Table 2-5 Summary of noise monitoring results - Logger 3, dB(A)

Date	Background L_{90} dB(A)			Ambient L_{Aeq} dB(A)		
	Day (7 am to 6 pm)	Evening (6 pm to 10 pm)	Night (10 pm to 7 am)	Day (7 am to 6 pm)	Evening (6 pm to 10 pm)	Night (10 pm to 7 am)
Thursday 4-Aug-16	35	38	33	48	45	45
Friday 5-Aug-16	28	31	19	51	47	45
Saturday 6-Aug-16	21	33	21	45	51	50
Sunday 7-Aug-16	22	34	26	44	48	51
Monday 8-Aug-16	26	34	23	43	51	50
Tuesday 9-Aug-16	26	39	29	48	48	44
Wednesday 10-Aug-16	28	40	32	44	52	47
Thursday 11-Aug-16	31	34	20	45	48	47
RBL	28	34	25	-	-	-
L_{Aeq} Overall	-	-	-	47	49	48

Attended noise monitoring results

A summary of the attended noise monitoring results are provided in Table 2-6. Weather conditions during attended measurements were generally wind speeds between 3 – 5 m/s from a south-east direction; a temperature of approximately 10°C and relative humidity of approximately 65%.

Table 2-6 Summary of attended noise monitoring results dB(A)

Monitoring location	Date	Measured noise levels dB(A)		Observations (instantaneous dB(A))
		L_{Aeq}	L_{A90}	
Logger 1	4/08/2016	51	44	• Intermittent birds 71 dB(A) • Wind through foliage 45 – 58 dB(A)
Logger 1	4/08/2016	50	45	• Intermittent birds 70 dB(A) • Wind through foliage 48 – 58 dB(A)
Logger 2	4/08/2016	51	42	• Intermittent cows 53 dB(A) • Intermittent birds 35 – 51 dB(A) • Wind through foliage 35 – 57 dB(A) • Insects 30 – 35 dB(A) • Gwydir Hwy road traffic 47 dB(A) – 60 dB(A).

Monitoring location	Date	Measured noise levels dB(A)		Observations (instantaneous dB(A))
		L_{Aeq}	L_{A90}	
Logger 2	4/08/2016	53	44	• Intermittent birds 35 dB(A) • Wind through foliage 35 – 58 dB(A) • Insects 30 – 35 dB(A) • Nearby truck start 52 dB(A) • Truck idling 35 dB(A) • Gwydir Hwy road traffic 49 dB(A) – 69 dB(A).
Logger 3	4/08/2016	47	40	• Intermittent birds 35 – 61 dB(A) • Wind through foliage 35 – 55 dB(A)
Logger 3	4/08/2016	49	42	• Intermittent dog barking 40 – 45 dB(A) • Intermittent birds 35 – 40 dB(A) • Wind through foliage 35 – 58 dB(A)

3. Project description

3.1 Overview

The Project involves the establishment of a hard rock quarry with an extraction rate of up to 300,000 tonnes per year. The actual extraction rate per annum will be dictated by demand requirements. The maximum daily extraction and haul rate would be about 3,000 tonnes but this extraction rate would be rare.

Project activities will be generally as follows:

- Progressive installation of environmental controls including erosion and sediment control measures
- Construction of site access road
- Construction of fencing
- Delineation of the site and stockpiling areas
- Vegetation clearance, soil stripping and stockpiling
- Construction of temporary drainage controls
- Commence quarry operations
- Close and rehabilitate the quarry

3.2 Construction

The construction phase of the quarry would be relatively short (i.e. about 1 month). The main activity would be the upgrade of the Gwydir Highway intersection. Other activities would be:

- Progressive installation of environmental controls including erosion and sediment control measures
- Construction of fencing
- Vegetation clearance, soil stripping and stockpiling
- Construction of temporary drainage controls

A dozer, excavator and haul trucks are the main pieces of equipment likely to be required during construction. Other equipment may include:

- Roller
- Grader
- Water cart
- Compactor
- Light vehicles
- Hand tools

3.3 Proposed site operations

The quarry operations would be carried out in stages and in response to market demand.

Stripping would occur in stages prior to excavation, generally stripping each area immediately prior to quarrying. Overburden would either be stockpiled for future rehabilitation works, or placed in final location as voids are created. The total area of the extraction area would be stripped with excavation continuing to establish a quarry face of about seven metres. Excavation would commence on the western side and continue in an easterly direction.

Once the first bench has been exhausted, a second seven metre wide bench would be established and the process would be repeated until the final depth of approximately 20 metres below the current ground level at each extraction area is reached.

Extracted material would then be crushed, screened and where necessary blended with other materials from the quarry, or material imported to the quarry. The materials would be stockpiled on the quarry floor in numbered stockpiles of approximately 4,000 tonnes each. This material would be loaded onto trucks as required for transportation off-site.

The main activities during operation of the quarry are described below.

3.3.1 Drilling and blasting

Underlying fresh rock will require blasting. Blasting will be strictly controlled and conducted by a suitably qualified blasting contractor who will bring explosives onto site as required and fill a series of holes pre-drilled by a separate drilling contractor. Bulk emulsion explosives such as Ammonium Nitrate Fuel Oil will be used. Following blasting, all blasting equipment and any unused explosives will be removed from site. No explosives would be stored on the Project site. Blasting will be undertaken in 30,000 tonne volumes similar to the existing Glen Innes Aggregates site. It is anticipated that up to one blast per month would be required.

3.3.2 Crushing and screening

Contractors would crush and screen the extracted material using mobile plant positioned close to the extraction area. An excavator would feed the excavated rock into a mobile primary crusher. The primary crusher will pass material to a secondary mobile crusher and then to the screening plant to sort the crushed aggregate into different grades depending on market demand. The screening plant will discharge into a stockpile area using a radial stacking conveyor.

3.3.3 Stockpiling

Material would be stockpiled in designated areas close to the respective pits. Material would be stored in various grades for sale or distribution. Ridge gravels may be brought to site from time to time to blend road base products. These components may form up to 10% of the finished product.

3.4 Project life and working hours

As the demand for product from the site will vary depending on the progress of certain major projects and fluctuating market conditions, it is not possible to put firm durations on each stage of activity. However, the quarry is expected to commence operation in late 2016 and be in operation for at least 30 years.

Construction and operation would generally be limited to the following times:

- Monday to Friday: 7.00 am to 5.00 pm
- Saturday: 8.00 am to 4.00 pm
- No work on Sundays or Public Holidays

Staff may arrive and leave site before and after these times to ‘start-up’ and ‘shut-down’ the quarry but excavation, crushing or loading would not occur outside the times specified above. Blasting would only occur on weekdays between the hours of 10 am and 3 pm.

3.5 Operational plant and equipment

Equipment at the quarry will depend on levels of activity which will vary from time to time. A description of the plant and equipment to be used is provided in Table 3-1. The frequency of use is relevant to the periods when the quarry is operating. As an example, when the quarry is operating during daytime, the crushers will be operating the majority of the time but when there is no demand for material, no works will occur at the quarry. The blast hole drill has assumed to only operate 2 days out of any month, or approximately 6% of the time.

Table 3-1 Proposed quarry plant and equipment

Type	Approximate Number	Typical Frequency of use during operation	Description
Blast drill	1	6%	Preparing blast holes prior to blasting.
Dozer	1	10%	Clearing and grubbing of vegetation and stripping of topsoil. Rehabilitation
Excavators	2	100%	Excavating material and stockpiling Clearing and grubbing of vegetation and stripping of topsoil
Screen	1	100%	Only for aggregate/gravel production and overburden screening
Front-end Loader	1	100%	Loading material onto the haul trucks and stockpiling material within the pit floor
Primary and secondary crusher	1 each	100%	Crushing rock
Haul Trucks	Up to 100/day	100%	Delivery of materials to customers and stockpiling in pit if needed and carting unsuitable to rehabilitation areas.
Water Cart	1	10%	To water haul roads and stockpiles
Water Pump	3	10%	To dewater excavation/basin and to fill watercart from standpipe To water stockpiles and put moisture in products
Hand tools	5	5%	General activities maintaining plant
Light vehicles	Up to 12	20%	Transporting staff to, from and around site

It is anticipated that not all of the equipment listed above would be operational on-site at any one time.

3.6 Access and traffic

The source, destination and route of light and heavy vehicles accessing the quarry is not possible to predict at this stage however it is assumed they would travel via various routes to projects and customers around the area via the Gwydir Highway. Alternate routes may be used to supply aggregate to specific projects, such as the Glen Innes Wind Farm project directly south of the Project site, which would transfer material along an internal access road.

The access road from the Gwydir Highway along the public road reserve has been approved as part of the Glen Innes Wind Farm and is not part of this Project. However, the intersections (one in and one out) with the Gwydir Highway will need to be upgraded.

3.6.1 Construction traffic generation

During the construction phase, the traffic generated is expected to be limited to a few heavy vehicle movements at the start and end of the construction. A few light vehicles would also access the site daily during the construction works.

3.6.2 Operation traffic generation

Workforce Traffic

During operation it is likely that there would be a maximum of twelve construction workers or plant operators on the site at any one time. This would yield a daily workforce traffic generation in the order of 24 vehicle trips per day (vtpd). It is assumed the majority of the workforce would arrive between 6:30 am and 7:30 am and depart generally between 3:00 pm and 6:30 pm.

Heavy Vehicle Traffic

Truck and dog trailer combinations have a capacity of about 32 tonnes. At maximum daily production (i.e. 3000 tonnes), the quarry is expected to generate about 200 truck movements per day. The truck movements would start at 7 am and continue evenly throughout the day, until 5 pm.

This rate of truck movements is expected to be infrequent and for short durations. The average number of truck movements is expected to be a lot less and there will be times when no trucks would be operating.

4. Noise criteria

4.1 Construction

Construction noise is assessed with consideration to the *Interim Construction Noise Guideline* (ICNG) (DECC, 2009). The ICNG provides noise management levels for construction noise at residential receivers. These management levels are to be calculated based on the rating background levels (RBL) at nearby residential locations, as shown in Table 4-1.

Table 4-1 ICNG construction noise criteria at residential receivers, dB(A)

Time period	Management level $L_{Aeq(15\ min)}$
Recommended standard hours: Monday to Friday: 7.00 am to 6.00 pm. Saturday: 8.00 am to 1.00 pm. No work on Sundays or public holidays	Noise affected level: $RBL_{(period)}$ + 10 Highly noise affected level: 75
Outside recommended standard hours	Noise affected level: $RBL_{(period)}$ + 5

The above levels apply at the most noise impacted point on the property or at the most affected point within 30 m from the residence where the property boundary is more than 30 m from the residence.

The *noise affected level* represents the point above which there may be some community reaction to noise. Where the *noise affected level* is exceeded all feasible and reasonable work practices to minimise noise should be applied and all potentially impacted residents should be informed of the nature of the works, expected noise levels, duration of works and a method of site contact.

The *highly noise affected level* represents the point above which there may be strong community reaction to noise and is set at 75 dB(A). Where noise is above this level, the relevant authority may require respite periods by restricting the hours when the subject noisy activities can occur, taking into account:

- Times identified by the community when they are less sensitive to noise (such as mid-morning or mid-afternoon for works near residences).
- If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.

Project specific construction noise criterion for residential receivers during recommended standard hours is determined from information provided in Table 4-1 and is presented in Table 4-2.

Table 4-2 Project specific construction noise criterion for residential receivers

Time period	Management level $L_{Aeq(15\ min)}$
Recommended standard hours: Monday to Friday: 7.00 am to 6.00 pm. Saturday: 8.00 am to 1.00 pm. No work on Sundays or public holidays	Noise affected level: 40 Highly noise affected level: 75
Outside recommended standard hours (Saturday 1 pm to 4 pm):	Noise affected level: 35

The ICNG also provides criteria for non-residential receivers. The criteria for non-residential receivers will not be discussed in this report since all of the identified sensitive receivers nearby to the proposal are residential.

Potential noise impacts due to construction traffic along public roads is assessed against the same criteria as operational road traffic impacts, and is discussed in Section 4.3.

4.2 Operational noise

Operational industrial noise criteria are derived from the NSW INP.

The INP provides non mandatory industrial noise criteria to aid in the assessment of industrial noise sources scheduled under the *Protection of the Environment Operations Act 1997*. The policy sets two separate noise criteria to meet environmental noise objectives, one to account for intrusiveness and the other to protect the amenity of particular land uses.

Intrusiveness is assessed by determining the background noise level, where the equivalent continuous noise level from quarry operations should not be more than 5 decibels (dB) above the measured background level. The amenity criterion is based on noise criteria specific to the land use and associated activities. The project specific level is the more stringent of the intrusive and amenity criteria.

The intrusive, amenity and project specific levels are shown Table 4-3.

The INP rural residential category has been adopted for all identified receivers to determine the applicable amenity criteria.

Table 4-3 Project specific operational noise criteria – daytime dB(A)

Criterion	Logger 1 (261 Malboona Rd)	Logger 2 (1296 Gwydir Hwy)	Logger 3 (160 Rose Hill Rd)
Rating background level, $L_{A90(Period)}$	29[1]	29[1]	28[1]
Intrusiveness criteria, $L_{Aeq(15min)}$	35	35	35
Amenity criteria (rural), $L_{Aeq(period)}$	50	50	50
Project specific criterion, $L_{Aeq\ (15min)}$	**35**	**35**	**35**

Note 1: The NSW INP notes that “where the rating background level is found to be less than 30 dB(A), then it is set to 30 dB(A).

