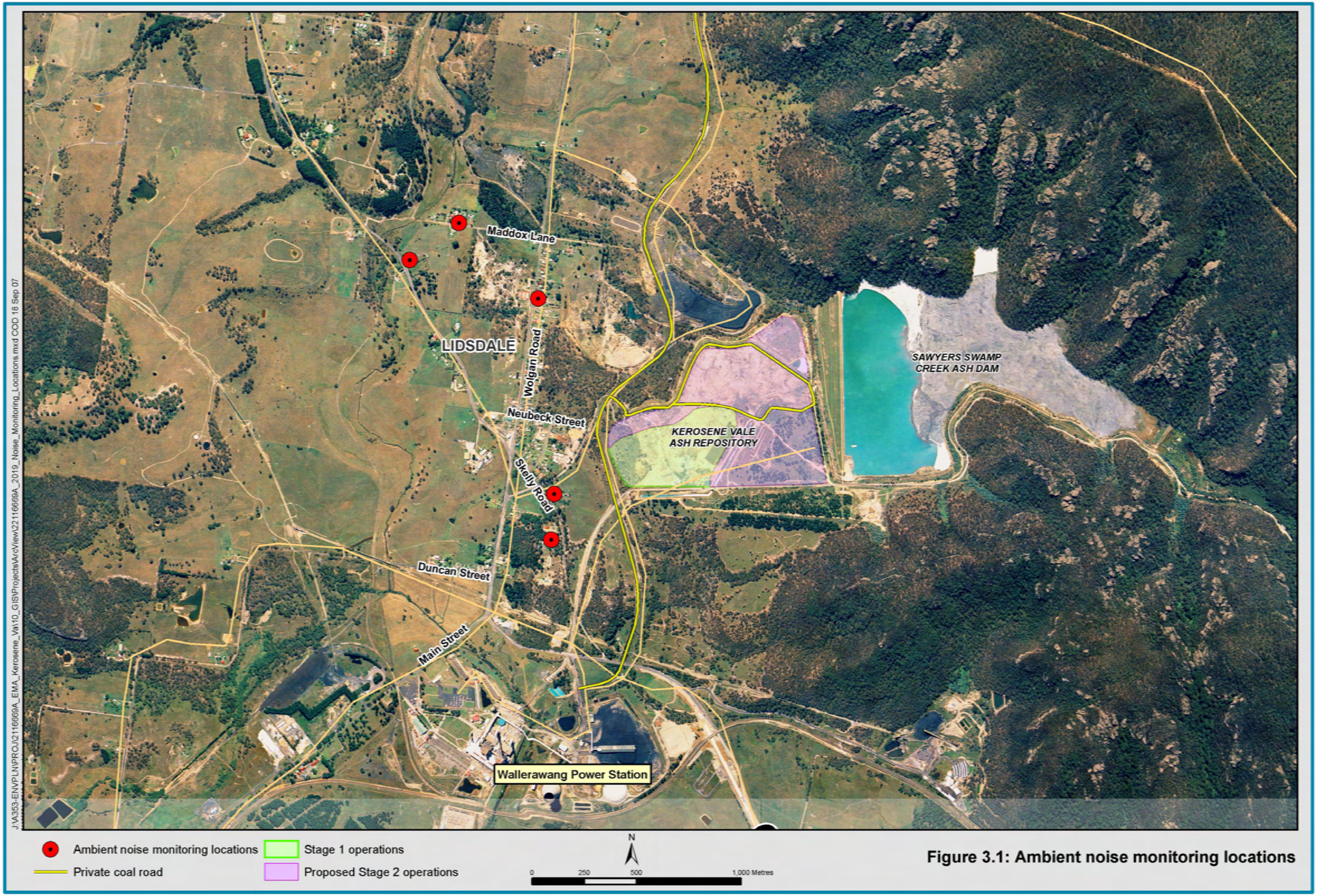


Figure 3.1: Ambient noise monitoring locations

### 3.2.2 Haul road truck monitoring

To determine noise impacts of the trucks operating on the haul road between WPS and KVAR, noise monitoring of truck events was undertaken on 20 July 2007. Individual truck pass by events were measured where the trucks were operating at a consistent speed and when accelerating.

Noise monitoring locations have been chosen where representative of the truck operating conditions, not in the presence of extraneous noise events and with respect to safety and accessibility.

Noise monitoring locations were as detailed below and are illustrated in Figure 3-2.

- Location 6: Consistent operating (Site A)

The haul road becomes level at the southern end of the road bridge and trucks are no longer accelerating, operating at a constant speed signposted as 100 kilometres per hour.

At this location the local topography is such that the haul road is elevated approximately 15 metres above the nearest potentially impacted receivers at Skelly Road.

- Location 7: Acceleration

As the truck engines are accelerating and operating under greater power on this section of the route the noise output is likely to vary from where the trucks are operating at a constant speed. The trucks are required to accelerate as they travel up the gradient. The speed limit is signposted as 100 kilometres per hour.

As the trucks pass under the Castlereagh Highway the haul road rises at a gradient of approximately 5 degrees from the horizontal. This section is 750 metres in length and local topography raises the haul road by approximately 60 metres.

Measured truck sound pressure levels are detailed in Table 4.5, Section 4.

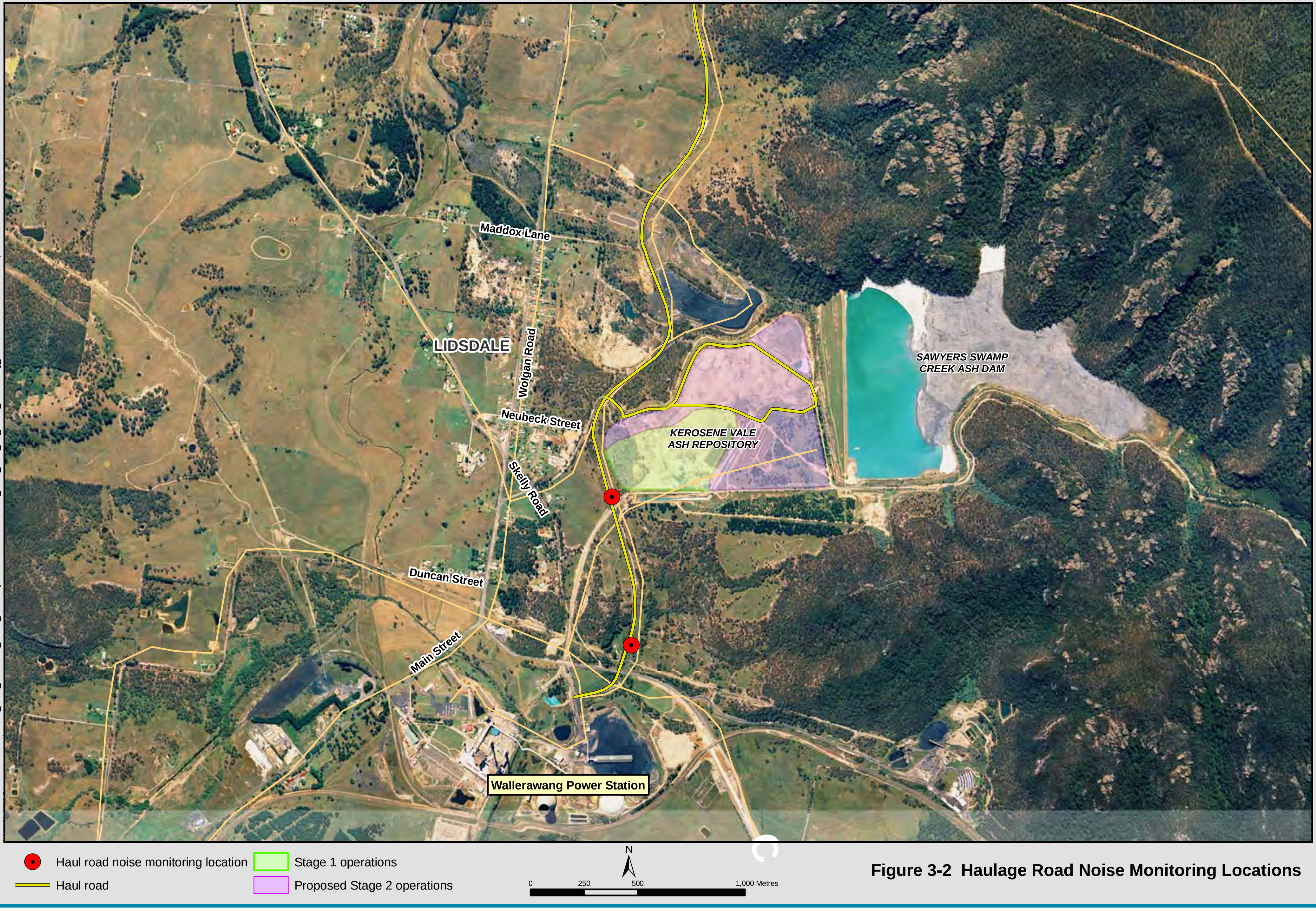


Figure 3-2 Haulage Road Noise Monitoring Locations

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# 4. Existing noise environment

This section details the characterisation of the existing noise environment as determined through unattended and attended noise monitoring.

## 4.1 Unattended noise monitoring

For the survey period 20 July 2007 to 27 July 2007, the results of the ambient noise monitoring program are presented in Table 4-1 and 4-2. Daily noise logger graphs have been included in Appendix B.

**Table 4-1: Unattended noise monitoring Site 1 Skelly Road**

| Date | Day (7 am – 6 pm) | | Evening (6 pm – 10 pm) | | Night (10 pm – 7 am) | |
|---|---|---|---|---|---|---|
| | $L_{Aeq}$ | $L_{A90}$ | $L_{Aeq}$ | $L_{A90}$ | $L_{Aeq}$ | $L_{A90}$ |
| Friday 20/07/07 | 45 | 42.5 | 50 | 44.5 | 43 | 45.5 |
| Saturday 21/07/07 | 46 | 39.5 | 47 | 39.5 | 47.5 | 40 |
| Sunday 22/07/07 | 47 | 33.5 | 48.5 | 37.5 | 44.5 | 38 |
| Monday 23/07/07 | 45.5 | 35 | 51.5 | 39.5 | 45 | 35 |
| Tuesday 24/07/07 | 48 | 41.0 | 52.5 | 40 | 47 | 38 |
| Wednesday 25/07/07 | 48 | 41.5 | 52.5 | 40.5 | 47 | 38.5 |
| Thursday 26/07/07 | 48.5 | 38 | 53 | 39.5 | 47.5 | 40 |
| Friday 27/07/07 | 46.5 | 41 | - | - | 47 | 36 |
| **Median** | **46.5** | **36.5** | **51.5** | **39.5** | **46.5** | **38.5** |

Notes: Values expressed as dB(A); dB(A) = decibels, A-weighted; $L_{Aeq}$ = equivalent continuous (energy average) A-weighted sound pressure level; $L_{A90}$ = A-weighted sound pressure level exceeded for 90 percent of the time (background); All values rounded to nearest 0.5 dB(A).

**Table 4-2: Unattended noise monitoring Site 5 Woodlands (off Castlereagh Highway)**

| Date | Day (7 am – 6 pm) | | Evening (6 pm – 10 pm) | | Night (10 pm – 7 am) | |
|---|---|---|---|---|---|---|
| | $L_{Aeq}$ | $L_{A90}$ | $L_{Aeq}$ | $L_{A90}$ | $L_{Aeq}$ | $L_{A90}$ |
| Friday 20/07/07 | 45 | 37.5 | 48 | 42 | 40 | 41 |
| Saturday 21/07/07 | 46 | 34 | 42.5 | 31.5 | 45.5 | 32.5 |
| Sunday 22/07/07 | 44 | 30.5 | 45 | 35 | 41.5 | 30 |
| Monday 23/07/07 | 46.5 | 31.5 | 46 | 40.5 | 42.5 | 26.5 |
| Tuesday 24/07/07 | 49 | 31.5 | 46.5 | 38 | 45.5 | 38 |
| Wednesday 25/07/07 | 50 | 38 | 46.5 | 38.5 | 46 | 36 |
| Thursday 26/07/07 | 49 | 37 | 47.5 | 37.5 | 45.5 | 37.5 |
| Friday 27/07/07 | 48.5 | 41.5 | - | - | 46 | 28.5 |
| **Median** | **47.5** | **37** | **46.5** | **38** | **45.5** | **34.5** |

Notes: Values expressed as dB(A); dB(A) = decibels, A-weighted; $L_{Aeq}$ = equivalent continuous (energy average) A-weighted sound pressure level; $L_{A90}$ = A-weighted sound pressure level exceeded for 90 percent of the time (background); All values rounded to nearest 0.5 dB(A).

The noise environs followed typical diurnal trends where background noise levels were reduced during the night time period. However, at both monitoring locations the evening period demonstrated an increase in noise level from the day time averages. This has been accounted for by peak road traffic activity from the Castlereagh Highway. A 3 dB(A) $L_{A90}$ increase background noise levels between day time and evening time noise levels was measured at Skelly Road and 1 dB(A) $L_{A90}$ at Site 5 Woodlands.

The $L_{Aeq}$ and $L_{A90}$ descriptors display similar trends for the noise environs and analysis of the daily noise logger graphs indicated background noise levels were relatively consistent throughout the day time.

## 4.2 Attended noise monitoring

Attended day time and night time noise monitoring results are presented below in Tables 4-3 and Table 4-4. Meteorological conditions during the attended noise monitoring program were observed to be satisfactory for noise monitoring purposes.

**Table 4-3: Attended noise monitoring (day)**

| Location | Date / Time | $L_{A10}$ | $L_{Aeq}$ | $L_{A90}$ | Comments |
|---|---|---|---|---|---|
| Site 1 Skelly Road | 11:00 20/07/07 | 54 | 52 | 49 | Wind blown vegetation 52 – 53<br>Distant traffic pass by 49 – 51<br>Fauna 52 – 58<br>Trucks on haul road 46 – 49, peak 58<br>Power Station impacts 50 – 52<br>Power Station audible in S.S. 47 – 49 |
| Site 5 Woodlands | 12:00 20/07/07 | 52 | 49 | 41 | Residential activity 48 – 50<br>Distant traffic 41 – 45, truck 44 – 58<br>Fauna 41 – 46<br>S.S. 37 – 38 |

Note: Values expressed as dB(A) and rounded to nearest 0.5 dB(A); S.S. = observed steady state noise level; $L_{Aeq}$ = Equivalent noise level (average); $L_{A90}$ = Noise level 90% of time (background); $L_{A10}$ = Noise level 10% of the time.

The day time noise environment at Skelly Road is influenced by WPS, which was audible in the steady state measurements. Noise from WPS can be characterised as an ‘industrial hum’ and a reversing alarm was sporadically audible in the steady state.

Truck movements associate with WPS operations on the haul road were audible, pass by events were measured to be 46 – 58 dB(A). The pass by events were measured from when the trucks became audible from the steady state as they approached the monitoring location, to when they became inaudible in the steady state as they moved away. Pass by event duration was approximately 20 seconds. Truck pass by events were measured where the noise environment was influenced by WPS.

Distant traffic was audible from the Castlereagh Highway, vehicle pass by was sporadic and measured up to 2 dB(A) above the steady state noise level.

The surrounding environment to Skelly Road is bush woodland and noise from wind blown vegetation was an influencing event. The monitoring was conducted away from vegetation as detailed in Section 4.3.

At Site 5 Woodlands, distant road traffic pass by from Castlereagh Highway influenced the noise environment. Road traffic pass by events were between 41 – 58 dB(A), noise levels were dependent upon vehicle type, traffic volume and whether pass by on both lanes occur simultaneously.

Noise from the haul road, Stage 1 KVAR fly ash placement and WPS were not audible at the Site 5 Woodlands location.

**Table 4-4: Attended noise monitoring (night)**

| Location | Date / Time | $L_{A10}$ | $L_{Aeq}$ | $L_{A90}$ | Comments |
|---|---|---|---|---|---|
| Site 2 Skelly Road | 23:39 (01/08/07) | 45.5 | 44 | 37 | Fauna 38<br>Trucks on haul road 39 – 41, peak 50<br>Air braking peak 51<br>Reversing alarm 39<br>Distant traffic 40<br>Local traffic 41<br>Power Station audible in S.S. 36 – 37 |
| Site 4 Maddox Lane | 00:03 (02/08/07) | 41 | 39 | 36 | Fauna 35 – 36<br>Distant traffic 36 – 37<br>Traffic pass by 34 – 40<br>S.S. 35 – 37 |
| Site 3 Wolgan Road | 00:23 (02/08/07) | 44 | 52.5 | 36 | Fauna 38 – 39<br>Distant traffic 42 – 45<br>Trucks on haul road 45<br>S.S. 35 – 36 |

Note: Values expressed as dB(A) and rounded to nearest 0.5 dB(A); S.S. = observed steady state noise level; $L_{Aeq}$ = Equivalent noise level (average); $L_{A90}$ = Noise level 90% of time (background); $L_{A10}$ = Noise level 10% of the time.

The night time noise environment at Site 1 Skelly Road was dominated by fauna noise as a result the monitoring was not considered representative and therefore deemed to be unsuitable. Night time monitoring was conducted at the property boundary of Site 2 Skelly Road where the noise environment was conducive for representative noise measurements.

At Site 2 Skelly Road the movement of trucks on the haul road had a pass by noise level of 39 – 41 dB(A) with a peak noise of a 50 dB(A). It was determined that air braking noise events from the trucks had a noise peak of 51 dB(A). Braking events were sporadic and did not occur with each truck pass by.

The WPS was audible in the steady state of 36 – 37 dB(A) with infrequent reversing alarm events having a peak noise audible above the steady state of 39 dB(A).

Traffic pass by events from local roads and the Castlereagh Highway were infrequent, noise levels were measured to be 40 – 41 dB(A).

The Site 5 Woodlands property was not accessible during the night time, a representative location Site 4 Maddox Lane was utilised, as detailed in Figure 3-1. The local noise environment was influenced by fauna, distant traffic noise from the Castlereagh Highway and local residential traffic.

Noise from the haul road, Stage 1 fly ash placement and WPS were not audible at the Site 5 Woodland location.

During the initial site visit on 20 July 2007 residents commented that during the night time, trucks on the haul road were sometimes audible. Additional night time noise measurements were carried out at Site 3 Wolgan Road to determine influences on the night time noise environment and potential noise impacts from trucks operating on the haul road. Figure 3-2 details the monitoring location.

At Site 3 Wolgan Road the noise environment was influenced by fauna and distant road traffic noise in the steady state was measured at 35 – 36 dB(A). Noise events from trucks operating on the haul road were measured at 45 dB(A).

Meteorological conditions during the attended night time measurements have been determined to be satisfactory for noise monitoring (Section 5).

## 4.3 Haul road truck noise measurements

The attended noise measurements for the trucks operating on the haul road when accelerating / braking and driving at constant speed are detailed in Table 4-5. Measured sound pressure levels have been used to determine sound power levels for monitored truck events. Constant speed measurements were taken over 20 second intervals and acceleration measurements over 10 second intervals.

**Table 4-5: Measured sound pressure levels for haul road trucks**

| Truck | Event | Lp dB(A) | Lw dB(A) |
|---|---|---|---|
| Fly ash full | Constant speed | 76 | 102 |
| | Acceleration | 81.5 | 105 |
| Fly ash empty | Constant speed | 76.5 | 100 |
| | Braking | 80.5 | 104 |
| Coal full | Constant speed | 77 | 100.5 |
| Coal empty | Constant speed | 75 | 99 |
| | Acceleration | 79 | 102.5 |

Note: Values expressed as dB(A) and rounded to nearest 0.5 dB(A

The attended coal and fly ash truck noise measurements were made within 6m and 8m of the lane centre lines. At the monitoring distances adopted during the field work program, the wheel road interface generally dominated the noise source profiles environment during a pass by events.

The presence of personnel during the noise source measurements may have had some influence on measured noise levels, drivers acknowledged persons working in proximity to the road and as required reduced speed for safety reasons.

It should be noted that the coal truck on the haul road are operated and managed by the colliery, Delta operate and managed only the fly trucks.

# 5. Meteorological data

Meteorological data for the period 2004 to 2007 was obtained from the Delta Electricity operated Mount Piper Meteorological Station. Analysis of Met data was required to characterise conditions in the study area to identify the propensity for received noise impacts to be influenced by seasonal meteorological conditions throughout the day, evening and night periods.

The results of the regional meteorological analysis are included in Appendix C.

The NSW INP guidance (Section 5, INP) for the assessment of influencing meteorological conditions was applied to the data set. The INP determines that 'where source to receiver wind speeds of 3 m/s or below occur for 30 percent of the time or more in any assessment period (day, evening, night) in any season' they are considered a feature of the area.

Through analysis of wind speed and wind direction data sets from 1 January 2004 to July 2007, gradient wind events have been identified as not being a feature for the study area. Wind speeds less than 3 m/s were present for less than 30 % of the time for day, evening and night time periods for all seasons.

Gradient wind events were therefore not included in the noise assessment.

