Appendix N

Noise Impact Assessment

Gladstone Pacific Nickel

Proposed Nickel Refinery, Gladstone

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Prepared for

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1 Introduction

ASK Consulting Engineers was commissioned by URS Pty Ltd on behalf of Gladstone Pacific Nickel Limited (GPNL) to carry out a noise impact assessment for the proposed high-pressure acid leach (HPAL) plant (refinery) to be located in the Yarwun Precinct of the Gladstone State Development Area (GSDA). The findings of the noise assessment are to be included in the Environmental Impact Statement (EIS). The refinery will produce nickel and cobalt metal. The location of the refinery is shown on Figure 2.1.

Stage 1 of the refinery will be built in two phases and will produce approximately 126,000 tonnes per annum of nickel and approximately 10,800 tonnes per annum of cobalt.

It is understood that the refinery will source 1.0 to 2.6 Mt/a of beneficiated ore directly from a proposed nickel and cobalt laterite mine at Marlborough, approximately 180 km north-west of Gladstone, via a dedicated ore slurry pipeline. Additional higher quality nickel laterite ore will be sourced from the South West Pacific.

The layout of the proposed refinery is shown in Appendix A.

This study addresses the noise impact of the construction and operational phases of the proposed refinery in accordance with the Environmental Protection (Noise) Policy 1997.

The purpose of this assessment is as follows:

- Undertake long term noise monitoring at the nearest noise sensitive receptors to the proposed refinery in order to obtain ambient noise levels;
- Determine the appropriate noise limits for the proposed refinery;
- Establish the likely source noise levels from the refinery for the operational and construction phases;
- Predict noise levels for the future operational phase and construction phase of the refinery in the surrounding area for various meteorological conditions;
- Assess operational noise levels in accordance with the relevant noise criteria;
- Assess potential noise impacts from the proposed construction works; and
- Provide recommendations for inclusion in the EIS.

2 Project Description

2.1 Area Description

The proposed refinery is located in the Yarwun Precinct of the GSDA. The site is located to the south of Hanson Road, and is bounded by the Calliope River to the east and Reid Road to the west.

The Gladstone State Development Area (GSDA) is located approximately 15 kms to the north west of Gladstone. The Queensland Government established the GSDA in 1993, with the purpose of providing a large area of suitable land with ready access to a deep water port for large scale industrial development. The GSDA now comprises the Clinton, Yarwun, Aldoga and Targinie precincts in Gladstone City and Calliope Shire and totals approximately 21,000 hectares.

Other industrial sites in the vicinity of the proposed refinery are Cement Australia, Comalco Refinery and Orica, which is located opposite the proposed refinery on the western side of Reid Road.

The site location is shown in **Figure 2.1**. Also shown in **Figure 2.1** is the noise logging locations **S1** to **S8**, and attended monitoring location **L2**, **L3** & **L4**. Note: Location **L1** is the same as location **S2**.

2.2 Sensitive Locations

The nearest sensitive locations are summarised in **Table 2.1** including the approximate distance from the proposed refinery.

Table 2.1: Nearest Sensitive Receivers (Refer Figure 2.1)

Site	Address	Distance from Proposed Refinery (Kilometres)	Direction from Proposed Refinery
S1	2B Linhow Crescent, Clinton	4.3 km	SE
S2	56 Fishermans Drive, Yarwun	3.4 km	NW
S3	748 Calliope River Road, Yarwun	5.0 km	SSW
S4	Mt Miller Road, Yarwun	2.4 km	SSE
S5	65 Stewart Road, Beecher	6.0 km	SSE
S6	68 Flinders Road, Gladstone	6.8 km	ESE

Site	Address	Distance from Proposed Refinery (Kilometres)	Direction from Proposed Refinery
S7	12 Lord Street, Gladstone	7.8 km	E
S8	3 Lindherr Road, Yarwun	4.0 km	W

*Note: Long term noise monitoring was undertaken by ASK at **S1** – **S4**. Connell Wagner carried out long term noise monitoring at **S5** – **S8**.*

Figure 2.1: Site Locations

3 Proposed Refinery Operations

Stage 1 of the refinery will be built in two phases and will produce approximately 126,000 tonnes per annum of nickel and approximately 10,800 tonnes per annum of cobalt.

The refinery will source 1.0 to 2.6 Mt/a of beneficiated ore directly from a proposed nickel and cobalt laterite mine at Marlborough, approximately 180 km north-west of Gladstone, via a dedicated ore slurry pipeline. Additional higher quality nickel laterite ore will be sourced from the South West Pacific.

The processing plant will consist of a high pressure acid leach circuit followed by unit operations to neutralise, and precipitate metal values with hydrogen sulphide to produce an intermediate product of mixed nickel and cobalt sulphides. Metal refining will be achieved by re-leaching the mixed sulphides, followed by impurity removal, solvent extraction to separate nickel and cobalt, and recovery of metal by hydrogen reduction to produce metal briquettes.

The nickel and cobalt metal briquettes are exported via containers out of either the Port of Gladstone or the Port of Brisbane. Transfer of the containers is either via truck or rail.

An overview of the nickel and cobalt extraction process is shown in Appendix A.

4 Monitoring

4.1 Long Term Noise Monitoring Results

ASK Consulting Engineers carried out long term noise monitoring at three (3) locations (S1, S2 & S3) between Tuesday 7 February 2006 and Friday 17 February 2006, and one location (S4) between Friday 17 February 2006 and Sunday 19 February 2006 using calibrated ARL EL215 Type 2 environmental noise loggers. The noise loggers were configured to obtain statistics over 15 minute periods throughout the monitoring period. The long term noise measurements were carried out in accordance with the Environmental Protection Noise Policy (EPP(Noise)).

Long term noise monitoring was carried out at locations S1, S2, S3 and S4 in order to obtain background noise levels at the nearest noise sensitive residences to the proposed refinery.

Connell Wagner carried out long term noise monitoring at four (4) different locations (S5, S6, S7, and S8) in the area surrounding the proposed refinery and the noise monitoring data was supplied to ASK.

The noise monitoring locations are described in Table 4.1 and included in Figure 2.1.

Table 4.1: Long-Term Noise Monitoring Locations

Location ID	Description	Monitoring Company
S1	Residence, 2/2 Linhow Crescent, Gladstone	ASK
S2	Residence, 56 Fishermans Drive, Yarwun	ASK
S3	Residence, 748 Calliope River Road, Yarwun	ASK
S4	Residence, Mount Miller Road, Yarwun	ASK
S5	Residence, 65 Stewart Road, Beecher	Connell Wagner
S6	Residence, 68 Flinders Road, Gladstone	Connell Wagner
S7	Residence, 12 Lord Street, Gladstone	Connell Wagner
S8	Residence, 3 Lindherr Road, Yarwun	Connell Wagner

The measured noise levels at S1 – S8 are summarised in Table 4.2. The analysis of the long term noise monitoring was only undertaken for complete days of monitoring. The noise levels are expressed in terms of the L_{eq}, L_{10} and the minL_{90}. The L_{10} and L_{90} are respectively the A-weighted noise levels exceeded 10%, and 90% of the time. The L_{90} is commonly referred to as the background noise level. The L_{eq} is the energy average noise level containing the same acoustic energy as the actual fluctuating noise level.

The L_{Aeq} and L_{A10} noise levels in Table 4.2 are the arithmetic average of all 15 minute periods during the period in question. The minL_{A90} is the median of the daily lowest-10th-percentile value as defined in EPA EcoAccess guideline Planning For Noise Control.

Appendix B shows a summary of the measured daily noise levels and charts of the noise levels measured during the monitoring period at ASK's monitoring locations S1 – S4. The noise levels obtained are expressed in terms of the L_{eq}, L_{10}, and L_{90}.