The NSW INP requires that the noise level at residences be assessed at the most affected point on or within the residential boundary or, if this is more than 30 m from the residence, at the most-affected point within 30 m of the residence.

4.3 Traffic on public roads

Haul trucks may enter or exit the Project site along either the wind farm access road or the Gwydir Highway. Therefore, the Project has the potential to create additional traffic noise on these public roads. The quarry access road is located on the site and is not a public road. Noise from the access road is assessed under the INP.

The NSW *Road Noise Policy* (RNP) (OEH, 2011) provides non-mandatory road traffic noise target levels for land use developments with potential to create additional traffic on public roads.

Gwydir Highway has been considered an arterial road while the wind farm access road has been considered a local road. The road traffic noise target levels applicable to both construction traffic and operational traffic along public roads is presented in Table 4-4.

Table 4-4 RNP traffic noise target levels at residential receivers – dB(A)

Type of development	Day (7 am – 10 pm)	Night (10 pm – 7 am)
Existing residences affected by additional traffic on existing arterial roads generated by land use developments.	$L_{Aeq(1\ hour)}$ 60 (external)	$L_{Aeq(1\ hour)}$ 55 (external)
Existing residences affected by additional traffic on existing local roads generated by land use developments.	$L_{Aeq(1\ hour)}$ 55 (external)	$L_{Aeq(1\ hour)}$ 50 (external)

The Application Notes for the RNP state that 'for existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level as a result of the development should be limited to 2 dB above that of the noise level without the development. This limit applies wherever the noise level without the development is within 2 dB of, or exceeds, the relevant day or night noise assessment criterion.'

If road traffic noise during proposal construction is within 2 dB(A) of current levels, the objectives of the RNP (DECCW, 2011) are met and no specific mitigation measures are required.

5. Noise impact assessment

5.1 Noise modelling methodology

The noise emissions from Project operations have been assessed through noise modelling using Computer Aided Noise Abatement software (CadnaA v4.6) to predict sound pressure levels at the nearest identified noise sensitive receivers.

CadnaA is a computer program for the calculation, assessment and prognosis of noise propagation. CadnaA calculates environmental noise propagation according to ISO 9613-2, *Acoustics – Attenuation of sound during propagation outdoors*. Propagation calculations take into account sound intensity losses due to hemispherical spreading, atmospheric absorption and ground absorption.

The ISO 9613-2 algorithm also takes into account the presence of a well-developed moderate ground based temperature inversion, such as commonly occurs on clear, calm nights or downwind conditions which are favourable to sound propagation. As a result, predicted received noise levels are expected to represent a worst case scenario.

5.2 Noise generating equipment

Table 5-1 displays a list of identified significant noise generating equipment used during site establishment and operations and their corresponding sound power levels and modelled noise source height. Noise source sound power data has been sourced from measurements on-site, data held by GHD from previous projects and Australian Standard AS 2436:2010 where available. While the selection of operational equipment remains to be finalised, their operational noise levels are unlikely to be dissimilar from those adopted for this assessment.

Table 5-1 Noise sources and sound power levels

Noise source	Octave centre frequency (Hz) dB(lin)								Lw dB(A)	Height of noise source (m)
	63	125	250	500	1k	2k	4k	8k		
Excavator	92	96	99	100	105	101	94	86	108	2.5
Front end loader	73	93	96	101	100	100	95	87	106	2
Primary crusher	90	103	106	103	109	107	103	93	114	3
Secondary crusher	90	103	106	103	109	107	103	93	114	3
Screen	65	81	94	107	112	112	106	94	116	3
Haul trucks	87	97	98	100	102	99	93	85	107	3
Blast hole drill	89	102	105	102	108	106	102	92	113	2
Bulldozer	75	95	98	103	102	102	97	89	108	2.5
Grader	75	95	98	103	102	102	99	91	108	2.5

5.3 Modifying factor corrections

Where a noise source contains certain characteristics, such as tonality, impulsiveness, intermittency or dominant low-frequency content, it can cause greater levels of annoyance than other noise sources at the same noise level. The INP provides correction factors which are to be applied to the predicted noise levels for when such sources exist.

A review of site noise sources has been undertaken, based on the noise data supplied and the type of operations. The assessed noise sources are not expected to contain tonal or low-frequency noise. Therefore, no modifying factors have been applied to these sources.

Reverse beepers on mobile plant such as trucks and loaders on site could be considered as tonal and/or intermittent noise. The INP (EPA 2000) does provide a 5 dB adjustment for intermittent noise; however, it is only applicable during the night-time period (10 pm – 7 am). As Project operations would be during daytime hours only, this adjustment is not applicable. Tonal noise from reverse beepers can be eliminated through the use of broadband 'quacker' style beepers.

Based on the above, no modifying factor corrections have been applied to Project noise sources.

The presence of tonal, low-frequency or impulsive noise should be confirmed through compliance noise monitoring at sensitive receiver locations.

A review of site noise sources has been undertaken, and no on-site noise sources are expected to contain low frequency or tonal characteristics. Intermittency characteristics need only be assessed where the noise source occurs during the night period. Since the Project will not operate during the night time period, intermittency was not assessed.

5.4 Model configuration

General noise model parameters are presented in Table 5-2.

Table 5-2 General noise modelling parameters

Parameter	Value
Calculation algorithm	ISO 9613-2
General ground absorption coefficient	1.0 to represent vegetated area surrounding the Project
Meteorological conditions	10°C, 70% relative humidity
Receiver height	1.5 metres above ground level
Noise source heights	As per Table 5-1

5.4.1 Construction

Construction of the access road has been identified as the most significant construction activity for the Project and is therefore the focus of this construction noise assessment. This construction noise assessment has considered the highest predicted noise levels at each receiver generated by the simultaneous operation of a bulldozer, a grader and a haulage truck at the minimum point of separation between each receiver and the access road being constructed. This is considered a worst case scenario for construction noise.

5.4.2 Operational

As the quarry progresses throughout its lifetime, the shape of the working area would change. For example, the height of the pit floor would decrease relative to the existing ground level and the walls would become higher relative to the pit floor, offering shielding to receivers. For this reason, early operations before the pit floor is lowered represents the worst case scenario for potential operational noise impacts.

The following plant have been time adjusted as per Table 3-1 and modelled to be at the western side of the extraction area at the existing ground elevation. This is considered to be worst case scenario for operational noise:

- Primary and secondary crusher operating 100% of the 15-minute assessment period.
- Screen operating 100% of the 15-minute assessment period.
- Front end loader operating 100% of the 15-minute assessment period.
- Excavator operating 100% of the 15-minute assessment period.
- Blast hole drill operating 6% of the 15-minute assessment period.
- 3 heavy vehicles to enter and exit the extraction area during the 15-minute assessment period.

5.5 Construction noise and vibration results

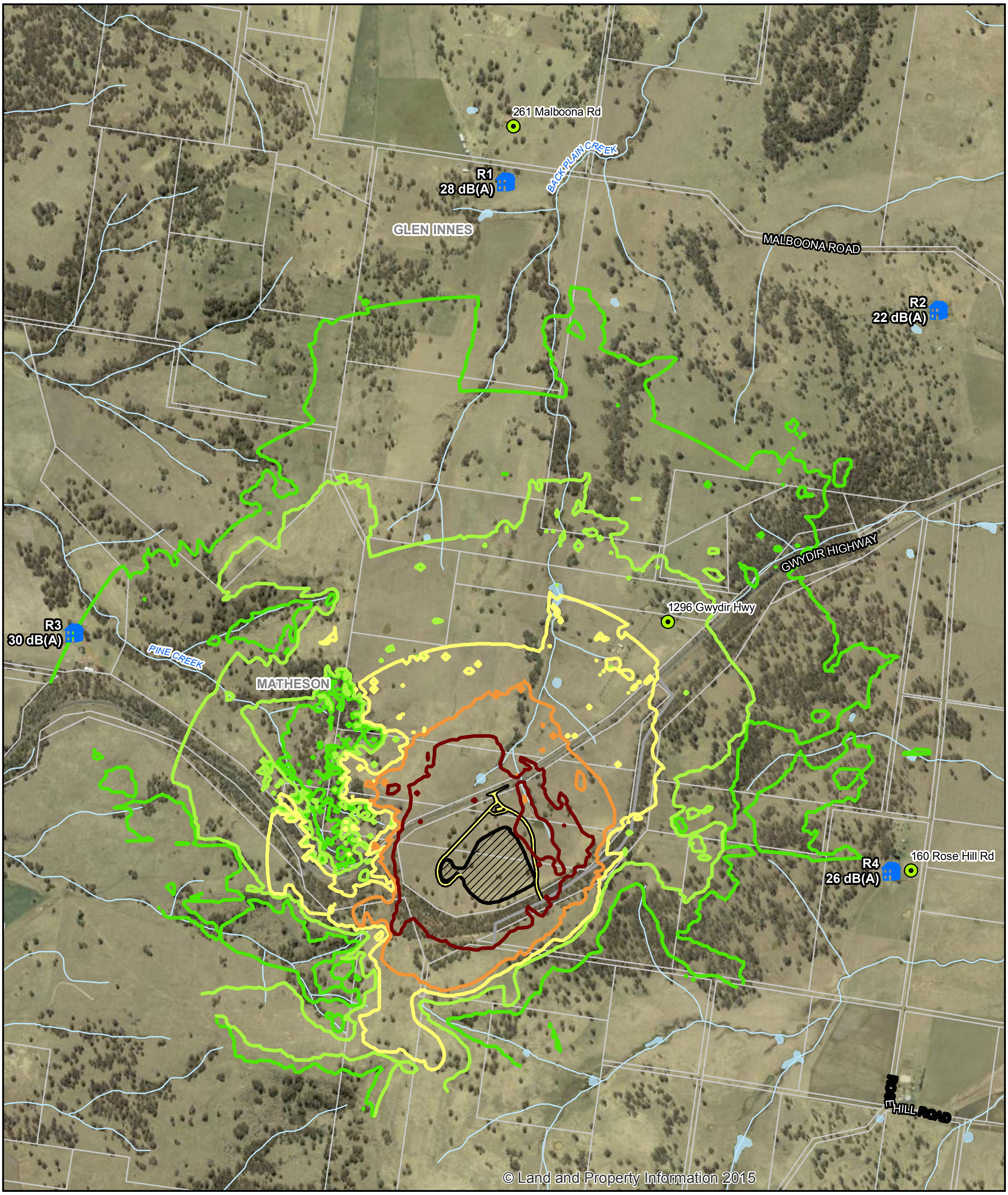
The highest predicted noise level for any receiver due to construction noise is approximately 26 dB(A) at receiver R3. This is less than the background noise level recorded at each of the three monitoring locations, and is also less than the construction noise criteria set out in Table 4-1.

The construction phase is anticipated to generate only minor construction traffic. Therefore, no construction noise traffic impacts are anticipated.

Given that all identified receivers are more than 1 km away from construction areas, construction vibration is anticipated to be below the threshold of human perception. Therefore, no construction vibration impacts are anticipated.

5.6 Operational noise and vibration results

Noise levels were predicted based on the operating conditions outlined in Section 5.4.2. The predicted noise levels for daytime site operations are shown in Figure 5-1 and Table 5-3.



LEGEND

- Cadastre
- Watercourse
- Waterbody
- Disturbance area
- Existing access
- Site access
- Residences
- Noise monitoring location

Noise Contours: LAeq
Grid height: 1.5m
Predicted using ISO 9613
No Mitigation Measures

- 30
- 35
- 40
- 45
- 50

Paper Size A4

0 90 180 360 540 720

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

Glen Innes Severn Council
Wattle Vale Quarry
Noise and Vibration Impact Assessment

Job Number 18380
Revision
Date 15 Nov 2016

Predicted operational noise contours

Figure 5-1

Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 T 61 2 4979 9999 F 61 2 4979 9988 E ntlmail@ghd.com W www.ghd.com.au

G:\22\18380\GIS\Maps\Deliverables\SouthernQuarryEIS\Noise\2218380_SQN002_NoisePredictions_A.mxd

Data source: LPI: DCDB & DTDB, 2012,Aerial Imagery, 2016; Geoscience Australia: 250k Topographic Data Series 3, 2006; GISSC: Quarry data, 2016. Created by: fmackay, kpsroba

Table 5-3 Predicted operational noise levels, dB(A)

Receiver ID	Day time noise criteria, dB(A)	Predicted level, dB(A)
R1	35	28
R2	35	22
R3	35	30
R4	35	26

Model results indicate that noise levels generated from quarry operations are predicted to comply with the INP daytime noise criteria at all sensitive receivers. It should be noted that modelling predictions have been based on meteorological conditions that are favourable to noise propagation.

Noise predictions have been based on operations at the existing ground level. It is noted that as the pit floor is lowered, the quarry walls will offer increasing shielding. Predicted noise levels are therefore expected to reduce as the quarry progresses.

Given that all identified receivers are over 1 km away from operational plant, operational vibration is anticipated to be below the threshold of human perception. No operational vibration impacts are therefore anticipated.

5.7 Road traffic on public roads

2011 bi directional Annual Average Daily Traffic data (AADT) along the Gwydir Highway, west of Glen Innes (station ID 91068) provides a traffic count of 1,349 vehicles. At maximum production, Wattle Vale Quarry is predicted to generate up to 200 additional heavy vehicle movements along the Gwydir Highway. This is less than a 15% increase in vehicle movements, and is therefore not anticipated to trigger the RNP 2 dB increase criterion stated in 4.3 (an increase in traffic of approximately 60% would be required to increase existing traffic noise by 2 dB).