Temperature inversions were analysed applying the NSW INP guidance methodologies for determining frequency of temperature inversions. Temperature inversions are a feature when they occur for at least 30% (approximately 2 nights per week) of the total evening and night time in winter, with inversions considered to be present during F-class and / or G-Class stability conditions and wind speeds less than 2 metres per second and between 2 – 3 metres per second.

To determine the presence of temperature gradients analysis of temperature and wind speed was carried out using the Pasquill – Gifford scheme (Appendix E of the NSW Industrial Noise Policy). The assessment procedure requires Sigma-theta temperature data and wind speed data in m/s. Data was obtained for these descriptors from the Mount Piper Met Station, potential temperature inversions were assessed for the 2005 and 2006. An occurrence of less than 5 percent in 2005 and in 2006 was present based on wind speed conditions of 3 metres per second and less.

The data, and analysis approach adopted, infers that temperature gradients are unlikely to be a feature of the area.

The meteorological data measured at Mount Piper Power Station was also applied to the unattended and attended noise monitoring. The NSW INP guidance advises that noise monitoring measurements should be carried out during suitable conditions, namely where wind speeds are less than 5 m/s and precipitation is nil.

Where unsuitable monitoring conditions occurred it has been identified in the reporting of the monitoring results. Periods of inclement weather have been identified in the unattended noise logger graphs in Appendix B.

# 6. Adopted criteria

## 6.1 Overview

The Protection of the Environment Operations Act, 1997 (POEO Act) regulates noise generation and prohibits the generation of “offensive noise” as defined by the POEO Act.

In addition to the regulatory requirements under the POEO Act, the NSW Department of Environment and Conservation provides guidelines regarding acoustic criteria and noise controls.

The current operations are not specifically licensed for noise emissions under the POEO Act. Environment Protection Licence 766 does not specify applicable noise limits within Clause L6.

## 6.2 Construction noise

Noise criteria for construction sites are established in accordance with Chapter 171 of the Environmental Noise Control Manual (NSW EPA ENCM, 1994). The acoustic design objectives for construction are presented in Table 7-1. The recommended criteria are planning goals only.

The potential noise impacts from construction works should be assessed with respect to additional factors such as the social benefits of the activity, economic constraints, and the nature and duration of a proposed construction program.

The NSW Department of Environment and Conservation recognise that individuals accept higher perceived noise impacts for emission sources with a limited duration and identified end date.

**Table 6-1: Acoustic design objectives for construction activities**

| Construction Period | Acoustic Design Objective |
|---|---|
| <4 weeks | Received $L_{A10} \leq L_{A90}$+ 20 dB(A) |
| >4 weeks and <26 weeks | Received $L_{A10} \leq L_{A90}$ + 10 dB(A) |
| >26 weeks | Received $L_{A10} \leq L_{A90}$ + 5 dB(A) |

Construction work is scheduled to be between 4 and 26 weeks in duration, the resultant adopted construction noise impact design limits would be:

- Site 1 Skelly Road **46.5 dB(A)** $L_{A10}$ (36.5 dB(A) + 10 dB(A))
- Site 5 Woodlands **47 dB(A)** $L_{A10}$ (37 dB(A) + 10 dB(A))

Construction works would be undertaken during the day time period only (7 am – 6 pm, weekdays, 7 am – 1 pm Saturdays and no work on Sundays or public holidays).

## 6.3 Operational noise

Noise emissions from the operations of the site would require adherence to the NSW Industrial Noise Policy (NSW EPA INP, 2000).

The policy sets out two criteria that are used to assess potential off-site noise impacts. The first criterion aims at controlling intrusive short-term noise impacts for residences (intrusive criterion). The second criterion aims at maintaining the long-term amenity of particular land uses (amenity criterion). The more conservative of the two limits are established as project-specific operational noise goals.

The relevant intrusive criterion can be summarised as follows:

- $L_{Aeq\ (15\ min)} \leq$ rating background level + 5 dB(A)

The rating background level (RBL) is the overall background level representing the day, evening and night periods over the whole background noise monitoring period.

The amenity criterion is determined based on guidelines presented in the INP (EPA 2000). The acceptable amenity limits for a suburban area are listed in Table 6-2.

**Table 6-2: NSW INP amenity criteria – suburban environment**

| Type of receiver | Period of day/ day of week | Acceptable Noise Level ($L_{Aeq}$) |
|---|---|---|
| Residential-Day-Time interval | 7 am – 6 pm, Monday to Saturday<br>8am – 6 pm, Sundays and Public Holidays | 55 dB(A) |
| Residential-Evening interval | 6 pm – 10 pm | 45 dB(A) |
| Residential-Night-Time interval | remaining periods | 40 dB(A) |
| Commercial Premises | when in use | 65 dB(A) |
| Industrial Premises | when in use | 70 dB(A) |

Note: $L_{Aeq}$ = Equivalent noise level (average); Source: Table 2.1 NSW EPA INP

Amenity criterion is established with reference made to the $L_{Aeq}$ noise levels for the area and the existing industrial noise influence. The amenity criterion is then corrected with reference being made to Table 2.2 of the INP (EPA 2000).

### 6.3.1 Adopted operational noise criteria

The rating background noise levels have been determined from the unattended noise monitoring carried out at Site 1 Skelly Road and Site 5 Woodlands. Table 6-3 details the adopted intrusive and amenity noise criteria.

**Table 6-3: Adopted noise criteria**

| Location | Period | Measured | | | Intrusive limit | Amenity limit | Adopted Criteria |
|---|---|---|---|---|---|---|---|
| | | $L_{A90}$ | $L_{Aeq}$ | industry influence | | | |
| Site 1 Skelly Road | Day Time (7 am – 6 pm) | 36.5 | 46.5 | 47 | 41.5 | 55 | **42** |
| | Evening (6 pm – 10 pm) | 39.5 | 51.5 | not measured | 44.5 | 45 | **44** |
| | Night Time (10 pm – 7 am) | 38.5 | 46.5 | 37 | 43.5 | 37 | **37** |
| Site 5 Woodlands (indicative background) | Day Time (7 am – 6 pm) | 37 | 47.5 | Inaudible (<37) | 42 | 55 | **42** |
| | Evening (6 pm – 10 pm) | 38 | 46.5 | not measured | 43 | 45 | **43** |
| | Night Time (10 pm – 7 am) | 34.5 | 45.5 | Inaudible (<35) | 39.5 | 38 | **38** |

Note: Values expressed as dB(A) and rounded to nearest 0.5 dB(A)

Adopted criteria are considerate of existing industrial influences. The adopted noise criteria for the Site 5 Woodlands site are representative of the indicative background levels. They shall be applied to determine the potential noise impact of the Stage 2 proposed operations as a noise source introduced to the local environment.

## 6.4 Sleep Disturbance

The emission of peak noise levels for an instant or very short time period may cause sleep disturbance to residents. In accordance with the Environmental Noise Control Manual (NSW EPA ENCM, 1994), the $L_{A1}$ level of any specific noise source should not exceed the background noise level ($L_{A90}$) by more than 15 dB(A) when measured outside the bedroom window of the nearest potentially affected receiver. The night time background noise level has been applied for assessment as it is consider indicative of the worst case.

The calculated sleep disturbance criteria have been indicated in Table 6-4.

**Table 6-4: Sleep disturbance criteria**

| Location | Measured $L_{A90}$ | $L_{A1}$ Sleep Disturbance criteria |
|---|---|---|
| Site 1 Skelly Road | 38.5 | **53** |
| Site 5 Woodlands | 34.5 | **49** |

Note: Measured LA90 based on unattended noise monitoring

Sleep disturbance is subjective and not all persons are affected by noise to the same degree, the noise criteria for sleep disturbance are designed to protect potentially impacted residents from sleep arousal.

## 6.5 Road traffic noise

Consideration has been given to road traffic noise events resultant from the proposed Stage 2 operations. Associated Stage 2 vehicle movements have been determined to be confined to the haul road only. As a result all vehicle movements included in the noise impact assessment shall be subject to assessment as per the NSW INP.

Assessment of road traffic noise impact applying the NSW Environmental Criteria for Road Traffic Noise (EPA 1999) has not been considered necessary.

## 6.6 Vibration

Two main issues can be present in relation to vibration levels from construction and operational activities. These are expected to include disturbance to residents from intermittent vibration resulting from activities such as heavy vehicle passage and potential architectural / structural damage to off-site buildings.

Generally, if disturbance issues are controlled, there exists limited potential for structural damage to buildings.

Human comfort and structural damage limits vary across the frequency spectrum, although they are generally a constant level across the frequency range generated by most construction activities. Adopted vibration criteria have been outlined below.

### 6.6.1 Annoyance/human comfort

The NSW DEC Environmental Noise Management Assessing Vibration: a technical guideline (2006) provides recommendations for vibration criteria from continuous, impulsive and intermittent sources. Construction works associated with the proposal have potential vibration sources such as the day time movement of heavy vehicles, operation of compactors and bulldozers. This type of vibration is assessed on the basis of vibration dose levels.

**Table 6-5: Acceptable vibration dose levels for intermittent vibration ($m/s^{1.75}$)**

| Location | Day time | |
|---|---|---|
| | **Preferred value** | **Maximum value** |
| Residences | 0.20 | 0.40 |

Notes: Day time is the period between 7 am to 10 pm
Sources: BS 6472-1992

### 6.6.2 Structural damage

Although not specified by the DEC, German Standard DIN 4150: Part 3-1986 provides guidance on vibration velocity for evaluating potential structural damage. Limits range from 5 mm/s (< 10 Hz), 5-15 mm/s (10-50 Hz) and 15-20 mm/s (50-100 Hz) at the foundation for a residential dwelling. At the upper most storey floor plane, a vibration limit of 15 mm/s is applicable for a residential dwelling.

# 7. Stage 2 Construction noise impact assessment

The Stage 2 development at KVAR requires construction and redevelopment of new and existing infrastructure. The potential noise impacts of the proposed construction programme are required to be assessed. This section details predicted noise impacts from the proposed construction methodology and associated plant and equipment.

It should be noted that at the time of the assessment the full construction programme had not been finalised. As such, where deemed necessary, PB has applied its experience and knowledge in construction practises to apply standard construction techniques and plant in the modelled scenarios.

## 7.1 Construction activities

The following construction activities have been identified for noise impact assessment:

- Re-alignment of the Sawyers Swamp Creek

  The realignment of the creek has a proposed construction period of 8 weeks. Construction works are anticipated to require the use of a tracked excavator, a bulldozer and 2 trucks for removal of material.

- Kerosene Vale stabilisation works

  The Kerosene Vale existing bund is required to be buttressed and strengthened to contain the proposed ash storage. Material from the pine plantation would be excavated to provide space for the fly ash, excavated material would be used for capping of Stage 1 and Stage 2 areas.

All works are proposed to be undertaken during day time hours. The nature of the required works are such that potential impact events ($L_{Amax}$ / $L_{A1}$) would not be of sufficient noise level and duration to result in disturbance at the nearest potentially impacted receivers.

## 7.2 Construction noise source data

Construction noise source sound power levels were determined from PB's existing data sets to represent expected construction and equipment noise sources. Table 7-1 details the sound power levels for the associated construction activities and required plant.

**Table 7-1: Adopted construction noise source data**

| Plant | Sound Power Level ($L_{A10}$) |
|---|---|
| Dump truck | 122.5 |
| Tracked excavator | 122 |
| Bulldozer | 113 |

Note: Values expressed as dB(A) and rounded to nearest 0.5 dB(A)

## 7.3 Noise model inputs

A noise propagation model was established in the assessment of potential construction noise impacts from the proposed construction works. Noise modelling was undertaken through the use of ENM Noise Prediction Software (Version 3.06). The modelling was based on the following:

- linear weighted 1/3 octave band noise source data ($L_{A10}$) for all plant, as detailed in Table 7-1
- one each of plant identified in Table 7-1 adopted
- digital land topography 10m contours
- ground types (absorptive co-efficient) consistent with open grassland, asphalt sealed by dust and use
- predictions presented for ground level receivers (reduced level + 1.5 metres)
- percentage on times scenarios assumed maximum operations
- locations of plant selected at nearest point to receiver
- hours of construction activity daytime 7 am – 6 pm Monday to Friday
- worst case location assumed for separation distances between plant and receivers
- worst case fly ash capping height assumed as 940m.

It has been assumed that all plant and equipment shall be operated and maintained within relevant guidelines and health and safety requirements.

## 7.4 Construction noise impact

Tables 7-2 and Table 7-3 below detail the noise impact of the associated construction works with regard to the NSW EPA ENCM noise design goals (Section 6.2), for the indicative nearest potentially impacted receptor locations.

### 7.4.1 Sawyers Swamp realignment works

**Table 7-2: Sawyers Swamp realignment noise impact**

| Location | Adopted noise goal $L_{A10}$ | Cumulative noise impact $L_{A10}$ | Compliance |
|---|---|---|---|
| Skelly Road | 46.5 | 23 – 29.5 | Yes |
| Neubeck Street | 46.5 | 24 | Yes |
| Wolgan Road | 46.5 | 38 | Yes |
| Site 5 Woodlands | 47 | 33 | Yes |
| Maddox Lane | 47 | 33.5 | Yes |

Note: Values expressed as dB(A) and rounded to nearest 0.5 dB(A)

$L_{A10}$ = Noise level 10% of the time

### 7.4.2 Stabilisation works

**Table 7-3: Stabilisation works noise impact**

| Location | Adopted noise goal $L_{A10}$ | Cumulative noise impact $L_{A10}$ | Compliance |
|---|---|---|---|
| Skelly Road | 46.5 | 25.5 – 34.5 | Yes |
| Neubeck Street | 46.5 | 26.5 | Yes |
| Wolgan Road | 46.5 | 43 | Yes |
| Site 5 Woodlands | 47 | 38 | Yes |
| Maddox Lane | 47 | 38.5 | Yes |

Note: Values expressed as dB(A) and rounded to nearest 0.5 dB(A)

$L_{A10}$ = Noise level 10% of the time

### 7.4.3 Cumulative construction impact

The construction activities can potentially be undertaken concurrently, the cumulative noise impact of the works has been assessed, predicted noise impact levels are detailed in Table 7-4.

**Table 7-4: Cumulative construction noise impact**

| Location | Adopted noise goal $L_{A10}$ | Cumulative noise impact $L_{A10}$ | Compliance |
|---|---|---|---|
| Skelly Road | 46.5 | 27.5 – 35.5 | Yes |
| Neubeck Street | 46.5 | 28.5 | Yes |
| Wolgan Road | 46.5 | 44 | Yes |
| Site 5 Woodlands | 47 | 39.5 | Yes |
| Maddox Lane | 47 | 40 | Yes |

## 7.5 Statement of impact

The noise impact assessment for the Stage 2 construction works have been determined to be compliant with the NSW EPA ENCM noise design objectives for all identified potentially affected receivers.

- Separation distances between the nearest potentially impacted receptors and the construction working areas are such that, considered with the noise attenuation provided by the intervening topography, resultant received noise levels from the considered construction plant in operation are sufficiently mitigated to achieve the NSW EPA ENCM noise design objectives.

Construction impacts have been determined where the following assumptions have been applied:

- construction working hours are to be 7 am – 6 pm Monday to Friday and 7 am – 1 pm Saturday. No works are proposed for Sundays or Public Holidays

- construction activities should be undertaken in accordance with Australian Standard AS 2436-1981 *Guide to Noise Control on Construction, Maintenance and Demolition Sites*. All equipment used on site would be required to demonstrate compliance with the noise levels recommended within AS 2436-1981
- appropriate use of all plant and equipment, with reasonable work practices applied with no extended periods of 'revving', idling or 'warming up' within the proximity of existing residential receivers. Any excessively loud activities should be scheduled during periods of the day when an increase in general ambient noise levels is apparent. This would reduce the potential for cumulative noise impacts (relating to worst-case elevated operations) and extended periods of off-site annoyance
- works shall adopt Best Management Practice (BMP) and Best Available Technology Economically Achievable (BATEA) practices as encouraged by the NSW Department of Environment and Conservation and as addressed in current acoustic guidelines. BMP includes some of the factors discussed within this report but also includes the encouragement of a general staff attitude to reducing noise emissions. Contractors would be made aware of the problems associated with noise. BATEA practices involve the incorporation of the most advanced and affordable technology to minimise noise emissions. All plant is to be selected after considering noise emissions from the items of equipment.

Controls and management practices aimed at minimising the potential for residential annoyance have been outlined within Section 11.

Where the construction programme is subject to revision the noise impact assessment should be revised, in particular where works are to occur in closer proximity to potential receivers.

# 8. Stage 1 Existing noise environment

The existing noise impact from the haul road and fly ash placement has been established to assist in the assessment of potential change in noise impact profiles and noise model validation purposes.

Stage 1 fly ash and coal truck movements and hours of operation have been based on information provided by Delta Electricity.

## 8.1 Stage 1 operational noise assessment

### 8.1.1 Fly ash truck movements

Data from the weighbridge at WPS for the month of July 2007 was analysed to determine typical fly ash truck movements during the day (7 am – 6 pm), evening (6 pm – 10 pm) and night (10 pm – 2 am) periods.

Averaged daily fly ash truck movements are detailed in Figure 8-1, where truck numbers are determined from two truck passages; from the WPS to the repository loaded with fly ash and the return when empty.

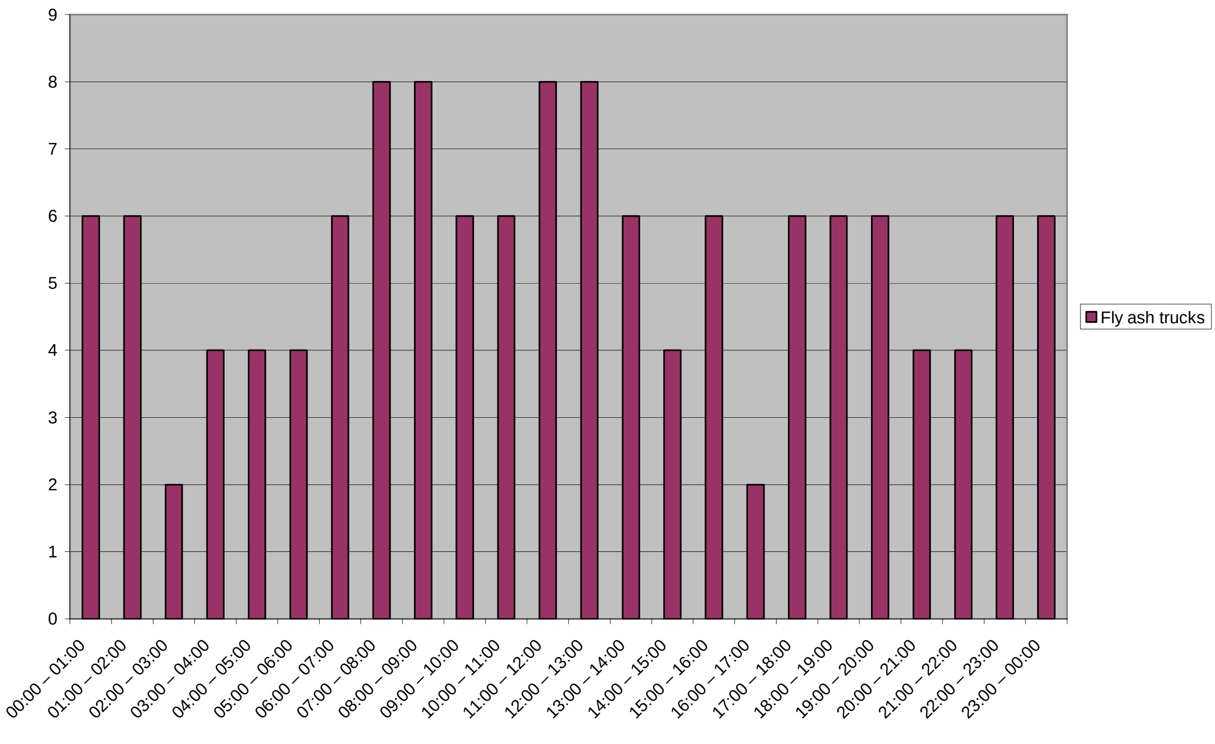


**Figure 8-1: Existing average fly ash truck movements on the haul road**

### 8.1.2 Coal truck daily movements

The WPS requires a regular supply of coal for power generation operations, associated coal truck movements are manged by the colliery. Coal is supplied to WPS from the local colliery by trucks operating on the haul road. The variable nature of coal supply and demand to WPS is such that weekly and daily average truck movements are not readily available.

Indicative monthly coal truck figures have been determined from the ratio of coal required to fly ash production. It has been assumed that the average truck volume is 50 tonnes.

- Indicative monthly coal truck requirement 2,700.
- Assumed hours of operation 7 am – 10 pm (day time 7 am – 6 pm, evening 6 pm – 10 pm).
- Coal truck events represent trucks movements to WPS loaded with coal and the return to the colliery when empty.
- Hourly truck movements assumed uniform throughout the daytime and evening periods.

## 8.2 Stage 1 existing ash placement

Stage 1 fly ash placement is currently in operation at KVAR, as detailed in Figure 2-1. Fly ash is deposited by the trucks at the edge of the ash pad where it distributed by a bulldozer and compactor to form benches.