Table 4.2: Summary of Measured Noise Levels at S1 – S8 in dB(A)

Site	Monitoring Period	Day			Evening			Night		
		L10	*minL90*	Leq	L10	*minL90*	Leq	L10	*minL90*	Leq
S1	7/2/06 – 17/2/06	52	41	50	50	42	48	47	40	45
S2	7/2/06 – 17/2/06	50	40	48	47	39	46	47	39	45
S3	7/2/06 – 17/2/06	47	33	45	44	35	42	40	29	39
S4	17/2/06 – 19/2/06	49	31	47	53	34*	51	50	29*	48
S5	5/4/06 – 18/4/06	48	36	45	48	33	45	40	29	38
S6	5/4/06 – 18/4/06	44	38	43	46	37	46	40	33	39
S7	5/4/06 – 18/4/06	56	42	53	60	45	57	44	36	44
S8	5/4/06 – 18/4/06	49	34	48	47	34	46	42	33	42

Note: *minLA90 is the lower 10% of the L90 for the period in question as defined in the EPA EcoAccess guideline Planning For Noise Control.*

** evening and night-time background noise levels at Location S4 were higher than the daytime background noise level. This data is considered to have been affected by a local noise issue such as air-conditioning plant and/or insects. Therefore, it is proposed to discard the data obtained at Location S4 and to use an average of the background noise levels from locations S3 and S5.*

4.2 Attended Monitoring

Attended monitoring was conducted by ASK on 7th and 8th February 2006 using a Rion NA27 Type 1 Sound Level Meter. A summary of the results is included in Table 4.3.

Table 4.3: Summary of Attended Monitoring Results

Loc.	Date & Time	Period (Seconds)	L10, dB(A)	L90, dB(A)	Comments
L1/S2	07/02/06 04:53 PM	370 sec	50	43	Cicadas, Wind in trees, traffic on Hanson Rd, and 1 plane passover.
S3	08/02/06 03:58 PM	270 sec	54	44	Wind in trees was dominant. Some infrequent traffic on nearby road. Cicadas audible but less than wind noise. Plant was inaudible.
S4	08/02/06 05:34 PM	597 sec	50	38	Wind in trees & long grass, rail passbys, cicadas, hum of power station which was a low level, low frequency noise, period of talking on phone in car.
S4	08/02/06 05:44 PM	500 sec	49	38	As above, but not talking on phone in car.
L1/S2	08/02/06 11:00 PM	301 sec	*44*	*39*	Comalco dominating the background noise, and Cicadas. (the operational status of Ticor & Cement Australia was not confirmed).
L1/S2	08/02/06 11:09 PM	302 sec	*49*	*41*	As above.
S3	08/02/06 11:27 PM	353 sec	*42*	*25*	Cicadas dominant, and 1 car passby. Plant was inaudible.
L2	08/02/06 11:42 PM	581 sec	*42*	*31*	Cicadas & wind in trees were dominant, 1 car passby, truck idling at 200m for last minute of measurement.
L3	09/02/06 12:01 AM	182 sec	57	55	Noise from Orica was dominant, and cicadas were audible.
L4	09/02/06 12:12 AM	468 sec	73	43	Cicadas were dominant, wind in trees audible, power station audible (considered to be 63Hz to 250Hz), and a coal train passed by for approximately 2 minutes.
L4	09/02/06 12:20 AM	91 sec	*39*	*34*	As above, but no coal train passby.

Note: The L10 and L90 noise levels in italics and underlined have been modified by removing the insect noise in the high frequency one-third octave bands.

5 Environmental Values

The object of the *Environmental Protection Act 1994* is to protect Queensland's environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends.

The *Environmental Protection Act 1994* states a person must not carry out any activity that causes, or is likely to cause, environmental harm unless the person takes all reasonable and practicable measures to prevent or minimise the harm. This is termed the 'general environmental duty'.

Environmental harm is defined as any adverse effect, or potential adverse effect (whether temporary or permanent and of whatever magnitude, duration or frequency) on an environmental value, and includes environmental nuisance.

Environmental nuisance for this report is unreasonable interference or likely interference with an environmental value caused by noise or vibration.

5.1 Environmental Protection (Noise) Policy

The *Environmental Protection Act 1994* is the principal legislation in Queensland relating to environmental noise. This legislation refers to the Environmental Protection (Noise) Policy 1997.

Section 10 of the EPP(Noise) states:

> The environmental values to be enhanced or protected under this policy are the qualities of the acoustic environment that are conducive to:
>
> *(a) The wellbeing of the community or a part of the community, including its social and economic amenity; or*
>
> *(b) The wellbeing of an individual, including the individual's opportunity to have sleep, relaxation and conversation without unreasonable interference from intrusive environmental noise.*

5.2 EPA EcoAccess Noise Guidelines

The Environmental Protection Agency Ecoaccess Guideline "Planning For Noise Control" contains procedures and methods that are applicable for setting conditions relating to noise emitted from industrial premises for planning purposes. The guideline is applicable to noises from all sources, individually and in combination, which contribute to the total noise from a site.

The procedure takes into account three factors: firstly, the control and prevention of background noise creep in the case of a steady noise level from equipment such as caused by ventilation fans and other continuously operating machinery; secondly, the containment of variable noise levels and short-term noise events such as those caused by forklifts and isolated hand tools, to an acceptable level

above the background noise level; thirdly, the setting of noise levels that should not be exceeded to avoid sleep disturbance.

The Environmental Protection Agency has an Ecoaccess Guideline "Assessment of Low Frequency Noise". The procedures and methods contained in the guideline are applicable for setting conditions relating to noise emitted from industrial premises for planning purposes. The guideline is applicable to noises from all sources, individually and in combination, which contribute to the total noise from a site. It specifically relates to noise in the 10 Hz to 200 Hz frequency range.

5.2.1 Control and Prevention of Background Creep

The acceptable noise guideline levels for the measurement locations have been determined in **Table C.1** in **Appendix C**. The results are summarised in **Table 5.1.**

Table 5.1: EcoAccess Background Creep Guideline Levels

Location ID	Description	EcoAccess Background Creep Guideline Levels, $L_{Aeq,adj}$		
		Day	Evening	Night
S1	Residence, 2/2 Linhow Crescent, Gladstone	46	33	28
S2	Residence, 56 Fishermans Drive, Yarwun	48	47	47
S3	Residence, 748 Calliope River Road, Yarwun	41	28	28
S4	Residence, Mount Miller Road, Yarwun	39	42	37
S5	Residence, 65 Stewart Road, Beecher	41	33	28
S6	Residence, 68 Flinders Road, Gladstone	38	28	28
S7	Residence, 12 Lord Street, Gladstone	33	28	28
S8	Residence, 3 Lindherr Road, Yarwun	42	29	28

From **Table 5.1** it can be seen that the night-time guideline level is 28 dB(A) at all receivers except **S2** & **S4**.

Locations **S2** and **S4** are considered to be in industrial areas, hence a higher noise level is permitted. The EcoAccess guideline levels are already exceeded by 10 to 20 dB(A) during the night-period for

Locations S1 and S3 to S8, and therefore the application of the guideline levels at these locations is considered inappropriate because they are unrealistically low.

The guideline level of 47 dB(A) Leq at Location S2 may be appropriate as the existing night-time average Leq is 45 dB(A). The guideline level of 37 dB(A) Leq at Location S4 may also be appropriate. The recommended noise levels at these locations will be considered in more detail later in this report.

5.2.2 Single Event Noise Levels Criteria

The Ecoaccess guideline addresses the situation where there are noise events with relatively high noise levels and large fluctuations in sound pressure levels. It is unlikely that these types of events form part of the normal operations at the refinery. As a result assessment of this type of noise event will not be considered further.

