global environmental solutions

Santos Drill Rig 103

Glasserton 2, 3 & 4 Drill Sites

Consideration of Noise Emissions

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1 INTRODUCTION

SLR Consulting Pty Ltd Australia (SLR Consulting) has been engaged by Santos QNT Pty Ltd (Santos) to undertake a noise assessment for the drill sites known as “Glasserton 2, 3 & 4”, located near Quirindi in New South Wales.

The purpose of the assessment is to predict noise emissions from the Glasserton 2, 3 & 4 sites with Drill Rig 103 in operation. The predictions include the effect on noise propagation of the topography surrounding the site and the influence of atmospheric conditions.

Noise source levels for Drill Rig 103 were measured during a recent study at the Kahlua 4 drill site. The measurement results have been incorporated into the Glasserton 2, 3 & 4 drill rig noise assessment.

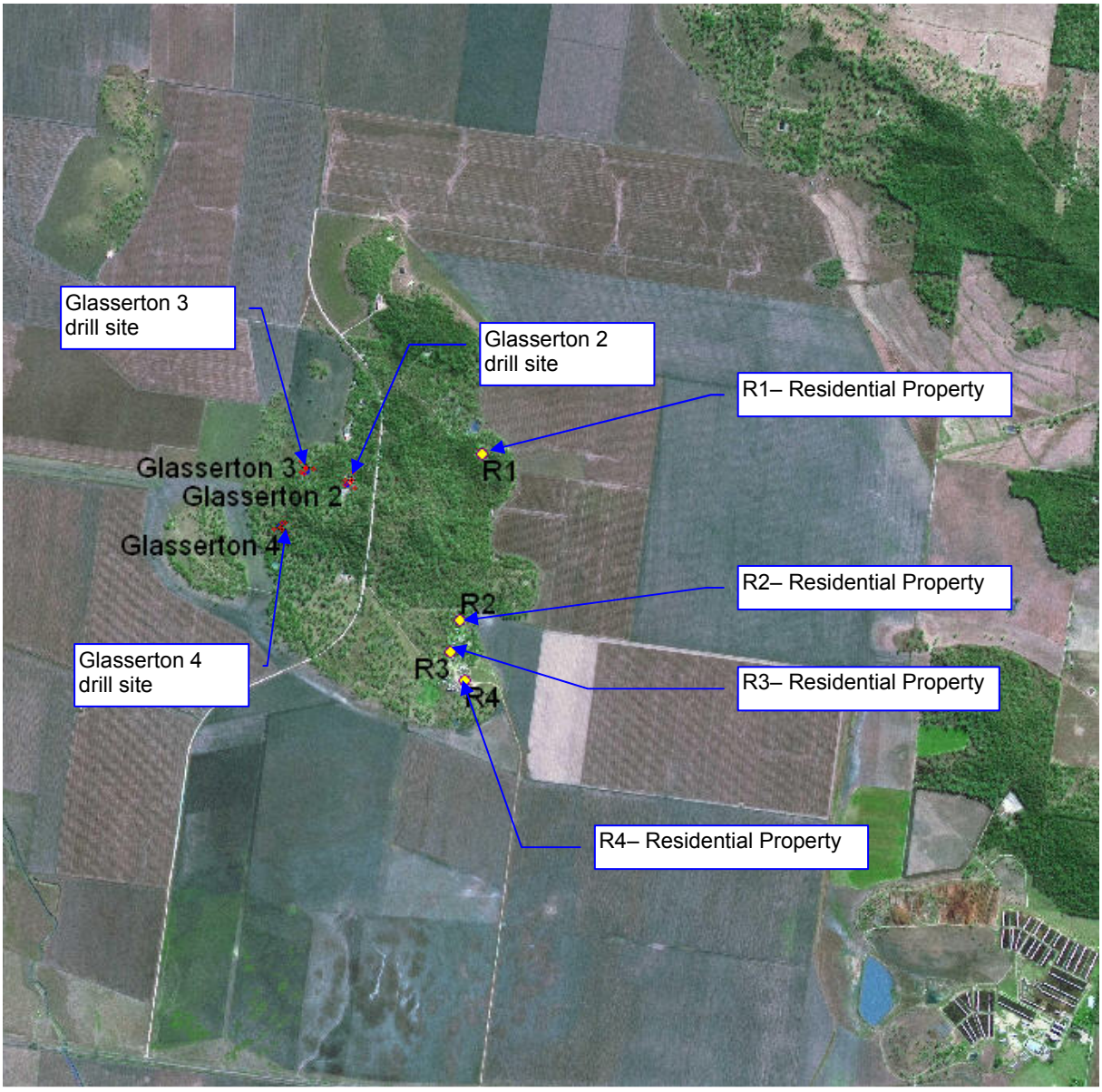
As the activity on the Glasserton drill sites is short term in nature (approximately 7 days per drill site), drill rig noise emissions have been assessed against noise criteria determined in accordance with the New South Wales *Interim Construction Noise Guideline* issued by the Office of Environment and Heritage (OEH – formerly DECCW). Reference has also been made to the NSW industrial noise policy (INP) and Environmental criteria for road traffic noise (ECRTN) in this report.

Appendix A provides information on noise fundamentals and terminology used in this assessment.

2 PROJECT SITE AND ENVIRONS

The Glasserton 2, 3 & 4 drill sites and nearby noise-sensitive receivers are shown in **Figure 1**.

Figure 1 Glasserton 2, 3 & 4 Drill Sites and Environs



2.1 Hours of Operation

The proposed hours of operation for Glasserton 2, 3 & 4 drill sites are as follows:

- 24 hour operations for a period of 7 days per drill site.

3 IMPACT ASSESSMENT PROCEDURES

3.1 Assessing Construction Noise

The OEH released the Interim Construction Noise Guideline (July 2009). This policy sets out noise management levels for residential receivers and sensitive land uses and how they are to be applied. The policy suggests restriction to the hours of construction that applies to activities that generate noise at residences above the 'highly affected' noise management level. A summary of the noise management levels is contained in **Table 1** and **Table 2**.

Table 1 Noise at Residences using Quantitative Method

Time of day	Management level LAeq(15minute)	How to apply
Recommended standard hours Monday to Friday 7am to 6pm Saturday 8am to 1pm No work Sundays or public holidays	Noise Affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured LAeq (15 min) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. • The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dBA	The highly noise affected level represents the point above which there may be strong community reaction to noise. • Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: 1. times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences 2. if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise Affected RBL + 5 dB	A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the noise affected level. • Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community. • For guidance on negotiating agreements see section 7.2.2.

Table 2 Noise at Sensitive Land Uses (other than Residences) using Quantitative Assessment

Land use	Management Level, $L_{Aeq(15minute)}$ (applies when properties are being used)
Classrooms at schools and other educational institutions	Internal noise level 45 dB(A)
Hospital wards and operating theatres	Internal noise level 45 dB(A)
Places of worship	Internal noise level 45 dB(A)
Active recreation areas (characterized by sporting activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion)	External noise level 65 dB(A)
Passive recreation areas (characterized by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation)	External noise level 60 dB(A)
Community Centres	Depends on the intended use of the centre. Refer to the recommended 'maximum' internal levels in AS2107 for specific uses.

3.2 Assessing Sleep Disturbance

The OEH has acknowledged that the relationship between maximum noise levels and sleep disturbance is not currently well defined. Criteria for assessing sleep disturbance has not been defined under the INP but it is assumed that conformance with the INP would protect against the likelihood of awakening reactions. Not withstanding the preceding, sleep arousal has been assessed using the guidelines set out in the OEH's Environmental Noise Control Manual (ENCM) Section 19-3.

To avoid the likelihood of sleep disturbance the ENCM recommends that the $L_{A1(1minute)}$ of the noise source under consideration should not exceed the background noise level (L_{A90}) by more than 15 dBA when measured outside the bedroom window of the receiver during the night-time hours (10.00 pm to 7.00 am).

The Environmental Criteria for Road Traffic Noise (ECRTN) provides further guidance with regard to sleep disturbance and calls upon a number of studies that have been conducted into the effect of maximum noise levels on sleep. The OEH policy document acknowledges that, at the current level of understanding, it is not possible to establish absolute noise level criteria that would correlate to an acceptable level of sleep disturbance. However, the ECRTN provides that maximum internal noise levels below 50 dBA to 55 dBA are unlikely to cause awakening reactions and one or two events per night, with maximum internal noise levels of 65 dBA to 70 dBA (inside dwellings) are not likely to significantly affect health and wellbeing.

4 EXISTING ACOUSTICAL AND METEOROLOGICAL ENVIRONMENT

4.1 General Methodology

Ambient noise surveys were conducted to characterise and quantify the existing acoustical environment in the area surrounding the proposed Glasserton drill sites. A background monitoring survey was undertaken at two (2) locations considered representative of the nearest potentially-affected noise-sensitive receivers to the proposed Glasserton drill sites. The noise monitoring locations are shown in **Figure 2**.

The background noise monitoring consisted of continuous, unattended noise logging and operator attended noise surveys. The operator attended noise surveys help to define noise sources and the character of noise in the area and are, therefore, used to qualify unattended noise logging results.

All acoustic instrumentation employed throughout the monitoring programme has been designed to comply with the requirements of AS IEC 61672.1 - 2004, “Electroacoustics - Sound Level Meters” and carries current NATA or manufacturer calibration certificates. Instrument calibration was checked before and after each measurement survey, with the variation in calibrated levels not exceeding ±0.5 dBA.

4.2 Operator-Attended Noise Monitoring

Operator attended noise measurements were conducted during the daytime periods at both noise monitoring locations. The purpose of these surveys was to qualify the unattended noise logging results and to determine the contribution of existing ambient noise environment.

Each noise survey was conducted over a 15 minute period using a SVAN 957 integrating sound level meter (serial number 20666). The results of the operator-attended noise measurements are given in **Table 3**. Ambient noise levels given in the table include all noise sources such as insects, birds.

During the operator attended noise surveys the weather conditions were warm, dry and 2 m/s winds from the south.

Figure 2 Noise Monitoring Locations

Image Source: Google Earth

Table 3 Operator Attended Noise Survey Results

Location	Date/ Start time/ Weather	Primary Noise Descriptor (dBA re 20 μPa)					Description of Noise Emission, Typical Maximum Levels LAmax (dBA)
		LAmax	LA1	LA10	LA90	LAeq	
Location 1 Lot 1 Clift Road, Spring Ridge	**Day** 4/05/2011 1:13pm Temp 22 °C Wind <2m/s S	63	50	46	33	42	Birdsong ~ 63 Leaf rustle ~ 40
Location 2 Lot 2 Clift Road, Spring Ridge	**Day** 4/05/2011 12:38pm Temp 22 °C Wind <2m/s S	59	49	43	34	41	Birdsong ~ 59 Leaf rustle ~ 40

Results of operator-attended noise surveys indicate that, the natural environment is the main contributors to the ambient noise environment during all monitoring periods at each monitoring location.

4.3 Unattended Continuous Noise Monitoring

Background noise levels were monitored by SLR Consulting. The objective of the background noise survey was to measure $L_{A90(period)}$ and $L_{Aeq(15minute)}$ noise levels at the nearest potentially affected residential locations during the day, evening and night-time periods to enable the determination of the intrusiveness and amenity criteria for the project.

Background noise levels were monitored at two separate locations, considered to be representative of the nearest potentially affected receivers, from Wednesday 4 May 2011 to Wednesday 11 May 2011, inclusive. Details of monitoring locations are provided in **Table 4** and **Figure 2**.

Table 4 Ambient Noise Monitoring Locations

Location	Address Location Description	Logger Serial No.
Location 1	Lot 1 Clift Road, Spring Ridge	16-203-531
Location 2	Lot 2 Clift Road, Spring Ridge	16-301-473

ARL Type EL316 noise loggers were used to monitor the ambient noise levels at each location. The noise loggers were programmed to record statistical noise level indices continuously in 15 minute intervals, including L_{Amax}, L_{A1}, L_{A50}, L_{A90}, L_{A99}, L_{Amin} and L_{Aeq}.

Weather data for the survey period was obtained from the Bureau of Meteorology (BOM) weather station located at Gunnedah Airport (approximately 44 km north of the project site). Noise data corresponding to periods of rainfall and/or wind speeds in excess of 5 m/s (approximately 9 knots) were discarded in accordance with INP data exclusion methodology. A summary of the results of the background surveys is given in **Table 5**. Results are displayed graphically in **Appendix B** and **Appendix C**.

Table 5 Summary of Existing Ambient Noise Levels

Location	Period	Measured Background L_{A90} Noise Level
Location 1 Lot 1 Clift Road, Spring Ridge (Easting 245382.42, Northing 6528053.34)	Day	30 dBA[1]
	Evening	30 dBA[1]
	Night	30 dBA[1]
Location 2 Lot 2 Clift Road, Spring Ridge (Easting 246699.64, Northing 6527864.07)	Day	30 dBA[1]
	Evening	30 dBA[1]
	Night	30 dBA[1]

Note: Daytime 7.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 7.00 am
On Sundays and Public Holidays, Daytime 8.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 8.00 am

The L_{A90} represents the level exceeded for 90% of the interval period and is referred to as the average minimum or background noise level

1. The rating background was below 30dBA and therefore has been adjusted to equal 30dBA as stated in the NSW Industrial Noise Policy (INP)

All noise levels reported here are from free-field measurements, meaning that no noise reflections occurred from buildings/structure facades near the logging sites.

4.4 Effects of Meteorology on Noise Levels

4.4.1 Wind

Wind has the potential to increase noise at a receiver when it is light and stable and blows from the direction of the source of the noise. As the strength of the wind increases the noise produced by the wind will obscure noise from most industrial and transport sources.

Wind effects need to be considered when wind is a feature of the area under consideration (in accordance with the INP). Where wind blows from the source to the receiver at speeds up to 3 m/s for more than 30% of the time in any season, then wind is considered to be a feature of the area and noise level predictions must be made under these conditions.

In order to determine the prevailing conditions for the subject site, 12 months of weather data was obtained from the closest Bureau of Meteorology automatic weather station at Gunnedah Airport, approximately 44km north east of the subject site.

This data was analysed to determine the frequency of occurrence of winds of speeds up to 3 m/s in each season during the day, evening and night time periods. The results of the wind analysis for daytime, evening, and night-time winds are presented in **Table 6**, **Table 7** and **Table 8** respectively. In each table, the wind directions and percentage occurrence are those dominant during each season. The percentage occurrence figures provided in bold are those that exceed the 30% threshold.

Table 6 Seasonal Frequency of Occurrence of Wind Speed Intervals - Daytime

Period	Calm	Wind Direction	0.5 - 2 m/s	2 - 3 m/s	0.5 - 3 m/s
Summer	1.7%	SE±45	2.1%	7.5%	9.6%
Autumn	3.2%	SE±45	2.6%	9.3%	11.9%
Winter	3.8%	SE±45	3.0%	8.7%	11.7%
Spring	1.4%	NW±45	1.8%	7.1%	8.9%

Table 7 Seasonal Frequency of Occurrence of Wind Speed Intervals - Evening

Period	Calm	Wind Direction	0.5 - 2 m/s	2 - 3 m/s	0.5 - 3 m/s
Summer	8.0%	SE±45	3.1%	9.1%	12.2%
Autumn	5.8%	SSE±45	4.7%	8.8%	13.5%
Winter	7.3%	S±45	3.5%	11.7%	15.2%
Spring	8.6%	SSE±45	4.4%	6.9%	11.3%

Table 8 Seasonal Frequency of Occurrence of Wind Speed Intervals - Night

Period	Calm	Wind Direction	0.5 - 2 m/s	2 - 3 m/s	0.5 - 3 m/s
Summer	8.5%	SE±45	2.6%	16.9%	19.6%
Autumn	11.3%	SE±45	5.2%	14.9%	20.1%
Winter	10.3%	SE±45	6.3%	13.8%	20.0%
Spring	9.9%	SE±45	5.9%	12.2%	18.1%

From the above weather data, significant wind (ie wind speed of up to 3 m/s) was recorded but not more than the assessment threshold of 30 % during the period between May 2010 and May 2011 and therefore prevailing wind condition was not considered in this assessment.