The hours of operation for the fly ash distribution have been determined to be between day time 7 am – 6 pm and evening 6 pm – 10 pm. Hours of operation are variable dependent upon demand from fly ash delivery and is approximately 9 hours a day in total.

## 8.3 Stage 1 existing noise environment predictive model inputs

Noise modelling was carried out using ENM Software Version 3.06, the model was constructed using the following data sets:

- digital land topography 10 metre contours
- geometric spreading consistent with noise emanating from a point source
- receivers have been established relative to the topography with receiver heights of 1.2 meter above the ground.
- assumed fly ash truck movements have been determined through analysis of weighbridge data for July 2007. Coal truck movements have been determined through coal demand predictions. Fly ash truck movements are as detailed in Table 8-1
- indicative worst case 15 minute period determined as 6 fly ash trucks and 6 coal trucks
- fly ash and coal truck movements have been identified for worst case and day, evening and night time periods
- 1/3 octave sound power levels for the fly ash trucks of Lw, A 103 dB and coal trucks Lw, A of 103.5 dB
- worst case assumptions have been made for trucks travelling on the nearest lane to the receivers
- cumulative scenarios are considerate of worst case where Stage 1 fly ash trucks and coal trucks are concurrently operational
- truck pass by events at receivers have been considered to be 20 seconds in duration
- hours of operation for the trucks day time 7 am – 6 pm, evening 6 pm – 10 pm and night time 10 pm – 7 am

- it has been assumed that a compactor and bulldozer undertake the placement of fly ash within the Stage 1 area
- 1/3 octave sound power levels for the bulldozer Lw, A 113 dB and compactor Lw, A 99 dB
- 100 % and 50 % bulldozer and compactor 'on times' have been modelled
- receiver locations as presented in Figures 3-1.

## 8.4 Stage 1 noise impacts

The existing noise impact from Stage 1 has been established through predictive modelling of the operations of the haul road and the Stage 1 ash placement works. The noise impact of the coal and Stage 1 fly ash trucks is detailed in Table 8-1 and Table 8-2. The night time period has been included for consideration of emergency and abnormal events.

**Table 8-1: Existing noise impacts from Stage 1 fly ash truck and coal trucks**

| Location | Time | Noise goal | Neutral conditions ($L_{Aeq,\,15\,min}$ impacts), dB(A) fly ash truck | coal truck | cumulative |
|---|---|---|---|---|---|
| Site 1 Skelly Road | Worst case 15 mins | **38** | 38.5 | 39 | 42 |
| | Day (7 am – 6 pm) | **42** | 30 | 33 | 35 |
| | Evening (6 pm – 10 pm) | **43** | 29 | 33 | 34.5 |
| | Night (10 pm – 7 am) | **38** | 28.5 | - | - |
| Site 2 Skelly Road | Worst case 15 mins | **38** | 34.5 | 34 | 37.5 |
| | Day (7 am – 6 pm) | **42** | 24.5 | 28 | 29.6 |
| | Evening (6 pm – 10 pm) | **43** | 23.5 | 28 | 29.5 |
| | Night (10 pm – 7 am) | **38** | 23.5 | - | - |
| Neubeck Street | Worst case 15 mins | **38** | 38.5 | 39 | 42 |
| | Day (7 am – 6 pm) | **42** | 30 | 33 | 35 |
| | Evening (6 pm – 10 pm) | **43** | 29 | 33 | 34.5 |
| | Night (10 pm – 7 am) | **38** | 28.5 | - | - |
| Site 3 Wolgan Road | Worst case 15 mins | **38** | 29.5 | 30 | 33 |
| | Day (7 am – 6 pm) | **42** | 20.5 | 24 | 25.5 |
| | Evening (6 pm – 10 pm) | **43** | 19.5 | 24 | 25.5 |
| | Night (10 pm – 7 am) | **38** | 19.5 | - | - |
| Site 5 Woodlands | Worst case 15 mins | **38** | 24.5 | 25 | 28 |
| | Day (7 am – 6 pm) | **42** | 15.5 | 19 | 20.5 |
| | Evening (6 pm – 10 pm) | **43** | 14.5 | 19 | 20.5 |
| | Night (10 pm – 7 am) | **38** | 14.5 | - | - |
| Site 4 Maddox Lane | Worst case 15 mins | **38** | 25.5 | 26 | 29 |
| | Day (7 am – 6 pm) | **42** | 17 | 20.5 | 22 |
| | Evening (6 pm – 10 pm) | **43** | 16 | 20.5 | 22 |
| | Night (10 pm – 7 am) | **38** | 15.5 | - | - |

### 8.4.1 Stage 1 fly ash placement noise impact

Predicted noise impacts for Stage 1 fly ash placement works at the ash repository are provided in Table 8-2.

**Table 8-2: Stage 1 fly ash distribution noise impact**

| Location | Noise goal | | 100% on time | | | 50% on time | | |
|---|---|---|---|---|---|---|---|---|
| | Day time | Evening | Bulldozer | Compactor | Total noise impact | Bulldozer | Compactor | Total noise impact |
| Site 1 Skelly Road | 42 | 43 | 49 | 31 | 49 | 46 | 28 | 46 |
| Site 2 Skelly Road | 42 | 43 | 43 | 34 | 44 | 40 | 30.5 | 41 |
| Neubeck Street | 42 | 43 | 43 | 29 | 43 | 39.5 | 25.5 | 40 |
| Wolgan Road | 42 | 43 | 41 | 28 | 41 | 37.5 | 25 | 38 |
| Site 5 Woodlands | 42 | 43 | 38 | 25 | 38 | 34.5 | 21.5 | 35 |
| Maddox Lane | 42 | 43 | 38 | 24 | 38 | 34.5 | 21 | 35 |

Note: Values expressed as LAeq dB(A) and rounded to nearest 0.5 dB(A)

LAeq = Equivalent noise level (average)

The predicted noise impacts of the bulldozer and compactor have been determined where it has been assumed that the plant is operational at the most westerly point of the Stage 1 fly ash placement area (the closest point to residential receivers). The noise levels are considered worst case.

Fly ash placement works are transitory; it is unlikely that plant will be operational continuously through the day time or evening periods. Plant activity is determined from the frequency of fly ash delivery from WPS. In consideration of these factors worst case noise impacts are not expected to occur for the entire day time or evening periods.

## 8.5 Statement of noise impact

The established existing noise levels demonstrate that the operation of the Stage 1 fly ash trucks and the existing coal truck activities influence on the local noise environment.

- the noise impact from haul road truck movements has been determined to be 22 – 35 dB(A) daytime (7 am – 6 pm), 22 – 35 evening (6 pm – 10 pm) and night time 16 – 29 dB(A) (10 pm – 7 am)
- Skelly Road and Neubeck Street currently experience the greatest noise impact from the haul road. A noise impact range of 29 – 35 dB(A) occurs for day, evening and night time periods
- noise impacts between the day, evening and night periods demonstrate a 1 – 1.5 dB(A) change in noise level. This is reflective of the consistent movement of fly ash and coal trucks
- daytime, evening and night periods are not subject to intensification of truck movements determined noise impacts are reflective consistent truck movements

- the distribution of truck movements ensures that diurnal averaging does not 'dilute' noise impacts where the intrinsic noise impact is averaged over periods where truck operations are not in occurrence.

## 8.6 Model validation to existing haul road noise levels

Attended noise monitoring measurements were made at the nearest potentially impacted property to the private haul road during the day time and night time period. Individual coal and fly-ash truck movements on the haul road were recorded and the predicted levels have been compared to these measured noise levels.

The predicted $L_{Aeq,\ 15min}$ noise levels have been derived through the inclusion of predicted pass by noise impacts to existing background noise levels for non truck pass by periods. 3 – 5 truck pass by events were observed during monitoring periods.

The measured $L_{Aeq,\ 15min}$ noise levels are indicative of the existing ambient noise environment established during attended noise monitoring, as detailed in Section 4.

The evening period noise environments were influenced by peak road traffic noise from the Castlereagh Highway, Accordingly, the night time period is considered to be representative of received Stage 1 truck noise events, where the background noise environment is most sensitive.

**Table 8-3: Model validation results**

| Period | Measured | Predicted | Δ |
|---|---|---|---|
| Site 1 Skelly Road day time pass by event | 47 | 45 | **-2** |
| Site 1 Skelly Road 15 minute $L_{Aeq}$ (day) | 52 | 52 | **0** |
| Site 2 Skelly Road night time pass by event | 39 | 39 | **0** |
| Site 2 Skelly Road 15 minute $L_{Aeq}$ (night) | 44 | 43 | **-1** |

Note: Values expressed as LAeq dB(A) and rounded to nearest 0.5 dB(A)

The variance in noise levels is within 2 – 3 dB(A). The results indicate that the noise model is suitably accurate. Some variation during the day time can be accepted due to the influence of short term and potential a-typical noise events in the local environment during the attended monitoring. The night time measurements are known to have been conducted in the presence of minimal influencing noise events.

## 8.7 Stage 1 vibration assessment

Fly ash and coal truck pass by events and fly ash placement at the Stage 1 storage area operations occurred at a distance from receivers where potentially received vibration levels are not be of sufficient magnitude to result in human annoyance or structural damage.

Typical vibration levels from heavy trucks passing over normal (smooth) road surfaces generate relatively low vibration levels in the range of 0.01 – 0.2 millimetres per second at the footings of buildings located 10 – 20 metres from a roadway.

Vibration impacts are expected to be insignificant at a distance of 10 metres and immeasurable beyond 50 metres. Vibration emission levels would be negligible given the separation distances to the nearest potentially affected receivers. No structural damage is expected. Furthermore, annoyance due to vibration is not likely to be experienced.

Quantification of vibration levels for assessment to criteria outlined in Section 6.6, through an attended vibration monitoring program at the nearest potentially impacted receivers, is not required.

# 9. Stage 2 noise impact assessment

## 9.1 Predicted Stage 2 noise impact from the haul road

This section details the predictive noise modelling undertaken to determine the noise impact of the proposed Stage 2 operational fly ash truck movements on the private haul road. Scenarios have been presented to account for the varying fly ash truck events that will occur when Stage 2 is in operation.

For the purpose of the assessment it has been assumed that the proposed second silo for ash storage and handling at WPS will be operational. Delta Electricity have advised that the second silo will provide sufficient capacity of ash storage to restrict the transportation of fly ash to the repository during day time (7 am – 6 pm) and evening (6 pm – 10 pm) periods only. The Stage 2 operations are likely to reduce the frequency of abnormal truck movement events between 10 pm – 7 am.

The number of required fly ash trucks is not expected to vary from Stage 1 operations, an intensification of fly ash truck movements is expected during day time and evening periods.

### 9.1.1 Predicted Stage 2 fly ash truck operations

Data from the weighbridge at WPS for the month of July 2007 was analysed to determine typical fly ash truck movements during the day (7 am – 6 pm), evening (6 pm – 10 pm) periods.

Averaged daily fly ash truck movements are detailed in Figure 9-1, where truck numbers are determined from two truck passages; from the WPS to the repository loaded with fly ash and the return when empty.

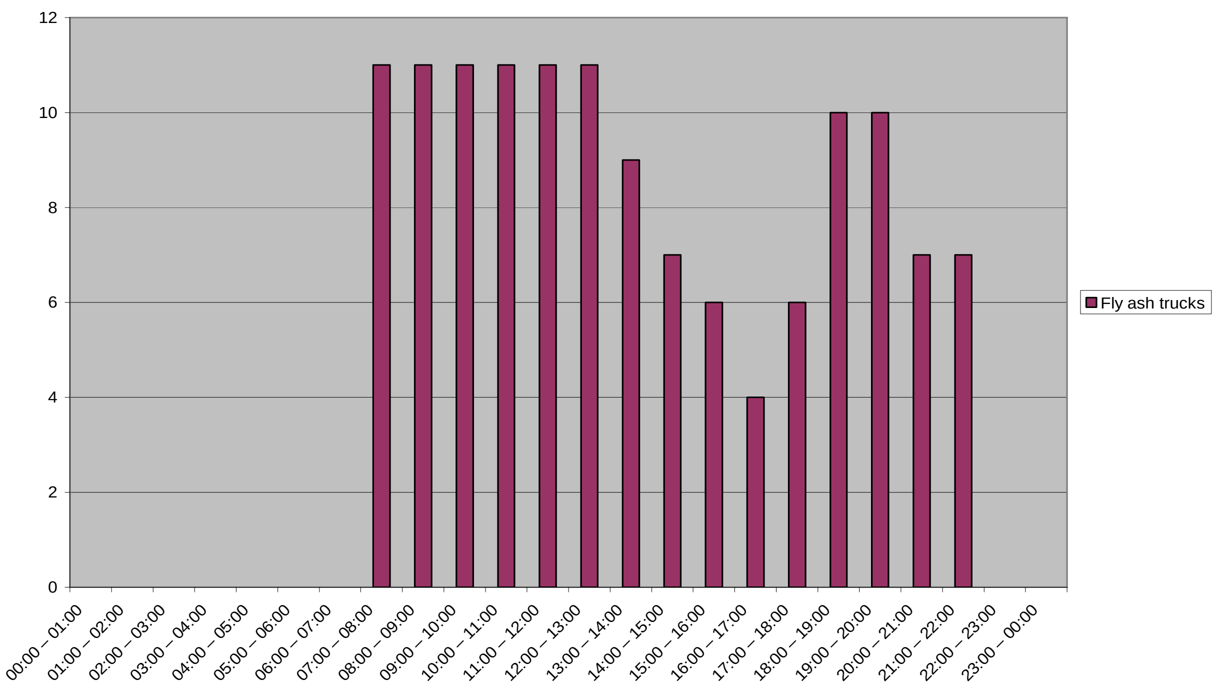


**Figure 9-1: Stage 2 average fly ash truck movements**

### 9.1.2 Predicted haul road fly ash truck noise model inputs

The prediction of the Stage 2 fly ash truck noise impacts was undertaken using a noise propagation model developed using the data sets used in the establishment of the existing noise impact model. Defined profiles for the fly ash truck noise sources allowed for the prediction of noise impact at residential receivers.

The modelling was undertaken using the Environmental Noise Model (ENM) Software Version 3.06. The modelling was based on the following:

- digital land topography 10 metre contours
- all sources set as point sources with geometric spreading consistent with noise emanating from a point source
- receivers have been established relative to the topography with receiver heights of 1.2 metres above the ground
- assumed Stage 2 fly ash truck movements have been determined through analysis of weighbridge data for July 2007. Coal truck movements have been determined through coal demand predictions. Fly ash truck movements are as detailed in Table 9-1
- indicative worst case 15 minute period determined as 6 fly ash trucks and for cumulative;6 fly ash truck and 6 coal trucks
- 1/3 octave sound power levels for the fly ash trucks of LW, A 103 dB and coal trucks LW, A of 103.5
- worst case assumptions have been made for trucks travelling on the nearest lane to the receivers
- cumulative scenarios are considered worst case where Stage 2 fly ash truck and coal truck are concurrently in operation
- it has been assumed that a programme of fly ash movement will be as detailed in Figure 9-1
- Stage 2 fly ash truck movements are proposed to be operational between 7 am – 10 pm
- truck pass by events at receivers have been considered to be 20 seconds in duration
- it has been assumed that a compactor and bulldozer undertake Stage 2 fly ash placement
- 1/3 octave sound power levels for the bulldozer LW, A 113 dB and compactor LW, A 99 dB
- 100% and 50% compactor and bulldozer on times have been considered
- receiver locations as presented in Figures 3-1.

## 9.2 Predicted haul road fly ash noise model scenarios

Scenarios have been modelled for fly ash truck operations, where a worst case scenario has been proposed accounting for potential peak fly ash truck movements of 1 per minute. The worst case scenario is designed to represent the highest predicted noise level.

The following Stage 2 scenarios have been modelled:

- Scenario 1 Stage 2 fly ash trucks day time (7 am – 6 pm), evening (6 pm – 10 pm).
- Scenario 2 Cumulative Stage 2 fly ash trucks and existing coal truck operations, day time and evening.
- Scenario 3. Stage 2 fly ash placement.

**Table 9-1: Scenario 1. Stage 2 predicted noise impact of fly ash truck operation**

| Location | Time | Noise goal | Neutral conditions ($L_{Aeq, 15 min}$ impacts), dB(A) | |
|---|---|---|---|---|
| | | | Impact | compliance |
| Site 1 Skelly Road | Worst case 15 mins | **42** | 39 | Yes |
| | Day (7 am – 6 pm) | **42** | 31.5 | Yes |
| | Evening (6 pm – 10 pm) | **43** | 31 | Yes |
| Site 2 Skelly Road | Worst case 15 mins | **38** | 35 | Yes |
| | Day (7 am – 6 pm) | **42** | 26 | Yes |
| | Evening (6 pm – 10 pm) | **43** | 26 | Yes |
| Neubeck Street | Worst case 15 mins | **42** | 39 | Yes |
| | Day (7 am – 6 pm) | **42** | 31.5 | Yes |
| | Evening (6 pm – 10 pm) | **43** | 31 | Yes |
| Site 3 Wolgan Road | Worst case 15 mins | **42** | 30 | Yes |
| | Day (7 am – 6 pm) | **42** | 22 | Yes |
| | Evening (6 pm – 10 pm) | **43** | 21.5 | Yes |
| Site 5 Woodlands | Worst case 15 mins | **42** | 25 | Yes |
| | Day (7 am – 6 pm) | **42** | 17 | Yes |
| | Evening (6 pm – 10 pm) | **43** | 17 | Yes |
| Site 4 Maddox Lane | Worst case 15 mins | **42** | 26 | Yes |
| | Day (7 am – 6 pm) | **42** | 18.5 | Yes |
| | Evening (6 pm – 10 pm) | **43** | 18 | Yes |

**Table 9-2: Scenario 2. Predicted noise impact of fly ash and coal truck operation**

| Location | Time | Noise goal | Neutral conditions ($L_{Aeq,\ 15\ min}$ impacts), dB(A) | | | |
|---|---|---|---|---|---|---|
| | | | fly ash truck | coal truck | cumulative | compliance |
| Site 1 Skelly Road | Worst case 15 mins | 42 | 39 | 39 | 42 | Yes |
| | Day (7 am – 6 pm) | 42 | 31.5 | 33 | 35.5 | Yes |
| | Evening (6 pm – 10 pm) | 43 | 31 | 33 | 35 | Yes |
| Site 2 Skelly Road | Worst case 15 mins | 42 | 34 | 34 | 37 | Yes |
| | Day (7 am – 6 pm) | 42 | 26 | 28 | 30 | Yes |
| | Evening (6 pm – 10 pm) | 43 | 26 | 28 | 30 | Yes |
| Neubeck Street | Worst case 15 mins | 42 | 39 | 39 | 42 | Yes |
| | Day (7 am – 6 pm) | 42 | 31.5 | 33 | 35.5 | Yes |
| | Evening (6 pm – 10 pm) | 43 | 31 | 33 | 35 | Yes |
| Site 3 Wolgan Road | Worst case 15 mins | 42 | 30 | 30 | 33 | Yes |
| | Day (7 am – 6 pm) | 42 | 22 | 24 | 26 | Yes |
| | Evening (6 pm – 10 pm) | 43 | 21.5 | 24 | 26 | Yes |
| Site 5 Woodlands | Worst case 15 mins | 42 | 25 | 25 | 28 | Yes |
| | Day (7 am – 6 pm) | 42 | 17 | 19 | 21 | Yes |
| | Evening (6 pm – 10 pm) | 43 | 17 | 19 | 21 | Yes |
| Site 4 Maddox Lane | Worst case 15 mins | 42 | 26 | 26 | 29 | Yes |
| | Day (7 am – 6 pm) | 42 | 18.5 | 20.5 | 22.5 | Yes |
| | Evening (6 pm – 10 pm) | 43 | 18 | 20.5 | 22.5 | Yes |

**Table 9-3: Comparison Stage 1 and Stage 2 fly ash truck haul road noise impacts**

| Location | Period | Neutral conditions | | |
|---|---|---|---|---|
| | | Stage 1 | Stage 2 | Change |
| Site 1 Skelly Road | Worst case 15 mins | 38.5 | 39 | +0.5 |
| | Day (7 am – 6 pm) | 30 | 31.5 | +1.5 |
| | Evening (6 pm – 10 pm) | 29 | 31 | +2 |
| | Night (10 pm – 7 am) | 28.5 | - | Impact removed |
| Site 2 Skelly Road | Worst case 15 mins | 34.5 | 35 | +0.5 |
| | Day (7 am – 6 pm) | 24.5 | 26 | +1.5 |
| | Evening (6 pm – 10 pm) | 23.5 | 26 | +2.5 |
| | Night (10 pm – 7 am) | 23.5 | - | Impact removed |
| Neubeck Street | Worst case 15 mins | 38.5 | 39 | +0.5 |
| | Day (7 am – 6 pm) | 30 | 31.5 | +1.5 |
| | Evening (6 pm – 10 pm) | 29 | 31 | +2 |
| | Night (10 pm – 7 am) | 28.5 | - | Impact removed |
| Site 3 Wolgan Road | Worst case 15 mins | 29.5 | 30 | +0.5 |
| | Day (7 am – 6 pm) | 20.5 | 22 | +1.5 |
| | Evening (6 pm – 10 pm) | 19.5 | 21.5 | +2 |
| | Night (10 pm – 7 am) | 19.5 | - | Impact removed |
| Site 5 Woodlands | Worst case 15 mins | 24.5 | 25 | +0.5 |
| | Day (7 am – 6 pm) | 15.5 | 17 | +1.5 |
| | Evening (6 pm – 10 pm) | 14.5 | 17 | +2.5 |
| | Night (10 pm – 7 am) | 14.5 | - | Impact removed |
| Site 4 Maddox Lane | Worst case 15 mins | 25.5 | 26 | +0.5 |
| | Day (7 am – 6 pm) | 17 | 18.5 | +1.5 |
| | Evening (6 pm – 10 pm) | 16 | 18 | +2 |
| | Night (10 pm – 7 am) | 15.5 | - | Impact removed |

## 9.3 Stage 2 fly ash placement noise impact

Stage 2 fly ash placement works are assumed to be undertaken as existing for Stage 1 operations; it has been assumed a bulldozer and compactor will be in operation. A worst case scenario where plant is operational at the nearest point to the potential receivers has been assumed.