Heavy vehicles may also enter and or exit Wattle Vale Quarry along the wind farm access road. Additional heavy vehicle movements along this access road may potentially trigger the RNP 2 dB increase criterion at receiver R4. For this reason, road traffic noise impacts due to additional heavy vehicles travelling along public roads have also been assessed against the total residential noise targets set out in Table 4-4, by modelling heavy vehicles as moving point sources along the wind farm access road and the Gwydir Highway. Table 5-4 presents the maximum predicted 1 hour noise exposure for any identified sensitive noise receiver due to additional heavy vehicles travelling along public roads during periods of peak production.

Table 5-4 Predicted road traffic noise level during peak daily production

Roadway	Generated heavy vehicle movements per day (peak daily production)	RNP criteria Day (7 am – 10 pm)	Maximum predicted road noise level from additional heavy vehicles travelling on public roads during peak daily production $L_{Aeq(1\ hour)}$ dB(A)
Gwydir Highway	200 (100 loads)	$L_{Aeq(1\ hour)}$ 60 (external)	< 35 dB(A)
Wind farm access road	200 (100 loads)	$L_{Aeq(1\ hour)}$ 55 (external)	< 35 dB(A)

Table 5-4 predicts that there will be no road traffic noise impacts due to additional heavy vehicles travelling along the wind farm access road. According to AADT data, additional heavy vehicles travelling along the Gwydir Highway would not be significant compared to existing traffic volumes, and would therefore not trigger the RNP 2 dB increase criterion. The RNP objectives are therefore predicted to be met for additional heavy vehicle movements along either public road.

6. Blast impact assessment

6.1 Criteria

The ANZEC Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration has been adopted for assessment of blasting noise and vibration impacts in this report. This guideline specifies recommended human comfort criteria for blasting activities.

The ANZECC recommended maximum level for airblast overpressure is 115 dB(L) peak. This level may be exceeded on up to 5% of the total number of blasts over a period of 12 months. However, the airblast overpressure must not exceed 120 dB(L) peak for any blast.

Ground-borne vibration level should not exceed 5 mm/sec Peak Particle Velocity (PPV). The recommended PPV level may be exceeded on up to 5% of the total number of blasts over a period of 12 months. However, the level should not exceed 10 mm/sec at any time.

ANZEC guideline recommends that blasting should only be permitted during the following hours:

- Monday to Saturday, 9 am to 5 pm.
- No blasting on Sundays or Public Holidays.

The frequency of blasting should not take place more than once per day. This requirement does not apply to minor blasts.

The abovementioned restrictions on times and frequency of blasting do not apply to premises where the effects of the blasting are not perceived at noise sensitive sites.

When a temperature inversion is known to exist, blasting should be avoided if practicable.

6.2 Blast prediction methodology

A general assessment of blasting has been undertaken to assess potential adverse impacts on the surrounding residential receivers. Blasting estimations have been undertaken with consideration to AS2187.2 (2006) *Explosives – Storage and use – Use of Explosives*.

Blasting is non-linear in nature and variability in ground type and meteorological conditions makes it difficult to accurately predict ground vibration and airblast overpressure without site specific measurement data.

Predictions made in this blasting impact assessment have been based on generic blast parameters and should be refined based on site specific data, once available. Site parameters can be determined through noise and vibration monitoring during initial blasts or test blasts at the quarry. The results of this assessment should be used as a guide for potential impacts only.

6.2.1 Airblast calculations

Airblast radiates outwards from the blast site and attenuates with distance. "Airblast levels have been estimated using the following cube root scaling formula:

$$P = K_a \left(\frac{R}{Q^{1/3}} \right)^a \qquad \textbf{Equation (1)}$$

Table 6-1 summarises the constants in Equation (1) and the values that have been assumed to estimate airblast levels. Site constants have been assumed in the absence of existing blast monitoring data. Once blast monitoring data becomes available, the sites constants can be determined and more accurate predictions can be made.

Table 6-1 Airblast parameters and assumptions

Parameter	Definition	Assumed value
P	Pressure (kPa)	N/A
Q	Explosive charge mass per hole (kg)	Range from 20 to 170
R	Distance from charge (m)	Range: 100 to 2000
a	Site exponent	-1.45
Ka	Site constant	50

6.2.2 Ground vibration calculations

Ground vibration radiates outwards from the blast site and gradually reduces in magnitude with distance from the blast.

Factors that affect the level of ground vibration arriving at a point from a blast typically include:

- Charge mass fired per hole
- Distance
- Ground transmission characteristics

Ground vibration levels have been estimated using the following formula.

$$V = K_g \left(\frac{R}{Q^{1/2}} \right)^{-B} \qquad \textbf{Equation (2)}$$

Table 6-2 summarises the constants in Equation (2) and the values that have been assumed to estimate ground vibration levels, based on the provided monitoring results.

Table 6-2 Ground vibration parameters and assumptions

Parameter	Definition	Assumed value
V	Ground vibration in Vector Peak Particle Velocity (VPPV) (m/s)	N/A
R	Distance from charge (m)	Range: 100 to 2000
Q	Maximum charge mass (kg)	Range from 20 to 100
Kg, B	Constants related to site and rock properties for estimation purposes	Kg = 1140) B = 1.6

6.3 Predicted results

6.3.1 Predicted blasting buffer distances

Air blast overpressure and ground vibration has been predicted for a range of charge masses and are shown in Figure 6-1 and Figure 6-2 for varying distances and assuming average blasting parameters. The distance to comply with the *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration* (ANZEC, 1990) are also shown.

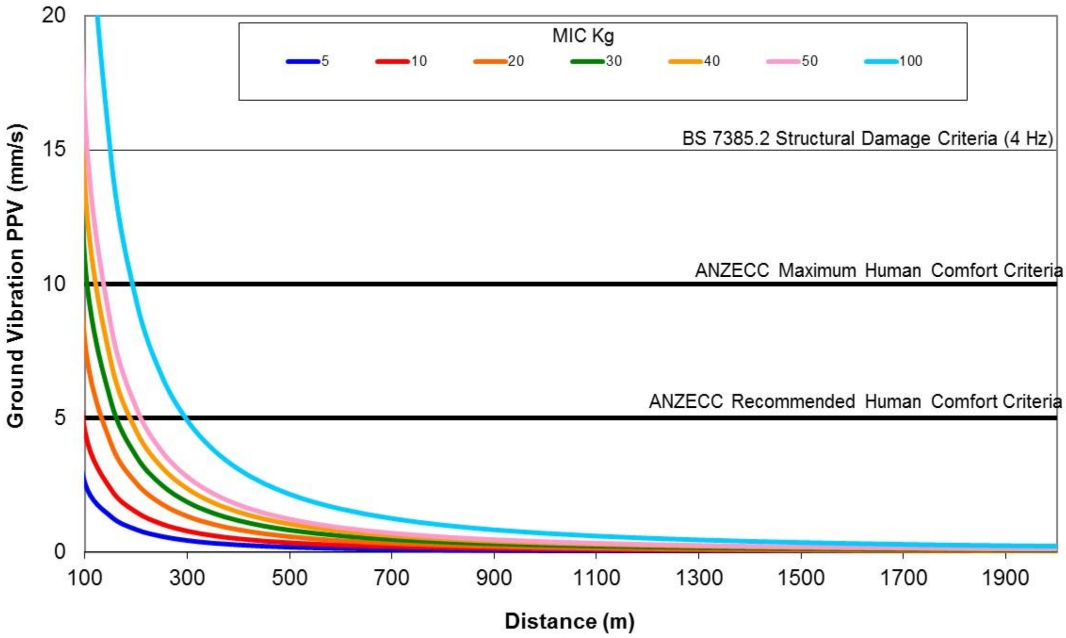


Figure 6-1 Ground vibration predictions for different charge masses and distances

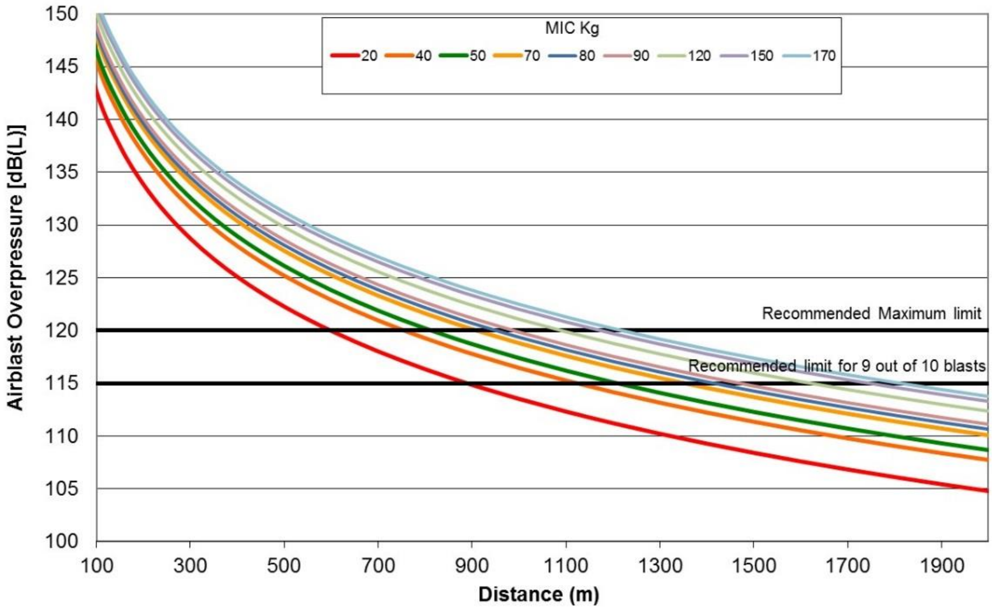


Figure 6-2 Air blast overpressure predictions for different charge masses and distances

6.3.2 Assessment of blasting impacts

The predicted results shown in Figure 6-1 and Figure 6-2 indicate that blasting would be restricted by the air blast overpressure rather than the ground vibration levels.

Based on the assumed site specific constants and an approximate distance of 1600 metres from receiver R4, Figure 6-2 indicates that the ANZEC recommended over pressure limit of 115 dB peak approximately equates to a MIC of 120 kilograms.

It is recognised that the blast design would be up to the blast contractor and that the above information has been assumed for this assessment only, in the absence of specific information regarding future blasting at the proposed site.

Once the exact location and details of blasting is known, the distance to the receiver should be used for the charge mass estimate. Blast monitoring should then be undertaken to assess compliance, determine the site specific blast parameters and confirm the predictions.

7. Discussion

7.1 Operational noise results

Noise modelling predictions indicate compliance of the operational noise criteria at all receivers. Modelling was based on meteorological conditions favourable to noise propagation, therefore is considered to be conservative. Modelling has also been based on existing ground elevation. The pit floor will be lowered as excavation progresses, with the quarry walls providing shielding to receivers. The modelled scenario is therefore considered to represent the worst case operational scenario, with predicted receiver noise levels to reduce as the life of the quarry progresses.

Although construction and operational noise for the Project is predicted to comply with the relevant noise criteria, general procedural mitigation measures are suggested in Section 7.2 and Section 7.3 to avoid community disturbance.

7.2 Work ethics

All site workers would be sensitised to the potential for noise impacts on local residents and encouraged to take practical and reasonable measures to minimise the impact during the course of their activities. This would include:

- Where practical, machines would be operated at low speed or power and switched off when not being used rather than left idling for prolonged periods.
- Keep truck drivers informed of designated vehicle routes, parking locations and delivery hours.
- Avoid dropping materials from height and avoid metal to metal contact on material.
- All engine covers would be kept closed while equipment is operating.

7.3 Community relations

Consultation and cooperation with the community would assist in minimising uncertainty, misconceptions and adverse reactions to noise. It is recommended the following community relation measures be implemented:

- The quarry manager would erect a sign at the entrance of the quarry with a phone number and permanent site contact so that noise complaints can be received and addressed in a timely manner.
- Upon receipt of a noise complaint, noise monitoring would be undertaken and reported as soon as possible. If exceedances are detected, the situation would be reviewed in order to identify means to attempt to reduce the impact to acceptable levels.

7.4 Blasting mitigation measures

It is recommended that all sensitive receivers be informed when blasting is to be undertaken. Reducing charge mass and increasing distance is the most effective way of reducing blasting impacts. Blasting should only occur from 9 am to 5 pm, Monday to Saturday and should not generally take place more than once per day.

Adverse meteorological conditions such as temperature inversions and wind direction can significantly increase airblast overpressure levels. Temperature inversions are most common during night and early morning periods, particularly during winter periods and therefore should not affect blasting during the recommended standard hours.

Due to variability in blasting impacts, it is recommended that monitoring be undertaken during initial blasts at the site to confirm predictions and assess compliance with the ground vibration and airblast overpressure limits.