4.4.2 Temperature Inversion

Temperature inversions, when they occur, have the ability to increase noise levels by focusing sound waves. Temperature inversions occur predominantly at night during the winter months. For a temperature inversion to be a significant characteristic of the area it needs to occur for approximately 30% of the total night-time during winter, or about two nights per week.

Meteorological data was not available from the surrounding weather stations to allow the determination of the percentage occurrence of temperature inversions during winter nights. A worst case analysis was therefore undertaken and the occurrence of temperature inversion during the night-time period has been considered as part of this noise assessment. Default temperature inversion values, as defined in the INP, have been assumed during the night-time period.

5 PROJECT SPECIFIC NOISE EMISSION CRITERIA

5.1 Construction Noise Goals

The relevant construction noise goals have been developed with reference to the Interim Construction Noise Guideline outlined in **Section 3.1** and are contained in **Table 9**.

Note that the Noise Affected level for daytime is determined as background noise plus 10 dBA. The Noise Affected level for evening and night (ie outside recommended hours) is determined as background noise plus 5 dBA. The Highly Noise Affected level is defined in the Interim Construction Noise Guideline. It should be noted that a Highly Noise Affected level is not defined for the evening or night periods. A strong justification would typically be required for works outside the recommended standard hours.

Table 9 Construction Noise Goals

Location	Period	Noise Goal $L_{Aeq(15minute)}$	
		Noise Affected (dBA)	**Highly Noise Affected (dBA)**
All Receiver Location	Day	40	75
	Evening	35	n/a
	Night	35	n/a
Classrooms at schools and other educational institutions	When in use	Internal noise level 45 dBA	
Active recreation areas[1]	When in use	External noise level 65 dBA	
Passive recreation areas[2]	When in use	External noise level 60 dBA	

For Monday to Saturday, Daytime 7.00 am - 6.00pm; Evening 6.00pm - 10.00pm; Night-time 10.00pm - 7.00am. On Sundays and Public Holidays, Daytime 8.00am - 6.00pm; Evening 6.00pm - 10.0 pm; Night-time 10.0 pm - 8.00am.

1. Characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion.
2. Characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation.

5.2 Sleep Disturbance Criteria

The Glasserton 2, 3 & 4 sleep disturbance noise emission design goals for the night-time period and have been set with reference to the ENCM as outlined in **Section 3.2** of this report and are presented in **Table 10.** These noise goals have been determined based on the $L_{A90(15minute)}$ measured noise level of 30 dBA as presented in **Table 5**.

Table 10 Sleep Disturbance Design Goals

Location	Period	Sleep Disturbance Noise Emission Design Goal ($L_{A1(1minute)}$)
R1 to R4	Night	**45 dBA**

6 MODELLING METHODOLOGY

The Conservation of Clean Air and Water Europe (CONCAWE) prediction methodology was utilised within SoundPLAN 3D modelling software (Version 7).

The CONCAWE prediction method is specially designed for facilities and incorporates the influence on noise propagation of distance, topography, ground and air absorption, and atmospheric conditions.

6.1 Topography

Ground topography for the project area was supplied by Santos in 3D electronic format and incorporated into the noise model. The location and layout of the Glasserton 2, 3 & 4 drill sites and surrounding noise-sensitive receivers have also been supplied by Santos.

The drill site areas have been modelled as a reflective (hard) surface and the off-site ground has been modelled as an absorptive (soft) surface.

6.2 Prediction Locations

Table 11 provides details of the nearest identified residential receivers used as assessment locations in the model. The locations are shown in **Figure 1**.

Table 11 Assessment Locations

Residential Receivers	Distance and Direction from Glasserton drill sites		
	Glasserton 2	**Glasserton 3**	**Glasserton 4**
R1	0.943km E	1.3 km E	1.5 km ENE
R2	1.3 km SE	1.5 km SE	1.4 km SE
R3	1.4 km SE	1.7 km SE	1.5 km SE
R4	1.6 km SE	1.9 km SE	1.7 km SE

All assessment locations have been assumed to be at 1.5 m above ground and a minimum of 4 m from a building facade or reflective surface (*i.e.* free-field).

6.3 Source Noise Levels

6.3.1 Drill Rig 103

The noise emission levels from Drill Rig 103, which is to be used at the Glasserton 2, 3 & 4 drill sites, have been sourced from measurements performed during operation at the Kahlua 4 drill site.

Sound Pressure Level (SPL) measurements were taken at a number of positions and offset distances around the drill rig. The results of the measurements were used to calculate Sound Power Level (SWL) "zones" of the drill rig.

Figure 3 presents the zones around the drill rig. **Table 12** presents a summary of the calculated sound power levels representative of the zones.

The drill rig to be located at Glasserton 2, 3 & 4 has been orientated in the model as shown in **Figure 4**, **Figure 5** and **Figure 6** respectively.

Figure 3 Sound Power Measurement Zones

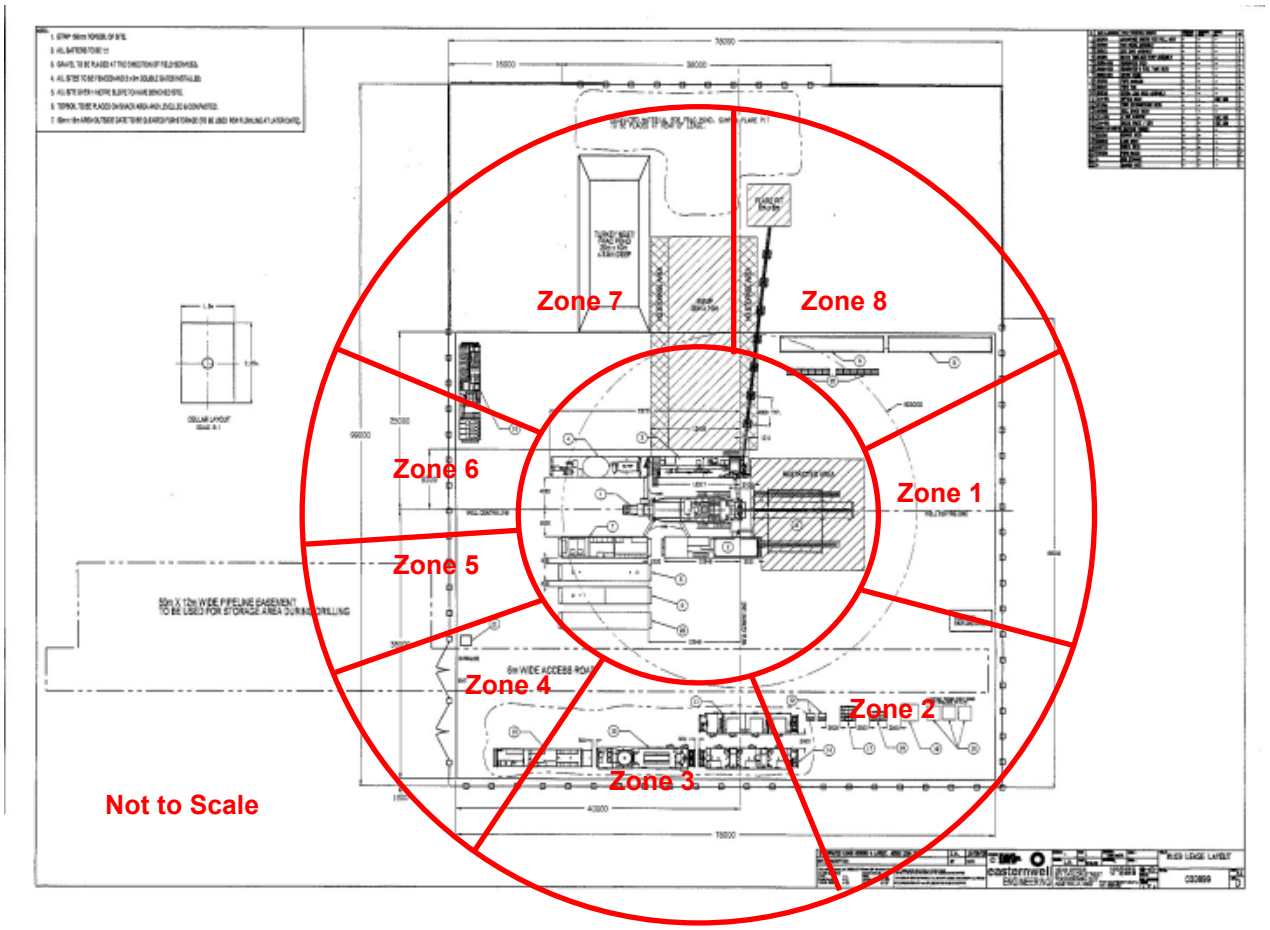


Table 12 Calculated Sound Power Levels of Drill Rig 103

SWL Zone	L_{eq} Sound Power Level (SWL) dBA re. 1 pW Octave Band Centre Frequency (Hz)								SWL Total dBA
	63	125	250	500	1k	2k	4k	8k	
1	109	116	112	107	96	95	100	84	109
2	112	118	114	112	109	110	106	96	116
3	112	110	106	106	102	104	104	85	110
4	116	123	116	113	110	108	107	93	117
5	118	126	120	119	115	114	115	101	122
6	115	122	112	115	113	113	113	93	120
7	118	117	114	114	112	111	109	95	118
8	109	110	107	110	108	103	97	92	112
Overall	115	121	115	114	111	110	110	95	118

Figure 4 Glasserton 2 Drill Rig Orientation

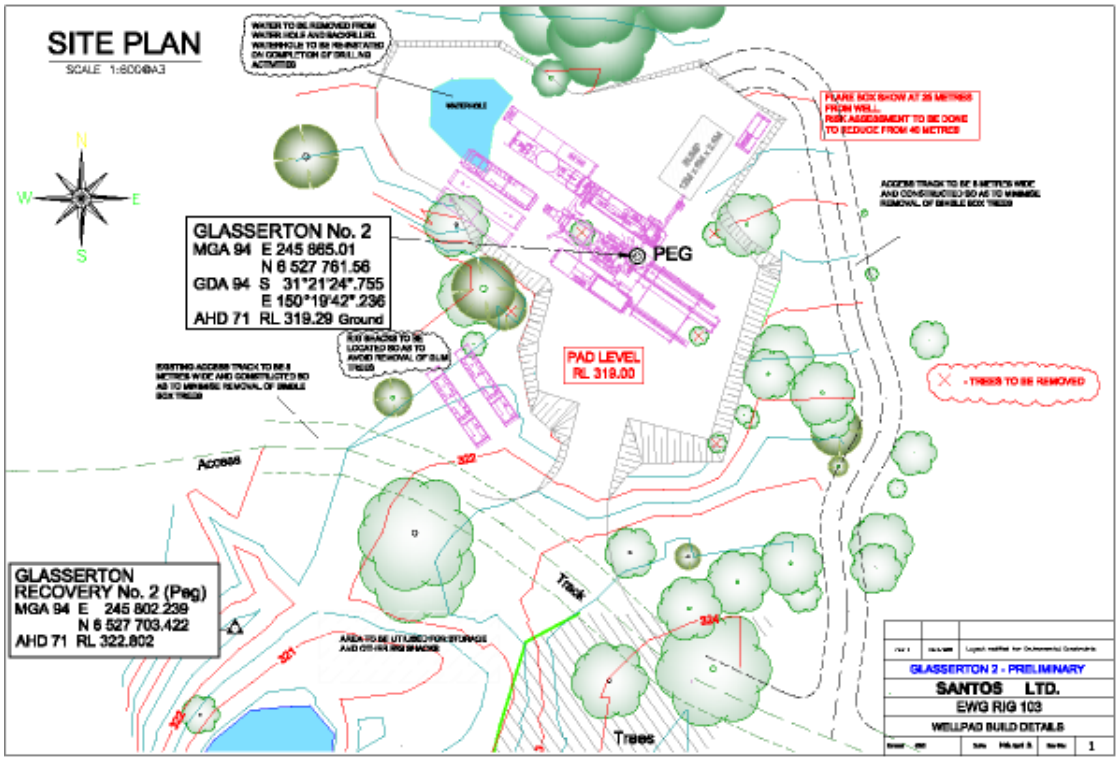


Figure 5 Glasserton 3 Drill Rig Orientation

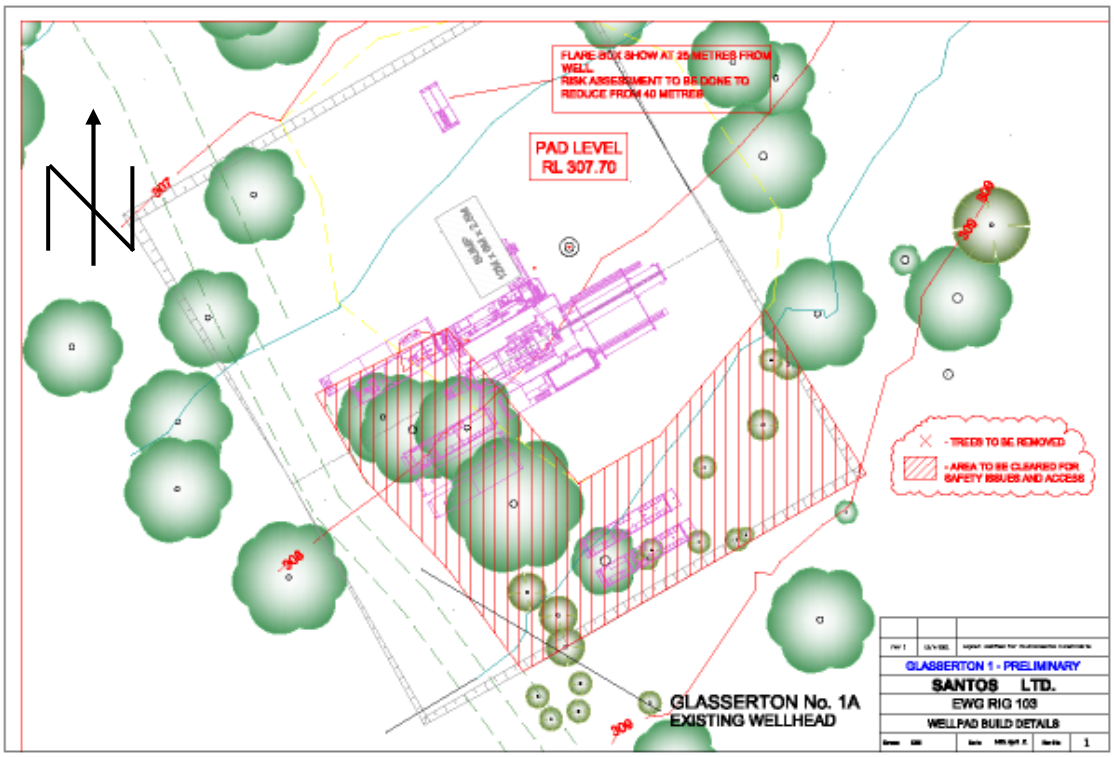
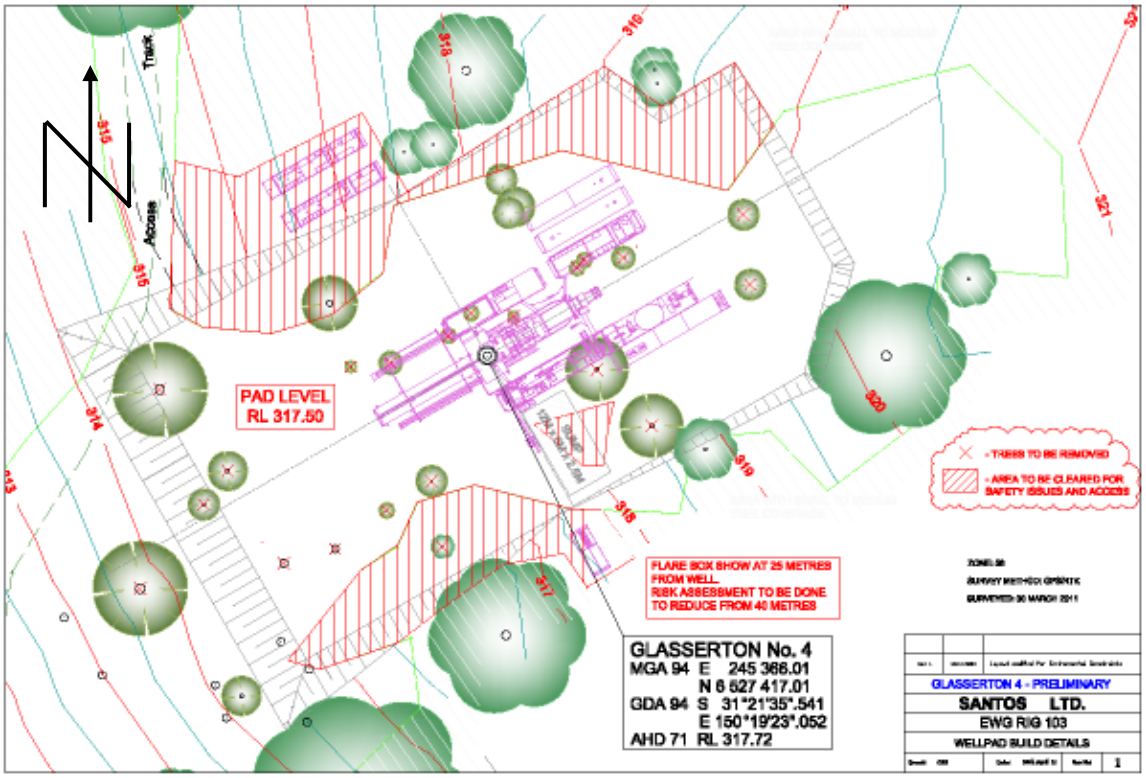