**Table 9-4: Scenario 3: Predicted noise impact of Stage 2 fly ash placement**

| Location | Noise goal | | 100% on time | | | 50% on time | | |
|---|---|---|---|---|---|---|---|---|
| | Day time | Evening | Bulldozer | Compactor | Total noise impact | Bulldozer | Compactor | Total noise impact |
| Site 1 Skelly Road | 42 | 43 | 33 | 23 | 33.5 | 30 | 20 | 30.5 |
| Site 2 Skelly Road | 42 | 43 | 34.5 | 22 | 35 | 31.5 | 19 | 32 |
| Neubeck Street | 42 | 43 | 32.5 | 20.5 | 33 | 29.5 | 17.5 | 30 |
| Wolgan Road | 42 | 43 | 31 | 19 | 31 | 28 | 16 | 28 |
| Site 5 Woodlands | 42 | 43 | 29 | 17.5 | 29.5 | 26 | 14.5 | 26.5 |
| Maddox Lane | 42 | 43 | 29 | 19 | 29.5 | 26 | 16 | 26.5 |

Note: Values expressed as LAeq dB(A) and rounded to nearest 0.5 dB(A)

$L_{Aeq}$ = Equivalent noise level (average)

The predicted noise impact of the proposed Stage 2 fly ash placement works demonstrate compliance with the required day time and evening noise design goals of the NSW INP. Noise impact prediction determines that compliance is within 10 dB(A) of the noise goals.

# 10. Statement of predicted noise impacts

The predicted noise impact of the proposed Stage 2 fly ash truck operations and the cumulative predicted noise impact of Stage 2 fly ash trucks and the continuation of the existing coal trucks have been considered below. Noise impacts have been stated and as required, comparison to the NSW INP noise design goals, established in Section 7.3, has been undertaken.

A sample ENM ranking file has been included as Appendix D. A sample ENM output file is included as Appendix E.

To aid in the assessment of results, noise contour impact isopleths have been prepared for the Stage 2 cumulative noise impact levels during the day time and evening period. It should be noted that the contour plots are provided to aid visual interpretation only.

## 10.1 Stage 2 proposed fly ash truck movements

The noise modelling for the study area details predicted noise impacts from Stage 2 fly ash trucks, under neutral meteorological conditions, to be 19 – 32 dB(A) during the day time period (7 am – 6 pm), 18 – 31 dB(A) during the evening period (6 pm – 10 pm). Stage 2 operations remove night time noise impacts except under abnormal or emergency conditions.

The nearest potentially impacted receptors, Skelly Road and Neubeck Street are predicted to experienced the greater received noise impacts; 26 – 32 dB(A). Wolgan Road, Site 5 Woodlands and Maddox Lane are located at a greater distance from the haul road where predicted received noise impacts are 9 – 15 dB(A) less.

Where gradient winds occur over a 15 minute period or longer, the noise impact from the fly ash trucks operating on the haul road would be increased for all receivers during the day and evening periods. An increase of between 1 – 6 dB(A) would not be unreasonable to expect (dependent on location). It should be noted that the analysis of regional meteorological conditions indicted that noise enhancing conditions need not be considered.

Stage 2 fly ash truck movements are not subject to short term periods of intensification sufficient to influence the diurnal averages.

## 10.2 Noise impact Stage 1 fly ash to Stage 2 fly ash operations

Resultant from increased fly ash management capacity provided by the second silo at WPS, the associated Stage 2 fly ash truck movements are predicted to be in occurrence during the day time and evening periods only. This represents a reduction in the potential hours of operation from Stage 1, achieved through increased fly ash truck movements during the day time and evening periods.

In order to determine the potential noise impact of this change upon the local environment, comparison of the Stage 1 noise impact and Stage 2 noise impacts has been considered. Comparative analysis has determined the following:

- predicted worst case 15 minute scenario noise impacts are expected to increase by less than 1 dB(A)

- day time (7 am – 6 pm) received noise impacts are predicted to increase by less than 2 dB(A) $L_{Aeq\ 11\ hour}$
- evening (6 pm – 10 pm) received noise impacts are predicted to increase by less than 3 dB(A) $L_{Aeq\ 8\ hour}$
- night time (10 pm – 7 am) experiences no noise impact as fly ash truck operation not required under normal operations.

Whereas the proposed Stage 2 fly ash truck operations have been predicted to result in an increase in received noise impacts during the day time and evening periods, the removal of night time operations is considered an over riding benefit of the proposal from existing Stage 1 fly ash truck haul road operations.

## 10.3 Noise impact Stage 2 fly ash and coal operations

Stage 2 fly ash truck movements on the haul road are to operate concurrently with ongoing coal truck operations. The Stage 2 proposal is not expected to result in changes to existing coal supplies and associated coal truck requirements, as detailed in Section 8.

Received noise impacts from coal truck operations have been predicted to be approximately 2 dB(A) greater than for Stage 2 fly ash trucks. As such the coal trucks have been considered to be the primary influence to cumulative noise levels.

Table 9-3 details the discrete and cumulative noise impacts of the proposed Stage 2 operational fly ash trucks and existing coal truck operations.

The cumulative noise impacts are provided in summary below:

- Skelly Road and Neubeck Street predicted received cumulative noise impacts: 30 – 36 dB(A) day time (7 am – 6 pm) and 30 – 35 dB(A) evening (6 pm – 10 pm)
- Wolgan Road, Site 5 Woodlands and Maddox Lane predicted received cumulative noise impacts:21 – 26 dB(A) day time and evening periods
- no night time cumulative noise impacts are predicted as fly ash and coal truck operations are not required
- comparison to Stage 1 cumulative noise levels demonstrates received noise levels are predicted to experience a increase of up to 0.5 dB(A).

## 10.4 Industrial noise policy compliance

In accordance with the NSW Industrial Noise Policy guidance, predicted noise levels from the proposed Stage 2 fly ash truck haul road operations have been assessed with regard to the adopted intrusive noise criteria, as detailed in Section 6.

### 10.4.1 Stage 2 fly ash truck noise impact compliance

Table 9-2 details the predicted noise impact of the Stage 2 fly ash trucks relative to the INP intrusive noise design goals for the day time and evening period operations.

For all receptors within the noise catchment area the day time and evening period noise levels are predicted to be compliant with the adopted intrusive noise design goals of 43 dB(A) day time and 42 dB(A) evening.

### 10.4.2 Stage 2 cumulative noise impact compliance

The cumulative noise impact of the Stage 2 fly ash trucks and the coal trucks for the worst case period (15 minute) are predicted to result in compliance for properties in the Lidsdale region determined from assessment of indicative nearest potentially impacted receptors.

The day time, evening and night time periods demonstrate compliance with the intrusive noise design goals.

Skelly Road and Neubeck Street have predicted worst case cumulative noise impacts of 42 dB(A) $L_{Aeq,\ 15\ mins}$ which is the intrusive noise design goal. In order to ensure received noise impacts maintain INP compliance adoption of management measures considered in Section 11 is recommended.

## 10.5 Short term intensification noise impact

The nature of the fly ash generation, storage and handling at WPS is such that reduced efficiency or break down of plant and equipment could result in short term intensification to the Stage 2 fly ash truck operations.

Application of assumed worst case 15 minute scenario operations, extended for throughout day time and evening periods, would correspond to an increase in received noise impact of up to 3 dB(A) for each period. This would account for a ‘doubling’ of truck movements in a given period.

Given the time associated with ash loading at the silo, unloading of ash at the repository and required journey times on the haul road it is considered unlikely that operational capacity could be maintained for the entire period durations.

A 3 dB(A) increase to the cumulative noise impacts would not result in a potential exceedance of the NSW INP adopted noise design goal at any identified receptors (neutral meteorological conditions).

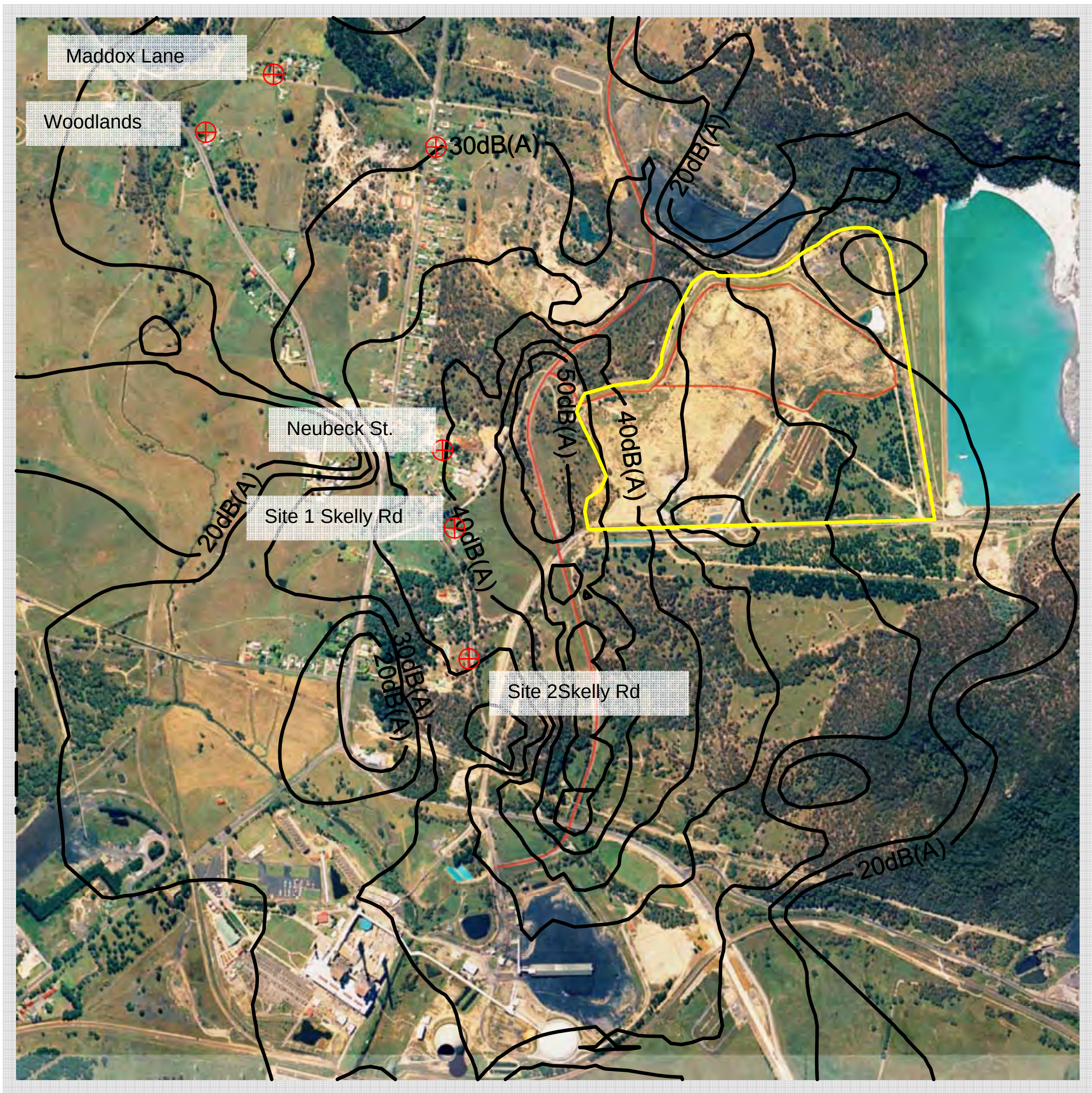


**Figure 10-1: Noise impact isopleth (Stage 2 cumulative impacts), worst case $L_{Aeq, 15min}$**

## 10.6 Sleep disturbance noise impact

The proposal for Stage 2 fly ash operations on the haul road and at the ash repository are to be undertaken during the day time and evening periods. No night time (10 pm – 7 am) operations are proposed under normal operations.

It has therefore been determined that an assessment of potential sleep disturbance at the nearest potentially impact receptors for normal Stage 2 haul road operations is not required.

Where proposed Sate 2 operations may require emergency or abnormal fly ash truck movements during the night time period, assessment of potential sleep disturbance should be carried out. A sleep disturbance assessment for emergency or abnormal works is detailed in Section 11.2.

## 10.7 Stage 2 operational vibration impact assessment

Stage 2 operational events have been determined to be consistent with the Stage 1 operational events and are not predicted to have a perceived impact at the nearest potentially impacted receivers.

A quantitative assessment of ground borne vibration has not been determined.

# 11. Recommended noise management and mitigation measures

## 11.1 Day time and evening fly ash operations

As detailed in Section 9, the Stage 2 fly ash truck operational noise impact assessment has determined received potential noise levels at the nearest receptors to be compliant with NSW INP noise design goals.

The worst case scenario of 7 fly ash trucks and 6 coal trucks in operation on the haul road has been predicted to result in received noise impacts of 42 dB(A) $L_{Aeq,\ 15\ mins}$ at the nearest receptors on Skelly Road. The adopted intrusive day time (7 am – 6 pm) noise design goal is 42 dB(A) $L_{Aeq,\ 15\ mins}$.

In order to reduce the potential for received noise impact creep and possible non compliance, a series of noise management recommendations have been provided below.

### 11.1.1 Operational noise management plan

It is recommended that a noise management plan as part of the OEMP for the proposed Stage 2 ash transfer be implemented, to manage potential noise impacts from the fly ash trucks. This noise management plan should consider, and is not limited to, the following:

#### Management of fly ash truck movements

The cumulative noise impact of fly ash trucks and the coal trucks operating on the road may result in potential noise design goal non compliance where truck movements are exceeded above the assumed worst case scenario of 6 fly ash trucks and 6 coal trucks operating in any day time or evening 15 minute period. The worst case scenario has been developed through application of Stage 1 fly ash weighbridge data and indicative monthly coal volume demand.

Fly ash truck operations are not routine, it is considered that implicit restriction on potential movements would be unfeasible and potentially result in intensification of truck operations at a later period.

Accordingly, management of fly ash truck movements should be a desired objective and not an overriding requirement. During periods of consistent fly ash transportation or where fly ash storage capacity allows, fly ash truck movements should be staged to ensure that worst case scenario conditions are not exceeded.

It is noted that coal truck movements are not managed by WPS. Where feasible, negotiation with the colliery to avoid intensive coal truck movements would be beneficial.

#### Source noise emissions

Delta Electricity should consider each of the following items to ensure every reasonable effort is made to minimise noise emission potential from the fly ash trucks:

- Residential class mufflers and, where applicable, engine shrouds (acoustic lining) to the engine would be used. Noise emissions would be an important consideration when selecting equipment for the site. All equipment would be maintained in good order including mufflers, enclosures and bearings to ensure unnecessary noise emissions are eliminated.

- Appropriate use of all plant and equipment, speed limit restrictions would be expected to result in a reduction of noise impact potential.
- Develop an operational noise management plan. The management plan would identify and address noise impacts on all potentially affected receivers, and provide procedures, noise mitigation measures and noise management practices proposed throughout the duration of the works as part of the OEMP.

**Hours of operation**

In line with the Stage 2 proposal, fly ash truck movements on the haul road should endeavour to occur between the hours of day time (7 am – 6 pm) and evening (6 pm – 10 pm). The operational noise impact assessment has determined that consolidation of daily average fly ash truck movements within these hours would ensure compliance with adopted NSW INP noise design goals.

Non operation of fly ash trucks during the night time period (10 pm – 6am) would remove potential noise impacts for the Lidsdale community during the most sensitive period of the noise environment.

**Truck and haul road maintenance program**

Noise emissions from the operational fly ash truck movements typically are from sources such as the tyre / road interface, engine and gear box, engine exhaust outlets and aerodynamic resistance.

Discrete measures to address the noise emissions are considered above. There are associated costs and time implications of detailed source noise mitigations. Where such measures are deemed unfeasible a routine maintenance program for the trucks can prevent exacerbation of noise emissions.

Maintenance would ensure engine and mechanical component efficiency, minimisation of exhaust noise breakout and appropriate tyre pressure and tread requirements.

The maintenance program should be extended, in consultation with the appropriate bodies, to include the haul road surface to ensure features which can contribute to increased noise impacts, such as holes or uneven surfaces, are minimised.

### 11.1.2 Post commissioning noise monitoring

Upon commissioning of Stage 2 operations, it is recommended that a noise monitoring strategy at the nearest potentially impacted receptors be implemented. The monitoring strategy would permit validation of the predicted noise impacts and an indicator of NSW INP noise design goal compliance. The monitoring strategy and subsequent reporting should be undertaken by a suitably qualified independent acoustic consultant.

Monitoring would typically involve periodic, short term day time and evening operator attended noise monitoring at identified key noise sensitive receptors during known periods of typical fly ash truck movements.

It is advised that the measured truck pass by noise impacts be used as a measure of Stage 2 performance and best practice evaluation rather than an indicative compliance exercise.

The results of the monitoring should be applied to appraisal of fly ash truck operations and to provide a feedback loop to the operational noise management plan.

## 11.2 Emergency and abnormal fly ash truck movements

The produced fly ash storage at WPS and distribution to the repository area can be subject to emergency and abnormal events which have propensity to require operations on the haul road additional to the day time (7 am – 6 pm) and evening (6 pm – 10 pm) periods. This has been reflected in the average fly ash truck movements for Stage 1, detailed in Section 8.

The night time period (10 pm – 7 am) is considered the indicative worst case for fly ash truck operations where the background noise levels are most sensitive. The following measures are designed to ensure that, where feasible, emergency and abnormal operations can be managed to minimise the resultant noise impact upon the localised environment.

### 11.2.1 Management of fly ash truck movements

Predictive assessment of fly ash truck noise impacts has been undertaken for the night time period (10 pm – 7 am) to NSW INP adopted intrusive night time noise design goal of 38 dB(A) $L_{Aeq}$ and a ENCM sleep disturbance criterion of 49 dB(A) $L_{A1.}$ It has been assumed that no coal trucks would be operation during the night time period.

In order to prevent potential non compliance of the noise design goals at the nearest noise sensitive receptors, identified to be Skelly Road, fly ash truck movements should be, where feasible, limited to a maximum of 5 trucks per 15 minute period.

This corresponds to a total of 10 truck movements accounting for two truck passages: from the WPS to the repository loaded and the return when unloaded.

The predicted noise impact of 10 fly ash truck movements at the nearest potentially impacted receptors would be 38 dB(A) $L_{Aeq,\ 15mins}$, which would be compliant with the noise design criteria.

The sleep disturbance criterion is determined for peak noise emissions for an individual truck pass. The application of truck $L_{A1}$ source term data determined a potential noise impact at the nearest receptors of 57 dB(A) $L_{A1}$. This would correspond to each truck pass by resulting in a potential sleep disturbance criteria exceedance of 8 dB(A) at the receptor.

The sleep disturbance assessment is determined through the noise impact of a discrete truck pass by peak noise event; it is not possible to recommend total fly ash truck movements for 15 minute or night time periods to achieve noise goal compliance.

It should be noted that the nature of emergency and abnormal events are such that constraint of operational parameters is not always applicable.

### 11.2.2 Adoption of sleep disturbance criteria

Sleep disturbance is subjective and accordingly criteria are not commensurate to all individuals. The adopted design goal determined from the ENCM of 49 dB(A) $L_{A1}$ is not the sole descriptor for sleep disturbance. World Health Organisation (WHO) guidance advises measurable disturbance to sleep from a continuous noise source commences at approximately 30 dB(A) $L_{Aeq}$ and for intermittent events 40 – 45 dB(A) $L_{Amax}$ An external façade noise level of 45 dB(A) $L_{Aeq}$ is recommended to ensure resultant internal noise environments, where windows are open, are within 35 – 37 dB(A) $L_{Aeq}$.

The noise impact assessment determined worst case received external noise levels to be up to 42 dB(A) for the cumulative noise impact of fly ash and coal trucks. This would result in a reciprocal internal noise level within WHO guidelines.