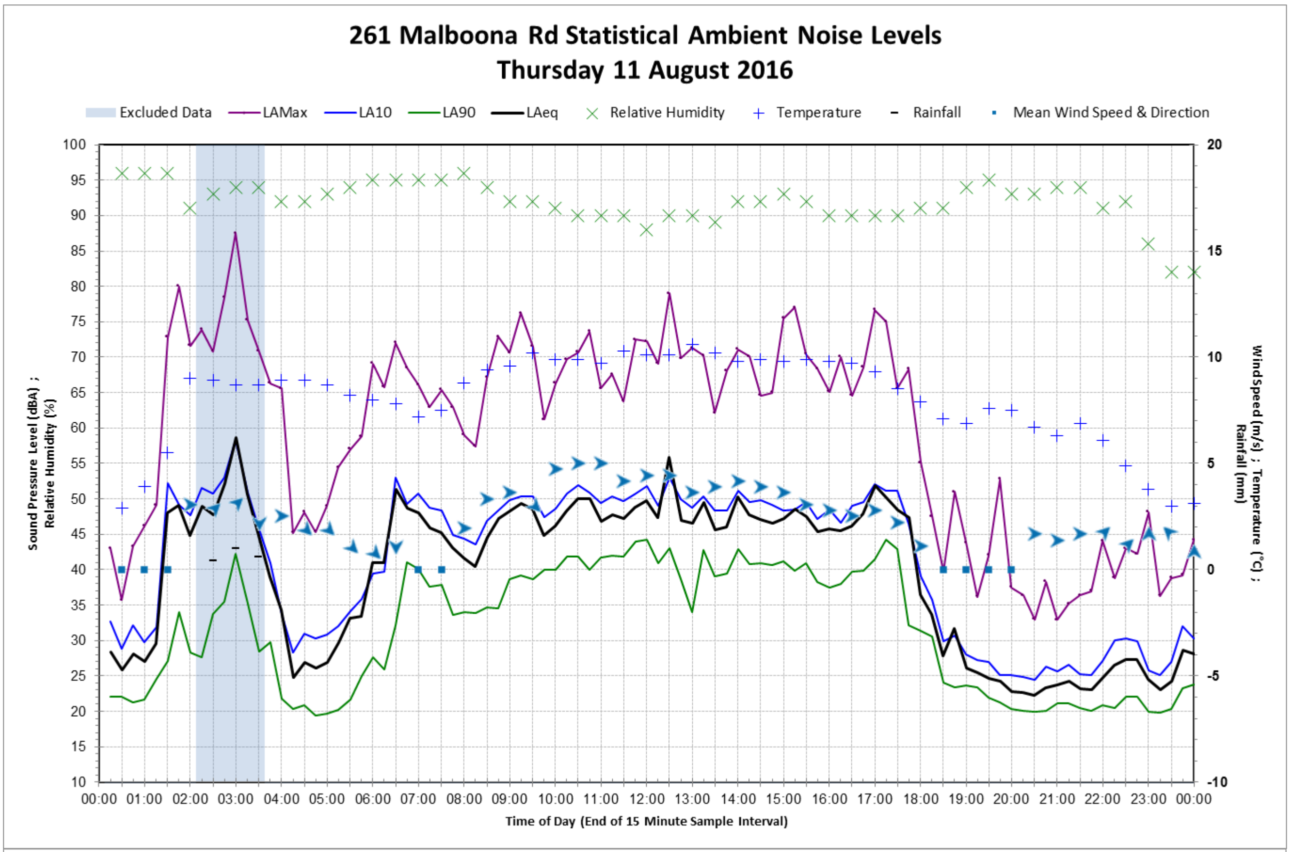
8. Conclusion

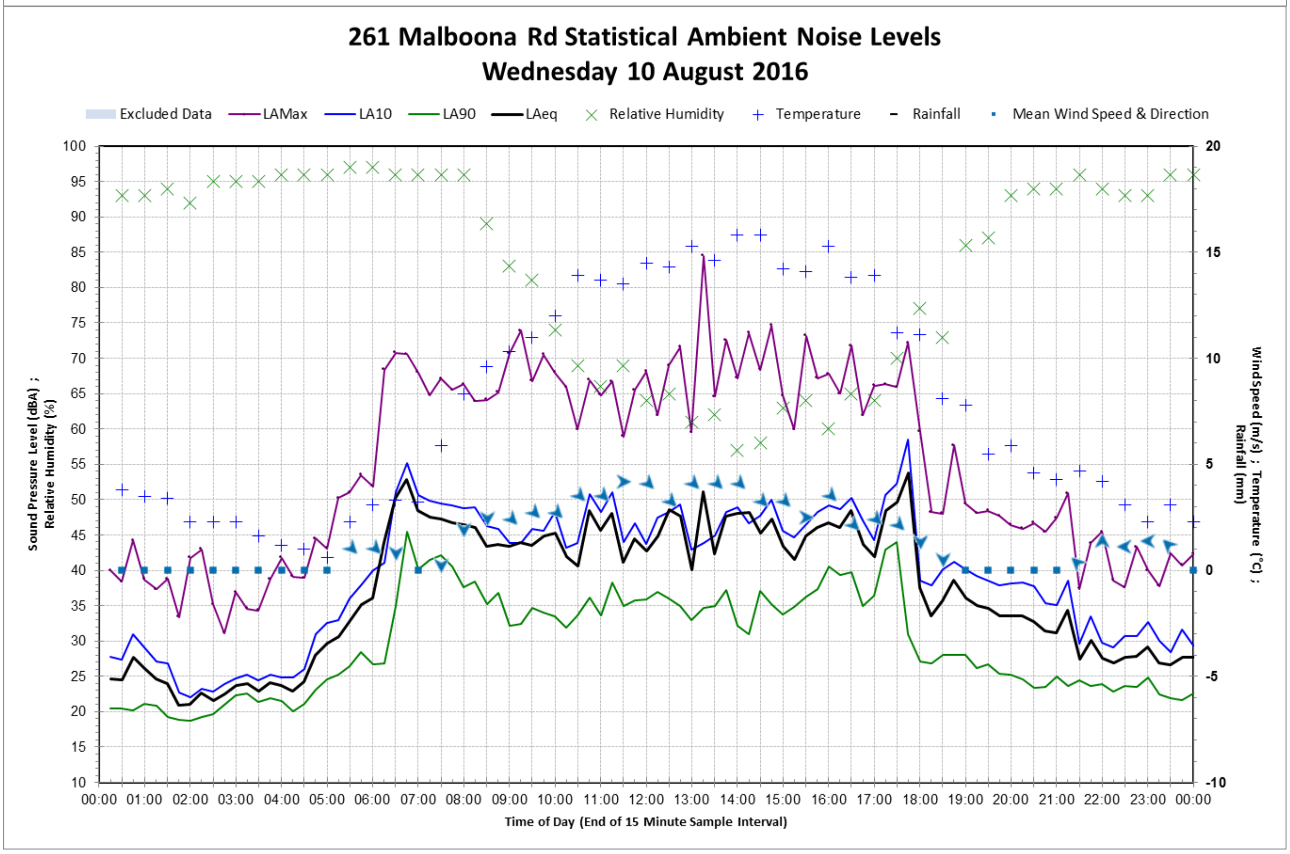
An assessment of the potential construction and operational noise and vibration impacts from the development of Wattle Vale Quarry has been undertaken. This assessment has led to the following conclusions, which are subject to the limitations outlined in Section 1.4 and 1.5:

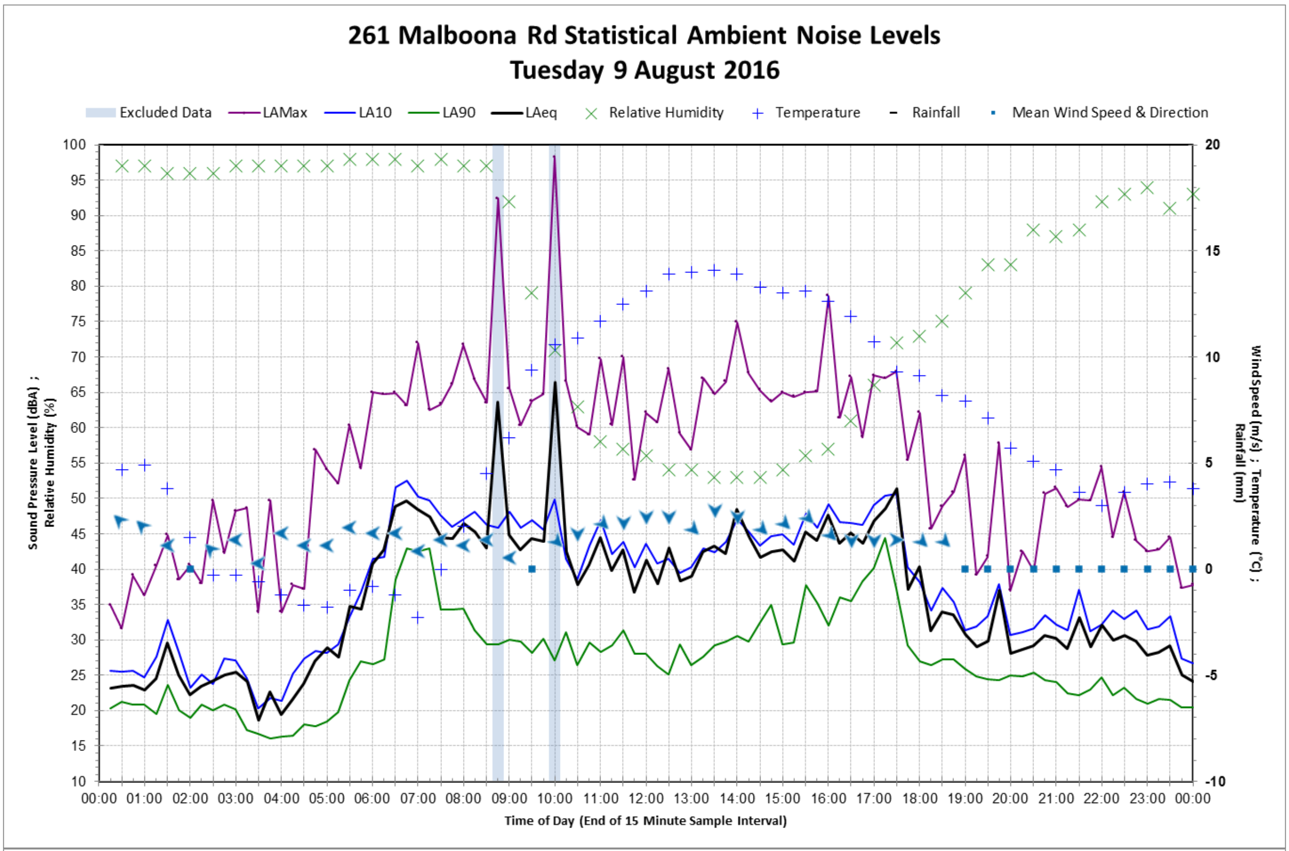
- Existing noise levels in the area surrounding the site are low and typical of a rural environment, and were found to be less than 30 dB(A) at each of the three monitoring locations. The RBL for these locations has been set to 30 dB(A) as directed by the INP.
- A construction noise criterion of 40 dB(A) $L_{eq(15\ min)}$ during standard construction hours and 35 dB(A) on a Saturday afternoon, outside of standard construction hours, was derived for all identified receivers.
- Construction noise was determined to be below the construction criteria, and construction vibration is anticipated to be below the threshold of human perception at all identified receivers, given the large separation distance between receivers and the construction works.
- An operational noise criterion of 35 dB(A) $L_{eq(15\ min)}$ was adopted at all identified receivers.
- The operational noise assessment predicted compliance without the need of any specific noise mitigation measures, for all identified sensitive receivers. Operational vibration is expected to be below the threshold of human perception at all identified receivers.
- The predicted growth in traffic along public roads due to quarry traffic during peak production operations was investigated and was determined to be insignificant relative to the RNP criteria.
- Over pressure limits rather than vibration limits were found to be the controlling factor to determine blast design. Based on assumed site constants, predictions indicate that the ANZEC recommended over pressure limit of 115 dB peak approximately equates to a MIC of 120 kilograms at a receiver distance of 1600 m from the blast. It is recommended that initial blast monitoring be conducted to confirm the site constants and refine the blast predictions.
- Further recommendations have been provided in Section 7 to assist in minimising potential noise impacts.
- No noise or vibration impacts to people, livestock, heritage items or infrastructure are anticipated to result due to the Project.