5.2.3 WHO Sleep Disturbance Criteria

5.2.3.1 Continuous Noise

The World Health Organization (WHO) issued it's "Guidelines for Community Noise" in April 1999. The WHO guideline states the following in regard to sleep disturbance from continuous noise from activities such as mining operations:

"Where noise is continuous, the equivalent sound pressure level should not exceed 30 dB(A) indoors, if negative effects on sleep are to be avoided. When noise is composed of a large proportion of low-frequency sounds a still lower guideline value is recommended, because low-frequency noise (eg from a ventilation system) can disturb rest and sleep even at low sound pressure levels."

To adapt the WHO criteria from indoor levels to outdoor levels requires consideration of the noise reduction through the building façade. A noise reduction of 7 dB(A) is proposed in the guidelines, which results in an external level of 37 dB(A) Leq.

Higher noise criteria may be possible if windows were kept closed, however, this would require that the bedroom is alternatively ventilated (e.g. air-conditioning) which is generally not the case for most rural residences.

It should be noted that this criterion is for the assessment of sleep disturbance, and does not consider annoyance due to significant changes to the acoustic environment brought about the establishment of industrial development.

5.2.3.2 Short-term Noise Events

The Ecoaccess Guideline "Planning for Noise Control", in referring to the WHO guidelines, makes the following general recommendation regarding short term transient noise events:

"As a rule in planning for short-term or transient noise events, for good sleep over eight hours, the indoor sound pressure level measured as a maximum instantaneous value should not exceed approximately 45 dB(A) maxL_{pA} more than 10 to 15 times per night. The corresponding external noise level, assuming partially closed windows, is 52 dB(A) maxL_{pA} measured in the free field."

For less regular night events, the allowable external noise level is higher, as follows:

- Approximately 3 events per night: 57 dB(A) maxL_{pA}; and
- Approximately 1 event per night: 62 dB(A) maxL_{pA}.

The WHO guideline states the following in regard to annoyance response to community noise:

"*Annoyance to community noise varies with the type of activity producing the noise. During the daytime few people are seriously annoyed by activities with LAeq levels below 55 dB(A); or moderately annoyed by LAeq levels below 50 dB(A). Sound pressure levels during the evening and night should be 5 – 10 dB(A) lower than during the day. Noise with low frequency components requires even lower levels.*"

5.2.3.3 Summary of WHO Criteria

The WHO criteria are summarised in Table 5.2.

Table 5.2 Summary of WHO Sleep Disturbance & Annoyance Criteria

Descriptor	Number of Noise Events	Indoor Criterion in dB(A)	Outdoor Criterion in dB(A)
Sleep Disturbance (Short Duration Events)	10 – 15	45	52
	3	50	57
	1	55	62
Sleep Disturbance (Continuous Noise)	Continuous	30	37
Annoyance (Night Time)	Continuous	35	42

Note: Based on an outdoor to indoor noise reduction of 7 dB(A) for partially closed windows.

5.2.4 Low Frequency Noise

The Environmental Protection Agency Ecoaccess Guideline "Assessment of Low Frequency Noise" contains methods and procedures that are applicable to low frequency noise emitted from industrial premises and mining operations for planning purposes. Items such as boilers, pumps, transformers, cooling fans, compressors, oil and gas burners, foundries, wind farms, electrical installations, diesel engines, ventilation and air-conditioning equipment, wind turbulence and large chimney resonance are sources of high level noise having frequency content less than 200 Hz.

These sources exhibit a spectrum that characteristically shows a general increase in sound pressure level with decrease in frequency. Annoyance due to low frequency noise can be high even though the dB(A) level measured is relatively low. Typically, annoyance is experienced in the otherwise quiet environments of residences, offices and factories adjacent to or near low frequency noise sources. Generally, low level/low frequency noises become annoying when the masking effect of higher frequencies is absent. This loss of high frequency components may occur as a result of transmission through the fabric of a building, or in propagation over long distances.

Where a noise immission occurs exhibiting an unbalanced frequency spectra, the overall sound pressure level inside residences should not exceed 50 dB(Linear) to avoid complaints of low frequency noise annoyance.

5.3 WHO Noise Criteria

The following sleep disturbance criteria are taken from the WHO Guidelines for Community Noise 1999:

"*Sleep disturbance is a major effect of environmental noise. It may cause primary effects during sleep, and secondary effects that can be assessed the day after night-time noise exposure…. For a good night's sleep, the equivalent sound level should not exceed 30 dB(A) L_{eq} for continuous background noise, and individual noise events exceeding 45 dB(A) L_{max} should be avoided.*"

The WHO Guidelines also recognize that lower noise limits may be required in areas where background noise levels are particularly low or where the noise contains significant low frequency noise.

It is considered that residential areas close to the refinery are also relatively close to Gladstone Power Station and thus background noise levels are not expected to be particularly low. Low frequency noise is also addressed using criteria from EcoAccess.

5.4 EPA 'Background Plus' Criteria

The EPA's EPP(Noise) requires that the acoustic environment does not significantly deteriorate with the introduction of a new noise source. The criteria that are proposed for this assessment are commonly known as the 'Background Plus" criteria. The noise criteria are summarised in Table 5.3.

Table 5.3: 'Background Plus' Noise Criteria

Period of Day	Noise Criteria at Residence, $L_{Amax,adj,T}$, dB(A)	
	Measured Limit, i.e. Inclusive of Background Noise	Design Limit, i.e. Exclusive of Background Noise
Day	Background Noise Level + 5 dB(A)	Background Noise Level + 3 dB(A)
Evening	Background Noise Level + 5 dB(A)	Background Noise Level + 3 dB(A)
Night	Background Noise Level + 3 dB(A)	Background Noise Level + 0 dB(A)

The 'Background Plus' noise limits have been calculated using the EcoAccess derived lowest 10th-percentile L90 levels as the background noise level. The results are listed in Table 5.4.

Table 5.4: 'Background Plus' Design Noise Criteria

Site	Design Noise Criteria, $L_{Amax,adj,T}$, dB(A)		
	Day	Evening	Night
S1	44	45	40
S2	43	42	39
S3	36	38	29
S4	34	37	29
S5	39	36	29
S6	41	40	33
S7	45	48	36
S8	37	37	33

As the plant operates 24 hours/day, the night-time limits in Table 5.4 are most critical.

5.5 Summary

It is proposed to assess noise level predictions against all the criteria presented in this section.

6 Noise Model

6.1 Model Description

Noise modelling was carried out using the PEN computer program. It is a digital terrain noise model. The model includes the propagation effects of air absorption, ground reflection, meteorology, barriers and forest.

The model included terrain data digitised from a topographical map of the area.

The computer model also requires identification of ground types, tree zones, surface roughness estimates and meteorological data.

The default ground type is rough grass, with large areas of forest. The surface roughness assumed for this model is dependent on the type of terrain, quantity and density of vegetation and other factors. For all cases a surface roughness for grasslands of 0.023m was used.

The roughness of the surface influences the vertical wind speed profile. A rough surface means that the wind does not reach full speed until quite some distance from the ground. However, a smooth surface means that full wind speed is achieved much closer to the ground. The selected surface roughness is representative of the cleared farmland.

The model has been run with three meteorological cases (Refer Section 6.4 for further detail):

(i) Neutral atmosphere,

(ii) Inversion with 1 m/s easterly wind; and

(iii) Inversion with no wind.

6.2 Noise Sources (Stage 1B)

The site consists of a number of areas with designated identification numbers. Table 6.1 includes a list of the areas, their description, and the noise sources contained within them.