It is recommended that where potential sleep disturbance is considered as an assessment parameter for noise impact potential and, where required, the establishment of noise management and mitigation measures, it should be considerate of the range of recommended noise design goals.

# 12. Conclusion

This report documents an assessment of environmental noise and vibration issues for the proposed construction and operation of the stage 2 KVAR fly ash placement works.

A number of varying source emission scenarios were considered with impact potential (and loss of residential amenity / noise intrusion) compared with site-specific noise design goals derived in accordance with NSW Department of Environment and Climate Change guidelines.

No adverse noise impacts are expected to occur as a result of the required construction works.

Stage 2 works are proposed to be undertaken day time (7 am – 6 pm) and evening (6 pm – 10 pm) periods only. The noise impact assessment for these periods, including an indicative worst case cumulative fly ash and coal truck operational scenario, have been determined to be compliant with NSW INP noise design goal criteria for the nearest receptors.

The nature of WPS operations can require emergency and abnormal works to be undertaken which can involve fly ash truck movements during the night time (10 pm – 7 am) period. Predictive noise impact assessment for truck events during this period determined that where fly ash truck movements did not surpass 5 trucks (10 total movements) in any given 15 minute period, the night time period noise design goal of 38 dB(A) $L_{Aeq,\ 15\ mins}$ would not be exceeded.

The EPA ENCM sleep disturbance criteria of 49 dB(A) $L_{A1}$ for discrete truck pass by peak noise events is predicted to be exceeded by up to 8 dB(A).

To address potential sleep disturbance criteria exceedance, and to prevent potential for increases in received noise level which may result in future non compliance events, a range of noise management and mitigation measures have been recommended.

An operational noise management plan has been recommended to incorporate and address impact profiles for all potentially affected receivers and provide procedures, mitigation measures and management practices proposed throughout the duration of the works program.

# 13. References

AS 2436-1981 *Guide to Noise Control on Construction, Maintenance and Demolition Sites*

DIN 4150-3 1999 *Structural Vibration Part 3 Effects of Vibration on Structures*

NSW DEC Environmental Noise Management Assessing Vibration: a technical guideline (2006)

NSW EPA *Environmental Noise Control Manual* (1994)

NSW EPA *Industrial Noise Policy* (2000)

Protection of the Environment Operations Act (1997)

UK Department of Transport *Calculation of Road Traffic Noise* .

# 14. Limitations

### Scope of services and reliance of data

This noise impact study ('the study') has been prepared in accordance with the scope of work/services set out in the contract, or as otherwise agreed, between Parsons Brinckerhoff (PB) and the Client. In preparing this noise impact study, PB has relied upon data, surveys, analyses, designs, plans and other information provided by the Client and other individuals and organisations, most of which are referred to in the noise impact study ('the data'). Except as otherwise stated in the noise impact study, PB has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in this noise impact study ('conclusions') are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. PB will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to PB.

### Other limitations

To the best of PB's knowledge, the proposal presented and the facts and matters described in this noise impact study reasonably represent the Client's intentions at the time of printing of the noise impact study. However, the passage of time, the manifestation of latent conditions or the impact of future events (including a change in applicable law) may have resulted in a variation of the Proposal and of its possible noise impact.

PB will not be liable to update or revise the noise impact study to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of the noise impact study.

# Appendix A

Instrument set calibration certificates

# Sound Level Meter Test Report

Report Number : 07146.doc

**Date of Test :** 15/05/2007

**Report Issue Date :** 16/05/2007

**Equipment Tested:** **ARL Noise Logger**

**Model Number:** EL-316

**Serial Number:** 16-207-008

**Client Name :** Parsons Brinckerhoff

Ernst & Young Centre, Level 27, 680 George St

Sydney NSW 2000

**Contact Name :** Shane Harris

**Tested by :** Morgan Rae

**Approved Signatory :**

**Ken Williams**

**Date :** **16th May 2007.**

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Noise and Vibration Monitoring Instrumentation for Industry and the Environment

# Sound Level Meter Test Report

Report Number : 07147.doc

**Date of Test :** 15/05/2007

**Report Issue Date :** 16/05/2007

**Equipment Tested:** **ARL Noise Logger**

**Model Number:** EL-316

**Serial Number:** 16-207-009

**Client Name :** Parsons Brinckerhoff

Ernst & Young Centre, Level 27, 680 George St

Sydney NSW 2000

**Contact Name :** Shane Harris

**Tested by :** Morgan Rae

**Approved Signatory :**

**Ken Williams**

**Date :** **16th May 2007.**

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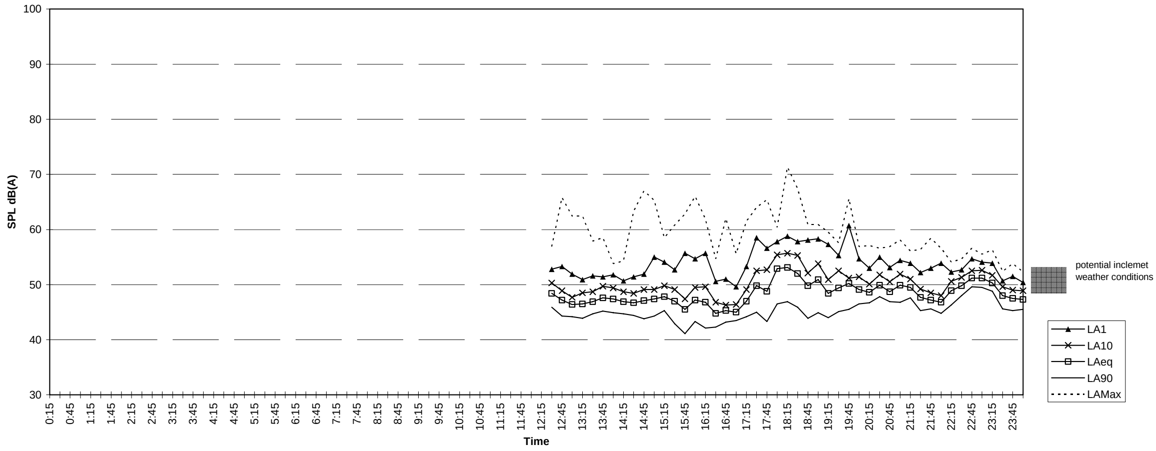
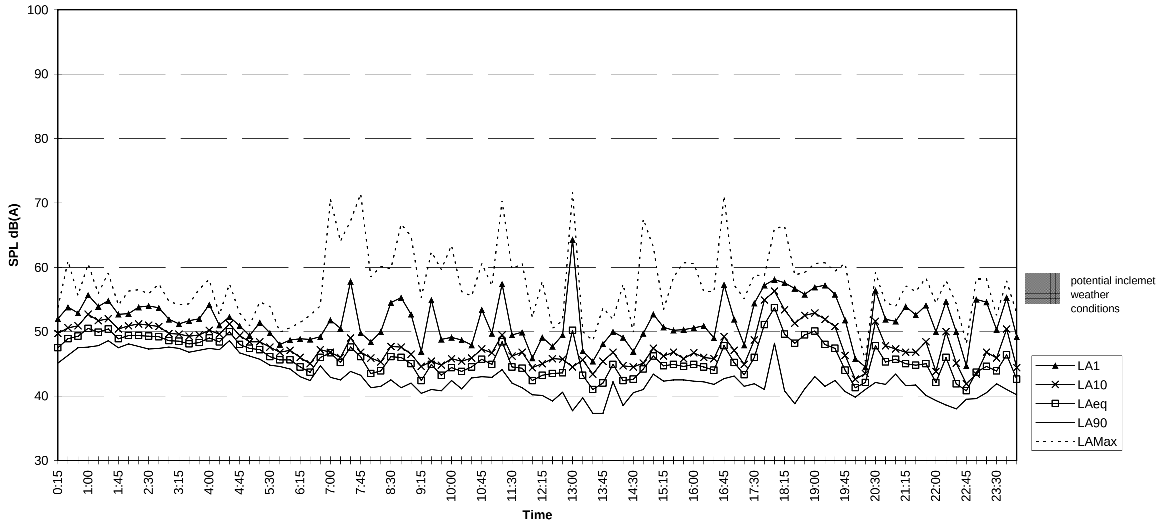
# Appendix B

Daily noise logger graphs

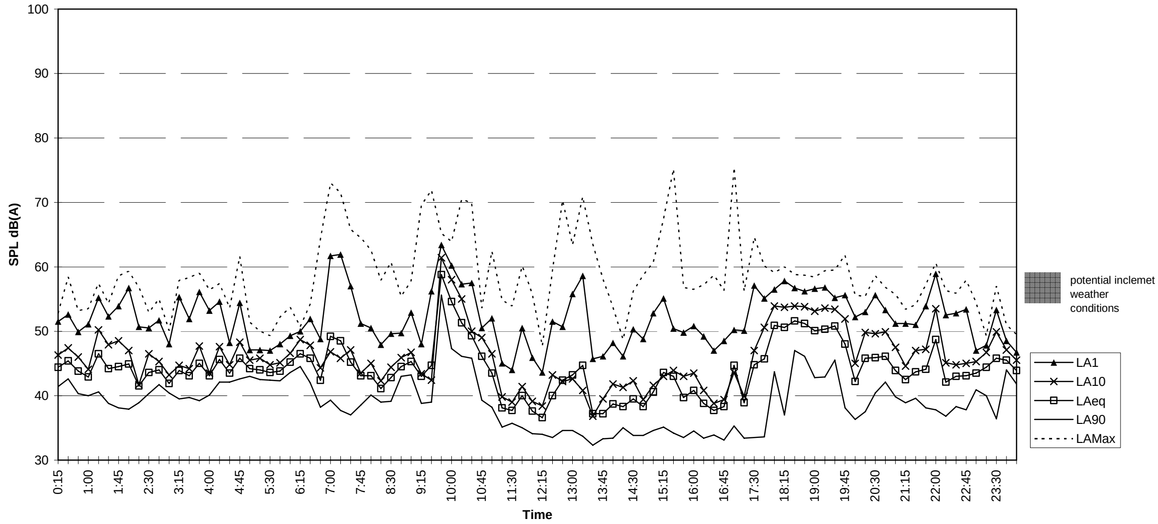
**Location 1 - Skelly Road**
**Measured Noise Levels - Friday 20th July, 2007**



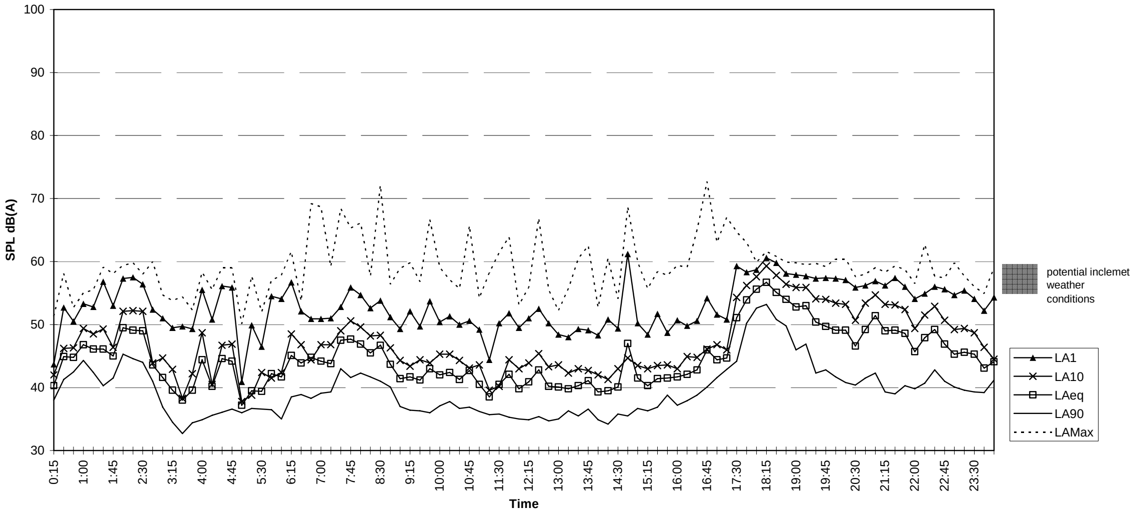

**Location 1 - Skelly Road**
**Measured Noise Levels - Saturday 21st July, 2007**



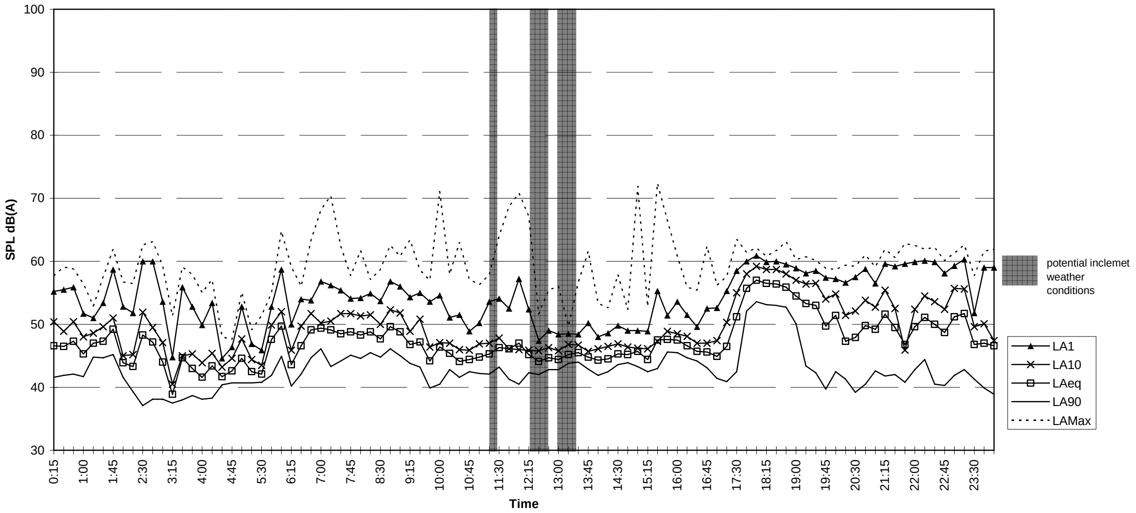

**Location 1 - Skelly Road**
**Measured Noise Levels - Sunday 22nd July, 2007**



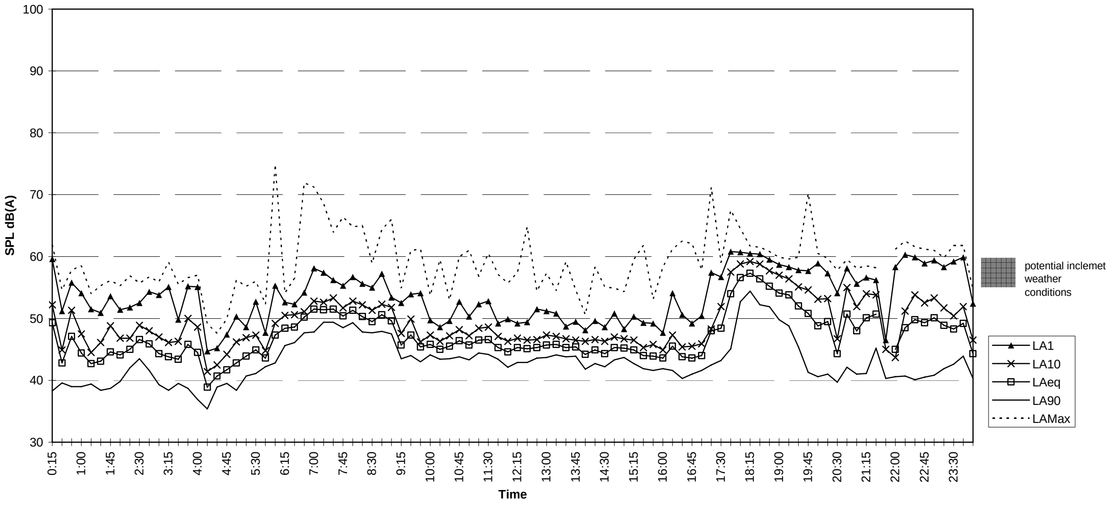
**Location 1 - Skelly Road**
**Measured Noise Levels - Monday 23rd July, 2007**



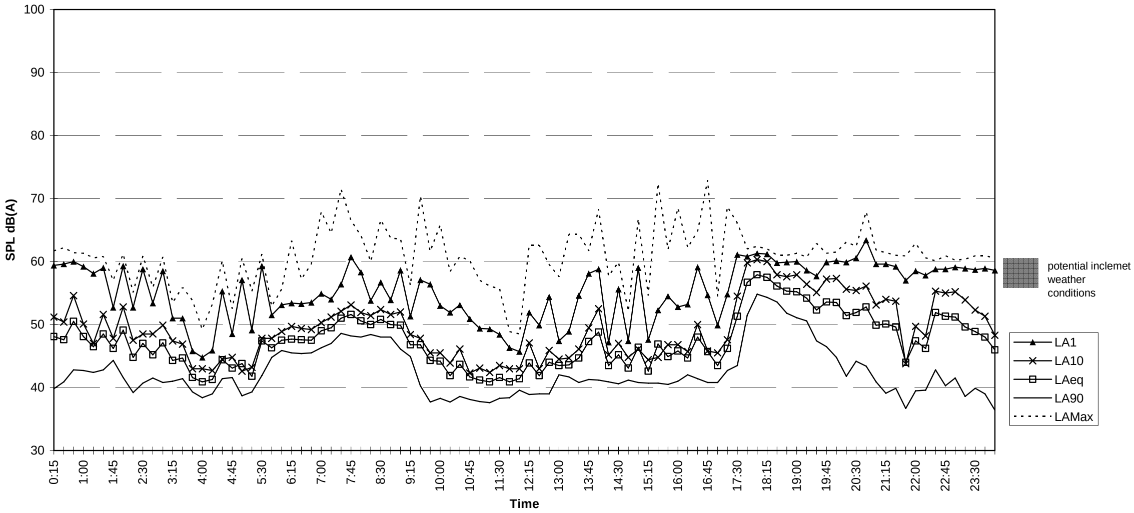

**Location 1 - Skelly Road**
**Measured Noise Levels - Tuesday 24th July, 2007**



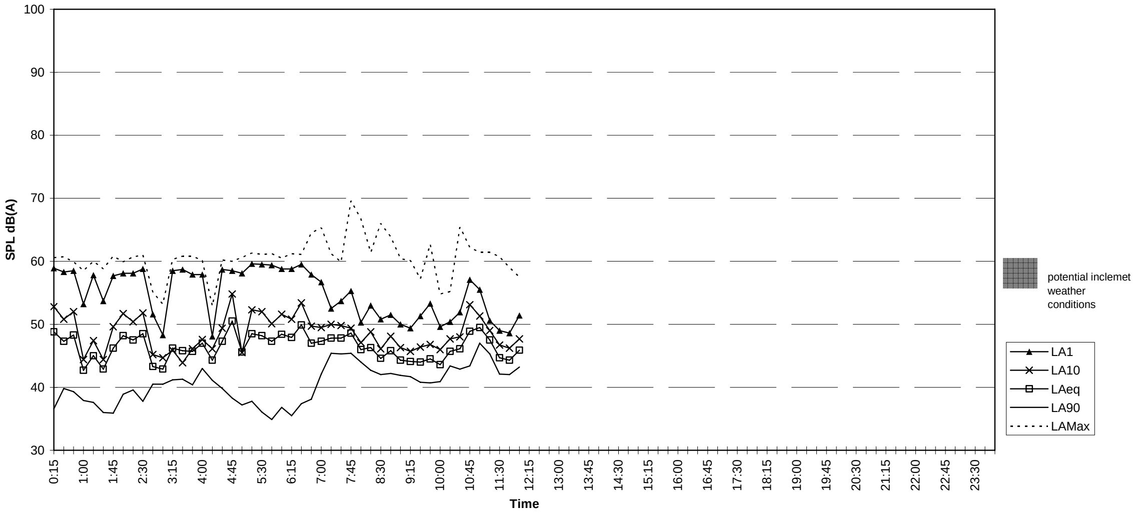

**Location 1 - Skelly Road**
**Measured Noise Levels - Wednesday 25th July, 2007**



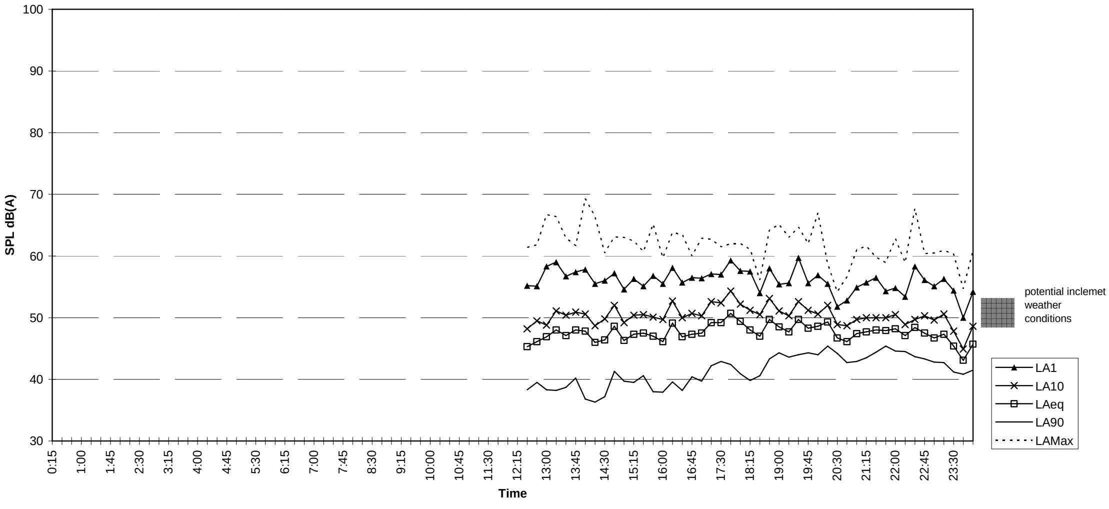
**Location 1 - Skelly Road**
**Measured Noise Levels - Thursday 26th July, 2007**