Figure 6 Glasserton 4 Drill Rig Orientation



6.3.2 Other Onsite Plant Equipment

The only other plant/equipment that generates significant noise emissions at the drill sites are the three diesel generator-powered lighting towers, the equipment associated with the tool shed (eg. handheld grinders etc) and a frontend loader.

The light towers have been located toward the corners of the drill sites.

The sound power level associated with this plant is presented in **Table 13**.

Table 13 Sound Power Level for Drill Rig Plant Items

Plant Items	Operation	SWL in dBA (per item)	Direction of Noise Emission
3x Light Tower Diesel generator	Normal operation	90	Main source emission from exhaust in direction of light (towards centre of drill site)
Workshop (eg. Handheld grinder)	Normal operation	96	Omni –directional
Front End Loader	Normal operation	91	Omni –directional
		Lmax 98	Omni –directional

It is relevant to note that since the Glasserton 2, 3 & 4 drill rig operations are considered constant in nature, there is no difference in the measured Leq and Lmax noise levels presented in **Table 12** and **Table 13** with the exception of the frontend loader. However, the only significant plant and equipment to cause sleep disturbance is from the drill rig. Therefore, only the drill rig noise levels have been used for the sleep disturbance noise assessment as a worst case scenario.

We also note that the workshop doesn't operate during the night-time period.

6.4 Atmospheric Conditions

Drill site noise levels have been predicted for 'calm' and 'temperature inversion' atmospheric conditions.

The SoundPLAN model calculates noise levels in all directions for the specified wind and atmospheric conditions.

The atmospheric parameters used in the CONCAWE model are presented in **Table 14**.

Table 14 Noise Model Weather Parameters

Atmospheric Condition	Air Temperature	Relative Humidity	Wind Velocity	Atmospheric Stability class
Calm	10^{o}C	70%	0 m/s	D
Temperature inversion	10^{o}C	90%	0 m/s	F

6.5 Noise Prediction Results

The predicted Glasserton 2, 3 & 4 drill site noise levels without noise mitigation at the assessment locations for two (2) types of atmospheric conditions are presented in **Table 15**, **Table 16** and **Table 17**.

Table 15 Predicted Glasserton 2 Drill Site Noise Levels – Without Mitigation

Prediction Location	Period	Predicted Noise Levels LAeq(15 min)		Project Specific Noise Criteria LAeq (15 minute) dBA	
		Calm Weather	Temperature Inversion Weather		
		dBA	dBA	Noise Affected	Highly Noise Affected
R1	Day	**36**	N/A	40	75
	Evening			35	N/A
	Night		**40**	35	N/A
R2	Day	<30	N/A	40	75
	Evening			35	N/A
	Night		<30	35	N/A
R3	Day	<30	N/A	40	75
	Evening			35	N/A
	Night		<30	35	N/A
R4	Day	<30	N/A	40	75
	Evening			35	N/A
	Night		<30	35	N/A

Table 16 Predicted Glasserton 3 Drill Site Noise Levels – Without Mitigation

Prediction Location	Period	Predicted Noise Levels LAeq(15 min)		Project Specific Noise Criteria LAeq (15 minute) dBA	
		Calm Weather	Temperature Inversion Weather		
		dBA	dBA	Noise Affected	Highly Noise Affected
R1	Day	<30	N/A	40	75
	Evening			35	N/A
	Night		32	35	N/A
R2	Day	**36**	N/A	40	75
	Evening			35	N/A
	Night		**41**	35	N/A
R3	Day	35	N/A	40	75
	Evening			35	N/A
	Night		**40**	35	N/A
R4	Day	33	N/A	40	75
	Evening			35	N/A
	Night		**39**	35	N/A

Table 17 Predicted Glasserton 4 Drill Site Noise Levels – Without Mitigation

Prediction Location	Period	Predicted Noise Levels LAeq(15 min)		Project Specific Noise Criteria LAeq (15 minute) dBA	
		Calm Weather	Temperature Inversion Weather		
		dBA	dBA	Noise Affected	Highly Noise Affected
R1	Day	30	N/A	40	75
	Evening			35	N/A
	Night		35	35	N/A
R2	Day	<30	N/A	40	75
	Evening			35	N/A
	Night		32	35	N/A
R3	Day	<30	N/A	40	75
	Evening			35	N/A
	Night		31	35	N/A
R4	Day	<30	N/A	40	75
	Evening			35	N/A
	Night		<30	35	N/A

Noise contour plots for the core drilling operation without mitigation at the Glasserton 2, 3 & 4 drill site, modelled for two types of atmospheric conditions are presented in **Appendix D**.

7 ASSESSMENT OF PREDICTED DRILL SITE NOISE

7.1 Construction Noise

Glasserton 2

The predicted noise levels under calm and worst case weather conditions were below or equal to the project specific 'noise affected' day, evening and night-time noise goals of 40 dBA $L_{Aeq(15\ minute)}$, 35 dBA $L_{Aeq(15\ minute)}$ and 35 dBA $L_{Aeq(15\ minute)}$ respectively at all locations with the exception of R1.

The predicted noise level at location R1 shows a **5 dBA** moderate noise level increase of the night-time 'noise affected' noise goal of 35 dBA $L_{Aeq(15\ minute)}$ under worst case temperature inversion weather conditions and a marginal noise level increase of **1dBA** of the 'noise affected' evening and night-time noise goal of 35 dBA $L_{Aeq(15\ minute)}$ under calm weather conditions. However, location R1 complies with the day-time 'noise affected' noise goal of 40 dBA $L_{Aeq(15\ minute)}$ under calm weather conditions.

Glasserton 3

The predicted noise levels under calm and worst case weather conditions were below or equal to the project specific 'noise affected' day, evening and night-time noise goal of 40 dBA $L_{Aeq(15\ minute)}$, 35 dBA $L_{Aeq(15\ minute)}$ and 35 dBA $L_{Aeq(15\ minute)}$ respectively at location R1.

However, the predicted noise levels at location R2, R3 and R4 exceed the night-time 'noise affected' noise goal of 35 dBA $L_{Aeq(15\ minute)}$ under worst case temperature inversion weather conditions by **6 dBA**, **5 dBA** and **4dBA** respectively. Also, predicted noise levels under calm weather conditions at location R2 exceeds the evening and night-time 'noise affected' noise goal of 35 dBA $L_{Aeq(15\ minute)}$ by **1 dBA** but complies with the day-time 'noise affected' noise goal of 40 dBA $L_{Aeq(15\ minute)}$. It is noted that location R3 and R4 comply with the day, evening and night-time noise goals under calm weather conditions.

Glasserton 4

The predicted noise levels under calm and worst case weather conditions were below or equal to the 'noise affected' day, evening and night-time noise goal of 40 dBA $L_{Aeq(15\ minute)}$, 35 dBA $L_{Aeq(15\ minute)}$ and 35 dBA $L_{Aeq(15\ minute)}$ respectively at all locations.

7.2 Sleep Disturbance

The predicted noise levels during calm temperature inversion weather conditions are below the adjusted sleep disturbance noise criterion of 45 dBA $L_{A1(1\ minute)}$ at all nearest affected residential receiver locations.

8 NOISE MITIGATION AND MANAGEMENT

Predicted worst case drilling operation noise levels at the closest affected residential receivers show exceedances of the project specific noise goals. Therefore, it is recommended that the proponent monitors noise from the drilling operation activities. The results of this monitoring will determine whether compliance is being achieved, and whether noise mitigation is warranted for the site. If mitigation is found to be warranted the following general noise mitigation procedures will be adopted.

8.1 General Noise Mitigation Options for Industrial Sources

Additional mitigation options that would be considered if required for noise control are:

- Control noise at the source.
- Best Management Practice (BMP)
- Best Available Technology Economically Achievable (BATEA).
- Control the transmission of noise.
- Use barriers and land-use controls to attenuate noise by increasing the distance between source and receiver.

8.1.1 Controlling Noise at the Source

Best Management Practice

Best Management Practice (BMP) may be adopted for particular operational procedures that minimise noise while retaining productive efficiency.

When an appropriate mitigation strategy that incorporates expensive engineering solutions is being considered, the extent to which cheaper, non-engineering-oriented BMP can contribute to the required reduction of noise will be taken into account.

Application of BMP will include the following types of practice:

- Siting noisy equipment behind structures that act as barriers, or at the greatest distance from the noise-sensitive area; or orienting the equipment so that noise emissions are directed away from any sensitive areas, to achieve the maximum attenuation of noise.
- Keeping equipment well maintained.
- Restricting truck speed on the site to reduce noise from the transport operation.
- Employing “quiet” practices when operating equipment (eg positioning and unloading of trucks in appropriate areas).
- Running staff-education programmes on the effects of noise and the use of quiet work practices.

Best Available Technology Economically Achievable (BATEA)

Equipment, plant and machinery that produce noise will incorporate advanced and affordable technology to minimise noise output.

Where BMP fails to achieve the required noise reduction by itself, the BATEA approach will be considered. Uses of BATEA which will be considered are:

- Using a non-acoustic warning method to warn of a vehicles reversing or if this method does not prove satisfactory for safety reasons, adjusting the reversing alarm volume on heavy equipment to make them “smarter”, by limiting acoustic range to immediate danger area.
- Using pieces of equipment with efficient muffler design.
- Using vehicles with quieter engines.
- Active noise control.

8.1.2 Controlling Noise in Transmission

Barriers

Barriers are more effective if they are near the source or the receiver. Their effectiveness is also determined by their height, the materials used (absorptive or reflective) and their density. The relationship of these design features to attenuation is well documented.

Barriers can take a number of forms - including free-standing walls, grass or earth mounds or bunds, and trenches or cuttings within which noise sources are sited. They are employed when source and receiver control is either impractical or too costly.

9 NOISE REPORTING AND RESPONSE PROCEDURES

The recommended noise monitoring and reporting system to be adopted at the Glasserton 2, 3 & 4 drilling locations is as follows:

9.1 Construction Noise Monitoring

9.1.1 General Requirements

The noise measurement procedures employed throughout the monitoring programme should be guided by the requirements of AS 1055-1997 “Acoustics - Description and Measurement of Environmental Noise”.

9.1.2 Monitoring Locations

Noise monitoring should be conducted at the closest affected receiver locations or at the boundary of the properties representative of the closest affected receiver locations to the east of the drill sites as identified previously as **R1** to **R4** in **Section 2.**

9.1.3 Continuous Noise Logging

Unattended noise logging should be carried out on a continuous basis for the duration the proposed drilling operations.

Unattended noise monitoring is used to quantify overall ambient noise amenity levels resulting from proposed drilling activity and other environmental noise sources. Unattended monitoring will show whether existing ambient noise levels have increased or decreased, when compared to previous monitoring periods.

9.1.4 Operator-Attended Noise Surveys

Operator attended noise measurements should be conducted at fortnightly intervals throughout the drilling operations by a qualified acoustic consultant.

Operator attended noise measurements and recordings will be conducted to quantify the contribution of the construction activity as well as the overall level of ambient noise.

The operator should quantify and characterise the maximum (L_{Amax} and L_{A10}) noise level from construction activity over a 15 minute measurement period. In addition, the operator should quantify and characterise the overall levels of ambient noise (ie L_{Amax}, L_{A1}, L_{A10}, L_{A50}, L_{A90}, L_{A99}, L_{Amin} and L_{Aeq}) over the 15 minute measurement interval.

9.1.5 Instrumentation and Measurement Parameters

All acoustic instrumentation employed throughout the monitoring programme should be designed to comply with the requirements of AS IEC 61672.1 - 2004, “Electroacoustics - Sound Level Meters” and carry current NATA or manufacturer calibration certificates. All instrumentation should be programmed to record continuously statistical noise level indices in 15 minute intervals which may include the L_{Amax}, L_{A1}, L_{A5}, L_{A10}, L_{A50}, L_{A90}, L_{A99}, L_{Amin} and the L_{Aeq}.

The statistical noise exceedance levels (L_{AN}) are the levels exceeded for N% of the 15 minute interval. The L_{A90} represents the level exceeded for 90% of the interval period and is referred to as the average minimum or background noise level. The L_{Aeq} is the equivalent continuous sound pressure level and represents the steady sound level which is equal in energy to the fluctuating level over the interval period. The L_{Amax} is the maximum noise level recorded over the interval.

Instrument calibration should be checked before and after each measurement survey, with the variation in calibrated levels not exceeding ±0.5 dB.

9.1.6 Reporting

A report of all noise monitoring results, conclusions and recommendations should be prepared on a fortnightly basis.

The unattended ambient noise logger data, together with the weather and site operating conditions will be presented graphically on a fortnightly basis.

It should be noted that the ambient noise levels do not necessarily reflect the contributed level of noise emissions from construction operations. The ambient noise level data quantifies the overall noise level at a given location independent of its source or character.

Prior to further analysis, the ambient noise level data from each monitoring location which correlates with periods of unstable weather (ie rainfall greater than 0.5 mm or wind speed greater than 5 m/s) should be discarded. The remaining ambient noise level data should be processed using an acceptable statistical technique and reported.