Table 6.1: Area Names & Noise Sources (Stage 1B)

Area	Area Name	Noise Sources
210	Imported Ore Receival	Conveyor 1400 metre, pumps
220	Imported Ore Beneficiation	Sag mill, ball mill, pumps, motors
230	Slurry Receival	Pumps, motors
240	Feed Thickening	Pumps, motors
250	Slurry Storage	Pumps, motors
310	Pressure Acid Leaching	Pumps, motors
320	Saprolite Neutralisation	Pumps, motors
330	Counter Current Decantation	Pumps, motors
340	Solution Neutralisation	Pumps, motors
350	Sulphide Precipitation	Pumps, motors
360	Final Neutralisation	Pumps, motors
370	Residue and Decant Liquor Handling	Pumps, motors
410	Sulphide Leach	Pumps, motors
420	Impurity Removal	Pumps, motors
430	Solvent Extraction	Pumps, motors
440	Nickel Reduction	Pumps, motors
450	Nickel Metal Handling and Packaging	Hammer Mill, Furnace, Pumps, motors
460	Cobalt Reduction	Pumps, motors
470	Cobalt Metal Handling and Packaging	Hammer Mill, Furnace, Pumps, motors
480	Solution Stripping	Pumps, motors
490	Ammonium Sulphate Plant	2 x 3100kw compressors (enclosed), motors

Area	Area Name	Noise Sources
510	Sulphuric Acid	2 x 7800kW compressors (enclosed), conveyor 900 metre, pumps
520	Process Gases (Hydrogen Plant)	2 x 6500kW compressors, 750kW compressor, motors
530	Limestone Plant - not required	*No sources*
540	Lime Plant	Pumps, motors
550	Residue Storage Facility	Pump
560	Flocculant Preparation	Pumps, motors
570	Reagent Preparation	Pumps, motors
580	Laboratory	*No sources*
610	Water Supply to Plant	Pumps, motors
620	Water Systems	Pumps
630	Site Services	Pump
640	Power Station	500kW generator, motors
650	Power Supply and Reticulation	*No sources*
660	Natural Gas and Reticulation	*No sources*
670	Air Systems	300kW compressor
680	Tank Farm	Pumps
690	Process Control System	*No sources*

Some additional notes are as follows:

- Conveyors are to be enclosed on three sides;
- Hammer mills and furnaces in Areas 450 & 470 are fully enclosed, such that they are not significant noise sources;
- Areas 530, 580, 650, 660 & 690 have no significant noise sources;

- Sound power levels for the Pressure Acid Leaching (310), Sulphide Leach (410), Sulphuric Acid (510), Hydrogen Plant (520) and Cooling Towers (620) are extracted from source sound power level data for the Kwinana Nickel Refinery. The Kwinana sound power levels are lower than what would would be calculated using empirical formulae, and therefore the Kwinana plant may include noise controls. The Gladstone Nickel refinery will be required to include similar noise controls, if any.

6.3 Noise Source Sound Power Levels (Stage 1B)

Sound power levels for noise sources were obtained from various sources, including data in ASK's library and empirical formulae. The modelled sound power levels are listed in Table 6.2.

Table 6.2: Sound Power Level Data (Includes Stages 1A & 1B)

Area	Sound Power Level in dB at Octave Band Centre Frequency (Hz)								Overall dB	Overall dB(A)
	63	125	250	500	1000	2000	4000	8000		
210	114	120	114	115	113	108	102	96	123	117
220	117	114	113	112	112	109	106	103	122	116
230	96	97	98	99	99	96	92	88	106	103
240	94	95	97	97	100	97	93	87	105	103
250	96	97	98	99	99	96	92	88	106	103
310	104	109	113	114	112	103	99	96	119	115
320	98	100	100	101	100	97	92	90	108	104
330	104	105	106	107	109	106	102	96	115	113
340	99	101	102	102	102	99	95	92	110	107
350	104	106	107	107	109	106	101	97	115	112
360	98	100	101	101	102	99	95	91	109	106
370	94	95	97	97	100	97	93	87	106	104
410-420	102	103	104	105	106	103	98	94	112	109

Area	Sound Power Level in dB at Octave Band Centre Frequency (Hz)								Overall dB	Overall dB(A)
	63	125	250	500	1000	2000	4000	8000		
430	96	97	99	99	101	98	94	89	107	105
440	101	102	104	104	105	102	98	94	112	109
450	100	102	102	103	101	98	93	92	109	105
460	92	93	95	95	96	93	89	85	103	100
470	89	91	92	92	93	90	86	82	100	97
480	97	98	100	100	102	99	95	90	108	106
490	114	114	110	109	107	105	101	95	120	112
510	112	117	115	116	114	107	102	97	123	118
520	110	111	109	111	110	111	104	98	119	116
540	99	101	101	102	99	96	91	91	108	104
550	91	92	94	94	97	94	90	84	102	100
560	102	104	104	105	102	99	94	94	111	107
570	94	96	96	97	95	92	86	86	104	100
610	102	103	105	105	107	104	100	95	113	111
620	104	107	108	107	108	106	105	105	116	113
630	91	92	94	94	97	94	90	84	103	101
640	96	98	98	99	96	93	87	88	106	101
670	103	108	107	105	108	113	110	103	118	117
680	92	94	94	95	94	91	86	84	102	99
TOTAL	122	124	122	123	122	119	115	111	131	126

The predicted sound power level of the entire plant (Stage 1B) is 126 dB(A) or 131 dB(Lin).

As a comparison, ASK measured the approximate sound power level of the Yabulu Nickel Plant as 126 dB(A), and the Kwinana Nickel Refinery is reported as 124 dB(A) and 132 dB(Lin).

6.4 Predicted Noise Levels From Stage 1B Operations

The noise levels at noise sensitive receptors have been calculated for the following three meteorological cases: (i) neutral atmosphere, (ii) inversion with 1 m/s easterly wind; and (iii) inversion with no wind.

The neutral atmosphere case refers to an atmospheric condition comprising a temperature gradient of zero with zero wind speed.

The inversion cases (ii) & (iii) incorporate a 3 deg/100 m vertical temperature gradient (starting at ground level).

This wind direction in case (ii) was determined from the EPA's meteorological file data for Gladstone. This scenario would be representative of typical adverse case night-time meteorological conditions for locations west of the refinery.

Noise contours for the two meteorological conditions are shown on the following Figures in Appendix E:

- Figure E.1 – Predicted noise levels with neutral meteorological case (i); and
- Figure E.2 – Predicted noise levels with temperature inversion and no wind case (iii).

Table 6.3 contains the predicted noise levels in terms of the A-weighted overall noise level, un-weighted overall noise level, and the difference between the A-weighted and un-weighted overall levels.

The un-weighted overall noise level, and the difference between the A-weighted and un-weighted overall levels, are both used to determined acceptability with respect to EcoAccess low frequency noise criteria.

Table 6.3: Predicted Operational Noise levels – Stage 1B

Location ID	Predicted Noise Levels, LAeq		Predicted Noise Levels, Leq, dB(Lin)		Effect of Weighting, Leq – LAeq	
	Neutral Case (i)	Inversion Case (ii)	Neutral Case (i)	Inversion Case (ii)	Neutral Case (i)	Inversion Case (ii)
S1	28	28	41	41	13	12
S2	31	41	44	51	12	10

Location ID	Predicted Noise Levels, LAeq		Predicted Noise Levels, Leq, dB(Lin)		Effect of Weighting, Leq – LAeq	
	Neutral Case (i)	Inversion Case (ii)	Neutral Case (i)	Inversion Case (ii)	Neutral Case (i)	Inversion Case (ii)
S3	3	33	20	46	17	13
S4	35	33	46	44	11	11
S5	23	24	38	38	14	14
S6	22	20	37	35	15	15
S7	19	18	35	33	16	16
S8	7	39	24	50	17	11

From Table 6.3 it can be seen that the temperature inversion has a significant effect on noise levels at location S2, S3 & S8.