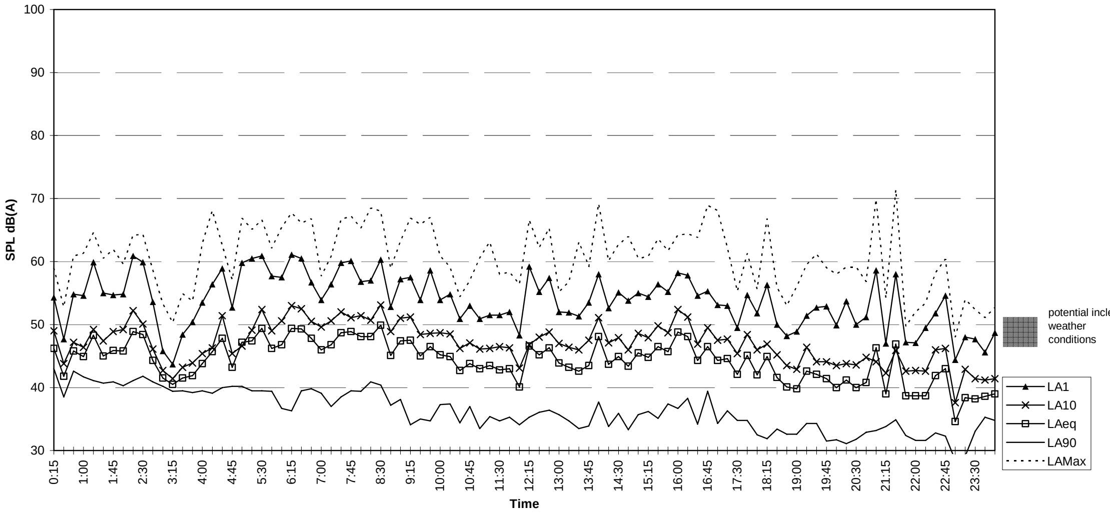

**Location 1 - Skelly Road**
**Measured Noise Levels - Friday 27th July, 2007**



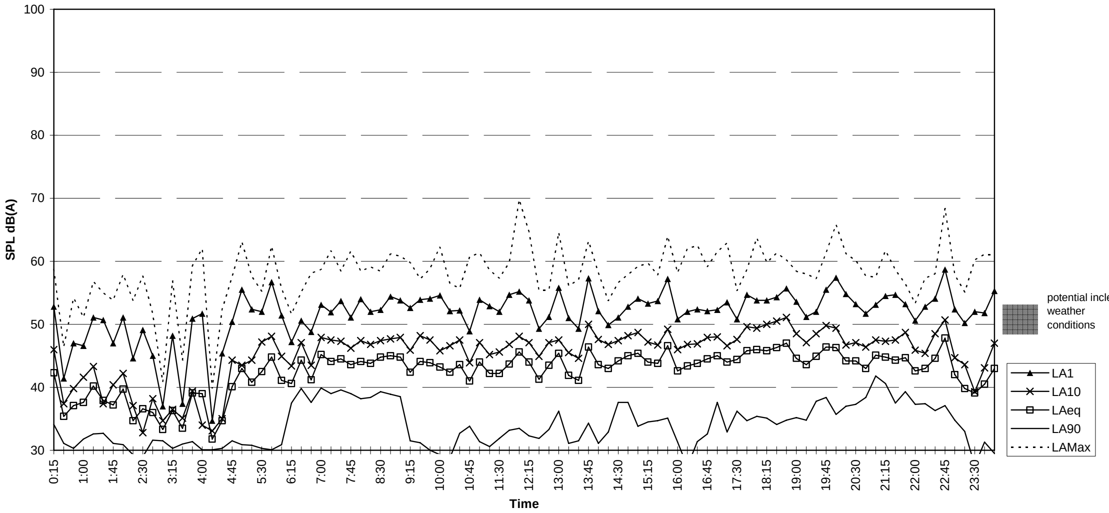

**Location 2 - Woodlands**
**Measured Noise Levels - Friday 20th July, 2007**



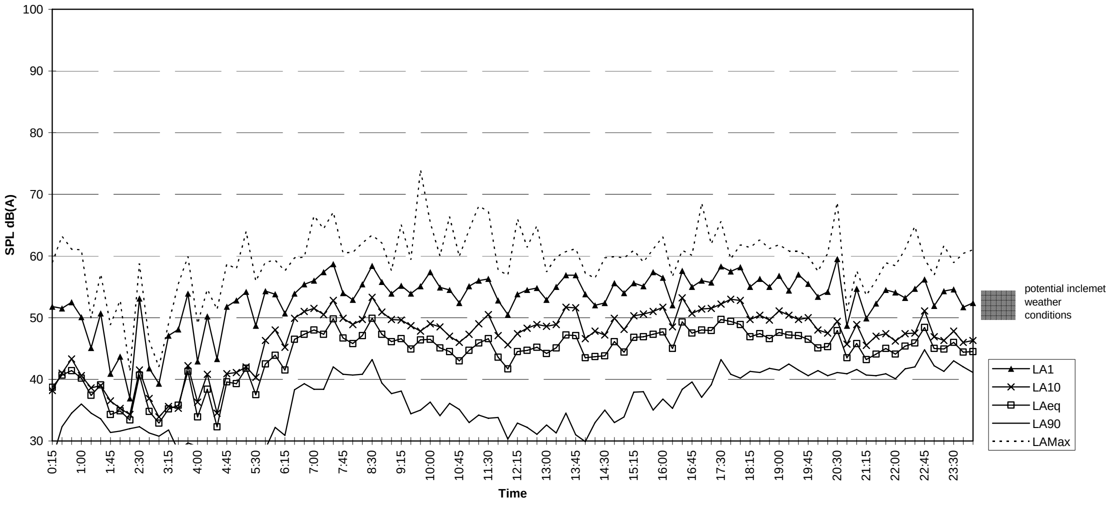
**Location 2 - Woodlands**
**Measured Noise Levels - Saturday 21st July, 2007**



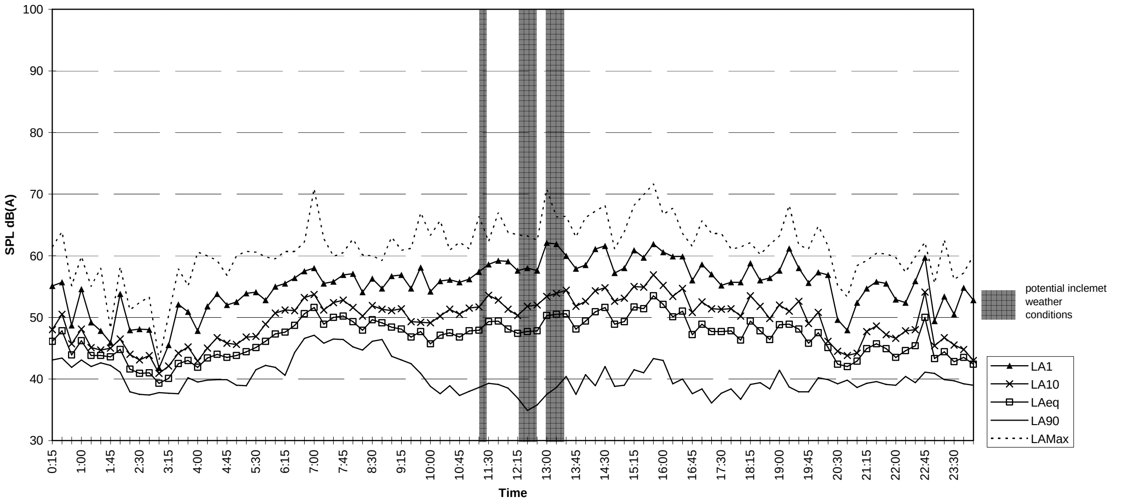

**Location 2 - Woodlands**
**Measured Noise Levels - Sunday 22nd, 2007**



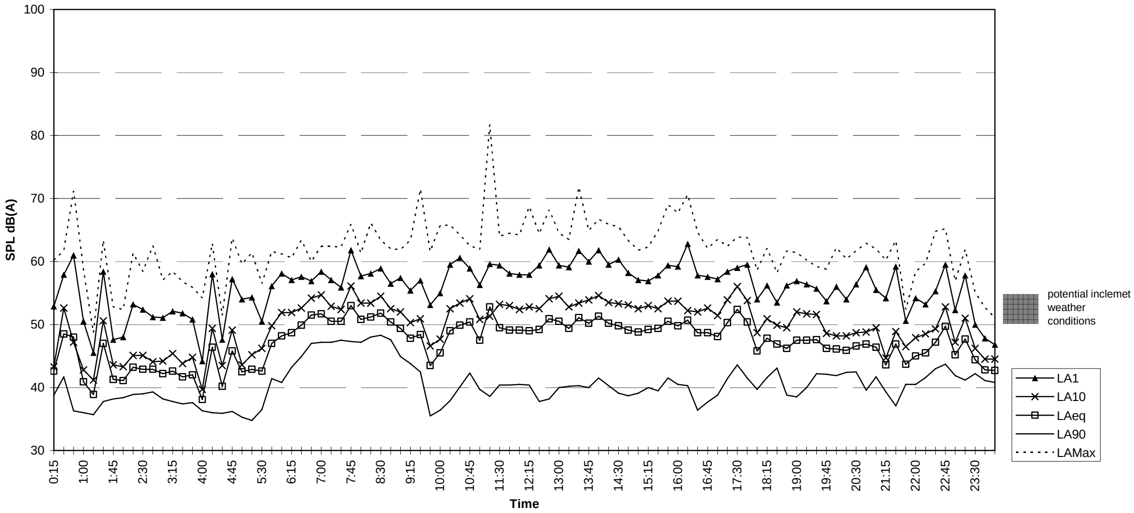

**Location 2 - Woodlands**
**Measured Noise Levels - Monday 23rd July, 2007**



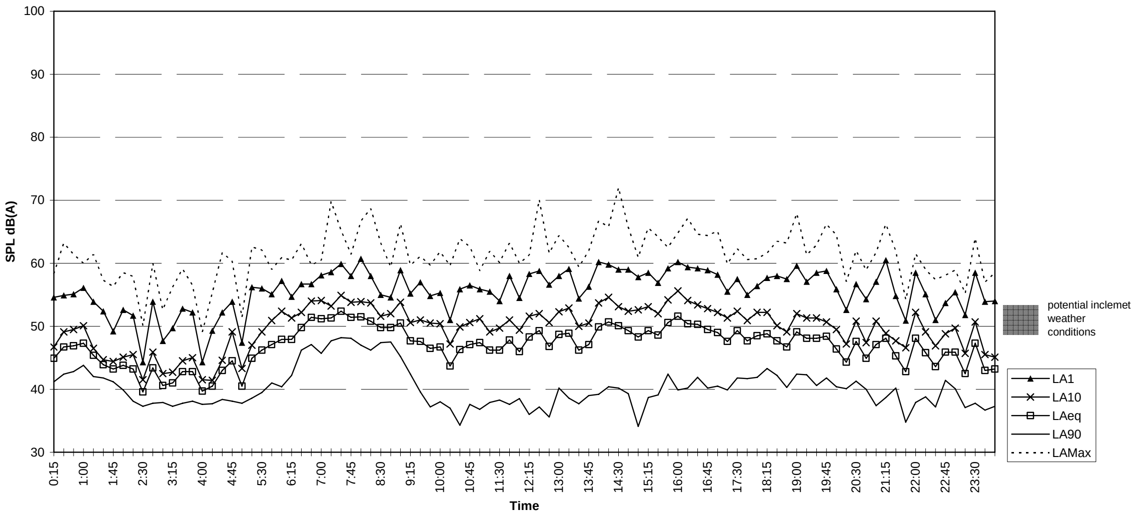
**Location 2 - Woodlands**
**Measured Noise Levels - Tuesday 24th July, 2007**



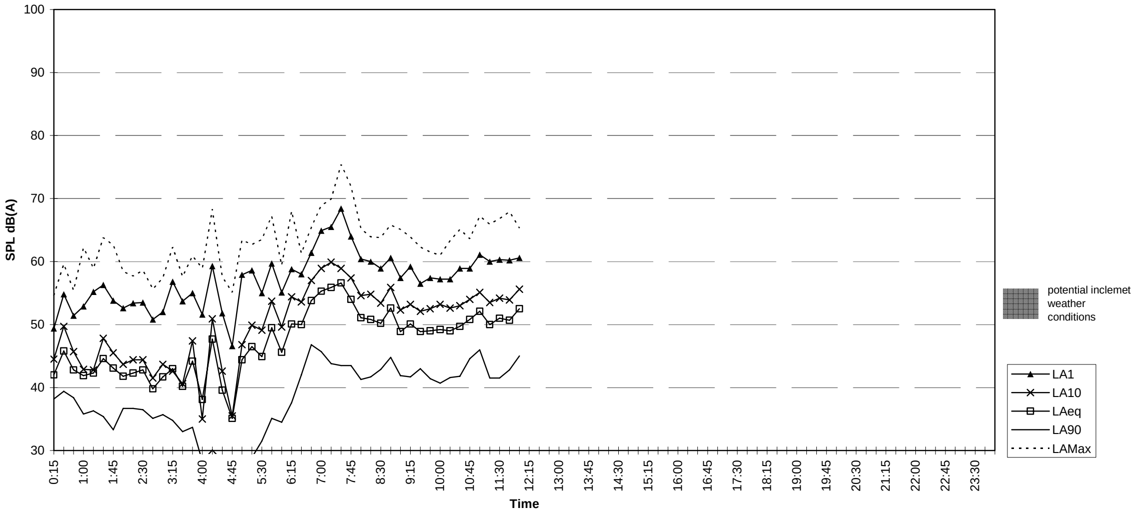

**Location 2 - Woodlands**
**Measured Noise Levels - Wednesday 25th July, 2007**




**Location 2 - Woodlands**
**Measured Noise Levels - Thursday 26th July, 2007**



**Location 2 - Woodlands**
**Measured Noise Levels - Friday 27th July, 2007**



# Appendix C

Regional meteorological analysis

### Noise enhancing wind conditions

The NSW Industrial Noise Source Policy has been referenced in relation to assessing meteorological conditions in potential noise impacts. The Policy states:

> *"Wind effects need to be assessed where wind is a feature of the area. Wind is considered to be a feature where source-to-receiver wind speeds (at a 10m height) of 3m/s or below occur for 30 percent of the time or more in any assessment period (day, evening, night) in any season."*

An analysis of regional wind enhancing noise conditions was undertaken as part of this assessment. This included an assessment of all hours of recorded wind flow patterns. The detailed assessment of noise enhancing meteorological conditions was based on wind speed data obtained for the Delta Electricity operated Mount Piper power station for the years 2004 - 2006. The data were separated into the four seasons and then into the daytime, evening and night time assessment periods.

The data has been tabulated for wind speeds of between 0.1 – 3 m/s and detailed below.

**Percentage occurrence of 0.1 – 3 m/s wind frequencies (daytime)**
**(values expressed as % percentages)**

| Direction (blowing from) | Summer | Autumn | Winter | Spring |
|---|---|---|---|---|
| **N** (337.5° - 22.5°) | 5.3 | 7 | 6.8 | 9 |
| **NE** (22.5° - 67.5°) | 4.6 | 4.1 | 2.2 | 1.3 |
| **E** (67.5° - 112.5°) | 6.3 | 5.4 | 2 | 3.5 |
| **SE** (112.5° - 157.5°) | 6.8 | 8.7 | 5 | 5.6 |
| **S** (157.5° - 202.5°) | 5.6 | 8.5 | 9.6 | 6 |
| **SW** (202.5° - 247.5°) | 11 | 9.8 | 16.3 | 15.1 |
| **W** (247.5° - 292.5°) | 7.4 | 8 | 11.9 | 7.9 |
| **NW** (292.5° - 337.5°) | 4.8 | 5.3 | 8.1 | 6.4 |

Note: daytime defined as 7 am – 6 pm

Review of the above data indicates that there was not a gradient or drainage wind flow regime present for more than 30% of the time (upon consideration of both directional and vector wind patterns) for all seasons during the day time period.

| **Percentage occurrence of 0.1 – 3 m/s wind frequencies (evening) (values expressed as % percentages)** | | | | |
|---|---|---|---|---|
| **Direction (blowing from)** | **Summer** | **Autumn** | **Winter** | **Spring** |
| **N (337.5° - 22.5°)** | 6.7 | 5.2 | 6.6 | 11.1 |
| **NE (22.5° - 67.5°)** | 5.1 | 3.1 | 0.5 | 1.6 |
| **E (67.5° - 112.5°)** | 12.7 | 7.1 | 1.4 | 5.4 |
| **SE (112.5° - 157.5°)** | 11.4 | 12.1 | 4.8 | 7.5 |
| **S (157.5° - 202.5°)** | 5.9 | 8.4 | 11.4 | 7.7 |
| **SW (202.5° - 247.5°)** | 15.3 | 25.4 | 27.5 | 19.6 |
| **W (247.5° - 292.5°)** | 13 | 17 | 20.1 | 17.3 |
| **NW (292.5° - 337.5°)** | 5.3 | 4.3 | 10 | 9.6 |

Note: evening defined as 6 pm – 10 pm

Review of the above data indicates that there was not a gradient or drainage wind flow regime present for more than 30% of the time (upon consideration of both directional and vector wind patterns) during the evening hours.

| **Percentage occurrence of 0.1 – 3 m/s wind frequencies (night time) (values expressed as % percentages)** | | | | |
|---|---|---|---|---|
| **Direction (blowing from)** | **Summer** | **Autumn** | **Winter** | **Spring** |
| **N (337.5° - 22.5°)** | 3.1 | 3.2 | 5.7 | 8.8 |
| **NE (22.5° - 67.5°)** | 5.5 | 2.6 | 0.8 | 2.3 |
| **E (67.5° - 112.5°)** | 6.9 | 4.3 | 1.6 | 2.7 |
| **SE (112.5° - 157.5°)** | 7.8 | 11.3 | 5.2 | 4.7 |
| **S (157.5° - 202.5°)** | 4.7 | 10.6 | 9.7 | 5.6 |
| **SW (202.5° - 247.5°)** | 12.6 | 26.2 | 24.6 | 20.5 |
| **W (247.5° - 292.5°)** | 12.7 | 22.5 | 20 | 14.9 |
| **NW (292.5° - 337.5°)** | 4.1 | 6.6 | 7.5 | 8.1 |

Note: night time defined as 10 pm – 7 am

Review of the above data indicates that there was not a gradient or drainage wind flow regime present for more than 30% of the time (upon consideration of both directional and vector wind patterns) throughout the year during the night time period.

**Temperature Inversion Conditions**

An analysis of the Delta Electricity Mount Piper Meteorological Station data was undertaken. The 2004 – 2007 data was adopted to maintain consistency with previous assessment works. The format was also such that stability classes were readily available to allow for the assessment of occurrence of temperature inversion conditions.

The 2004 – 2007 data sets were assessed in accordance with Section 5.2 of the NSW EPA Industrial Noise Policy to determine the significance of temperature inversions.

Individual lines of data were extracted from the dataset that matched the following criteria stipulated in the INP:

- season of Winter
- hours between 6 pm and 7 am
- F-class stability category
- wind speeds up to a maximum of 2m/s.

The percentage of occurrence of temperature inversions for the Mount Piper 2004 - 2007 meteorological data was calculated at less than 30%. This is below the recommendations of the Industrial Noise Policy.