10 CONTINGENCY RELATING TO NON-COMPLIANCE AND COMPLAINTS HANDLING

The non-compliance/complaints handling procedure will be as follows.

10.1 Community Information and Complaints Handling

In order to effectively manage any requests for information or respond to any public concerns in relation to the proposed Glasserton 2, 3 & 4 drilling activities and site operation, it is recommended that the following systems be maintained:

- The drilling company will supply the OEH and/or Department of Planning (DoP) with the names and appropriate contact numbers for the site construction manager during the construction period and one other senior staff member.
- An **Environmental Hotline Phone Number** will be put in place to allow contact with the Construction Company in relation to any environmental matter including those concerned with noise issues
- The drilling company will use a complaint handling system to monitor environmental noise complaints. All information relating to noise complaints will be kept in a register. The register will include but not be restricted to the following information
    - Date and Time of complaint
    - Complainant details (ie full name and contact details)
    - Nature and source of complaint
    - Action taken
    - Follow-up with complainant

The drilling company will endeavour to respond to any complaint within one working day of its receipt.

10.2 Management Response Strategy

Response measures, which would be adopted following noise complaints, would include:

- Identify the noise source that has caused the complaint. This would be done by consultation with the complainant and by conducting a noise and/or vibration survey to quantify the level of disturbance.
- Reassess the Best Management Practice (BMP) mitigation techniques employed at the site to reduce the impact of the noise source in question. Particular attention should be given to the scheduling of noisy activities and the siting of equipment used on site.
- If a management strategy is unsuccessful re-evaluate the Best Available Technology Economically Achievable (BATEA) mitigation strategies being used.
- Following the adoption of noise and/or vibration mitigation, a further noise survey would be conducted at the complainant's residence to ensure the success of the mitigation strategy.

11 CONCLUSIONS

SLR Consulting has considered noise emissions from Drill Rig 103 located at the "Glasserton 2, 3 & 4" drill sites, near Quirindi in New South Wales.

Construction Noise Assessment

The noise emissions have been predicted and compared to noise criteria determined in accordance with the NSW OEH Interim Construction Noise Guideline.

Modelling of drill site noise levels has been conducted using the CONCAWE prediction methodology within the SoundPLAN (Version 7) software.

Noise measurements of the Drill Rig 103 were used to determine sound power levels incorporated into the model.

Predicted drill site noise levels at nearby noise-sensitive locations without mitigation are contained within **Table 15**, **Table 16** and **Table 17**.

Noise contour plots of the predicted drill site noise levels are present in **Appendix D**.

Drill site noise levels at Glasserton 2 are predicted to exceed the night-time 'noise affected' noise goal of 35 dBA $L_{Aeq(15\ minute)}$ by 5dBA under worst case temperature inversion weather conditions and by **1dBA** of the project specific 'noise affected' evening and night-time noise goal of 35 dBA $L_{Aeq(15\ minute)}$ under calm weather conditions. However, location R1 complies with the day-time 'noise affected' noise goal of 40 dBA $L_{Aeq(15\ minute)}$ under calm weather conditions.

Drill site noise levels at Glasserton 3 are predicted to exceed the night-time 'noise affected' noise goal under worst case temperature inversion weather conditions at location R2, R3 & R4 by **6dBA, 5dBA** and **4dBA** respectively. Also, at Glasserton 3, a marginal noise level exdeedance of **1dBA** of the evening and night-time 'noise affected' noise goal of 35 dBA $L_{Aeq(15\ minute}$ under calm weather conditions are predicted at location R2. However, predictions at R2 comply with the day-time 'noise affected' noise goal of 40 dBA $L_{Aeq(15\ minute)}$. It is noted that location R3 and R4 comply with the day, evening and night-time noise goals under calm weather conditions.

Drill site noise levels are predicted to comply with the day, evening and night-time 'noise affected' noise goals of 40 dBA $L_{Aeq(15\ minute)}$, 35 dBA $L_{Aeq(15\ minute)}$ and 35 dBA $L_{Aeq(15\ minute)}$ respectively at all nearest potential affected residential receiver locations for the drill rig operations located at Glasserton 4 under calm and worst case weather conditions.

Sleep Disturbance

Drill site noise levels are predicted to comply with the sleep disturbance noise goals at all nearest potentially affected occupied residential receiver locations.

12 CLOSURE

This report has been prepared by SLR Consulting Australia Pty Ltd with all reasonable skill, care and diligence, and taking account of the manpower and resources devoted to it by agreement with the client. Information reported herein is based on the interpretation of data collected and has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of Santos QNT Pty Ltd. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR Consulting.

SLR Consulting disclaims any responsibility to the client and others in respect of any matters outside the agreed scope of the work.

1 Sound Level or Noise Level

The terms "sound" and "noise" are almost interchangeable, except that in common usage "noise" is often used to refer to unwanted sound.

Sound (or noise) consists of minute fluctuations in atmospheric pressure capable of evoking the sense of hearing. The human ear responds to changes in sound pressure over a very wide range. The loudest sound pressure to which the human ear responds is ten million times greater than the softest. The decibel (abbreviated as dB) scale reduces this ratio to a more manageable size by the use of logarithms.

The symbols SPL, L or L_P are commonly used to represent Sound Pressure Level. The symbol L_A represents A-weighted Sound Pressure Level. The standard reference unit for Sound Pressure Levels expressed in decibels is 2E-5 Pa.

2 "A" Weighted Sound Pressure Level

The overall level of a sound is usually expressed in terms of dBA, which is measured using a sound level meter with an "A-weighting" filter. This is an electronic filter having a frequency response corresponding approximately to that of human hearing.

People's hearing is most sensitive to sounds at mid frequencies (500 Hz to 4000 Hz), and less sensitive at lower and higher frequencies. Thus, the level of a sound in dBA is a good measure of the loudness of that sound. Different sources having the same dBA level generally sound about equally loud.

A change of 1 dBA or 2 dBA in the level of a sound is difficult for most people to detect, whilst a 3 dBA to 5 dBA change corresponds to a small but noticeable change in loudness. A 10 dBA change corresponds to an approximate doubling or halving in loudness. The table below lists examples of typical noise levels

Sound Pressure Level (dBA)	Typical Source	Subjective Evaluation
130	Threshold of pain	Intolerable
120 110	Heavy rock concert Grinding on steel	Extremely noisy
100 90	Loud car horn at 3 m Construction site with pneumatic hammering	Very noisy
80 70	Kerbside of busy street Loud radio or television	Loud
60 50	Department store General Office	Moderate to quiet
40 30	Inside private office Inside bedroom	Quiet to very quiet
20	Unoccupied recording studio	Almost silent

Other weightings (eg B, C and D) are less commonly used than A-weighting. Sound Levels measured without any weighting are referred to as "linear", and the units are expressed as dB(lin) or dB.

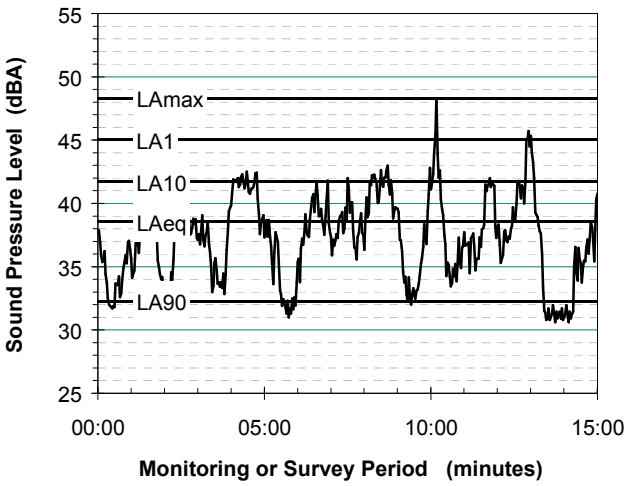
3 Sound Power Level

The Sound Power of a source is the rate at which it emits acoustic energy. As with Sound Pressure Levels, Sound Power Levels are expressed in decibel units (dB or dBA), but may be identified by the symbols SWL or LW, or by the reference unit 1E-12 W.
The relationship between Sound Power and Sound Pressure may be likened to an electric radiator, which is characterised by a power rating, but has an effect on the surrounding environment that can be measured in terms of a different parameter, temperature.

4 Statistical Noise Levels

Sounds that vary in level over time, such as road traffic noise and most community noise, are commonly described in terms of the statistical exceedance levels L_{AN}, where L_{AN} is the A-weighted sound pressure level exceeded for N% of a given measurement period. For example, the L_{A1} is the noise level exceeded for 1% of the time, L_{A10} the noise exceeded for 10% of the time, and so on.

The following figure presents a hypothetical 15 minute noise survey, illustrating various common statistical indices of interest.



Of particular relevance, are:

L_{A1} The noise level exceeded for 1% of the 15 minute interval.

L_{A10} The noise level exceed for 10% of the 15 minute interval. This is commonly referred to as the average maximum noise level.

L_{A90} The noise level exceeded for 90% of the sample period. This noise level is described as the average minimum background sound level (in the absence of the source under consideration), or simply the background level.

L_{Aeq} The A-weighted equivalent noise level (basically the average noise level). It is defined as the steady sound level that contains the same amount of acoustical energy as the corresponding time-varying sound.

When dealing with numerous days of statistical noise data, it is sometimes necessary to define the typical noise levels at a given monitoring location for a particular time of day. A standardised method is available for determining these representative levels.

This method produces a level representing the "repeatable minimum" L_{A90} noise level over the daytime and night-time measurement periods, as required by the EPA. In addition the method produces mean or "average" levels representative of the other descriptors (L_{Aeq}, L_{A10}, etc).

5 Tonality

Tonal noise contains one or more prominent tones (ie distinct frequency components), and is normally regarded as more offensive than "broad band" noise.

6 Impulsiveness

An impulsive noise is characterised by one or more short sharp peaks in the time domain, such as occurs during hammering.

7 Frequency Analysis

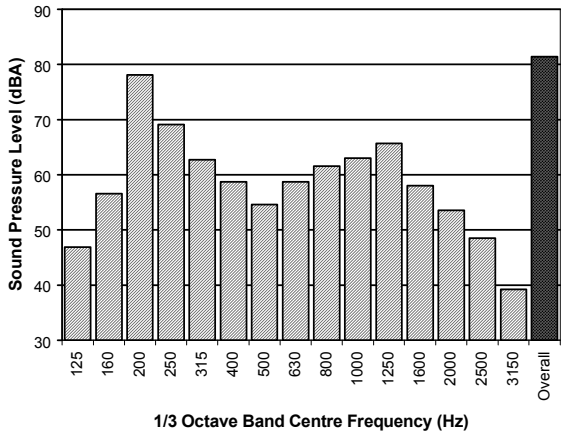
Frequency analysis is the process used to examine the tones (or frequency components) which make up the overall noise or vibration signal. This analysis was traditionally carried out using analogue electronic filters, but is now normally carried out using Fast Fourier Transform (FFT) analysers.

The units for frequency are Hertz (Hz), which represent the number of cycles per second.

Frequency analysis can be in:

- Octave bands (where the centre frequency and width of each band is double the previous band)
- 1/3 octave bands (3 bands in each octave band)
- Narrow band (where the spectrum is divided into 400 or more bands of equal width)

The following figure shows a 1/3 octave band frequency analysis where the noise is dominated by the 200 Hz band. Note that the indicated level of each individual band is less than the overall level, which is the logarithmic sum of the bands.



8 Vibration

Vibration may be defined as cyclic or transient motion. This motion can be measured in terms of its displacement, velocity or acceleration. Most assessments of human response to vibration or the risk of damage to buildings use measurements of vibration velocity. These may be expressed in terms of "peak" velocity or "rms" velocity.

The former is the maximum instantaneous velocity, without any averaging, and is sometimes referred to as "peak particle velocity", or PPV. The latter incorporates "root mean squared" averaging over some defined time period.

Vibration measurements may be carried out in a single axis or alternatively as triaxial measurements. Where triaxial measurements are used, the axes are commonly designated vertical, longitudinal (aligned toward the source) and transverse.

The common units for velocity are millimetres per second (mm/s). As with noise, decibel units can also be used, in which case the reference level should always be stated. A vibration level V, expressed in mm/s can be converted to decibels by the formula 20 log (V/V_o), where V_o is the reference level (1E-6 mm/s). Care is required in this regard, as other reference levels are used by some organizations.

9 Human Perception of Vibration

People are able to "feel" vibration at levels lower than those required to cause even superficial damage to the most susceptible classes of building (even though they may not be disturbed by the motion). An individual's perception of motion or response to vibration depends very strongly on previous experience and expectations, and on other connotations associated with the perceived source of the vibration. For example, the vibration that a person responds to as "normal" in a car, bus or train is considerably higher than what is perceived as "normal" in a shop, office or dwelling.

10 Over-Pressure

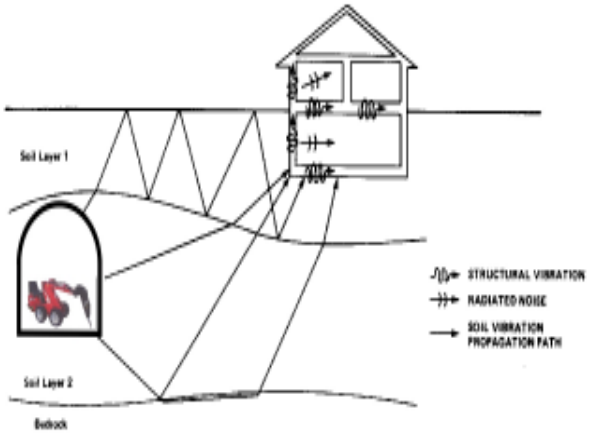
The term "over-pressure" is used to describe the air pressure pulse emitted during blasting or similar events. The peak level of an event is normally measured using a microphone in the same manner as linear noise (ie unweighted), at frequencies both in and below the audible range.

11 Regenerated Noise

Noise that propagates through a structure as vibration and is radiated by vibrating wall and floor surfaces is termed "regenerated noise", "structure-borne noise", or sometimes "ground-borne noise". Regenerated noise originates as vibration and propagates between the source and receiver through the ground and/or building structural elements, rather than through the air.

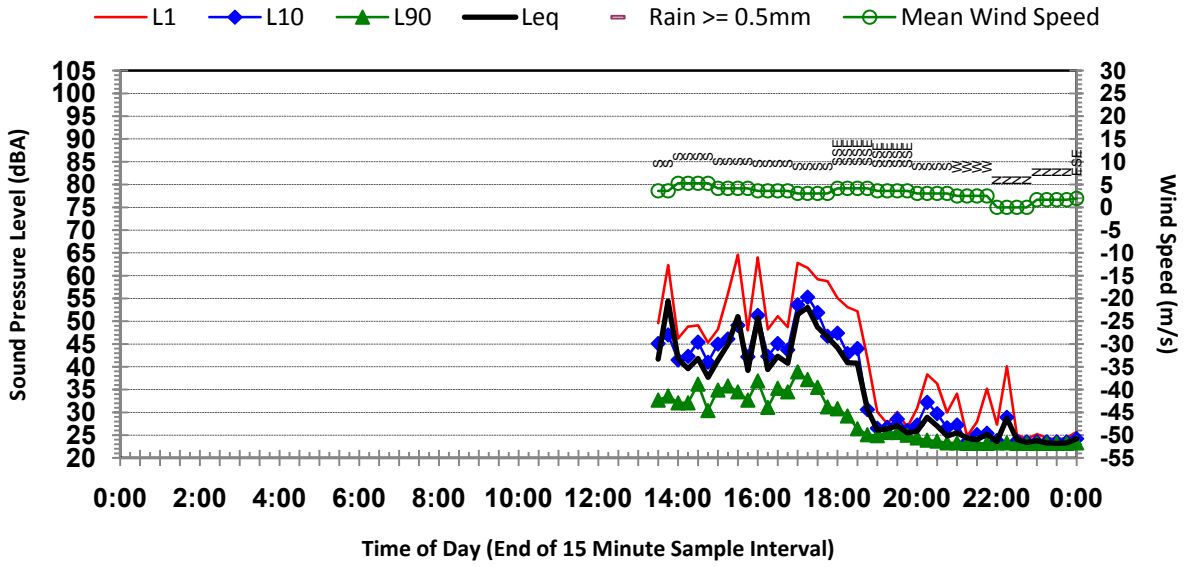
Typical sources of regenerated noise include tunnelling works, underground railways, excavation plant (eg rockbreakers), and building services plant (eg fans, compressors and generators).