Appendices

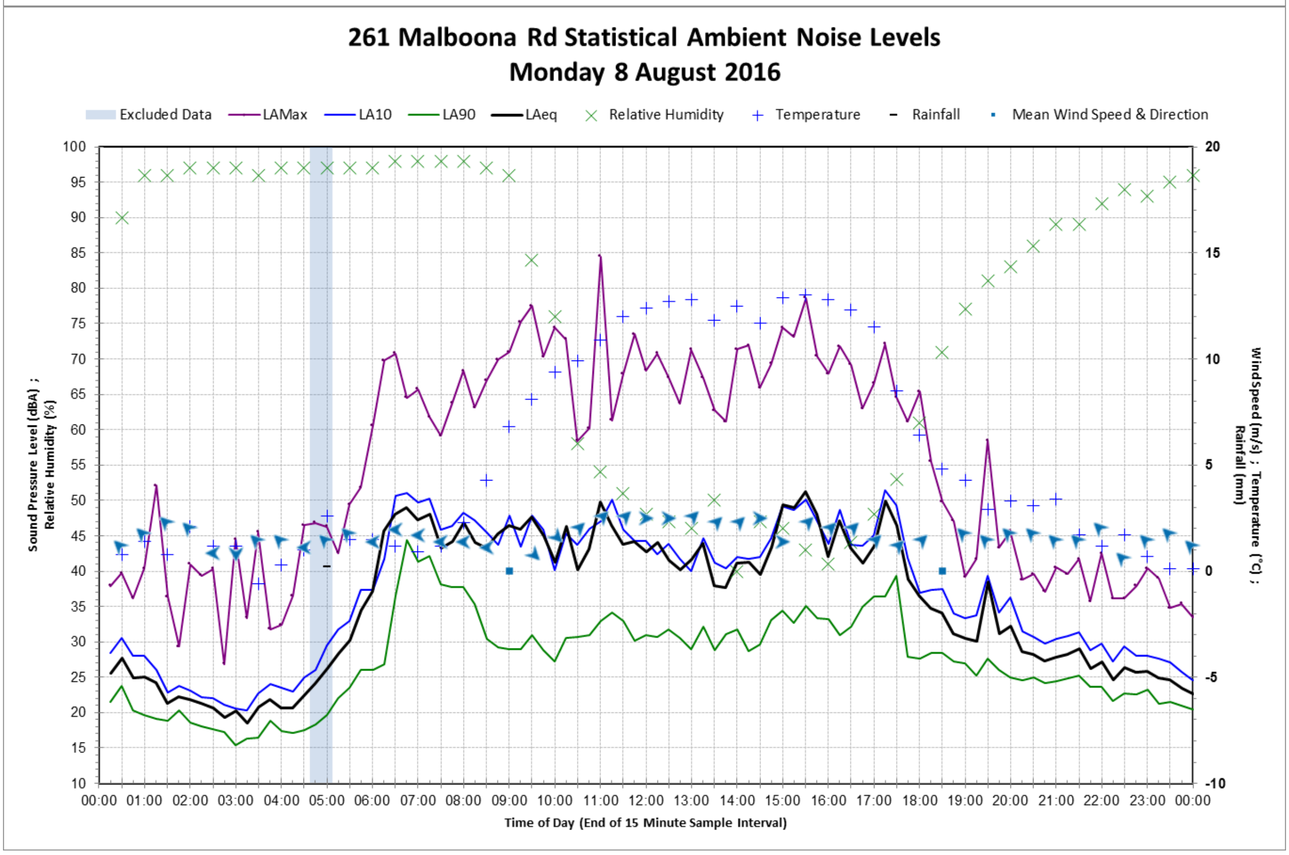
Appendix A – Unattended noise monitoring charts
261 Malboona Rd







261 Malboona Rd Statistical Ambient Noise Levels
Tuesday 9 August 2016
Excluded Data
LAMax
LA10
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dBA) ; Relative Humidity (%)
WindSpeed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)