# Appendix D

Sample ENM ranking file

OUTPUT FOR (.rnk) KVAR TEST

PROGRAM ENM SOURCE RANKING

SINGLE POINT CALCULATION

X= 1237.4 Y= 1558.4 Z= 901.2

| SOURCE TITLE | dB(A) |
|---|---|
| 1 Truck 8 Double Arti Truck manouvering | 44.3 |
| 5 Truck 9 Double Arti Truck manouvering | 44.0 |
| 3 Truck 10 Double Arti Truck manouvering | 41.2 |
| 4 Truck 13 Double Arti Truck manouvering | 25.3 |
| 2 Truck 6 Double Arti Truck manouvering | 23.7 |
| TOTAL | 48.2 |

PROGRAM ENM SOURCE RANKING

SINGLE POINT CALCULATION

X= 1278.8 Y= 1188.5 Z= 911.2

| SOURCE TITLE | dB(A) |
|---|---|
| 1 Truck 8 Double Arti Truck manouvering | 39.2 |
| 5 Truck 9 Double Arti Truck manouvering | 37.6 |
| 3 Truck 10 Double Arti Truck manouvering | 36.6 |
| 2 Truck 6 Double Arti Truck manouvering | 30.4 |
| 4 Truck 13 Double Arti Truck manouvering | 21.6 |
| TOTAL | 43.0 |

PROGRAM ENM SOURCE RANKING

SINGLE POINT CALCULATION

X= 1203.7   Y= 1778.1   Z=  901.2

| SOURCE TITLE | dB(A) |
|---|---|
| 5 Truck 9 Double Arti Truck manouvering | 43.2 |
| 1 Truck 8 Double Arti Truck manouvering | 41.8 |
| 3 Truck 10 Double Arti Truck manouvering | 41.2 |
| 4 Truck 13 Double Arti Truck manouvering | 27.0 |
| 2 Truck 6 Double Arti Truck manouvering | 25.2 |
| TOTAL | 47.0 |

PROGRAM ENM SOURCE RANKING

SINGLE POINT CALCULATION

X= 1184.9   Y= 2634.4   Z=  901.2

| SOURCE TITLE | dB(A) |
|---|---|
| 4 Truck 13 Double Arti Truck manouvering | 35.4 |
| 3 Truck 10 Double Arti Truck manouvering | 28.8 |
| 5 Truck 9 Double Arti Truck manouvering | 27.1 |
| 1 Truck 8 Double Arti Truck manouvering | 20.1 |
| 2 Truck 6 Double Arti Truck manouvering | 11.1 |
| TOTAL | 36.8 |

PROGRAM ENM SOURCE RANKING

SINGLE POINT CALCULATION

X= 534.5 Y= 2676.5 Z= 891.2

| SOURCE TITLE | dB(A) |
|---|---|
| 4 Truck 13 Double Arti Truck manouvering | 30.5 |
| 3 Truck 10 Double Arti Truck manouvering | 29.9 |
| 5 Truck 9 Double Arti Truck manouvering | 29.4 |
| 1 Truck 8 Double Arti Truck manouvering | 27.6 |
| 2 Truck 6 Double Arti Truck manouvering | 12.1 |
| TOTAL | 35.5 |

PROGRAM ENM SOURCE RANKING

SINGLE POINT CALCULATION

X= 726.4 Y= 2840.2 Z= 891.2

| SOURCE TITLE | dB(A) |
|---|---|
| 4 Truck 13 Double Arti Truck manouvering | 30.9 |
| 3 Truck 10 Double Arti Truck manouvering | 28.2 |
| 5 Truck 9 Double Arti Truck manouvering | 27.6 |
| 1 Truck 8 Double Arti Truck manouvering | 23.0 |
| 2 Truck 6 Double Arti Truck manouvering | 8.4 |
| TOTAL | 34.3 |

# Appendix E

Sample ENM output file

```
OUTPUT FOR (.out)    KVAR TEST
 SINGLE POINT CALCULATION
 ENM CALC MODULE

 FILENAMES
  TRUCK13
  TRUCK10
  TRUCK6
  TRUCK8
  TRUCK9
  KVARTEST.GEN
  C:\PROGRA~1\ENM\CALCUL~1\2115206A\KVARTEST

  OUT1 file and RNK1 file

 TEMP (deg C)        HUMIDITY (%)
      .0                   .0

 WIND SPEED (m/sec)  WIND DIR (deg)
      .0                   .0

 TEMP GRAD (deg C/100m)
      .0

 X=  1237.410   Y=  1558.360   Z=   901.200


 SOURCE  :      4
 Truck 13 Double Arti Truck manouvering

                  ______________________FREQUENCY Hz_________________________

                   31.5   63   125   250   500    1k    2k    4k    8k   16k

 POWER LEVEL       93.0 110.4  99.9  95.4  97.6  97.7  96.0  93.4  86.3    .0
 DIRECTIVITY         .0    .0    .0    .0    .0    .0    .0    .0    .0    .0

 DISTANCE          65.4  65.4  65.4  65.4  65.4  65.4  65.4  65.4  65.4  65.4
 BARRIER            5.7   6.4   7.6   9.6  11.8  13.5  16.6  19.6  22.6  25.0
 AIR ABSORPTION      .3    .4    .4    .5    .5    .6    .8   1.8   5.5  17.2
 TEMP & WIND         .0    .0    .0    .0    .0    .0    .0    .0    .0    .0
 GROUND            -4.1   1.2  11.0   2.8  -3.5  -3.7  -2.4  -2.3  -2.1  -3.4
                  ___________________________________________________________
 TOTAL  AWT  25.3  25.6  36.9  15.4  17.2  23.4  22.0  15.7   8.9  -5.1-100.0

 SOURCE  :      3
 Truck 10 Double Arti Truck manouvering

                  ______________________FREQUENCY Hz_________________________

                   31.5   63   125   250   500    1k    2k    4k    8k   16k

 POWER LEVEL       93.0 110.4  99.9  95.4  97.6  97.7  96.0  93.4  86.3    .0
 DIRECTIVITY         .0    .0    .0    .0    .0    .0    .0    .0    .0    .0

 DISTANCE          60.7  60.7  60.7  60.7  60.7  60.7  60.7  60.7  60.7  60.7
 BARRIER            5.0   5.0   4.9   4.8   4.3   3.2   1.6    .1    .0    .0
 AIR ABSORPTION      .2    .2    .3    .3    .3    .3    .5   1.1   3.3  10.9
 TEMP & WIND         .0    .0    .0    .0    .0    .0    .0    .0    .0    .0
 GROUND            -3.2   2.8   2.4  -3.5   -.2  -2.3  -2.2  -2.4  -2.1   -.6
                  ___________________________________________________________
 TOTAL  AWT  41.2  30.4  41.7  31.7  33.2  32.5  35.8  35.5  34.0  24.4 -70.9

 SOURCE  :      2
 Truck 6 Double Arti Truck manouvering

                  ______________________FREQUENCY Hz_________________________

                   31.5   63   125   250   500    1k    2k    4k    8k   16k

 POWER LEVEL       93.0 110.4  99.9  95.4  97.6  97.7  96.0  93.4  86.3    .0
 DIRECTIVITY         .0    .0    .0    .0    .0    .0    .0    .0    .0    .0

 DISTANCE          64.9  64.9  64.9  64.9  64.9  64.9  64.9  64.9  64.9  64.9
 BARRIER            5.9   6.7   8.0  10.1  12.2  14.3  17.3  20.3  23.3  25.0
 AIR ABSORPTION      .3    .4    .4    .4    .5    .5    .8   1.7   5.2  16.4
 TEMP & WIND         .0    .0    .0    .0    .0    .0    .0    .0    .0    .0
 GROUND            -4.9  -2.3   4.8  -2.3   -.6   -.9  -1.0  -2.8  -1.2  -2.4
                  ___________________________________________________________
 TOTAL  AWT  23.7  26.9  40.8  21.8  22.3  20.7  18.9  14.1   9.3  -5.9-100.0


 SOURCE  :      1
 Truck 8 Double Arti Truck manouvering

                  ______________________FREQUENCY Hz_________________________
```

| | 31.5 | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | 16k |
|---|---|---|---|---|---|---|---|---|---|---|
| POWER LEVEL | 93.0 | 110.4 | 99.9 | 95.4 | 97.6 | 97.7 | 96.0 | 93.4 | 86.3 | .0 |
| DIRECTIVITY | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| DISTANCE | 59.7 | 59.7 | 59.7 | 59.7 | 59.7 | 59.7 | 59.7 | 59.7 | 59.7 | 59.7 |
| BARRIER | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| AIR ABSORPTION | .2 | .2 | .2 | .2 | .3 | .3 | .4 | 1.0 | 3.0 | 9.9 |
| TEMP & WIND | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| GROUND | -5.5 | -4.2 | -.2 | 5.7 | -2.1 | -2.0 | -1.8 | -2.4 | -2.6 | -4.0 |
| TOTAL AWT 44.3 | 38.6 | 54.6 | 40.1 | 29.7 | 39.7 | 39.6 | 37.7 | 35.1 | 26.2 | -65.7 |

SOURCE : 5
Truck 9 Double Arti Truck manouvering

| | FREQUENCY Hz | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 31.5 | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | 16k |
| POWER LEVEL | 93.0 | 110.4 | 99.9 | 95.4 | 97.6 | 97.7 | 96.0 | 93.4 | 86.3 | .0 |
| DIRECTIVITY | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| DISTANCE | 59.6 | 59.6 | 59.6 | 59.6 | 59.6 | 59.6 | 59.6 | 59.6 | 59.6 | 59.6 |
| BARRIER | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| AIR ABSORPTION | .2 | .2 | .2 | .2 | .3 | .3 | .4 | .9 | 3.0 | 9.8 |
| TEMP & WIND | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| GROUND | -5.1 | -3.0 | 3.4 | -1.0 | -.5 | -1.7 | -1.5 | -2.2 | -2.3 | -3.4 |
| TOTAL AWT 44.0 | 38.3 | 53.5 | 36.7 | 36.5 | 38.2 | 39.5 | 37.5 | 35.0 | 26.0 | -66.1 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL AWT 48.2 | 42.0 | 57.4 | 42.2 | 38.9 | 42.5 | 43.5 | 41.8 | 39.5 | 30.4 | -62.2 |

SINGLE POINT CALCULATION
ENM CALC MODULE

FILENAMES
TRUCK13
TRUCK10
TRUCK6
TRUCK8
TRUCK9
KVARTEST.GEN
C:\PROGRA~1\ENM\CALCUL~1\2115206A\KVARTEST

OUT1 file and RNK1 file

| TEMP (deg C) | HUMIDITY (%) |
|---|---|
| .0 | .0 |

| WIND SPEED (m/sec) | WIND DIR (deg) |
|---|---|
| .0 | .0 |

TEMP GRAD (deg C/100m)
.0

X= 1278.850 Y= 1188.500 Z= 911.200

SOURCE : 4
Truck 13 Double Arti Truck manouvering

| | FREQUENCY Hz | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 31.5 | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | 16k |
| POWER LEVEL | 93.0 | 110.4 | 99.9 | 95.4 | 97.6 | 97.7 | 96.0 | 93.4 | 86.3 | .0 |
| DIRECTIVITY | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| DISTANCE | 69.6 | 69.6 | 69.6 | 69.6 | 69.6 | 69.6 | 69.6 | 69.6 | 69.6 | 69.6 |
| BARRIER | 5.4 | 5.8 | 6.6 | 7.9 | 10.0 | 12.2 | 14.1 | 17.1 | 20.1 | 23.1 |
| AIR ABSORPTION | .5 | .7 | .7 | .8 | .8 | .9 | 1.3 | 2.9 | 8.6 | 25.8 |
| TEMP & WIND | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| GROUND | -5.2 | -3.2 | 2.0 | 3.1 | -3.4 | -.2 | -2.4 | -2.2 | -2.7 | -1.6 |
| TOTAL AWT 21.6 | 22.6 | 37.5 | 21.0 | 14.0 | 20.6 | 15.3 | 13.4 | 6.0 | -9.3 | -100.0 |

SOURCE : 3
Truck 10 Double Arti Truck manouvering

| | FREQUENCY Hz | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 31.5 | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | 16k |
| POWER LEVEL | 93.0 | 110.4 | 99.9 | 95.4 | 97.6 | 97.7 | 96.0 | 93.4 | 86.3 | .0 |
| DIRECTIVITY | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |

| | | 31.5 | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | 16k |
|---|---|---|---|---|---|---|---|---|---|---|---|
| DISTANCE | | 66.7 | 66.7 | 66.7 | 66.7 | 66.7 | 66.7 | 66.7 | 66.7 | 66.7 | 66.7 |
| BARRIER | | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| AIR ABSORPTION | | .3 | .5 | .5 | .5 | .6 | .6 | .9 | 2.1 | 6.3 | 19.4 |
| TEMP & WIND | | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| GROUND | | -5.0 | -2.9 | 2.5 | 2.2 | -3.4 | -.8 | -1.3 | -2.5 | -3.1 | -3.0 |
| TOTAL AWT | 36.6 | 31.0 | 46.2 | 30.2 | 26.0 | 33.8 | 31.2 | 29.7 | 27.1 | 16.4 | -83.1 |

SOURCE : 2
Truck 6 Double Arti Truck manouvering

| | | FREQUENCY Hz | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 31.5 | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | 16k |
| POWER LEVEL | | 93.0 | 110.4 | 99.9 | 95.4 | 97.6 | 97.7 | 96.0 | 93.4 | 86.3 | .0 |
| DIRECTIVITY | | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| DISTANCE | | 61.4 | 61.4 | 61.4 | 61.4 | 61.4 | 61.4 | 61.4 | 61.4 | 61.4 | 61.4 |
| BARRIER | | 5.3 | 5.6 | 6.1 | 7.1 | 8.8 | 11.0 | 12.7 | 15.5 | 18.5 | 21.5 |
| AIR ABSORPTION | | .2 | .3 | .3 | .3 | .3 | .3 | .5 | 1.1 | 3.6 | 11.7 |
| TEMP & WIND | | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| GROUND | | -4.9 | -1.1 | 10.0 | 13.9 | 6.3 | -.3 | -4.8 | -2.5 | -2.6 | -2.7 |
| TOTAL AWT | 30.4 | 31.1 | 44.3 | 22.2 | 12.7 | 20.8 | 25.3 | 26.2 | 17.9 | 5.5 | -91.8 |

SOURCE : 1
Truck 8 Double Arti Truck manouvering

| | | FREQUENCY Hz | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 31.5 | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | 16k |
| POWER LEVEL | | 93.0 | 110.4 | 99.9 | 95.4 | 97.6 | 97.7 | 96.0 | 93.4 | 86.3 | .0 |
| DIRECTIVITY | | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| DISTANCE | | 64.0 | 64.0 | 64.0 | 64.0 | 64.0 | 64.0 | 64.0 | 64.0 | 64.0 | 64.0 |
| BARRIER | | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| AIR ABSORPTION | | .3 | .3 | .4 | .4 | .4 | .5 | .7 | 1.5 | 4.8 | 15.1 |
| TEMP & WIND | | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| GROUND | | -5.2 | -3.6 | .5 | 3.7 | -2.8 | -.4 | -1.3 | -1.9 | -2.5 | -1.9 |
| TOTAL AWT | 39.2 | 33.9 | 49.6 | 35.1 | 27.3 | 36.0 | 33.7 | 32.7 | 29.8 | 20.1 | -77.2 |

SOURCE : 5
Truck 9 Double Arti Truck manouvering

| | | FREQUENCY Hz | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 31.5 | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | 16k |
| POWER LEVEL | | 93.0 | 110.4 | 99.9 | 95.4 | 97.6 | 97.7 | 96.0 | 93.4 | 86.3 | .0 |
| DIRECTIVITY | | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| DISTANCE | | 65.4 | 65.4 | 65.4 | 65.4 | 65.4 | 65.4 | 65.4 | 65.4 | 65.4 | 65.4 |
| BARRIER | | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| AIR ABSORPTION | | .3 | .4 | .5 | .5 | .5 | .6 | .8 | 1.8 | 5.5 | 17.3 |
| TEMP & WIND | | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| GROUND | | -4.8 | -2.2 | 4.3 | -1.8 | -.5 | -1.0 | -1.6 | -2.8 | -2.1 | -1.7 |
| TOTAL AWT | 37.6 | 32.0 | 46.8 | 29.8 | 31.3 | 32.1 | 32.7 | 31.4 | 28.9 | 17.5 | -81.0 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL AWT | 43.0 | 38.3 | 53.3 | 37.4 | 33.7 | 39.2 | 37.7 | 36.6 | 33.7 | 23.1 | -74.9 |

SINGLE POINT CALCULATION
ENM CALC MODULE

FILENAMES
TRUCK13
TRUCK10
TRUCK6
TRUCK8
TRUCK9
KVARTEST.GEN
C:\PROGRA~1\ENM\CALCUL~1\2115206A\KVARTEST

OUT1 file and RNK1 file

| TEMP (deg C) | HUMIDITY (%) |
|---|---|
| .0 | .0 |

| WIND SPEED (m/sec) | WIND DIR (deg) |
|---|---|
| .0 | .0 |

TEMP GRAD (deg C/100m)

.0

X= 1203.660 Y= 1778.070 Z= 901.200

SOURCE : 4
Truck 13 Double Arti Truck manouvering

| | FREQUENCY Hz | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 31.5 | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | 16k |
| POWER LEVEL | 93.0 | 110.4 | 99.9 | 95.4 | 97.6 | 97.7 | 96.0 | 93.4 | 86.3 | .0 |
| DIRECTIVITY | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| DISTANCE | 62.6 | 62.6 | 62.6 | 62.6 | 62.6 | 62.6 | 62.6 | 62.6 | 62.6 | 62.6 |
| BARRIER | 5.9 | 6.7 | 8.1 | 10.1 | 12.3 | 14.3 | 17.3 | 20.3 | 23.3 | 25.0 |
| AIR ABSORPTION | .2 | .3 | .3 | .3 | .4 | .4 | .6 | 1.3 | 4.1 | 13.2 |
| TEMP & WIND | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| GROUND | -5.6 | -4.5 | -1.1 | 5.6 | -1.2 | -2.6 | -1.7 | -1.9 | -2.2 | -3.8 |
| TOTAL AWT 27.0 | 29.9 | 45.3 | 30.0 | 16.7 | 23.6 | 23.0 | 17.2 | 11.0 | -1.5 | -97.0 |

SOURCE : 3
Truck 10 Double Arti Truck manouvering

| | FREQUENCY Hz | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 31.5 | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | 16k |
| POWER LEVEL | 93.0 | 110.4 | 99.9 | 95.4 | 97.6 | 97.7 | 96.0 | 93.4 | 86.3 | .0 |
| DIRECTIVITY | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| DISTANCE | 59.1 | 59.1 | 59.1 | 59.1 | 59.1 | 59.1 | 59.1 | 59.1 | 59.1 | 59.1 |
| BARRIER | 5.0 | 5.0 | 5.0 | 4.9 | 4.8 | 4.7 | 3.7 | 2.3 | .5 | .0 |
| AIR ABSORPTION | .1 | .2 | .2 | .2 | .2 | .3 | .4 | .9 | 2.8 | 9.3 |
| TEMP & WIND | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| GROUND | -4.1 | .3 | 7.6 | .8 | -4.2 | .0 | -3.0 | -1.7 | -2.8 | -1.4 |
| TOTAL AWT 41.2 | 32.9 | 45.9 | 28.0 | 30.4 | 37.6 | 33.7 | 35.8 | 32.8 | 26.7 | -66.9 |

SOURCE : 2
Truck 6 Double Arti Truck manouvering

| | FREQUENCY Hz | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 31.5 | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | 16k |
| POWER LEVEL | 93.0 | 110.4 | 99.9 | 95.4 | 97.6 | 97.7 | 96.0 | 93.4 | 86.3 | .0 |
| DIRECTIVITY | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| DISTANCE | 67.6 | 67.6 | 67.6 | 67.6 | 67.6 | 67.6 | 67.6 | 67.6 | 67.6 | 67.6 |
| BARRIER | 5.6 | 6.2 | 7.2 | 8.9 | 11.2 | 12.8 | 15.7 | 18.7 | 21.7 | 24.7 |
| AIR ABSORPTION | .4 | .5 | .6 | .6 | .6 | .7 | 1.0 | 2.3 | 7.0 | 21.4 |
| TEMP & WIND | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| GROUND | -6.0 | -6.0 | -6.0 | -5.8 | -5.4 | -3.8 | 1.4 | 2.6 | -3.5 | -1.2 |
| TOTAL AWT 25.2 | 25.3 | 42.0 | 30.4 | 24.0 | 23.5 | 20.3 | 10.2 | 2.1 | -6.6 | -100.0 |

SOURCE : 1
Truck 8 Double Arti Truck manouvering

| | FREQUENCY Hz | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 31.5 | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | 16k |
| POWER LEVEL | 93.0 | 110.4 | 99.9 | 95.4 | 97.6 | 97.7 | 96.0 | 93.4 | 86.3 | .0 |
| DIRECTIVITY | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| DISTANCE | 62.4 | 62.4 | 62.4 | 62.4 | 62.4 | 62.4 | 62.4 | 62.4 | 62.4 | 62.4 |
| BARRIER | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| AIR ABSORPTION | .2 | .3 | .3 | .3 | .3 | .4 | .6 | 1.3 | 4.0 | 12.9 |
| TEMP & WIND | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| GROUND | -5.7 | -4.5 | -.4 | 9.3 | 6.1 | -1.5 | -5.0 | -.6 | -3.3 | -2.5 |
| TOTAL AWT 41.8 | 36.1 | 52.2 | 37.6 | 23.4 | 28.8 | 36.5 | 38.0 | 30.4 | 23.3 | -72.7 |