The following figure presents the various paths by which vibration and regenerated noise may be transmitted between a source and receiver for construction activities occurring within a tunnel.

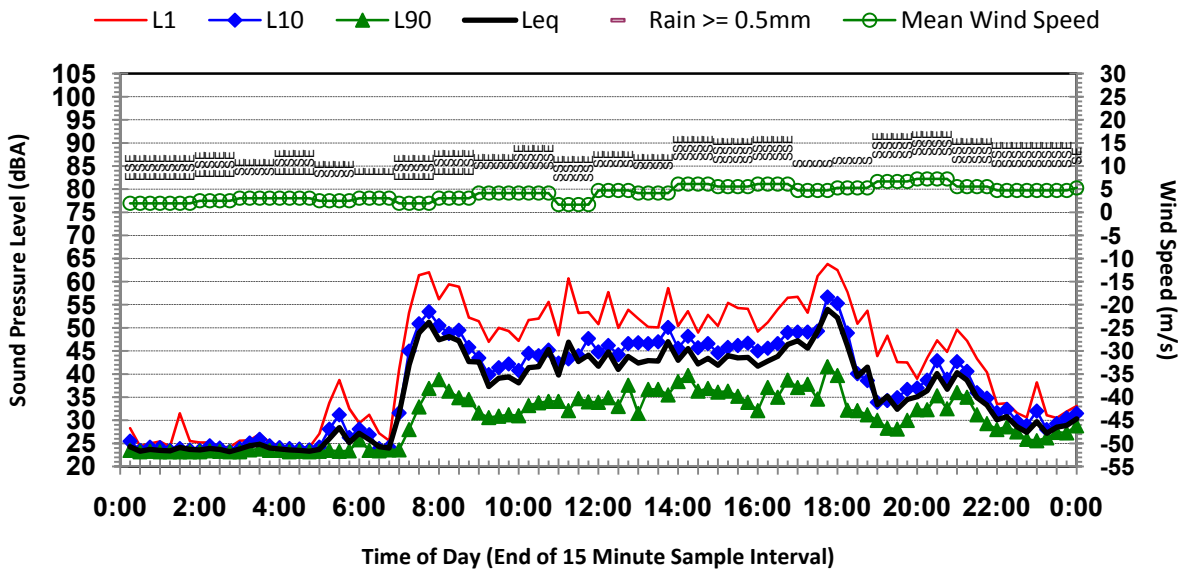


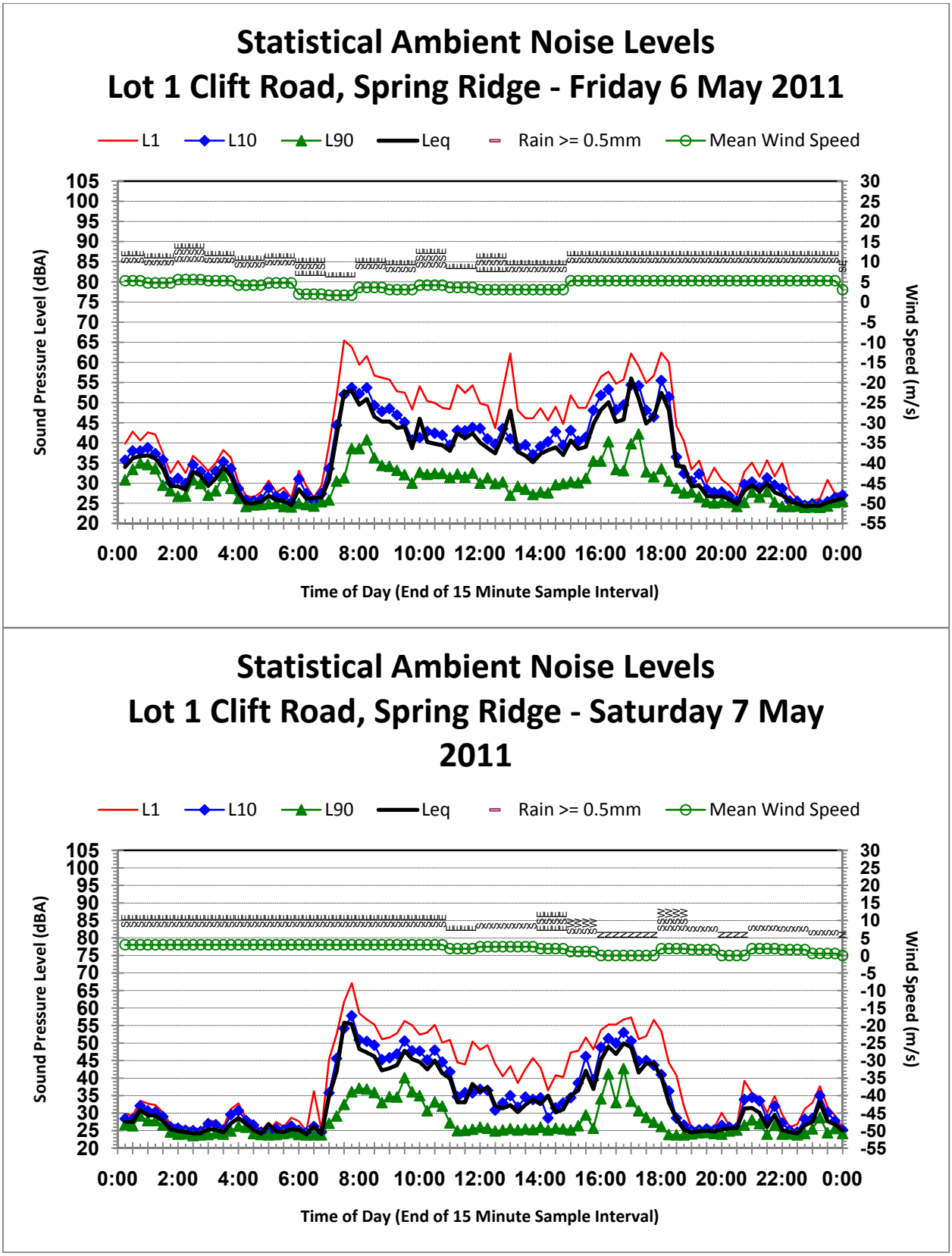
The term "regenerated noise" is also used to describe other types of noise that are emitted from the primary source as a different form of energy. One example would be a fan with a silencer, where the fan is the energy source and primary noise source. The silencer may effectively reduce the fan noise, but some additional noise may be created by the aerodynamic effect of the silencer in the airstream. This "secondary" noise may be referred to as regenerated noise.

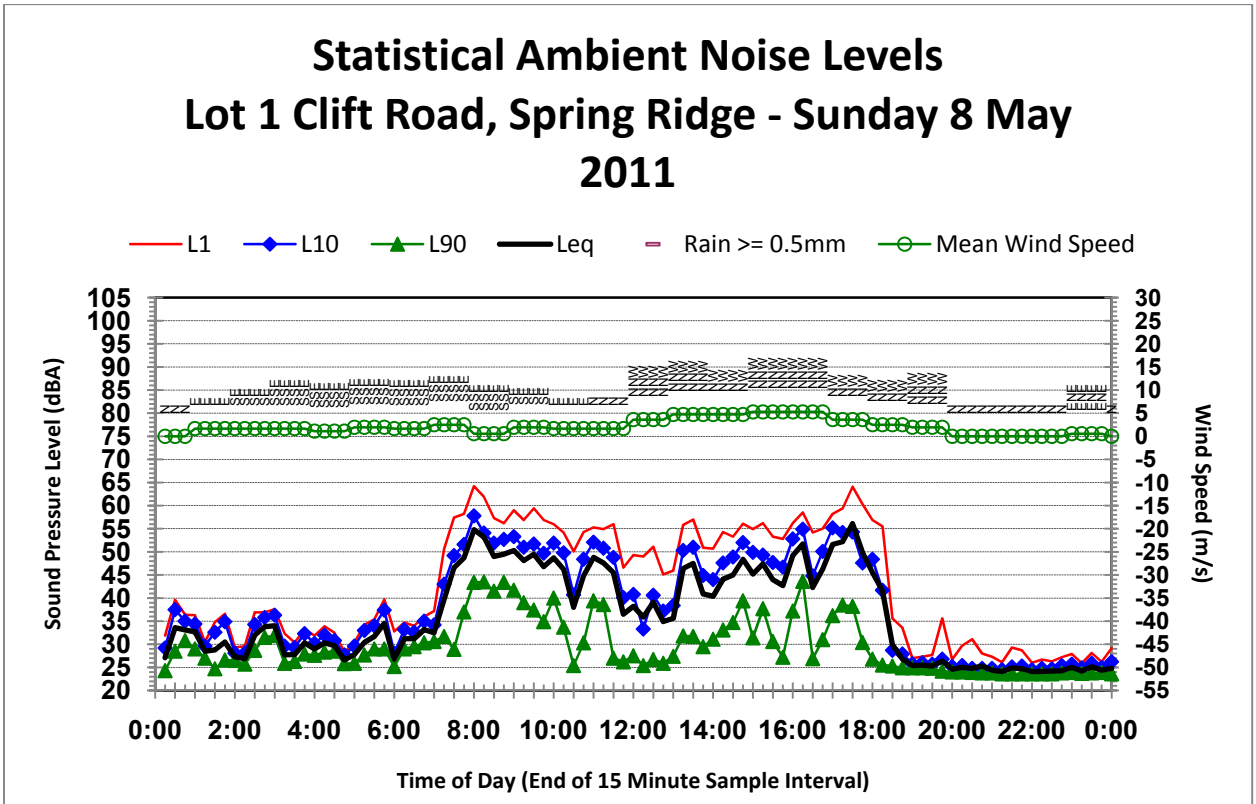
Statistical Ambient Noise Levels
Lot 1 Clift Road, Spring Ridge - Wednesday 4 May 2011

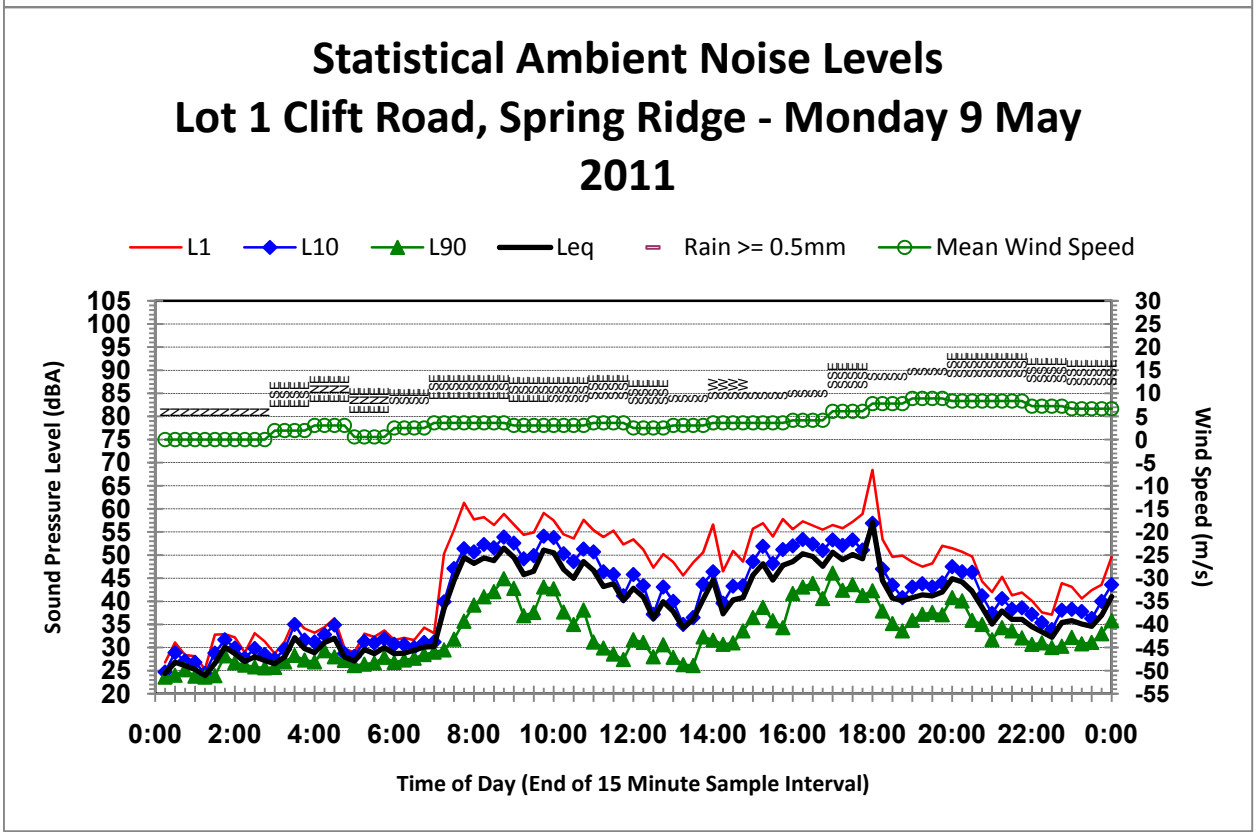


Statistical Ambient Noise Levels
Lot 1 Clift Road, Spring Ridge - Thursday 5 May 2011

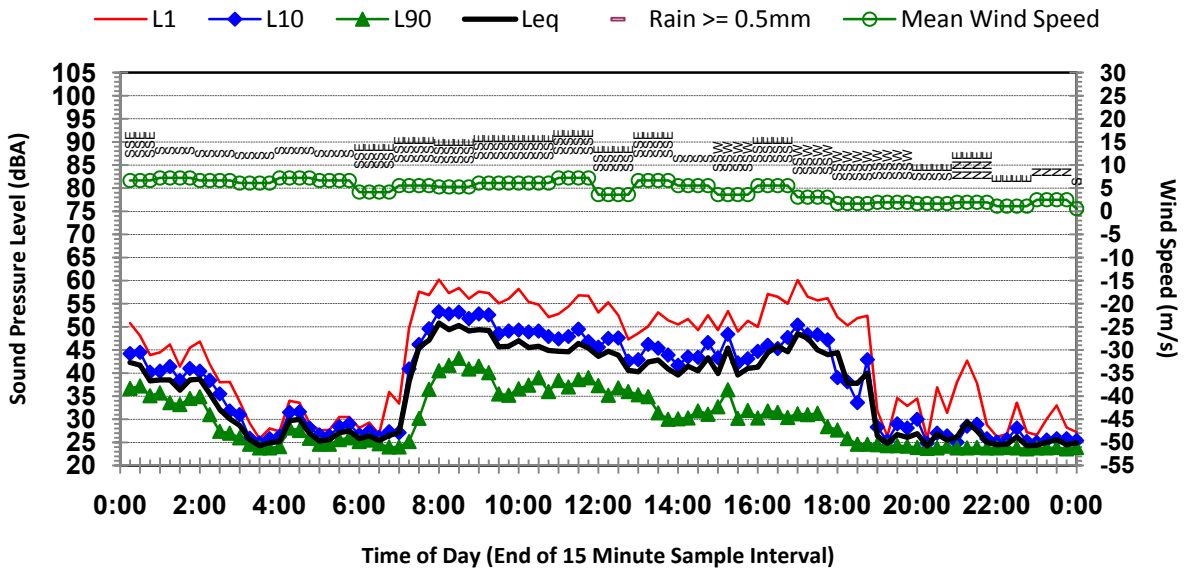



Statistical Ambient Noise Levels
Lot 1 Clift Road, Spring Ridge - Friday 6 May 2011
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed
Sound Pressure Level (dBA)
Wind Speed (m/s)
105 100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20
30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50 -55
0:00 2:00 4:00 6:00 8:00 10:00 12:00 14:00 16:00 18:00 20:00 22:00 0:00
Time of Day (End of 15 Minute Sample Interval)
Statistical Ambient Noise Levels
Lot 1 Clift Road, Spring Ridge - Saturday 7 May 2011
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed
Sound Pressure Level (dBA)
Wind Speed (m/s)
105 100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20
30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50 -55
0:00 2:00 4:00 6:00 8:00 10:00 12:00 14:00 16:00 18:00 20:00 22:00 0:00
Time of Day (End of 15 Minute Sample Interval)