261 Malboona Rd Statistical Ambient Noise Levels
Monday 8 August 2016
Excluded Data
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LA90
LAeq
Relative Humidity
Temperature
Rainfall
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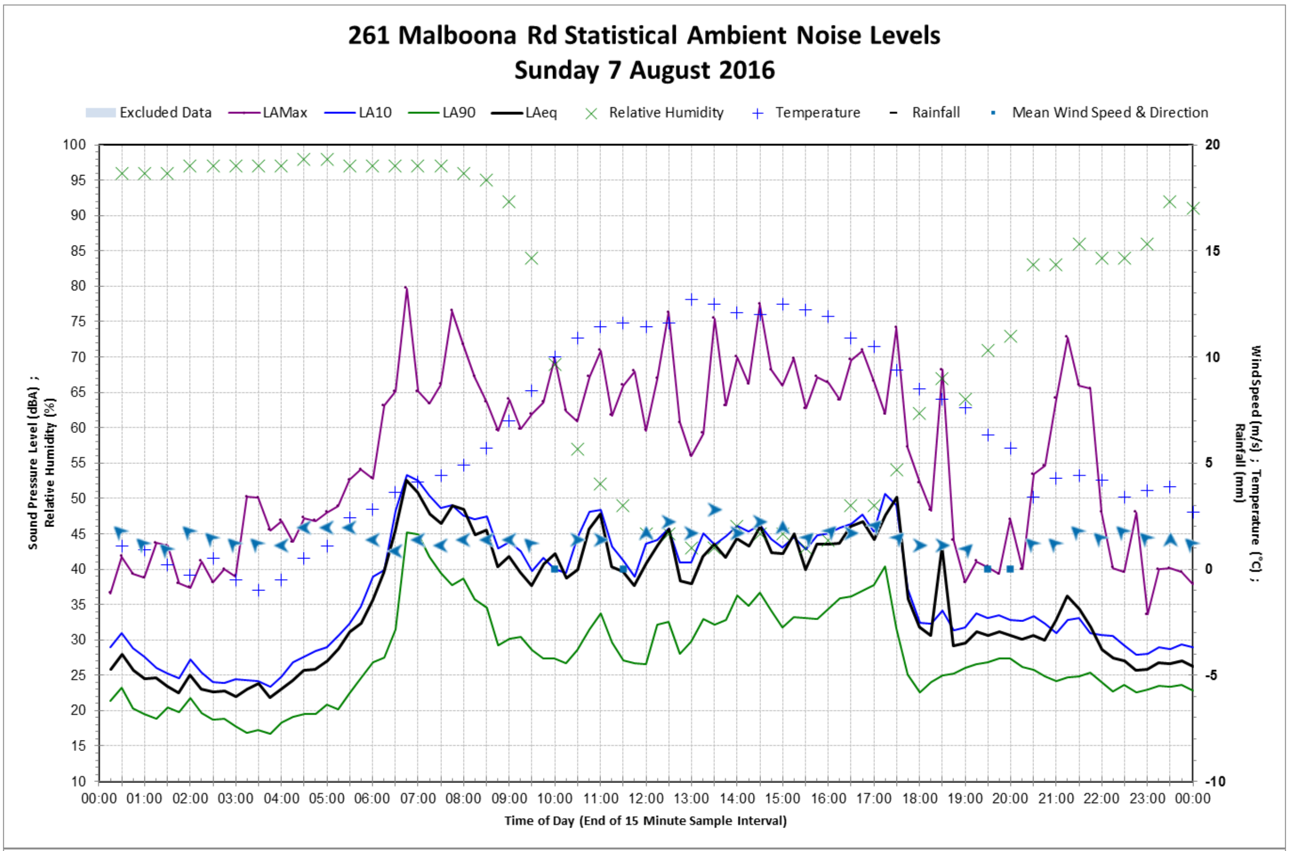
Sound Pressure Level (dBA) ; Relative Humidity (%)
WindSpeed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)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LA90
LAeq
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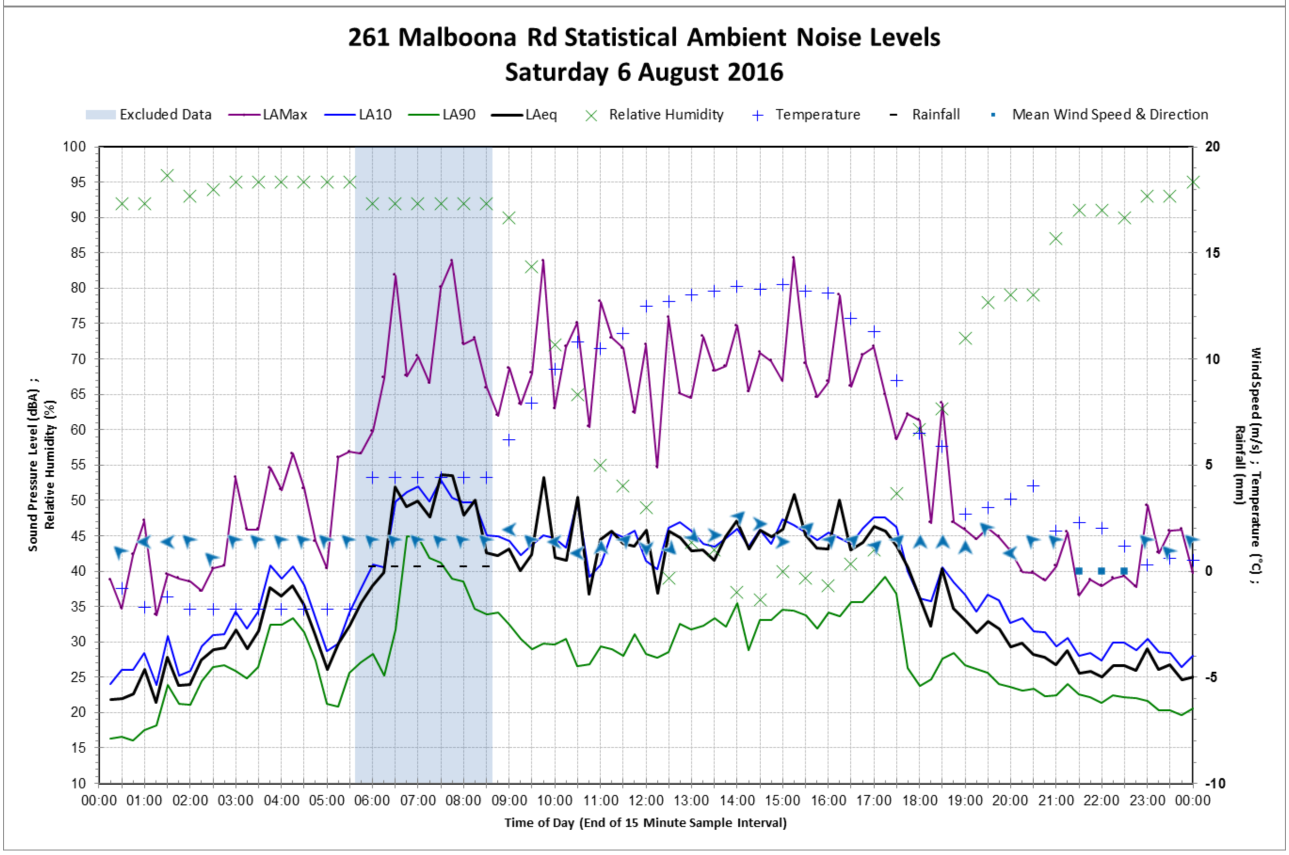
Temperature
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dBA) ; Relative Humidity (%)
WindSpeed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)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Saturday 6 August 2016
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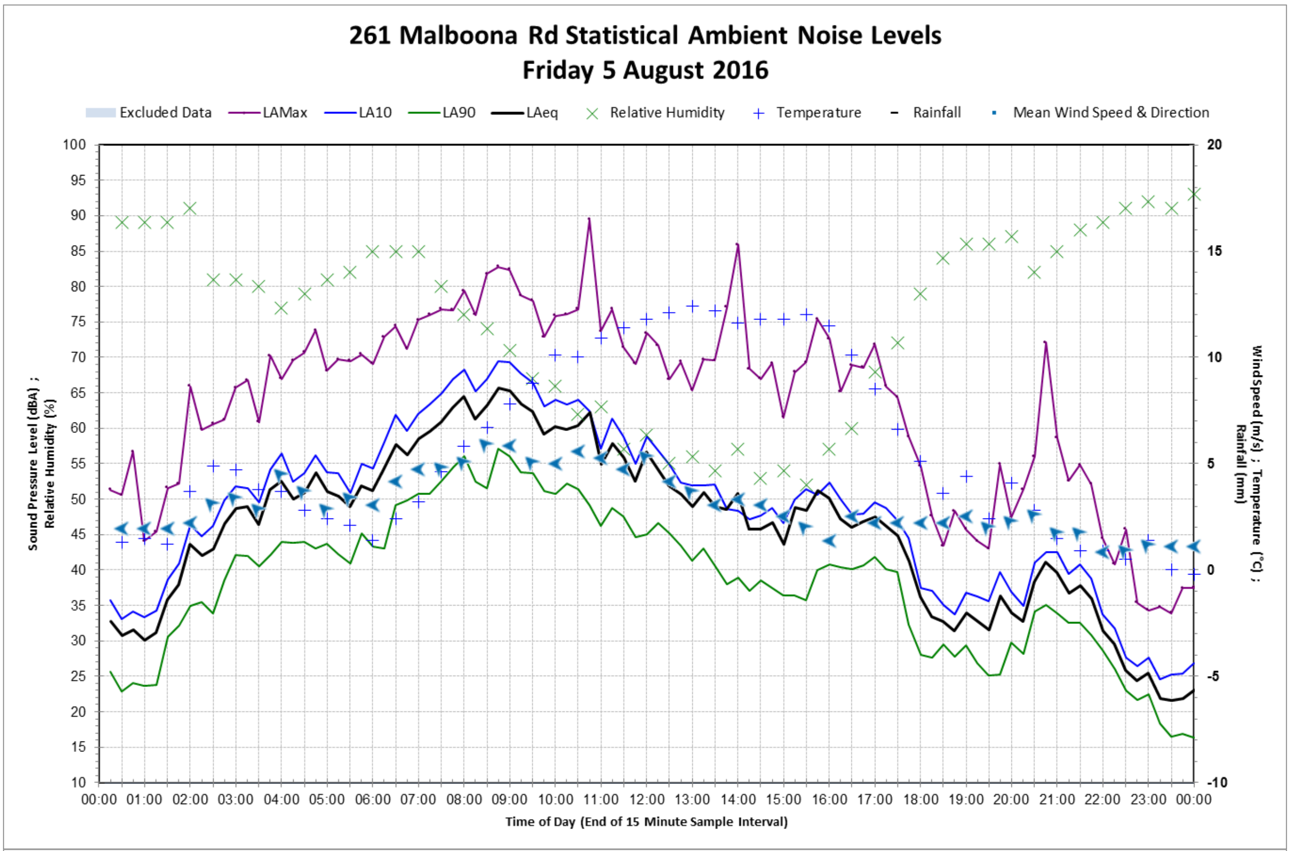
Temperature
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dBA) ; Relative Humidity (%)