The large increase at locations S3 & S8 occurs as the inversion refracts the noise over the mountain range west of the refinery, thus negating the shielding effect of the mountains. This effect, when modelled, causes an increase in noise levels of up to 30 dB(A). It is however, a difficult effect for modelling programs to account for, and thus a qualitative assessment of the existing acoustic environment has been conducted.

The Comalco refinery, located 2km north-west of the subject site, is expected to have an overall sound power level higher than that of the nickel refinery[1]. The Comalco refinery is located closer to residents near S8 (Yarwun) than the proposed nickel refinery, and there is lower intervening topography between Comalco and Yarwun than between the nickel refinery and Yarwun. Thus, it is reasonable to expect that noise levels from Comalco, when measured at S8 (Yarwun), would be higher than noise levels from the nickel refinery.

ASK had a brief discussion with the Gladstone office of the EPA, and was advised that there are no known noise complaints at Yarwun from operational noise at the Comalco refinery. Based on that information, we draw two conclusions: (i) noise from the nickel refinery should not cause complaints at S8 (Yarwun), and (ii) the noise modelling package is over-estimating the noise refraction over the mountains to the west of the nickel refinery to S3 & S8.

It is proposed that noise levels predicted west of the site (S3 & S8), under adverse meteorological conditions, are over-predicted by the modelling package.

[1] Reference was made to ASK's noise impact assessment report for the Comalco Refinery.

Locations S3 & S8 have been remodelled using different adverse meteorological conditions, incorporating a 3 deg/100 m vertical temperature gradient as before, but with a zero wind speed (i.e. case (iii)). The predicted noise levels at Locations S3 & S8 are 25 dB(A) and 29 dB(A) respectively. These noise levels may be more representative of future noise levels. Table 6.4 includes these new predictions, to be used for assessment in this report.

Table 6.4: Predicted Operational Noise levels – Stage 1B

Location ID	Predicted Noise Levels, LAeq		Predicted Noise Levels, Leq, dB(Lin)		Effect of Weighting, Leq – LAeq	
	Neutral Case (i)	Inversion Case (ii)/(iii)	Neutral Case (i)	Inversion Case (ii)/(iii)	Neutral Case (i)	Inversion Case (ii)/(iii)
S1	28	28	41	41	13	12
S2	31	41	44	51	12	10
S3	3	25*	20	38	17	14
S4	35	33	46	44	11	11
S5	23	24	38	38	14	14
S6	22	20	37	35	15	15
S7	19	18	35	33	16	16
S8	7	28*	24	40	17	12

Note: * Includes zero wind speed (case (iii)), whereas other adverse predictions include 1m/sec wind speed (case (ii)).

7 Assessment

7.1 EPA EcoAccess

7.1.1 Background Creep Assessment

Predicted noise levels in Table 6.4 are compared with the EcoAccess Background Creep Guideline Levels in Table 5.1. A summary of the Background Creep assessment is included in Table 7.1.

From Table 7.1 it can be seen that the background creep guideline levels are met at all receptors.

Table 7.1: Assessment of Predicted Stage 1B Operational Noise levels using Background Creep Guideline Levels

Location ID	Comparison of Predicted Noise Levels with EcoAccess Guideline Levels			
	Day	Evening	Night	
	Neutral Case (i)	Neutral Case (i)	Neutral Case (i)	Inversion Case (ii)/(iii)
S1	Acceptable	Acceptable	Acceptable	Acceptable
S2	Acceptable	Acceptable	Acceptable	Acceptable
S3	Acceptable	Acceptable	Acceptable	Acceptable
S4	Acceptable	Acceptable	Acceptable	Acceptable
S5	Acceptable	Acceptable	Acceptable	Acceptable
S6	Acceptable	Acceptable	Acceptable	Acceptable
S7	Acceptable	Acceptable	Acceptable	Acceptable
S8	Acceptable	Acceptable	Acceptable	Acceptable

7.1.2 WHO Sleep Disturbance – Continuous Noise

The indoor noise criteria proposed by WHO are 30 dB(A) Leq for sleep disturbance and 35 dB(A) Leq for annoyance. As stated in **Section 5.2.3**, this typically results in external noise criteria of 37 dB(A) Leq for sleep disturbance, and 42 dB(A) Leq for annoyance. From **Table 6.4** it can be seen that the 37 dB(A) Leq criterion is met under most conditions, except during temperature inversions, when the exceedance is 4 dB(A) at Location **S2**. The 42 dB(A) Leq criterion is achieved at all receptors under neutral and adverse meteorological conditions.

It is expected that noise from Stage 1A operations will be approximately 3 dB(A) lower than the Stage 1B operations, as plant requirements are approximately doubled from Stage 1A to Stage 1B. Thus, the WHO annoyance criterion of 37 dB(A) is only predicted to be excceded at one receptor location by 1 dB(A) during Stage 1A. This period of Stage 1A operation may allow for further noise monitoring to be conducted to accurately determine any noise exceedences (if any), and design and implement noise control measures prior to operation of Stage 1B.

7.1.3 WHO Sleep Disturbance – Intermittent Noise

The noise from the plant will generally be heard as a steady or quasi-steady noise, and therefore is not expected to cause sleep disturbance according to EcoAccess short-term event criteria.

7.1.4 Low Frequency Noise

Assessment of low frequency noise is a two step process. The first step is to compare the overall un-weighted (or linear-weighted) noise level with the 50 dB(Lin) criterion. If the noise level exceeds 50 dB(Lin), then its spectrum is required to be assessed to check for excessive low-frequency imbalance.

From Table 6.4, it can be seen that the predicted noise level exceeds 50 dB(Lin) in one instance by 1 dB(Lin). This instance will be considered further.

A check of frequency balance is to compare the overall un-weighted noise level with the overall A-weighted noise level. If the difference exceeds 15 dB, then further analysis is required. From Table 6.4, it can be seen where the predicted noise level exceeds 50 dB(Lin), the overall un-weighted noise level minus the overall A-weighted noise level, equals 10 dB. Therefore the low frequency noise is considered acceptable.

7.2 EPA 'Background Plus'

Predicted noise levels in Table 6.4 are compared with the EPA "Background Plus' Noise Criteria in Table 5.4. A summary of the assessment is included in Table 7.2.

Table 7.2: Assessment of Predicted Stage 1B Operational Noise levels using 'Background Plus' Noise Criteria

Location ID	Comparison of Predicted Noise Levels with 'Background Plus' Noise Criteria			
	Day	Evening	Night	
	Neutral Case (i)	Neutral Case (i)	Neutral Case (i)	Inversion Case (ii)/(iii)
S1	Acceptable	Acceptable	Acceptable	Acceptable
S2	Acceptable	Acceptable	Acceptable	Exceeds by 2 dB(A)

	Comparison of Predicted Noise Levels with 'Background Plus' Noise Criteria			
	Day	Evening	Night	
S3	Acceptable	Acceptable	Acceptable	Acceptable
S4	Exceeds by 1 dB(A)	Acceptable	Exceeds by 6 dB(A)	Exceeds by 4 dB(A)
S5	Acceptable	Acceptable	Acceptable	Acceptable
S6	Acceptable	Acceptable	Acceptable	Acceptable
S7	Acceptable	Acceptable	Acceptable	Acceptable
S8	Acceptable	Acceptable	Acceptable	Acceptable

From Table 7.2 it can be seen that the 'Background Plus' criteria are exceeded at locations S2 & S4, and these will be considered in more detail below:

- Location S2: The night-time noise criterion is exceeded by up to 2 dB(A) during inversion conditions with a light easterly breeze. It is noted from Table 7.1 that the EcoAccess 'Background Creep' criterion is met at this location because the area is considered industrial and therefore a higher noise level than 'Background Plus' is permitted.