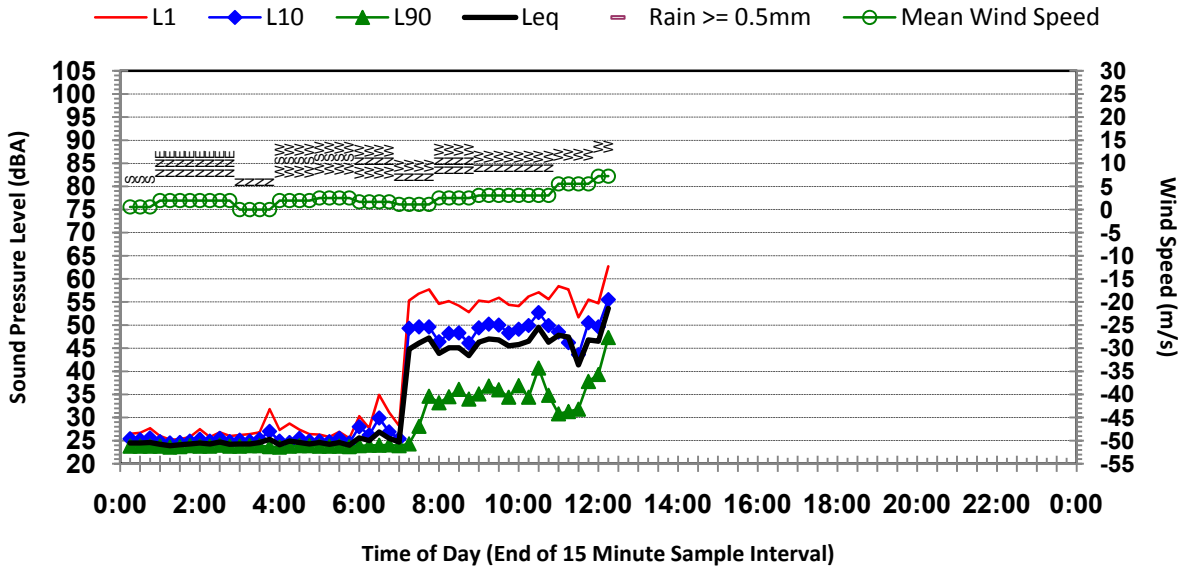

Statistical Ambient Noise Levels
Lot 1 Clift Road, Spring Ridge - Sunday 8 May 2011
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed
Sound Pressure Level (dBA)
Wind Speed (m/s)
105 100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20
30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50 -55
0:00 2:00 4:00 6:00 8:00 10:00 12:00 14:00 16:00 18:00 20:00 22:00 0:00
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Lot 1 Clift Road, Spring Ridge - Monday 9 May 2011
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed
Sound Pressure Level (dBA)
Wind Speed (m/s)
105 100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20
30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50 -55
0:00 2:00 4:00 6:00 8:00 10:00 12:00 14:00 16:00 18:00 20:00 22:00 0:00
Time of Day (End of 15 Minute Sample Interval)

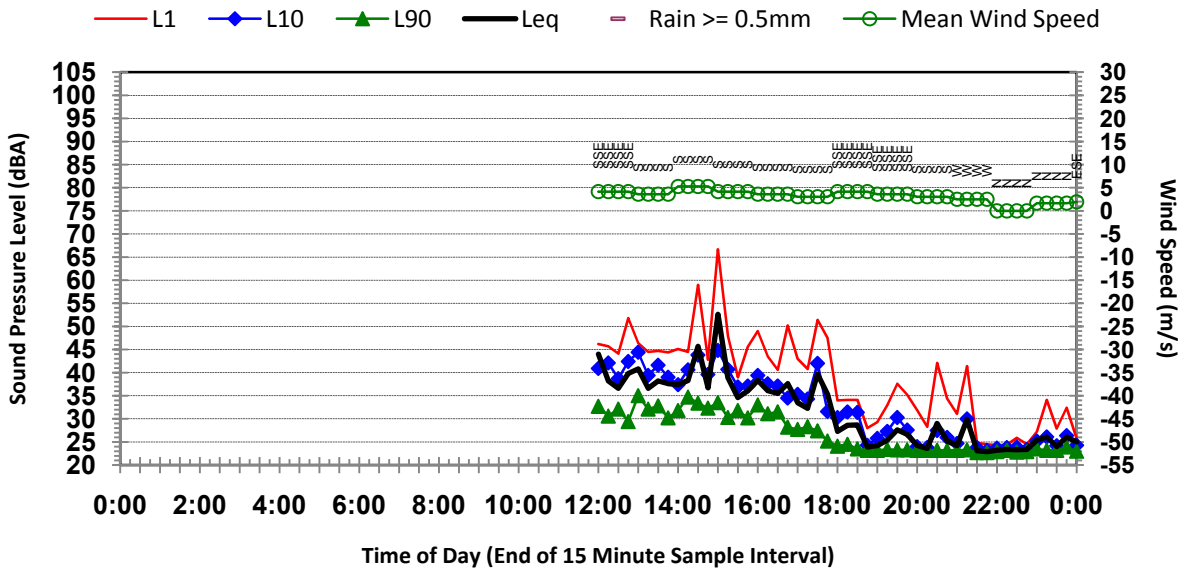
Statistical Ambient Noise Levels
Lot 1 Clift Road, Spring Ridge - Tuesday 10 May 2011



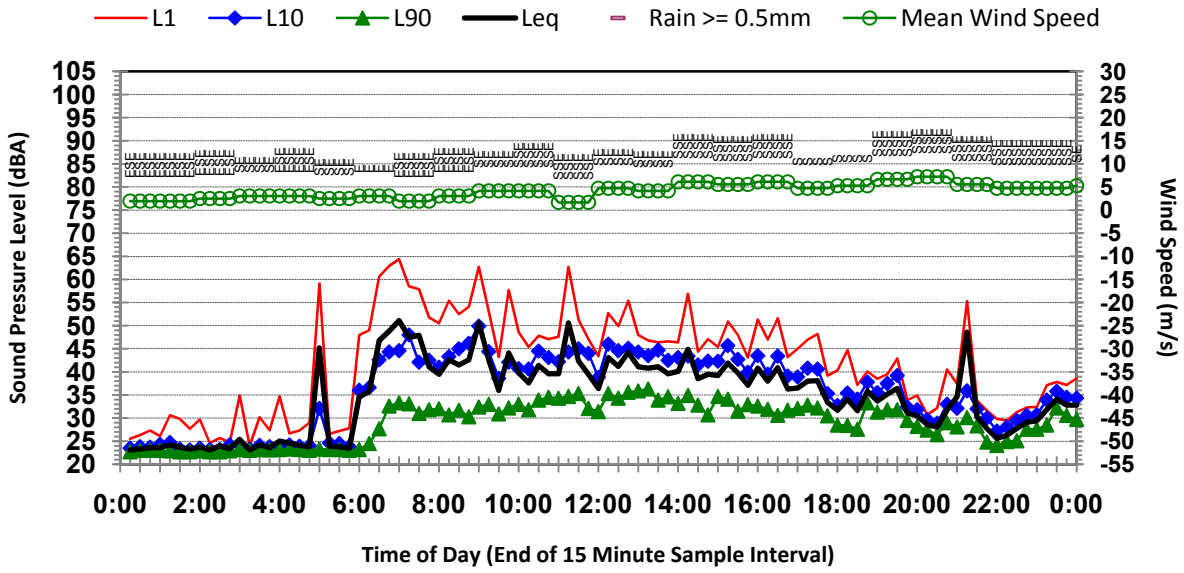
Statistical Ambient Noise Levels
Lot 1 Clift Road, Spring Ridge - Wednesday 11 May 2011

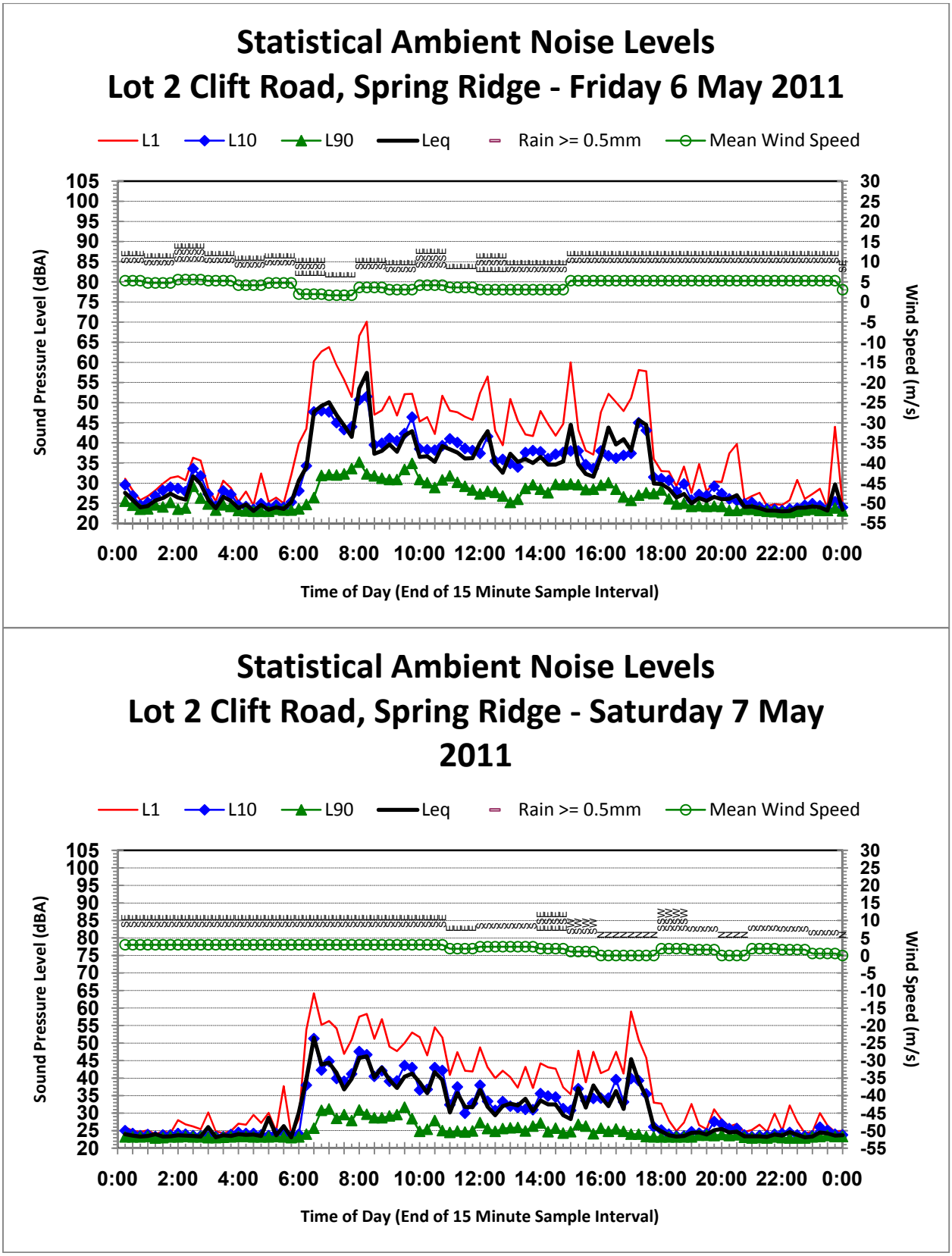


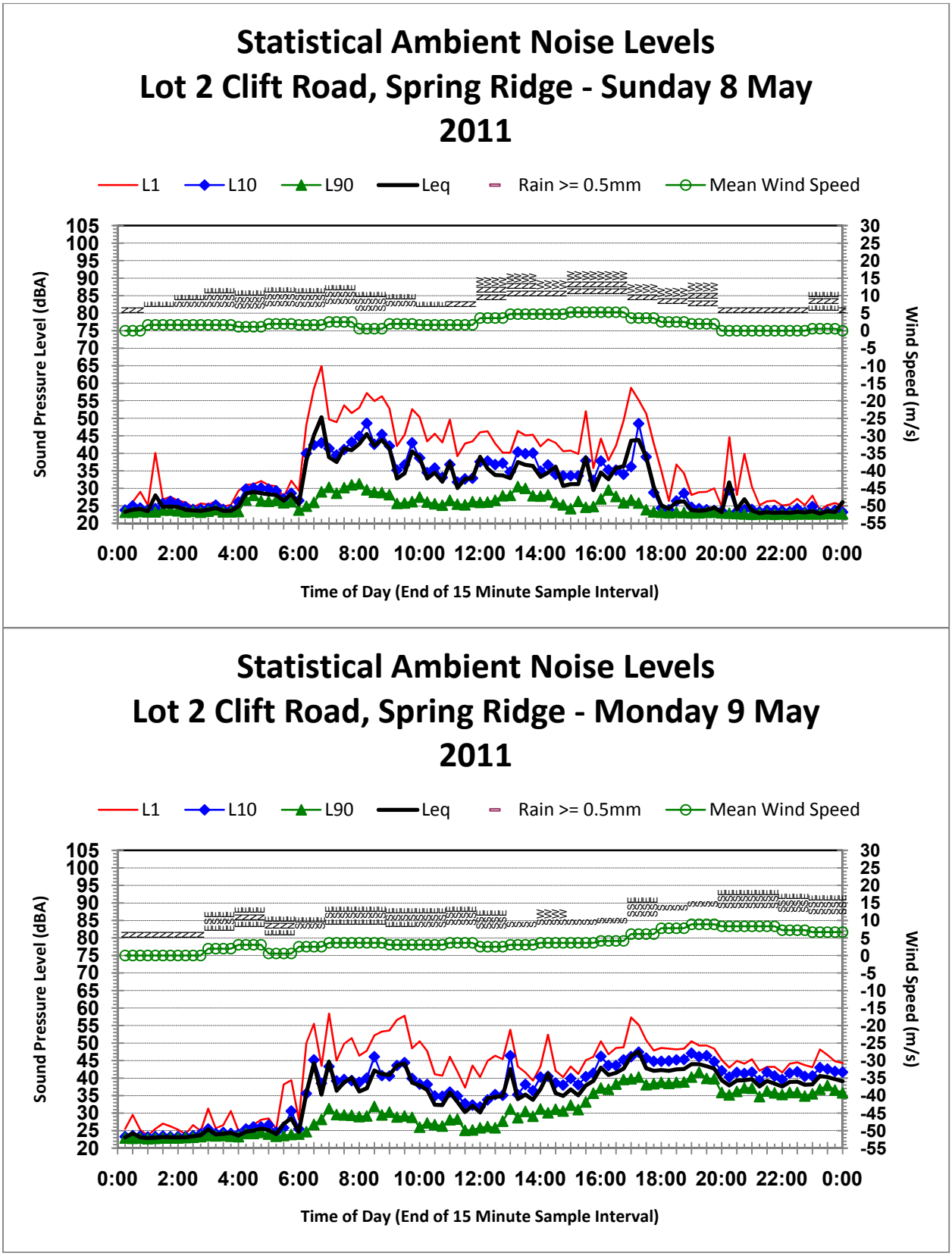
Statistical Ambient Noise Levels
Lot 2 Clift Road, Spring Ridge - Wednesday 4 May 2011