SOURCE : 5
Truck 9 Double Arti Truck manouvering

| | FREQUENCY Hz | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 31.5 | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | 16k |
| POWER LEVEL | 93.0 | 110.4 | 99.9 | 95.4 | 97.6 | 97.7 | 96.0 | 93.4 | 86.3 | .0 |
| DIRECTIVITY | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |

| | | 31.5 | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | 16k |
|---|---|---|---|---|---|---|---|---|---|---|---|
| DISTANCE | | 60.4 | 60.4 | 60.4 | 60.4 | 60.4 | 60.4 | 60.4 | 60.4 | 60.4 | 60.4 |
| BARRIER | | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| AIR ABSORPTION | | .2 | .2 | .3 | .3 | .3 | .3 | .5 | 1.0 | 3.2 | 10.6 |
| TEMP & WIND | | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| GROUND | | -5.3 | -3.7 | .9 | 2.6 | -2.6 | -1.1 | -1.6 | -1.8 | -1.7 | -2.9 |
| TOTAL AWT | 43.2 | 37.7 | 53.4 | 38.4 | 32.2 | 39.5 | 38.0 | 36.7 | 33.7 | 24.4 | -68.2 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL AWT | 47.0 | 41.2 | 56.8 | 41.9 | 35.1 | 42.0 | 41.3 | 41.7 | 37.3 | 29.8 | -63.9 |

SINGLE POINT CALCULATION
ENM CALC MODULE

FILENAMES
TRUCK13
TRUCK10
TRUCK6
TRUCK8
TRUCK9
KVARTEST.GEN
C:\PROGRA~1\ENM\CALCUL~1\2115206A\KVARTEST

OUT1 file and RNK1 file

TEMP (deg C)        HUMIDITY (%)
.0                  .0

WIND SPEED (m/sec)  WIND DIR (deg)
.0                  .0

TEMP GRAD (deg C/100m)
.0

X= 1184.940   Y= 2634.350   Z= 901.200

SOURCE : 4
Truck 13 Double Arti Truck manouvering

| | | FREQUENCY Hz | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 31.5 | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | 16k |
| POWER LEVEL | | 93.0 | 110.4 | 99.9 | 95.4 | 97.6 | 97.7 | 96.0 | 93.4 | 86.3 | .0 |
| DIRECTIVITY | | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| DISTANCE | | 68.0 | 68.0 | 68.0 | 68.0 | 68.0 | 68.0 | 68.0 | 68.0 | 68.0 | 68.0 |
| BARRIER | | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| AIR ABSORPTION | | .4 | .5 | .6 | .6 | .7 | .7 | 1.1 | 2.4 | 7.3 | 22.1 |
| TEMP & WIND | | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| GROUND | | -4.7 | -1.9 | 4.7 | -1.3 | -1.2 | -1.8 | -2.5 | -2.1 | -3.5 | -2.1 |
| TOTAL AWT | 35.4 | 29.4 | 43.8 | 26.7 | 28.1 | 30.2 | 30.8 | 29.4 | 25.1 | 14.6 | -88.0 |

SOURCE : 3
Truck 10 Double Arti Truck manouvering

| | | FREQUENCY Hz | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 31.5 | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | 16k |
| POWER LEVEL | | 93.0 | 110.4 | 99.9 | 95.4 | 97.6 | 97.7 | 96.0 | 93.4 | 86.3 | .0 |
| DIRECTIVITY | | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| DISTANCE | | 70.1 | 70.1 | 70.1 | 70.1 | 70.1 | 70.1 | 70.1 | 70.1 | 70.1 | 70.1 |
| BARRIER | | 5.0 | 5.0 | 5.0 | 5.0 | 4.9 | 4.7 | 4.1 | 2.9 | 1.2 | .0 |
| AIR ABSORPTION | | .5 | .7 | .8 | .8 | .8 | 1.0 | 1.4 | 3.1 | 9.1 | 27.3 |
| TEMP & WIND | | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| GROUND | | -5.1 | -2.9 | 3.7 | 3.0 | -3.7 | -.3 | -3.0 | -2.1 | -2.2 | -3.7 |
| TOTAL AWT | 28.8 | 22.4 | 37.4 | 20.3 | 16.5 | 25.5 | 22.2 | 23.3 | 19.4 | 8.1 | -93.7 |

SOURCE : 2
Truck 6 Double Arti Truck manouvering

| | | FREQUENCY Hz | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 31.5 | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | 16k |
| POWER LEVEL | | 93.0 | 110.4 | 99.9 | 95.4 | 97.6 | 97.7 | 96.0 | 93.4 | 86.3 | .0 |
| DIRECTIVITY | | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| DISTANCE | | 74.3 | 74.3 | 74.3 | 74.3 | 74.3 | 74.3 | 74.3 | 74.3 | 74.3 | 74.3 |
| BARRIER | | 7.2 | 8.9 | 11.1 | 12.8 | 15.6 | 18.6 | 21.6 | 24.7 | 25.0 | 25.0 |
| AIR ABSORPTION | | .8 | 1.1 | 1.3 | 1.3 | 1.4 | 1.5 | 2.3 | 4.9 | 13.8 | 41.4 |
| TEMP & WIND | | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| GROUND | -5.2 | -2.8 | 4.9 | 5.5 | -2.5 | -4.2 | -2.2 | -2.0 | -2.7 | -3.6 |
| TOTAL AWT 11.1 | 15.8 | 28.8 | 8.3 | 1.5 | 8.8 | 7.4 | .0 | -8.5 | -24.2 | -100.0 |

SOURCE : 1
Truck 8 Double Arti Truck manouvering

| | FREQUENCY Hz | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 31.5 | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | 16k |
| POWER LEVEL | 93.0 | 110.4 | 99.9 | 95.4 | 97.6 | 97.7 | 96.0 | 93.4 | 86.3 | .0 |
| DIRECTIVITY | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| DISTANCE | 71.9 | 71.9 | 71.9 | 71.9 | 71.9 | 71.9 | 71.9 | 71.9 | 71.9 | 71.9 |
| BARRIER | 5.3 | 5.7 | 6.2 | 7.3 | 9.1 | 11.4 | 12.9 | 15.9 | 18.9 | 22.0 |
| AIR ABSORPTION | .6 | .9 | 1.0 | 1.0 | 1.0 | 1.2 | 1.7 | 3.8 | 10.9 | 32.5 |
| TEMP & WIND | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| GROUND | -5.0 | -2.6 | 4.4 | 2.3 | -3.9 | -.1 | -3.1 | -1.9 | -3.2 | -1.7 |
| TOTAL AWT 20.1 | 20.2 | 34.6 | 16.4 | 12.9 | 19.5 | 13.4 | 12.6 | 3.7 | -12.3 | -100.0 |

SOURCE : 5
Truck 9 Double Arti Truck manouvering

| | FREQUENCY Hz | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 31.5 | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | 16k |
| POWER LEVEL | 93.0 | 110.4 | 99.9 | 95.4 | 97.6 | 97.7 | 96.0 | 93.4 | 86.3 | .0 |
| DIRECTIVITY | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| DISTANCE | 71.0 | 71.0 | 71.0 | 71.0 | 71.0 | 71.0 | 71.0 | 71.0 | 71.0 | 71.0 |
| BARRIER | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 4.9 | 4.7 | 4.1 | 2.9 |
| AIR ABSORPTION | .6 | .8 | .9 | .9 | .9 | 1.1 | 1.5 | 3.4 | 9.9 | 29.7 |
| TEMP & WIND | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| GROUND | -5.1 | -2.8 | 3.9 | 2.3 | -3.9 | -.1 | -3.0 | -2.1 | -2.1 | -3.7 |
| TOTAL AWT 27.1 | 21.5 | 36.4 | 19.1 | 16.2 | 24.5 | 20.8 | 21.6 | 16.3 | 3.3 | -99.9 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL AWT 36.8 | 31.2 | 45.8 | 28.5 | 28.8 | 32.5 | 31.8 | 31.0 | 26.6 | 15.7 | -86.3 |

SINGLE POINT CALCULATION
ENM CALC MODULE

FILENAMES
TRUCK13
TRUCK10
TRUCK6
TRUCK8
TRUCK9
KVARTEST.GEN
C:\PROGRA~1\ENM\CALCUL~1\2115206A\KVARTEST

OUT1 file and RNK1 file

TEMP (deg C) .0 HUMIDITY (%) .0

WIND SPEED (m/sec) .0 WIND DIR (deg) .0

TEMP GRAD (deg C/100m) .0

X= 534.540 Y= 2676.460 Z= 891.200

SOURCE : 4
Truck 13 Double Arti Truck manouvering

| | FREQUENCY Hz | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 31.5 | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | 16k |
| POWER LEVEL | 93.0 | 110.4 | 99.9 | 95.4 | 97.6 | 97.7 | 96.0 | 93.4 | 86.3 | .0 |
| DIRECTIVITY | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| DISTANCE | 72.4 | 72.4 | 72.4 | 72.4 | 72.4 | 72.4 | 72.4 | 72.4 | 72.4 | 72.4 |
| BARRIER | 4.9 | 4.9 | 4.7 | 4.0 | 2.7 | 1.0 | .0 | .0 | .0 | .0 |
| AIR ABSORPTION | .7 | .9 | 1.0 | 1.1 | 1.1 | 1.2 | 1.8 | 4.0 | 11.5 | 34.2 |
| TEMP & WIND | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| GROUND | -5.5 | -3.8 | 2.4 | 11.5 | 2.1 | -3.9 | -3.6 | -2.6 | -2.6 | -2.8 |
| TOTAL AWT 30.5 | 20.4 | 35.9 | 19.3 | 6.4 | 19.2 | 26.9 | 25.3 | 19.5 | 5.0 | -100.0 |

SOURCE : 3
Truck 10 Double Arti Truck manouvering

| | FREQUENCY Hz | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 31.5 | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | 16k |
| POWER LEVEL | 93.0 | 110.4 | 99.9 | 95.4 | 97.6 | 97.7 | 96.0 | 93.4 | 86.3 | .0 |
| DIRECTIVITY | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| DISTANCE | 73.2 | 73.2 | 73.2 | 73.2 | 73.2 | 73.2 | 73.2 | 73.2 | 73.2 | 73.2 |
| BARRIER | 4.9 | 4.8 | 4.6 | 3.5 | 1.9 | .3 | .0 | .0 | .0 | .0 |
| AIR ABSORPTION | .7 | 1.0 | 1.1 | 1.2 | 1.2 | 1.4 | 2.0 | 4.4 | 12.4 | 37.1 |
| TEMP & WIND | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| GROUND | -5.3 | -3.1 | 4.2 | 6.6 | -1.8 | -4.7 | -1.4 | -2.2 | -2.7 | -3.2 |
| TOTAL AWT 29.9 | 19.4 | 34.4 | 16.7 | 10.9 | 23.0 | 27.5 | 22.1 | 18.0 | 3.4 | -100.0 |

SOURCE : 2
Truck 6 Double Arti Truck manouvering

| | FREQUENCY Hz | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 31.5 | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | 16k |
| POWER LEVEL | 93.0 | 110.4 | 99.9 | 95.4 | 97.6 | 97.7 | 96.0 | 93.4 | 86.3 | .0 |
| DIRECTIVITY | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| DISTANCE | 76.1 | 76.1 | 76.1 | 76.1 | 76.1 | 76.1 | 76.1 | 76.1 | 76.1 | 76.1 |
| BARRIER | 5.5 | 6.0 | 6.9 | 8.5 | 10.7 | 12.6 | 15.0 | 18.0 | 21.1 | 24.1 |
| AIR ABSORPTION | 1.0 | 1.4 | 1.5 | 1.6 | 1.7 | 1.9 | 2.8 | 6.0 | 16.5 | 49.8 |
| TEMP & WIND | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| GROUND | -3.0 | 6.5 | 15.0 | 12.0 | 4.7 | -1.2 | -5.2 | -1.9 | -2.9 | -3.4 |
| TOTAL AWT 12.1 | 13.3 | 20.4 | .3 | -2.8 | 4.4 | 8.4 | 7.3 | -4.8 | -24.5 | -100.0 |

SOURCE : 1
Truck 8 Double Arti Truck manouvering

| | FREQUENCY Hz | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 31.5 | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | 16k |
| POWER LEVEL | 93.0 | 110.4 | 99.9 | 95.4 | 97.6 | 97.7 | 96.0 | 93.4 | 86.3 | .0 |
| DIRECTIVITY | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| DISTANCE | 74.4 | 74.4 | 74.4 | 74.4 | 74.4 | 74.4 | 74.4 | 74.4 | 74.4 | 74.4 |
| BARRIER | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| AIR ABSORPTION | .8 | 1.1 | 1.3 | 1.3 | 1.4 | 1.5 | 2.3 | 4.9 | 13.9 | 41.6 |
| TEMP & WIND | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| GROUND | -5.2 | -2.3 | 7.2 | 14.7 | 7.5 | .3 | -4.6 | -3.5 | -2.8 | -2.6 |
| TOTAL AWT 27.6 | 23.0 | 37.2 | 17.1 | 5.0 | 14.4 | 21.5 | 24.0 | 17.6 | .8 | -100.0 |

SOURCE : 5
Truck 9 Double Arti Truck manouvering

| | FREQUENCY Hz | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 31.5 | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | 16k |
| POWER LEVEL | 93.0 | 110.4 | 99.9 | 95.4 | 97.6 | 97.7 | 96.0 | 93.4 | 86.3 | .0 |
| DIRECTIVITY | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| DISTANCE | 73.8 | 73.8 | 73.8 | 73.8 | 73.8 | 73.8 | 73.8 | 73.8 | 73.8 | 73.8 |
| BARRIER | 4.9 | 4.8 | 4.3 | 3.2 | 1.5 | .0 | .0 | .0 | .0 | .0 |
| AIR ABSORPTION | .8 | 1.1 | 1.2 | 1.2 | 1.3 | 1.4 | 2.1 | 4.6 | 13.1 | 39.2 |
| TEMP & WIND | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| GROUND | -5.2 | -2.9 | 4.6 | 6.0 | -2.2 | -4.4 | -1.9 | -1.8 | -3.2 | -1.1 |
| TOTAL AWT 29.4 | 18.8 | 33.7 | 16.1 | 11.3 | 23.3 | 26.9 | 22.0 | 16.8 | 2.6 | -100.0 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL AWT 35.5 | 26.9 | 41.6 | 23.5 | 15.3 | 27.2 | 32.3 | 29.6 | 24.1 | 9.2 | -93.0 |

SINGLE POINT CALCULATION
ENM CALC MODULE

FILENAMES
TRUCK13
TRUCK10
TRUCK6
TRUCK8
TRUCK9
KVARTEST.GEN
C:\PROGRA~1\ENM\CALCUL~1\2115206A\KVARTEST

OUT1 file and RNK1 file

TEMP (deg C) HUMIDITY (%)
.0 .0

WIND SPEED (m/sec) WIND DIR (deg)
.0 .0

TEMP GRAD (deg C/100m)
.0

X= 726.380 Y= 2840.230 Z= 891.200

SOURCE : 4
Truck 13 Double Arti Truck manouvering

| | FREQUENCY Hz | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 31.5 | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | 16k |
| POWER LEVEL | 93.0 | 110.4 | 99.9 | 95.4 | 97.6 | 97.7 | 96.0 | 93.4 | 86.3 | .0 |
| DIRECTIVITY | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| DISTANCE | 72.2 | 72.2 | 72.2 | 72.2 | 72.2 | 72.2 | 72.2 | 72.2 | 72.2 | 72.2 |
| BARRIER | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| AIR ABSORPTION | .7 | .9 | 1.0 | 1.0 | 1.1 | 1.2 | 1.8 | 3.9 | 11.1 | 33.3 |
| TEMP & WIND | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| GROUND | -5.3 | -2.9 | 5.6 | 14.1 | 5.7 | -1.2 | -5.2 | -1.1 | -3.2 | -3.4 |
| TOTAL AWT 30.9 | 25.5 | 40.3 | 21.1 | 8.2 | 18.7 | 25.5 | 27.3 | 18.5 | 6.2 | -100.0 |

SOURCE : 3
Truck 10 Double Arti Truck manouvering

| | FREQUENCY Hz | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 31.5 | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | 16k |
| POWER LEVEL | 93.0 | 110.4 | 99.9 | 95.4 | 97.6 | 97.7 | 96.0 | 93.4 | 86.3 | .0 |
| DIRECTIVITY | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| DISTANCE | 73.2 | 73.2 | 73.2 | 73.2 | 73.2 | 73.2 | 73.2 | 73.2 | 73.2 | 73.2 |
| BARRIER | 5.0 | 4.9 | 4.9 | 4.7 | 3.9 | 2.6 | .8 | .0 | .0 | .0 |
| AIR ABSORPTION | .7 | 1.0 | 1.1 | 1.2 | 1.2 | 1.4 | 2.0 | 4.4 | 12.4 | 37.1 |
| TEMP & WIND | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| GROUND | -5.4 | -3.4 | 3.7 | 10.2 | 1.0 | -4.4 | -2.4 | -2.5 | -2.9 | -3.0 |
| TOTAL AWT 28.2 | 19.4 | 34.6 | 17.0 | 6.1 | 18.2 | 25.0 | 22.3 | 18.3 | 3.5 | -100.0 |

SOURCE : 2
Truck 6 Double Arti Truck manouvering

| | FREQUENCY Hz | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 31.5 | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | 16k |
| POWER LEVEL | 93.0 | 110.4 | 99.9 | 95.4 | 97.6 | 97.7 | 96.0 | 93.4 | 86.3 | .0 |
| DIRECTIVITY | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| DISTANCE | 76.3 | 76.3 | 76.3 | 76.3 | 76.3 | 76.3 | 76.3 | 76.3 | 76.3 | 76.3 |
| BARRIER | 6.4 | 7.6 | 9.4 | 11.7 | 13.4 | 16.4 | 19.4 | 22.4 | 25.0 | 25.0 |
| AIR ABSORPTION | 1.0 | 1.4 | 1.6 | 1.6 | 1.7 | 1.9 | 2.8 | 6.1 | 16.8 | 50.6 |
| TEMP & WIND | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| GROUND | -3.3 | 5.2 | 15.0 | 11.4 | 4.0 | -1.9 | -5.4 | -.8 | -3.4 | -3.0 |
| TOTAL AWT 8.4 | 12.6 | 20.0 | -2.4 | -5.6 | 2.3 | 5.0 | 2.9 | -10.5 | -28.3 | -100.0 |

SOURCE : 1
Truck 8 Double Arti Truck manouvering

| | FREQUENCY Hz | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 31.5 | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | 16k |
| POWER LEVEL | 93.0 | 110.4 | 99.9 | 95.4 | 97.6 | 97.7 | 96.0 | 93.4 | 86.3 | .0 |
| DIRECTIVITY | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| DISTANCE | 74.5 | 74.5 | 74.5 | 74.5 | 74.5 | 74.5 | 74.5 | 74.5 | 74.5 | 74.5 |
| BARRIER | 5.0 | 5.0 | 5.0 | 5.1 | 5.1 | 5.2 | 5.3 | 5.7 | 6.3 | 7.4 |
| AIR ABSORPTION | .9 | 1.2 | 1.3 | 1.3 | 1.4 | 1.6 | 2.3 | 5.0 | 14.0 | 42.0 |
| TEMP & WIND | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| GROUND | -5.5 | -3.7 | 3.1 | 13.9 | 5.1 | -1.8 | -5.3 | -.6 | -3.7 | -2.2 |
| TOTAL AWT 23.0 | 18.2 | 33.5 | 16.0 | .7 | 11.6 | 18.3 | 19.2 | 8.8 | -4.8 | -100.0 |

SOURCE : 5

Truck 9 Double Arti Truck manouvering

| | | FREQUENCY Hz | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 31.5 | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | 16k |
| POWER LEVEL | | 93.0 | 110.4 | 99.9 | 95.4 | 97.6 | 97.7 | 96.0 | 93.4 | 86.3 | .0 |
| DIRECTIVITY | | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| DISTANCE | | 73.8 | 73.8 | 73.8 | 73.8 | 73.8 | 73.8 | 73.8 | 73.8 | 73.8 | 73.8 |
| BARRIER | | 5.0 | 4.9 | 4.9 | 4.7 | 3.9 | 2.5 | .7 | .0 | .0 | .0 |
| AIR ABSORPTION | | .8 | 1.1 | 1.2 | 1.2 | 1.3 | 1.5 | 2.1 | 4.7 | 13.2 | 39.4 |
| TEMP & WIND | | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 |
| GROUND | | -5.4 | -3.2 | 4.3 | 9.8 | .7 | -4.5 | -2.1 | -2.6 | -3.1 | -3.0 |
| TOTAL AWT | 27.6 | 18.7 | 33.8 | 15.8 | 5.8 | 17.9 | 24.5 | 21.4 | 17.5 | 2.3 | -100.0 |
| TOTAL AWT | 34.3 | 27.8 | 42.6 | 24.1 | 12.0 | 23.4 | 30.1 | 29.7 | 23.1 | 9.3 | -93.0 |