WindSpeed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)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LAeq
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Temperature
Rainfall
Mean Wind Speed & Direction
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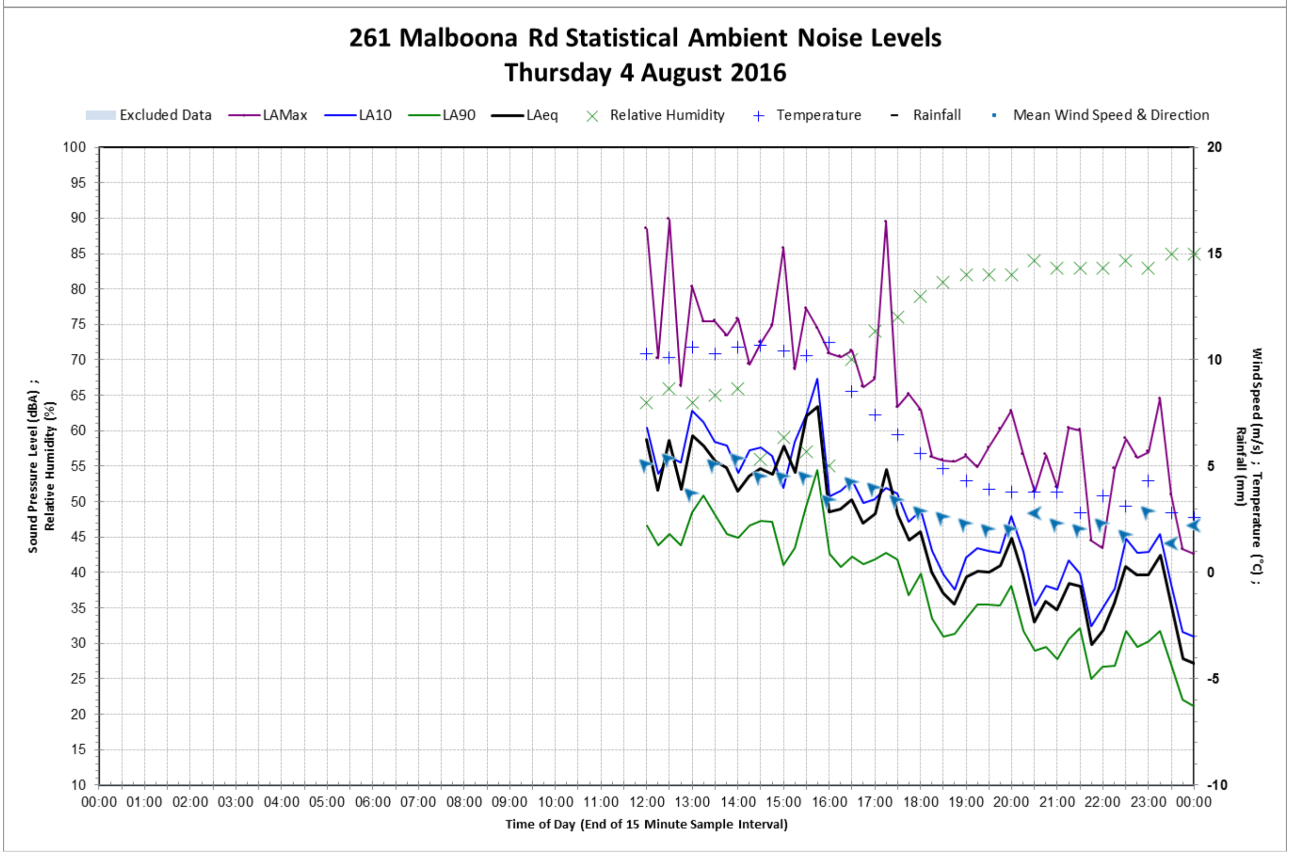
WindSpeed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)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LAeq
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Temperature
Rainfall
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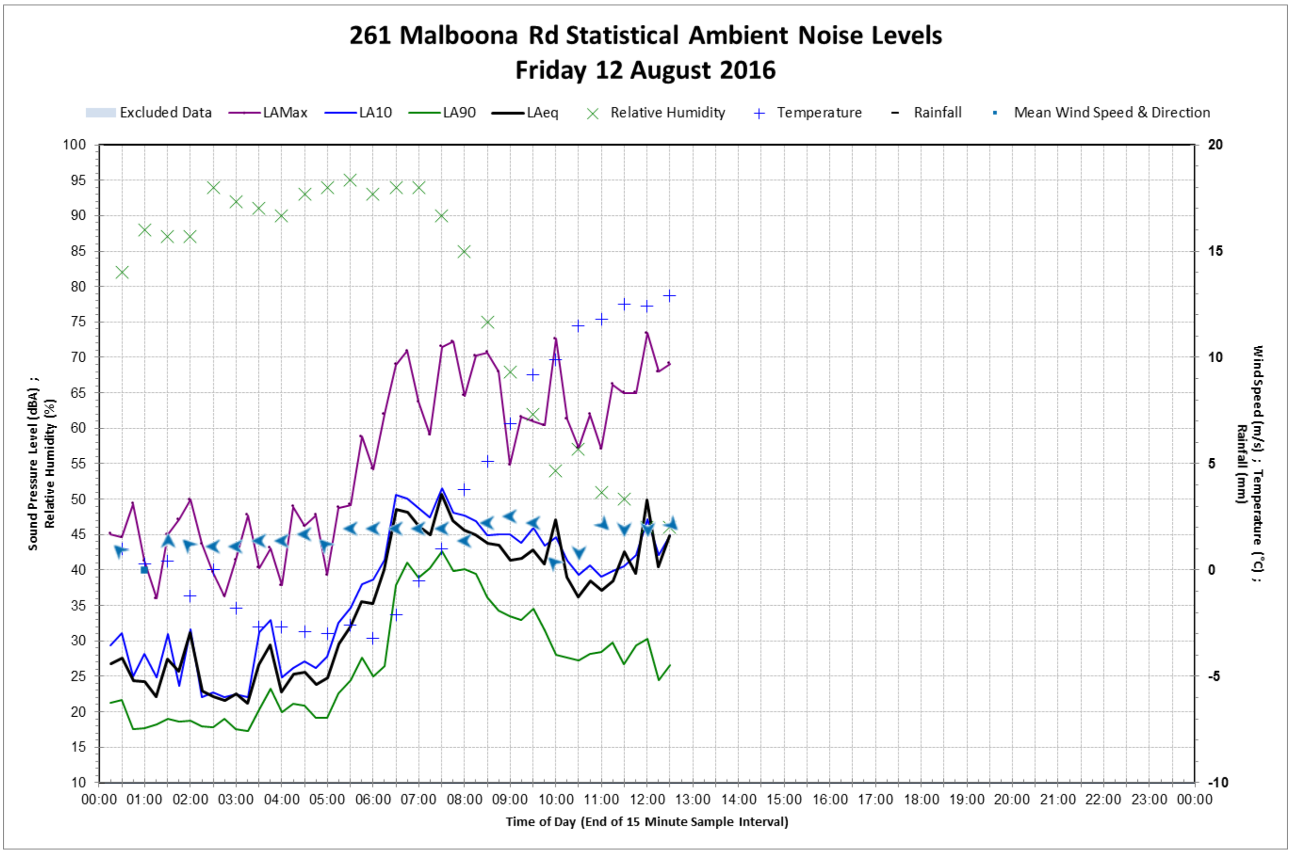
WindSpeed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)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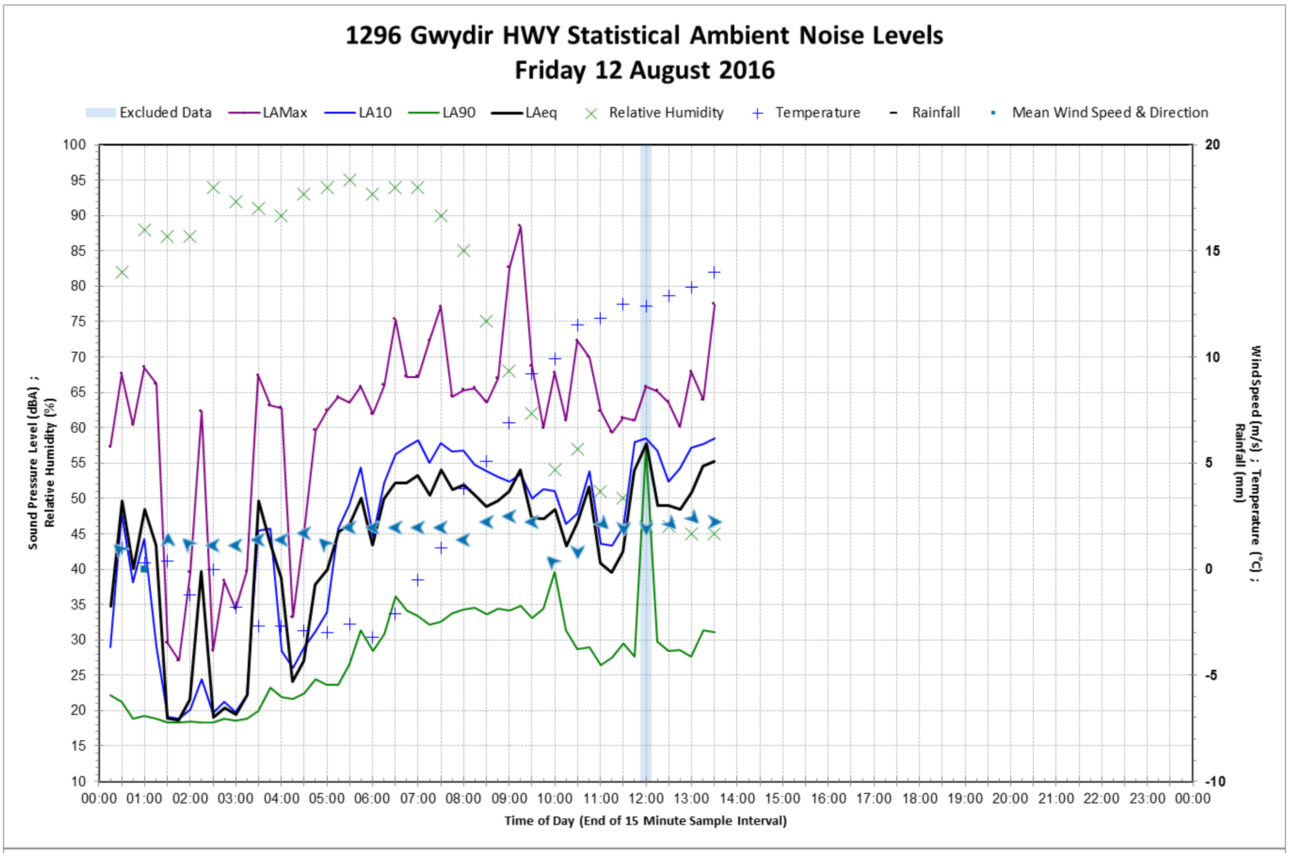
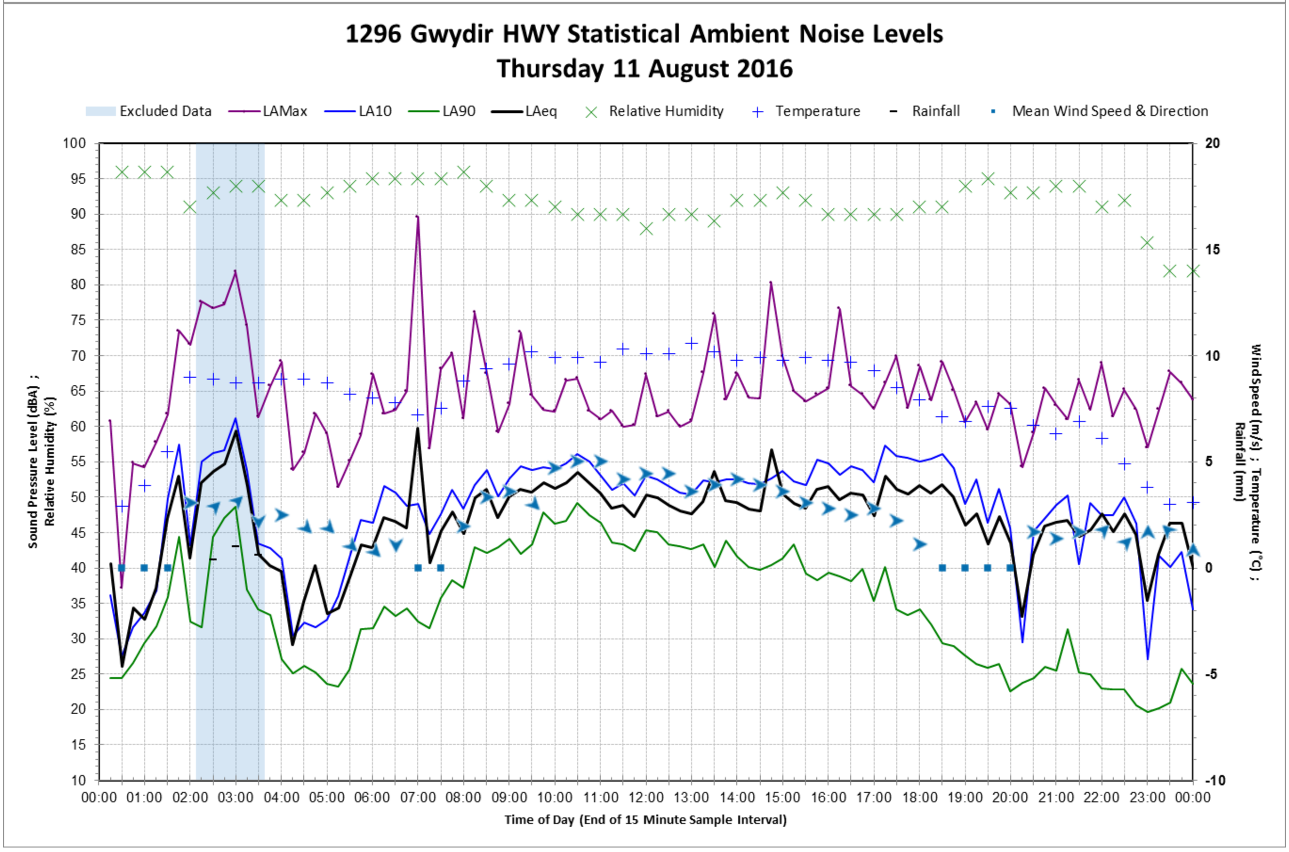
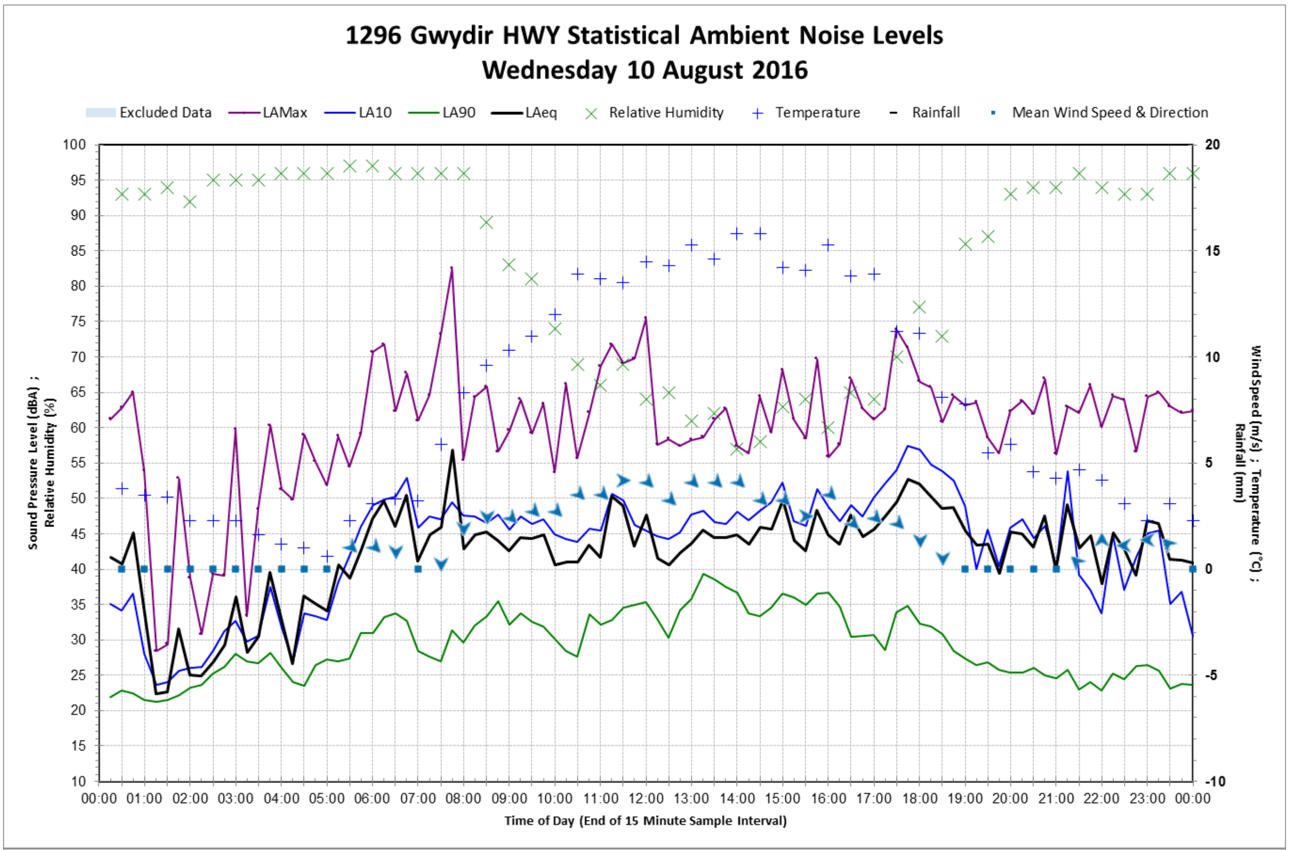
LA90
LAeq
Relative Humidity
Temperature
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)