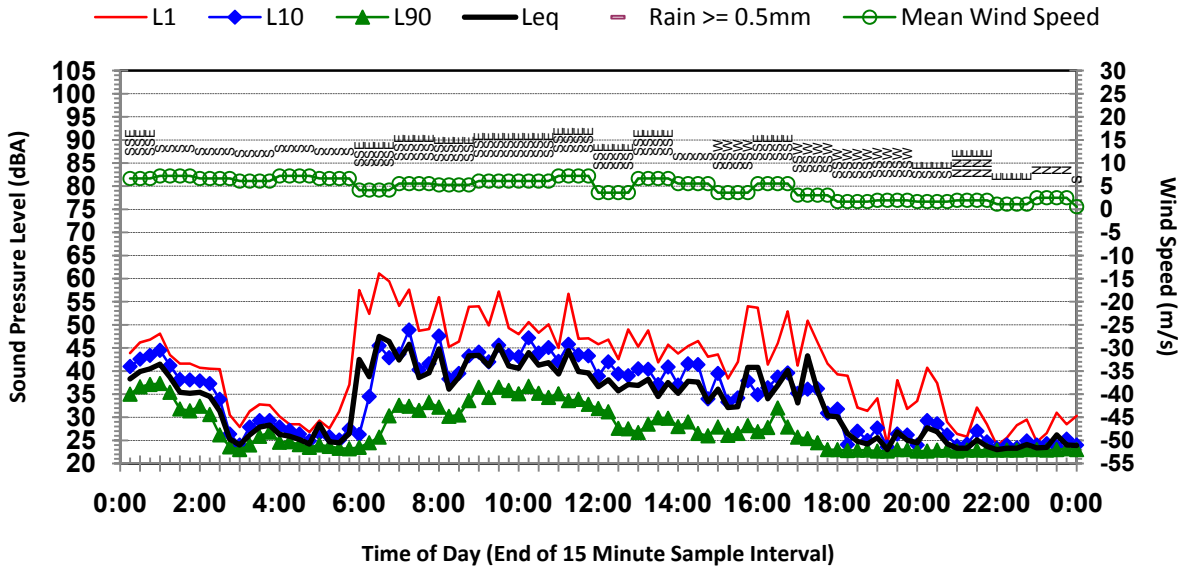
Statistical Ambient Noise Levels
Lot 2 Clift Road, Spring Ridge - Thursday 5 May 2011



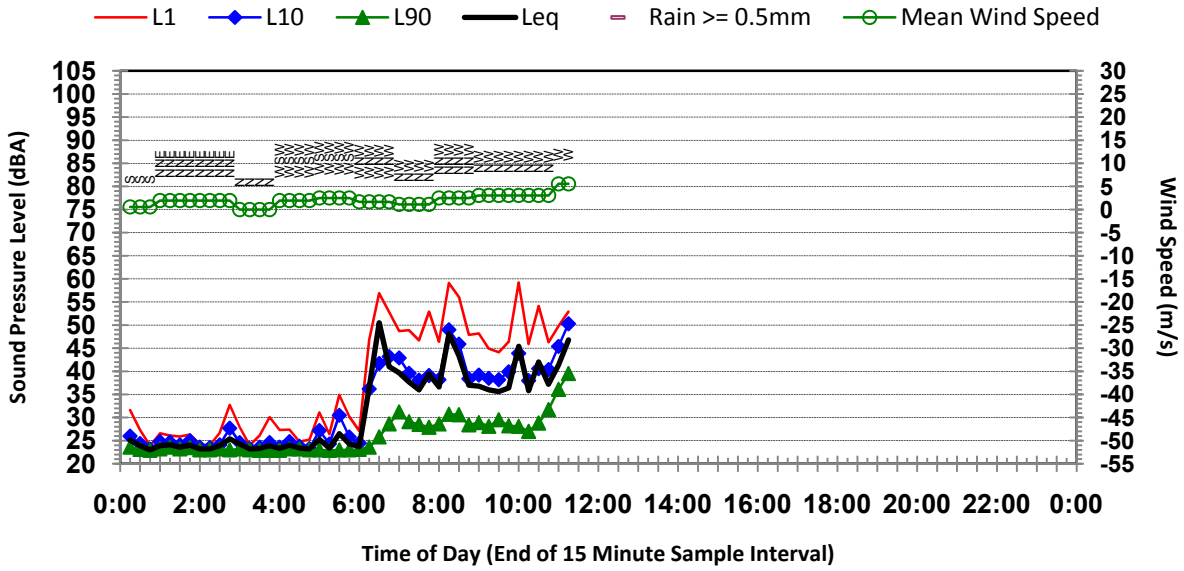

Statistical Ambient Noise Levels
Lot 2 Clift Road, Spring Ridge - Friday 6 May 2011
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed
Sound Pressure Level (dBA)
Wind Speed (m/s)
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
0:00 2:00 4:00 6:00 8:00 10:00 12:00 14:00 16:00 18:00 20:00 22:00 0:00
Time of Day (End of 15 Minute Sample Interval)
Statistical Ambient Noise Levels
Lot 2 Clift Road, Spring Ridge - Saturday 7 May 2011
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed
Sound Pressure Level (dBA)
Wind Speed (m/s)
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
0:00 2:00 4:00 6:00 8:00 10:00 12:00 14:00 16:00 18:00 20:00 22:00 0:00
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Lot 2 Clift Road, Spring Ridge - Sunday 8 May 2011
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed
Sound Pressure Level (dBA)
Wind Speed (m/s)
105 100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20
30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50 -55
0:00 2:00 4:00 6:00 8:00 10:00 12:00 14:00 16:00 18:00 20:00 22:00 0:00
Time of Day (End of 15 Minute Sample Interval)
Statistical Ambient Noise Levels
Lot 2 Clift Road, Spring Ridge - Monday 9 May 2011
L1
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed
Sound Pressure Level (dBA)
Wind Speed (m/s)
105 100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20
30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50 -55
0:00 2:00 4:00 6:00 8:00 10:00 12:00 14:00 16:00 18:00 20:00 22:00 0:00
Time of Day (End of 15 Minute Sample Interval)

Statistical Ambient Noise Levels
Lot 2 Clift Road, Spring Ridge - Tuesday 10 May 2011

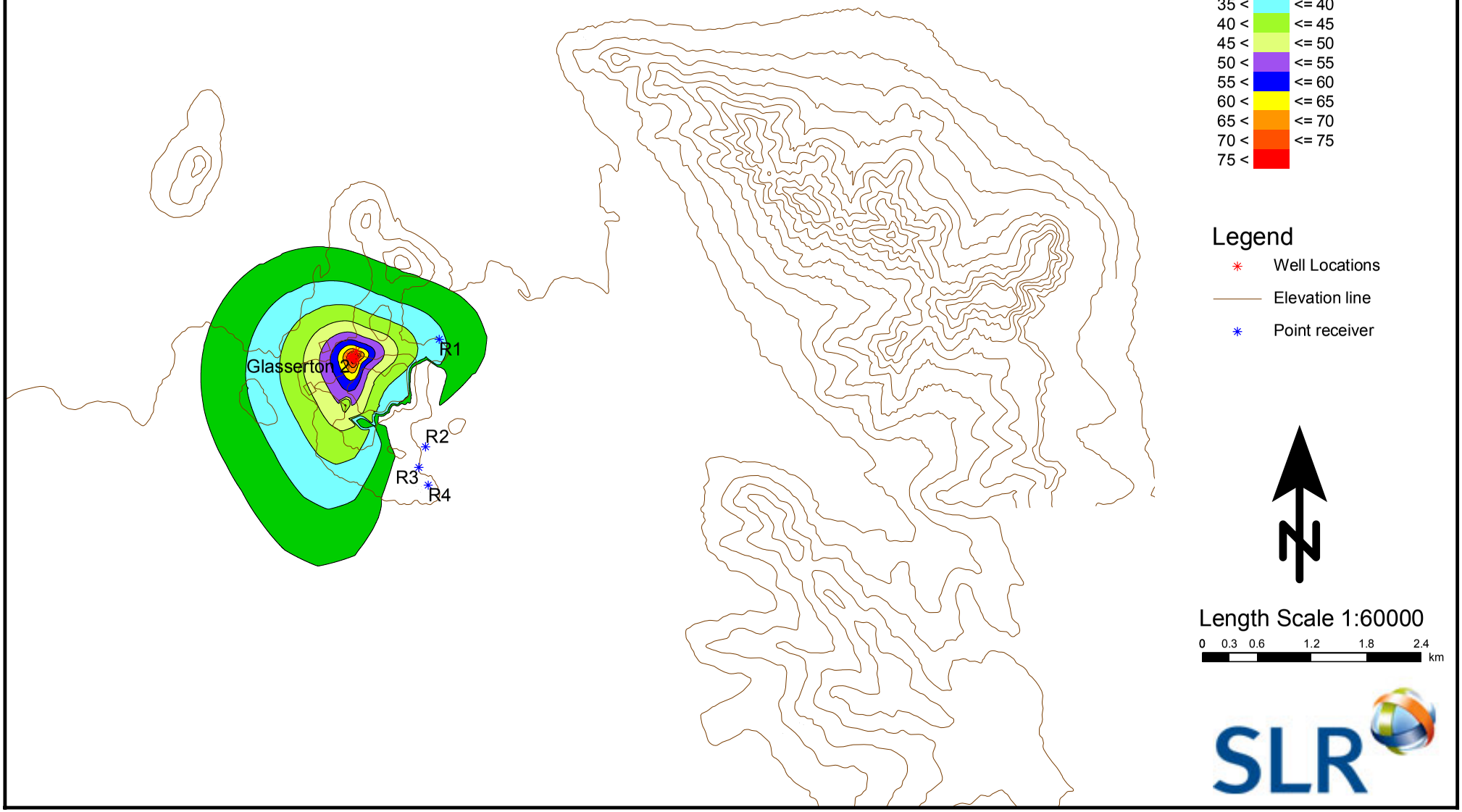


Statistical Ambient Noise Levels
Lot 2 Clift Road, Spring Ridge - Wednesday 11 May 2011



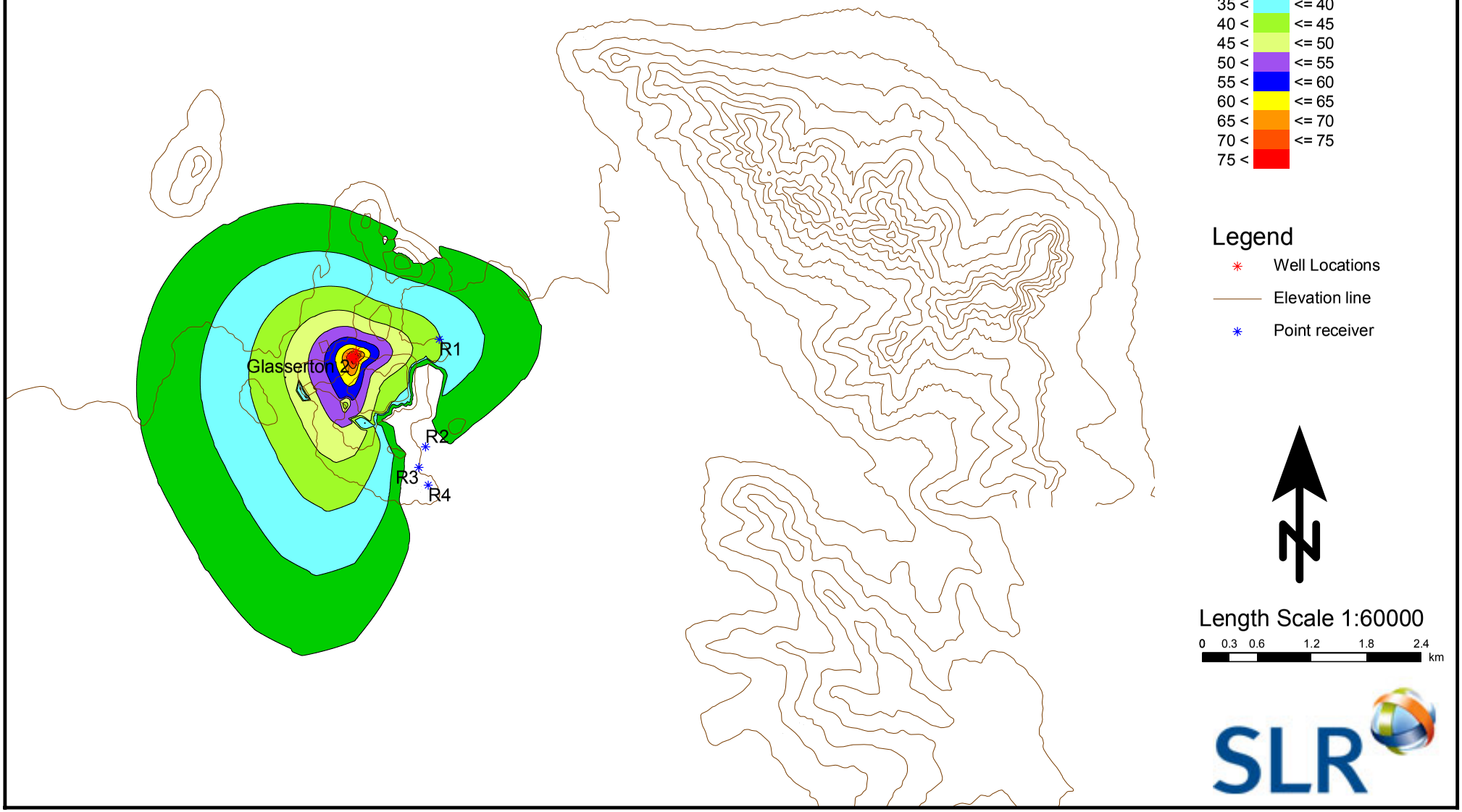
Appendix D - Santos Drill Rig 103 at Glasserton 2 - Calm Weather Conditions

Map 1 - LAeq Prediction at 1.5m above ground - Project specific intrusive noise criterion 35 dBA LAeq - No Mitigation