  The predicted noise level during an inversion is 41 dB(A) Leq. This compares with a background noise level of 39 dB(A), an average night-time L90 level of 42 dB(A), and an average night-time Leq level of 45 dB(A). Given the existing noise level environment, predicted noise levels of 31 dB(A) under neutral conditions, and 41 dB(A) under adverse inversion conditions, are considered acceptable.

  It is noted that Location S2 is an isolated residence in an otherwise industrial area.

  It is also noted that there is an industrial site between the subject site and Location S2, which would also result in audible noise at this Location S2.

- Location S4: The day, evening and night-time noise criteria are exceeded by up to 6 dB(A) at this location. It is noted from Table 7.1 that the EcoAccess 'Background Creep' criterion are met at this location because the area is considered industrial and therefore a higher noise level than 'Background Plus' is permitted.

  It is predicted that noise from the refinery will dominate the background noise at this location during the day, evening & night-time. The predicted noise levels of 33 to 35 dB(A) are approximately 13dB(A) below existing average Leq noise levels, although the Leq noise levels may be influenced by short-term noise events from nearby trains.

  It is understood that area around Location S4 is being resumed as parts of the Wiggins Island Project.

8 Haulage Truck Noise

Vehicle movements associated with the refinery are distributed on the local road network, including Gladstone-Mt Larcom Road, Hanson Road, Dawson Highway, Landing Road, Calliope River Road, and Reid Road. Of these roads, Calliope River Road is considered sensitive in terms of the potential noise impact of vehicle movements on nearby residences. The main noise issue would be heavy vehicles, particularly at night.

Calliope River Road is a recently sealed two lane, 100km/hr road. The northern section extends through the township of Yarwun. Through this section the adjacent land use is mainly residential and the speed limit is reduced to 60km/h.

The following information on the usage of Calliope River Road has been extracted from "Gladstone Pacific Nickel Refinery Traffic Report – Draft", by Cardno Eppel Olsen:

- The current daily traffic volume is 750 AADT, and this is projected to increased to 1500 AADT by 2026 in the absence of the proposed refinery;
- With the addition of the refinery the 2026 volume is projected to be 1550 AADT;
- Over the next 20 years, the refinery will add 50 to 100 vehicle per day to the traffic volume – an increase of 5% to 12%;
- The maximum number of vehicles using Calliope River Road each day to access the refinery will be 112 vehicles; of this 20% or 22 vehicles will be heavy.
- One method of lessening the impact of these additional heavy vehicles upon the residents of Yarwun, would be to ensure that they only pass through the town during the day time. If heavy vehicle movements are required between dusk and dawn, it is suggested that these vehicles use the Bruce Highway and Gladstone – Mt Larcom Road as a mean of accessing the refinery.

From our understanding of the traffic report, the existing traffic flow on Calliope River Road includes approximately 20% heavy vehicles, i.e. of the current daily volume of 750 AADT, approximately 150 will be heavy vehicles. Based on the traffic report, the additional heavy vehicle movements will be between 2 and 24 vehicles per day.

Although an increase of daily heavy vehicle movements from 150 to 174 may be noticeable by residents, it would not normally be considered a significant noise impact. In terms of average daily noise levels, the increase would be less than 0.5 dB(A) L_{10}(18hour)[2]. In terms of maximum noise levels of passing vehicles, the noise from refinery trucks would be expected to be similar to other large vehicles.

[2] The L10(18hour) noise level is calculated as the average of the L10(1hour) noise levels between 6am to midnight. The L10(1hour) noise level is the noise level exceeded for 10% of a 1 hour measurement period.

We do not have any data on night-time heavy vehicle movements, but would expect that there are few. Thus the impact of additional heavy vehicles at night, may be significant. Therefore, at this stage, we would agree with the recommendation of the traffic report that heavy vehicles are not to use Calliope River Road between dusk and dawn (i.e. typically 6pm to 6am).

9 Discussion

Initial modelling indicated that noise exceedences could be expected at residents located west of the site (e.g. S3 & S8 and Yarwun). Based on the EPA's comment that no complaints have been received with respect to the similarly located Comalco refinery, it is considered that the noise modelling program is over-predicting the noise diffraction over the intervening hills, and thus these two locations were remodelled with different meteorological parameters.

Whilst it is expected that noise levels will be acceptable at these locations, it is recommended that a noise monitoring program be developed. A suitable program may consist of conducting noise monitoring during warmer months (e.g. summer) and cooler months (e.g. winter) at locations west of the hills between the refinery and Yarwun (e.g. Locations S3 & S8).

Monitoring should be conducted for at least 1 week of fine weather, using a one-third octave band noise logger. The one-third octave band logger will be able to differentiate between low-frequency industrial noise and high-frequency insect and bird noise.

The monitoring could be conducted prior to the refinery operation, and during Stage 1A of the refinery operation.

The purpose of the monitoring is to assess the noise impact of the Stage 1A operation to verify noise levels, and to compare the before and after acoustic environments.

10Construction Noise & Vibration

Noise from construction of the refinery is expected to include steady or quasi-steady noise sources (e.g. motors, pumps etc) and intermittent noise sources (e.g. earthmoving equipment, site vehicles etc).

It is expected that the motors, pumps, and other steady noise sources, will result in lower noise levels than the operational noise, which includes steady/quasi-steady noise sources and intermittent noise sources. Never-the-less, it is proposed that noise emissions from steady or quasi-steady construction activities are to comply with the evening and night-time operational noise criteria in Table 5.4.

Noise from mobile equipment, and other intermittent noise sources (e.g. hammering), is required to comply with sleep disturbance criteria in Section 5.3 at night-time.

Typical noise emission levels from construction equipment are included in Table 10.1.

Table 10.1: Typical Sound Pressure Levels From Construction Equipment

Construction Plant	Noise Level at 7m, dB(A)*
Scraper	86
Bulldozer	85
Grader	84
Front-end loader	86
Vibrating roller	82
Backhoe	83
Excavator	80
Compressor	75
Concrete vibrator	87
Concrete pump	84
Dump truck	83
Water tanker	84
Compactor	85
Concrete saw	93

* Source RTA Environmental Noise Measurement Manual 2001

It is common practice that noise limits are relaxed during daytime construction works, where it may not be practicable to achieve operational noise limits. The reasons for the relaxation of limits include (i) construction activities are not a long-term noise source, (ii) operational noise can be controlled within enclosures or buildings, whereas these buildings are not completed during the construction phase. Never-the-less the daytime noise limit in Table 5.4 should be considered a goal during construction phase where it can be practically achieved.

Any blasting works included in the construction process should comply with the airblast and vibration limits in the EPA's Environmental Protection Regulation 1998. These limits are as follows:

"Noise from blasting is not unlawful environmental nuisance for an affected building if—

(a) the airblast overpressure is no more than 115 dB (Lin) Peak for 4 out of any 5 consecutive blasts; and

(b) the ground vibration is—

(i) for vibrations of more than 35 Hz—no more than 25 mm a second ground vibration, peak particle velocity; or

(ii) for vibrations of no more than 35 Hz—no more than 10 mm a second ground vibration, peak particle velocity."

The EcoAccess guideline "Noise and vibration from blasting" includes the following criteria:

- *"Noise criteria - Blasting activities must be carried out in such a manner that if blasting noise should propagate to a noise-sensitive place, then*

  (a) the airblast overpressure must be not more than 115dB(linear) peak for nine out of any 10 consecutive blasts initiated, regardless of the interval between blasts; and

  (b) the airblast overpressure must not exceed 120dB(linear) peak for any blast.

- *Vibration criteria - Blasting operations must be carried out in such a manner that if ground vibration should propagate to a noise-sensitive place:*

  (a) the ground-borne vibration must not exceed a peak particle velocity of 5mm per second for nine out of any 10 consecutive blasts initiated, regardless of the interval between blasts; and

  (b) the ground-borne vibration must not exceed a peak particle velocity of 10mm per second for any blast."