Appendix B – Unattended noise monitoring charts

1296 Gwydir Highway



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LAeq
Relative Humidity
Temperature
Rainfall
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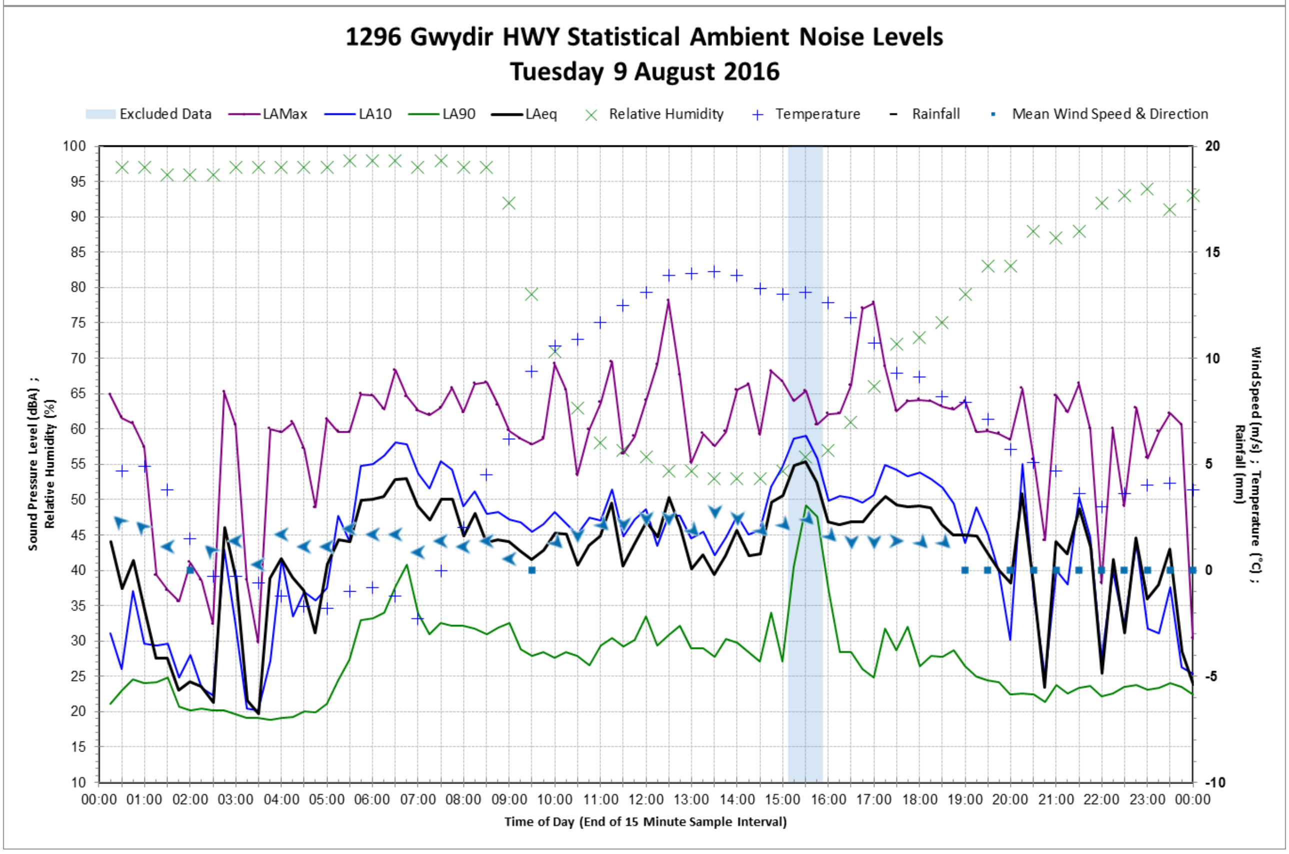
WindSpeed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)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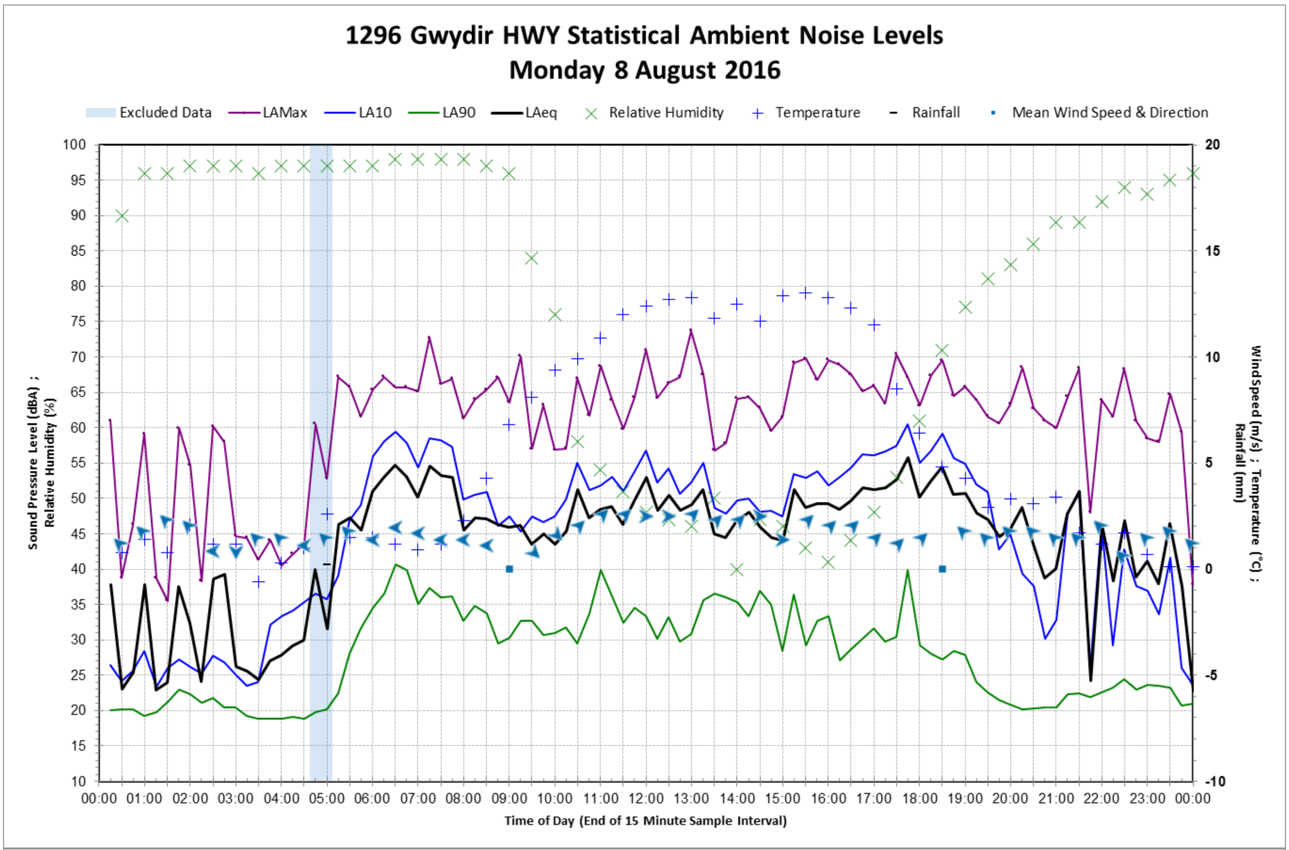
Temperature
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dBA) ; Relative Humidity (%)
WindSpeed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)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Monday 8 August 2016
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Temperature
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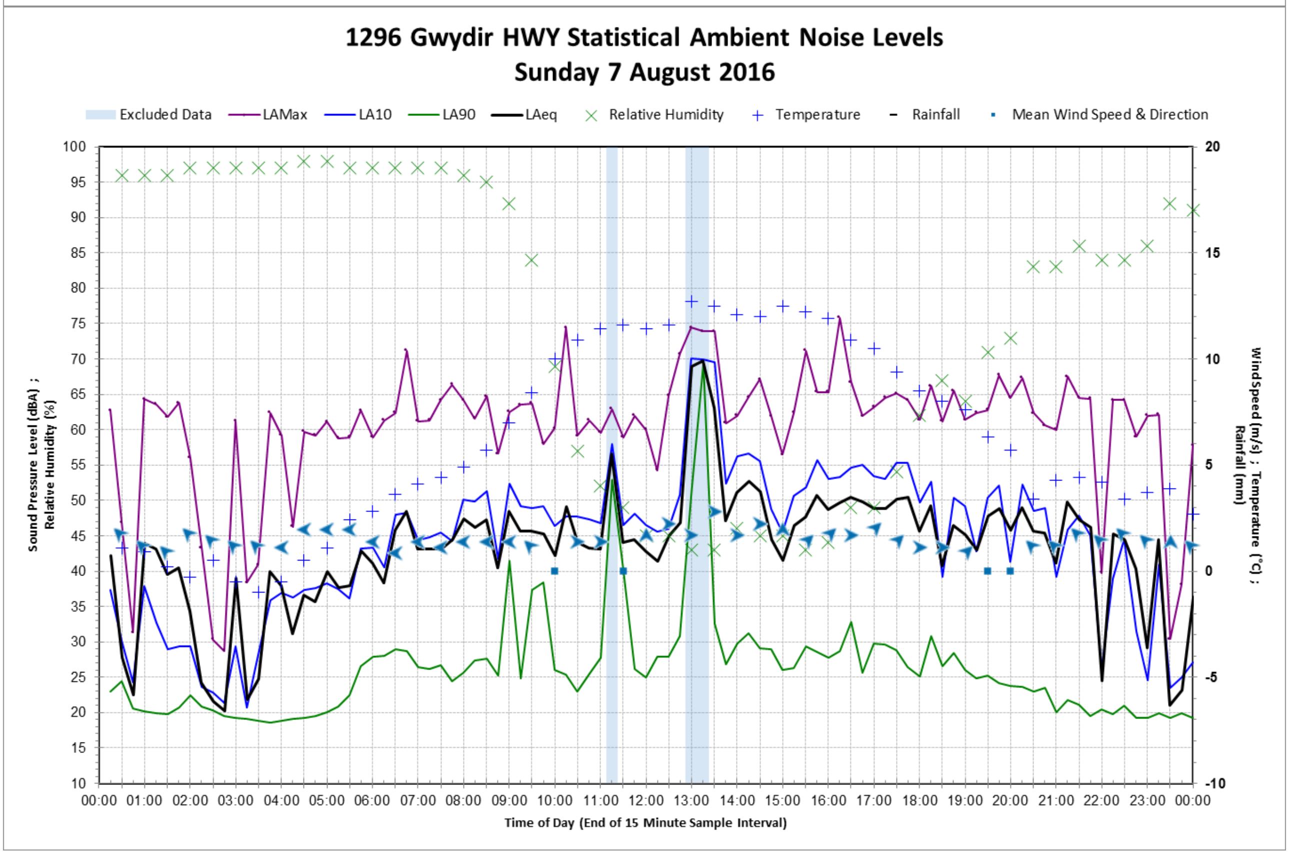
Time of Day (End of 15 Minute Sample Interval)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Sunday 7 August 2016
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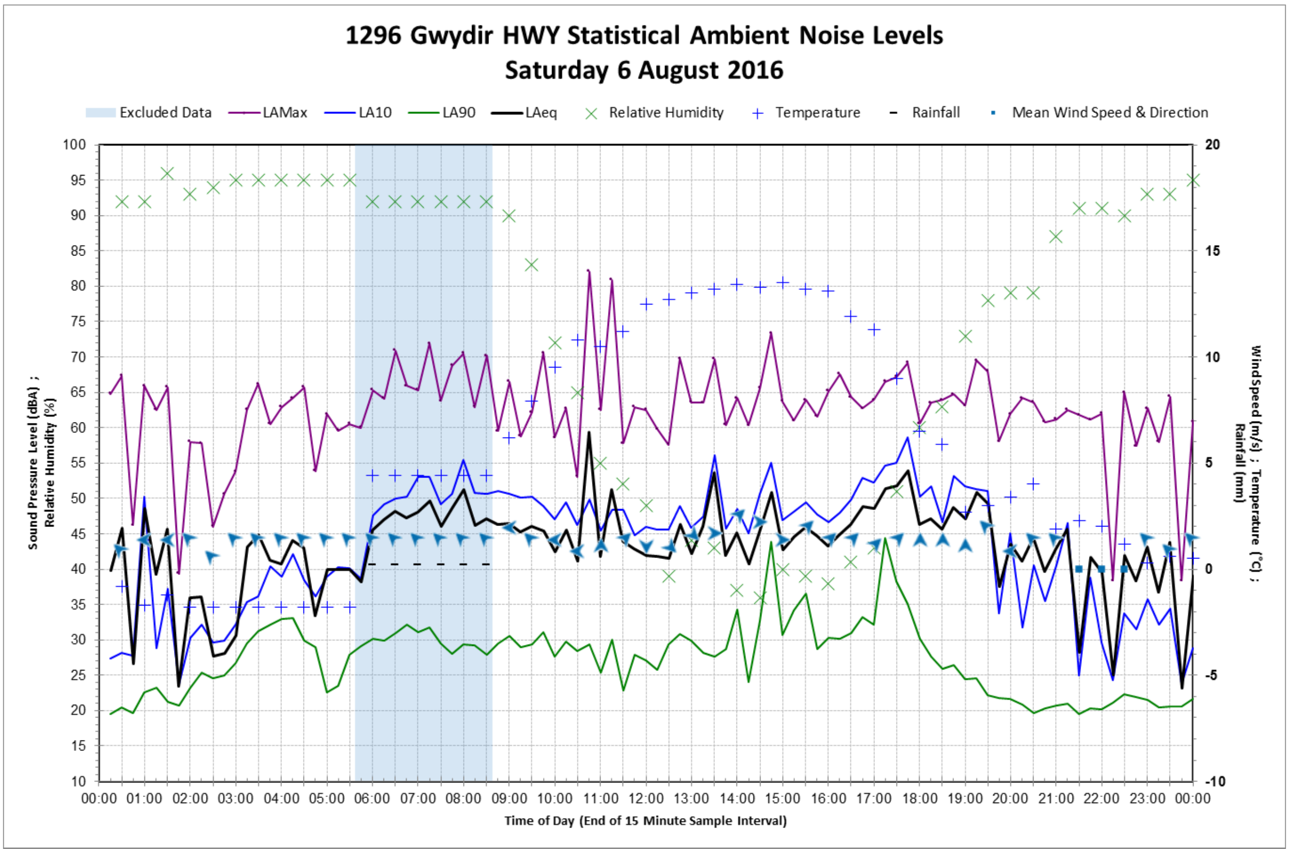
Relative Humidity
Temperature
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dBA) ; Relative Humidity (%)
WindSpeed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)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Saturday 6 August 2016
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Temperature
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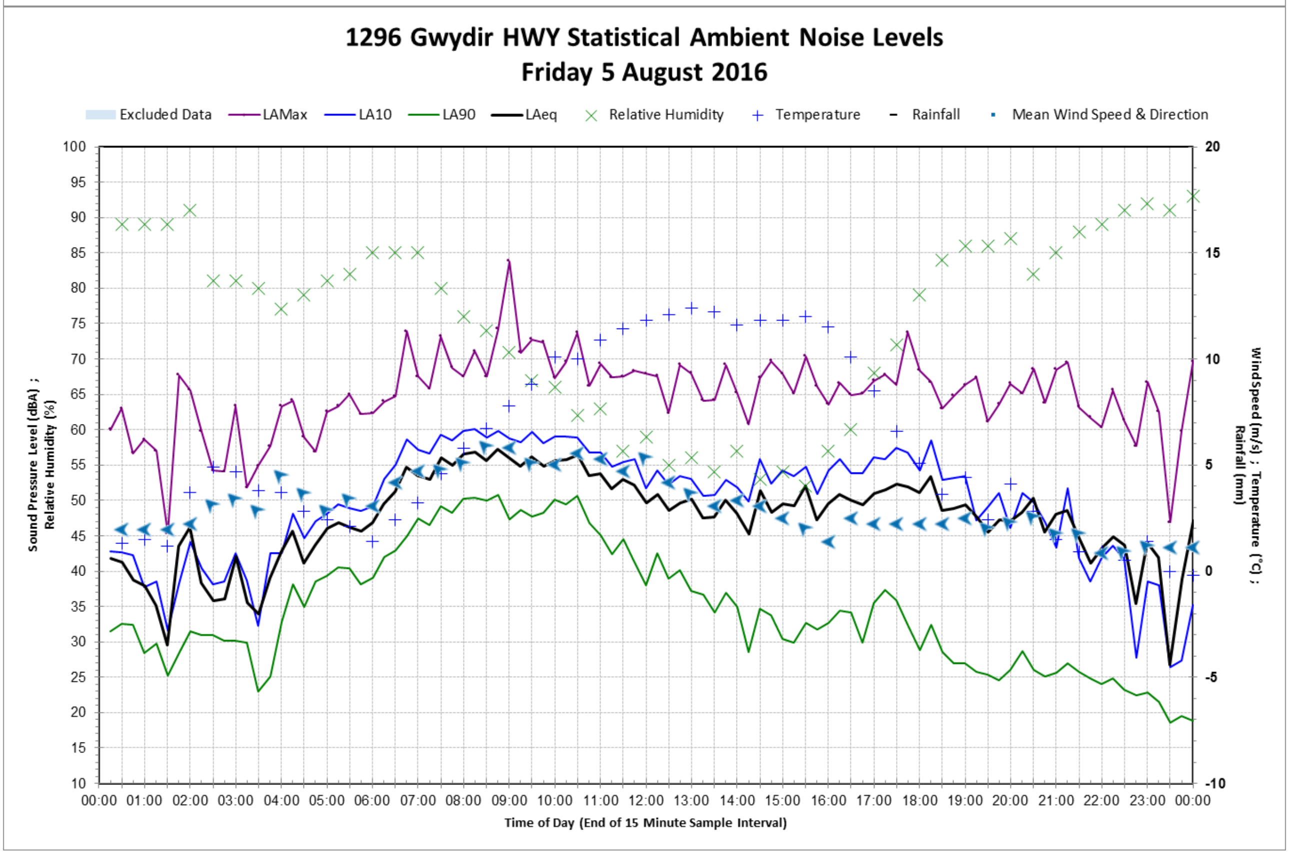
WindSpeed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)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Temperature
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Mean Wind Speed & Direction
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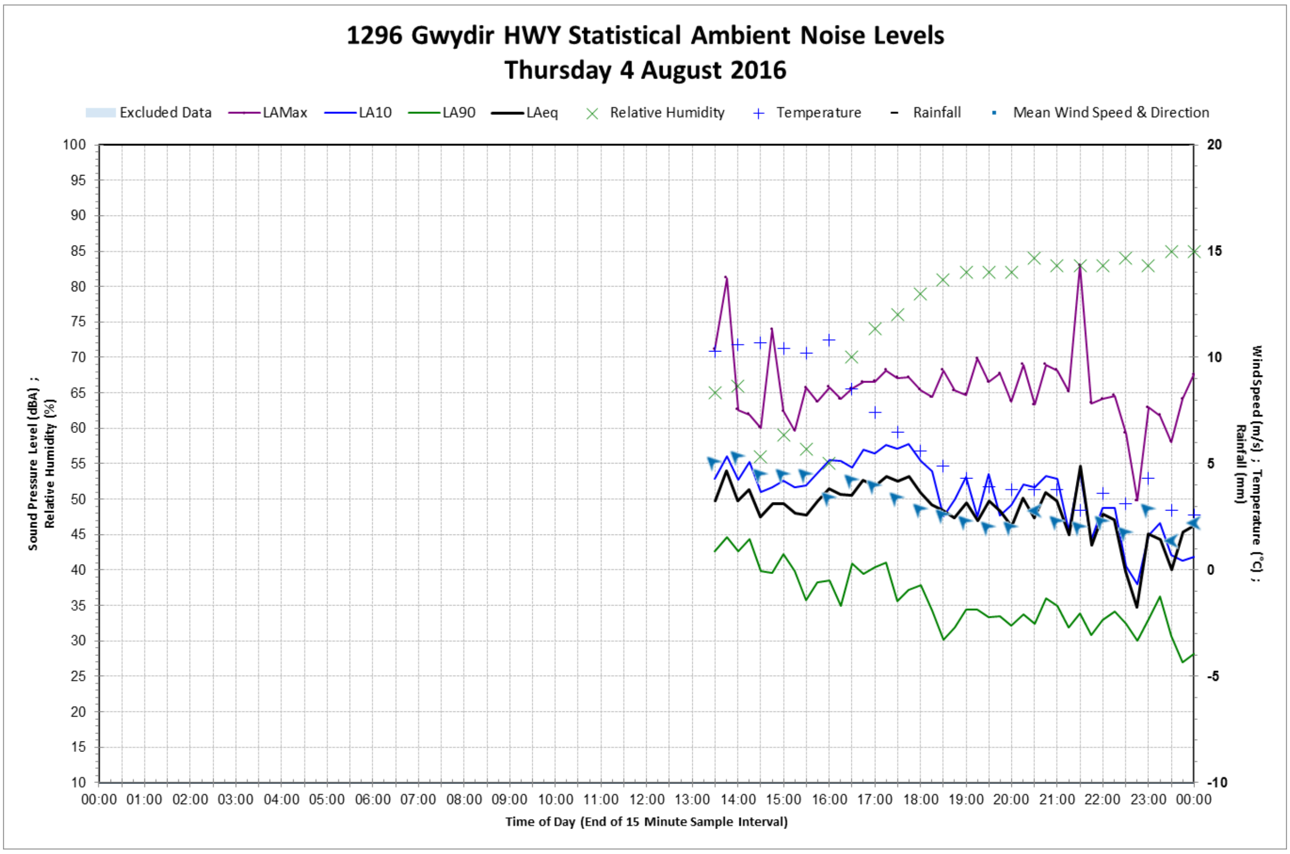
WindSpeed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)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Temperature
Rainfall
Mean Wind Speed & Direction
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)