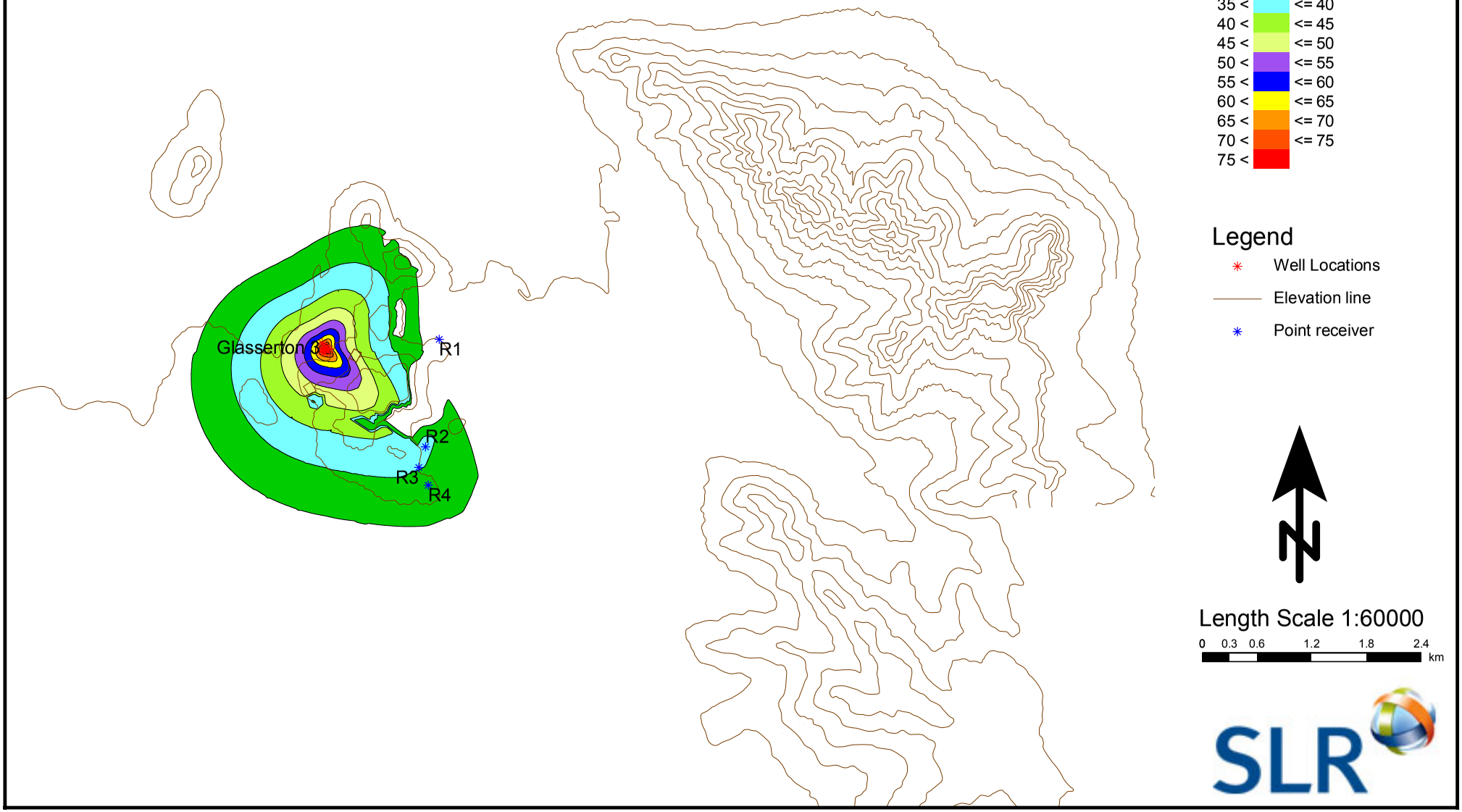
Appendix D - Santos Drill Rig 103 at Glasserton 2 - Temperature Inversion Weather Conditions

Map 2 - LAeq Prediction at 1.5m above ground - Project specific intrusive noise criterion 35 dBA LAeq - No Mitigation



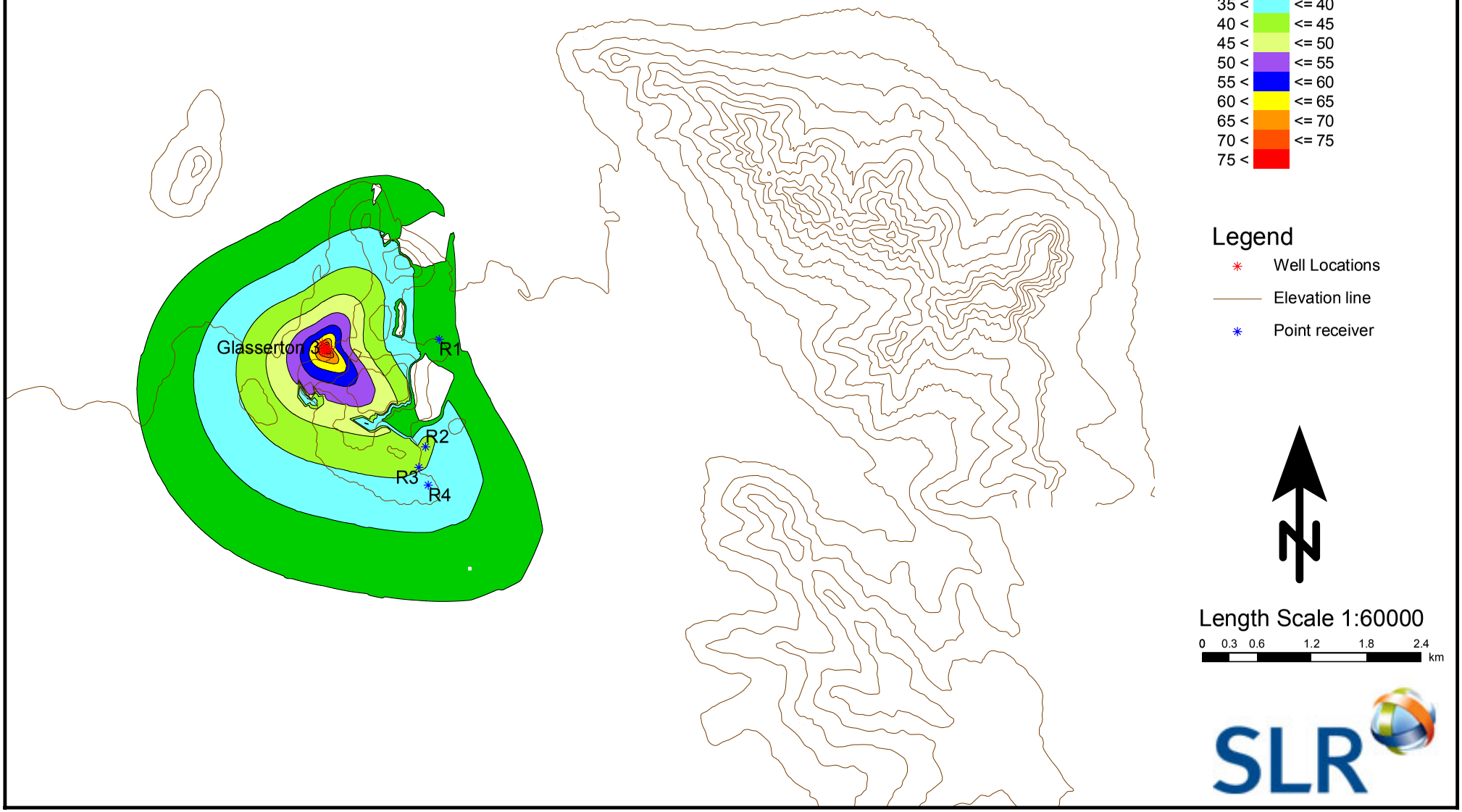
Appendix D - Santos Drill Rig 103 at Glasserton 3 - Calm Weather Conditions

Map 3 - LAeq Prediction at 1.5m above ground - Project specific intrusive noise criterion 35 dBA LAeq - No Mitigation



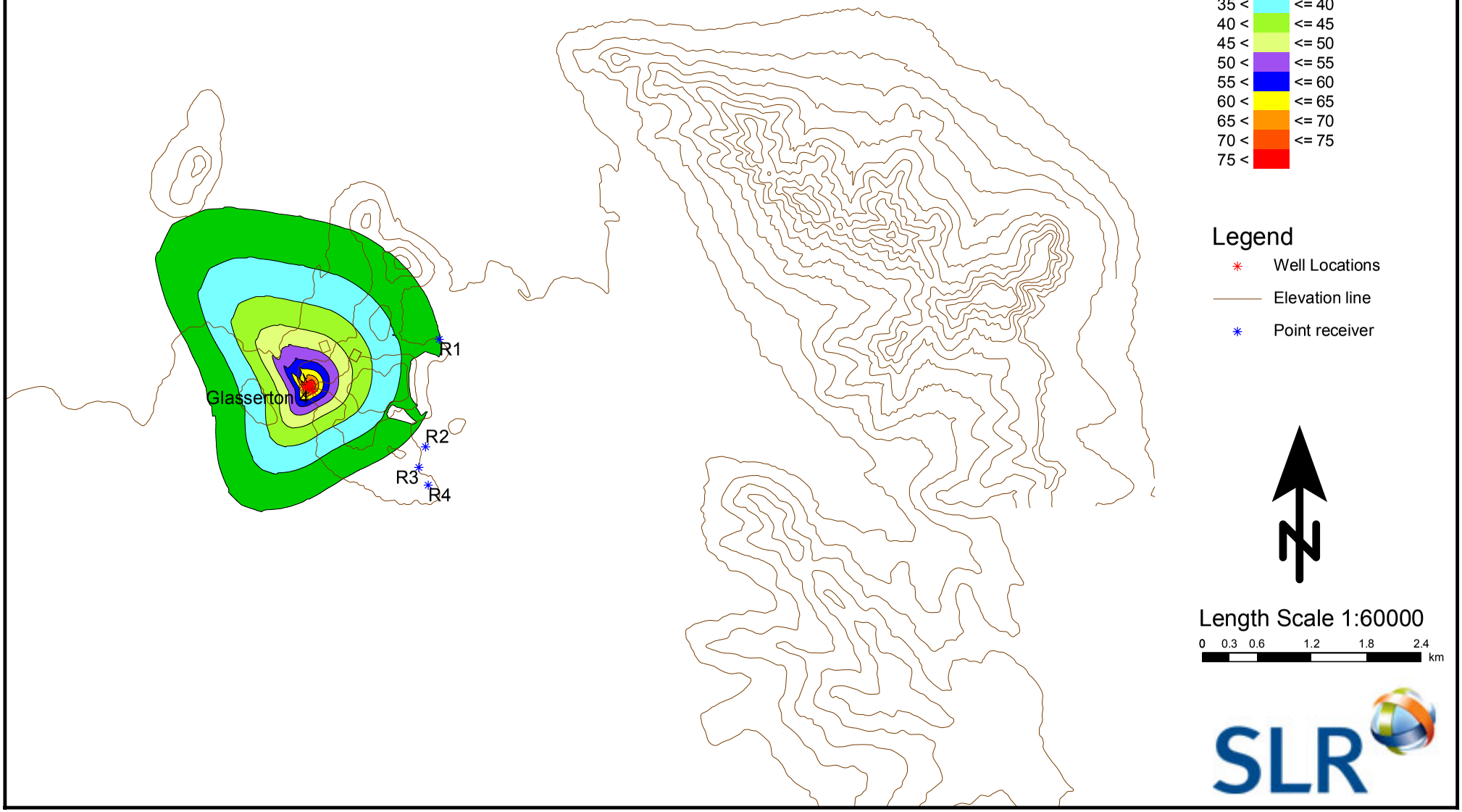
Appendix D - Santos Drill Rig 103 at Glasserton 3 - Temperature Inversion Weather Conditions

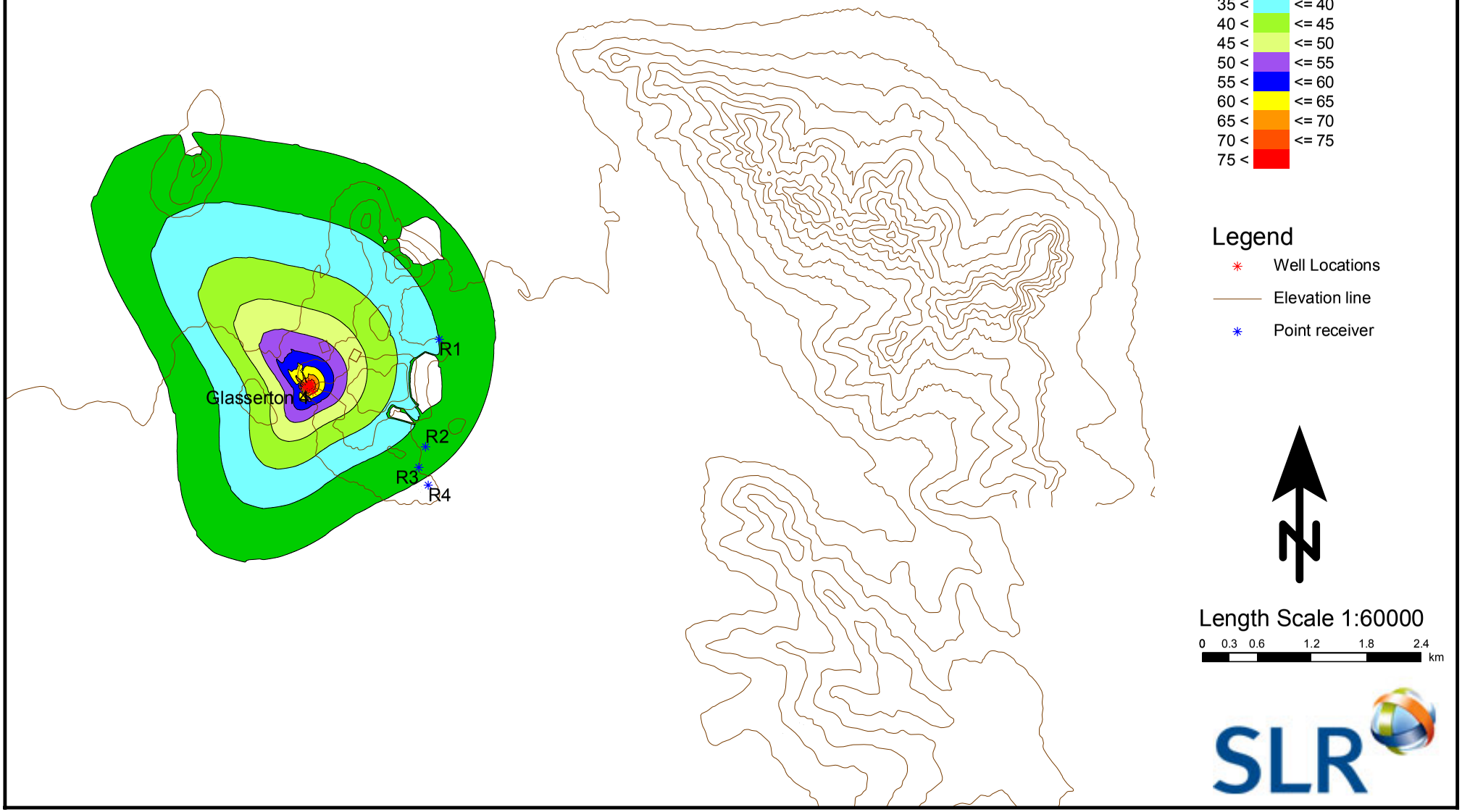
Map 4 - LAeq Prediction at 1.5m above ground - Project specific intrusive noise criterion 35 dBA LAeq - No Mitigation



Appendix D - Santos Drill Rig 103 at Glasserton 4 - Calm Weather Conditions

Map 5 - LAeq Prediction at 1.5m above ground - Project specific intrusive noise criterion 35 dBA LAeq - No Mitigation



Appendix D - Santos Drill Rig 103 at Glasserton 4 - Temperature Inversion Weather Conditions

Map 6 - LAeq Prediction at 1.5m above ground - Project specific intrusive noise criterion 35 dBA LAeq - No Mitigation