The EcoAccess document contains additional blasting information which may be relevant for the construction phase.

11 Conclusions

A range of noise criteria has been proposed for the refinery at Gladstone. It is considered that no one criterion is suitable for assessing the noise impact of the plant, but the range of noise criteria can determine if there is likely to be a noise nuisance.

Noise and vibration from the construction stage of the project is not expected to be a significant impact. Never-the-less it is recommended that the construction noise levels comply with the evening and night-time limits in Table 5.4. It is proposed that the daytime noise limits in Table 5.4 be used as a goal, whereby occasional exceedences are permitted if all practicable noise control measures have been implemented. Should blasting be required during construction, it is required to comply with EPR 1998 criteria, and the EcoAccess blasting guideline.

Initial modelling indicated that noise exceedences could be expected at residents located west of the site (e.g. S3 & S8 and Yarwun). The meteorological conditions for that model included a temperature inversion and easterly wind. But based on the EPA's comments with respect to the similarly located Comalco refinery, it is considered that the noise modelling program is over-predicting the noise diffraction over the intervening hills. The noise levels were recalculated using a zero wind speed temperature inversion condition, and the predicted noise levels were significantly lower, and considered acceptable.

Assessed against the EcoAccess Guideline levels the noise levels are acceptable.

Assessed against 'Background Plus' criteria, there is a 2 dB(A) exceedance at Location S2 at night, and an exceedance of up to 6 dB(A) at Location S4. Location S2 is an isolated residence in an otherwise industrial area, and we are advised that the dwelling at Location S4 is being resumed as part of the Wiggins Island Project. Therefore, these exceedences are considered acceptable. It is also noted that these two locations comply with EcoAccess criteria.

Predicted noise levels comply with the WHO internal annoyance criterion of 35 dB(A).

The following recommendations have been made:

- We agree with the recommendation of the traffic report that heavy vehicles are not to use Calliope River Road between dusk and dawn (i.e. typically 6pm to 6am).
- A noise monitoring program should be developed as outlined in Section 9.

If you have any queries regarding this report, please do not hesitate to contact the undersigned.

Yours faithfully

ASK Consulting Engineers

Stephen Pugh

Associate

Appendix A: Site Plans and Process Diagram

DRAWING No.	REFERENCE DRAWING TITLE	REVISION DESCRIPTION	REV.	BY	CHECKED	APPROVED	PROJ. ENG.	DATE
			P3	BJB				06/05/06
		GENERAL REVISION	P2	HS	-	JWR	JWR	06.03.06
		PRELIMINARY	P1	HS	-	JWR	JWR	16.02.06

APPROVED	BY	DATE	CLIENT: Gladstone Pacific Nickel Ltd
CLIENT APPROVED			
ISS'D FOR CONSTR.			

SCALE 1:5000 — 50 0 100 200 300 400 500m
DO NOT SCALE THIS DRAWING. USE WRITTEN DIMENSIONS ONLY.
STATUS: PRELIMINARY

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CLIENT No. | REV.
A.K.A No. 11085-00-MSK01 | REV. P3

GLADSTONE NICKEL PROJECT - DFS EIS INPUT
YARWUN FACILITIES
PLOT PLAN

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Date: 17-May-06 11:17 | Printed By:n1603371
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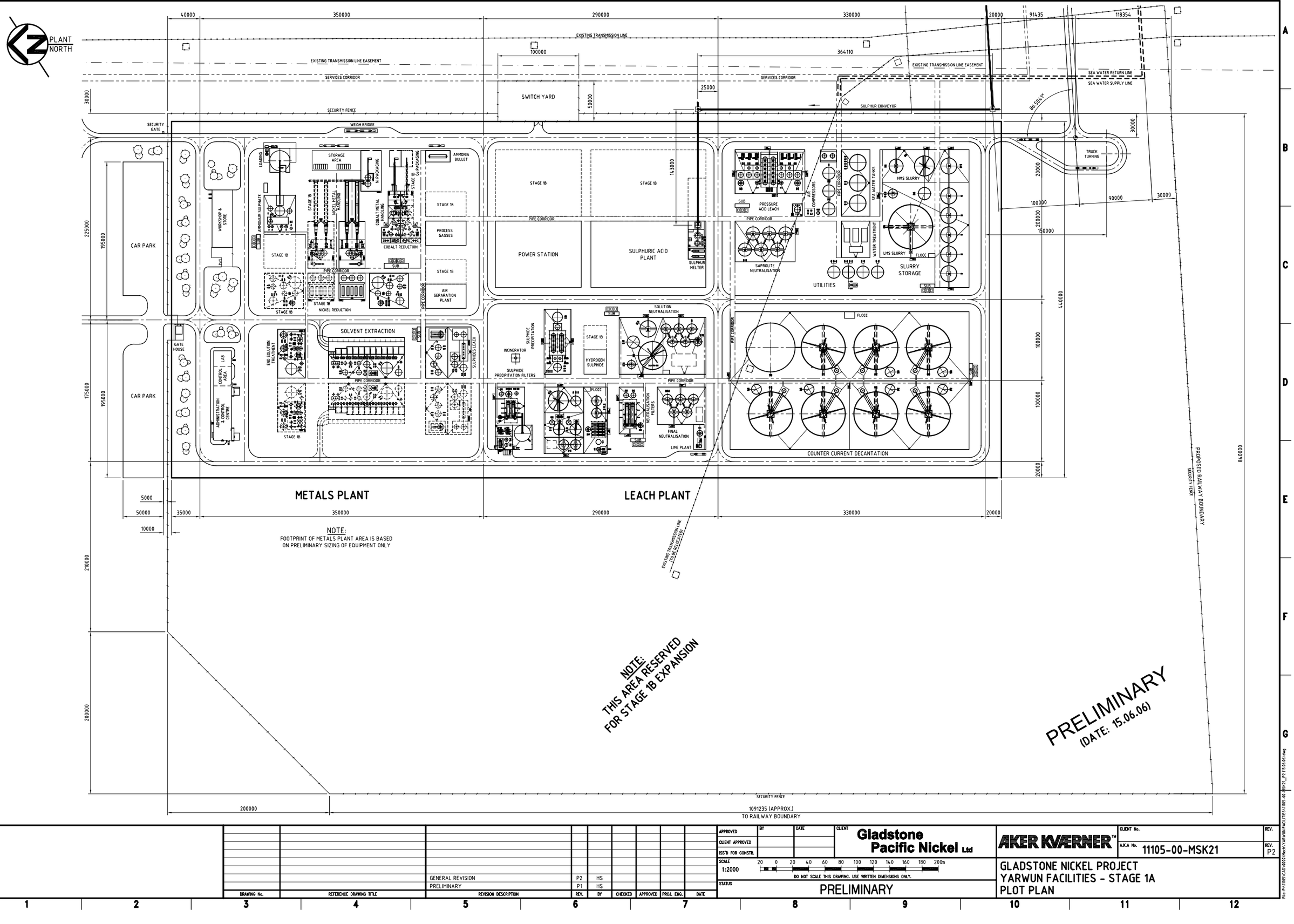

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		GENERAL REVISION	P2	HS				
		PRELIMINARY	P1	HS				

APPROVED	BY	DATE
CLIENT APPROVED		
ISS'D FOR CONSTR.		

CLIENT: Gladstone Pacific Nickel Ltd

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REV. P2

SCALE 1:2000

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STATUS: PRELIMINARY

GLADSTONE NICKEL PROJECT
YARWUN FACILITIES - STAGE 1A
PLOT PLAN

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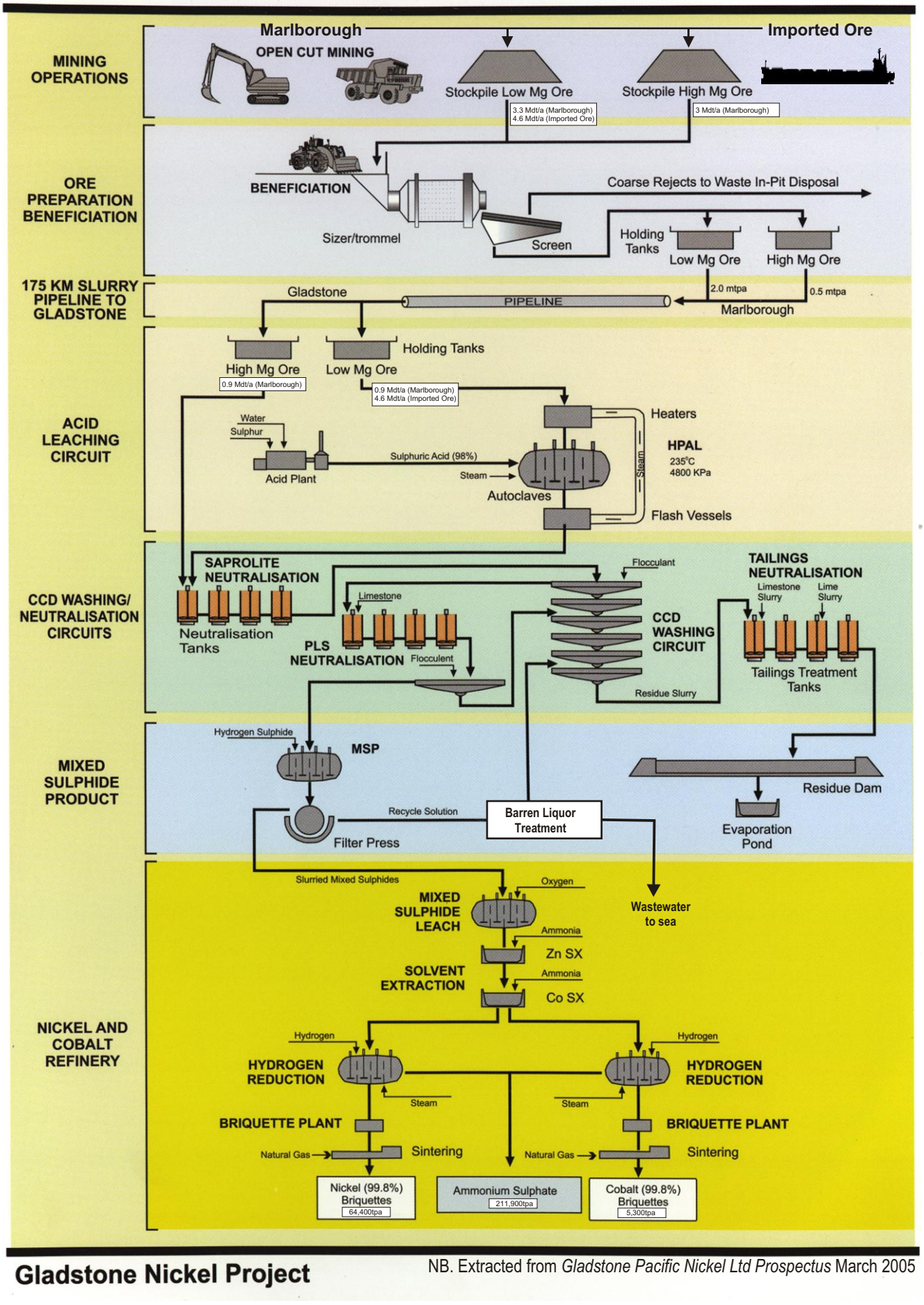


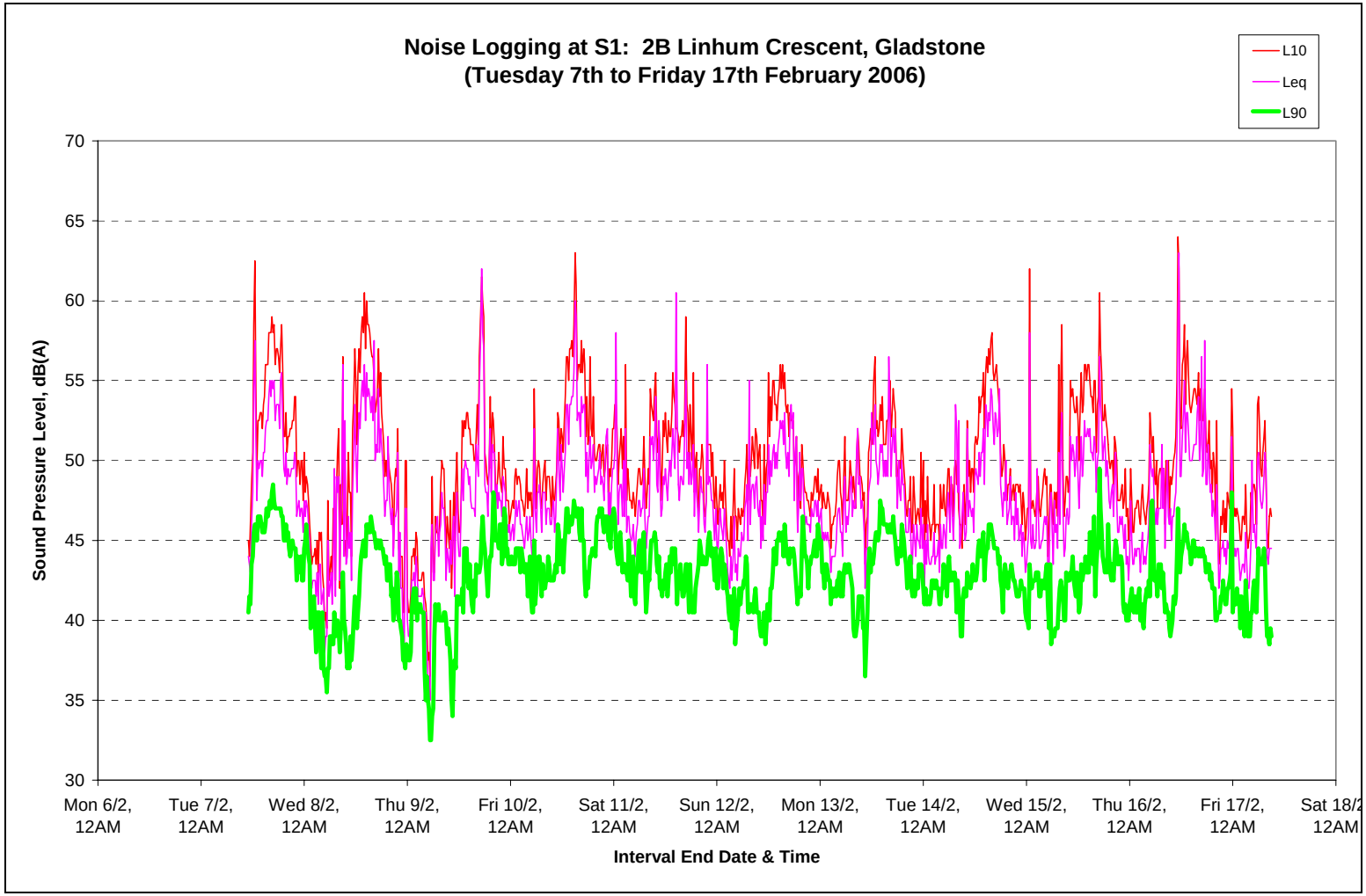
NB. Extracted from *Gladstone Pacific Nickel Ltd Prospectus* March 2005

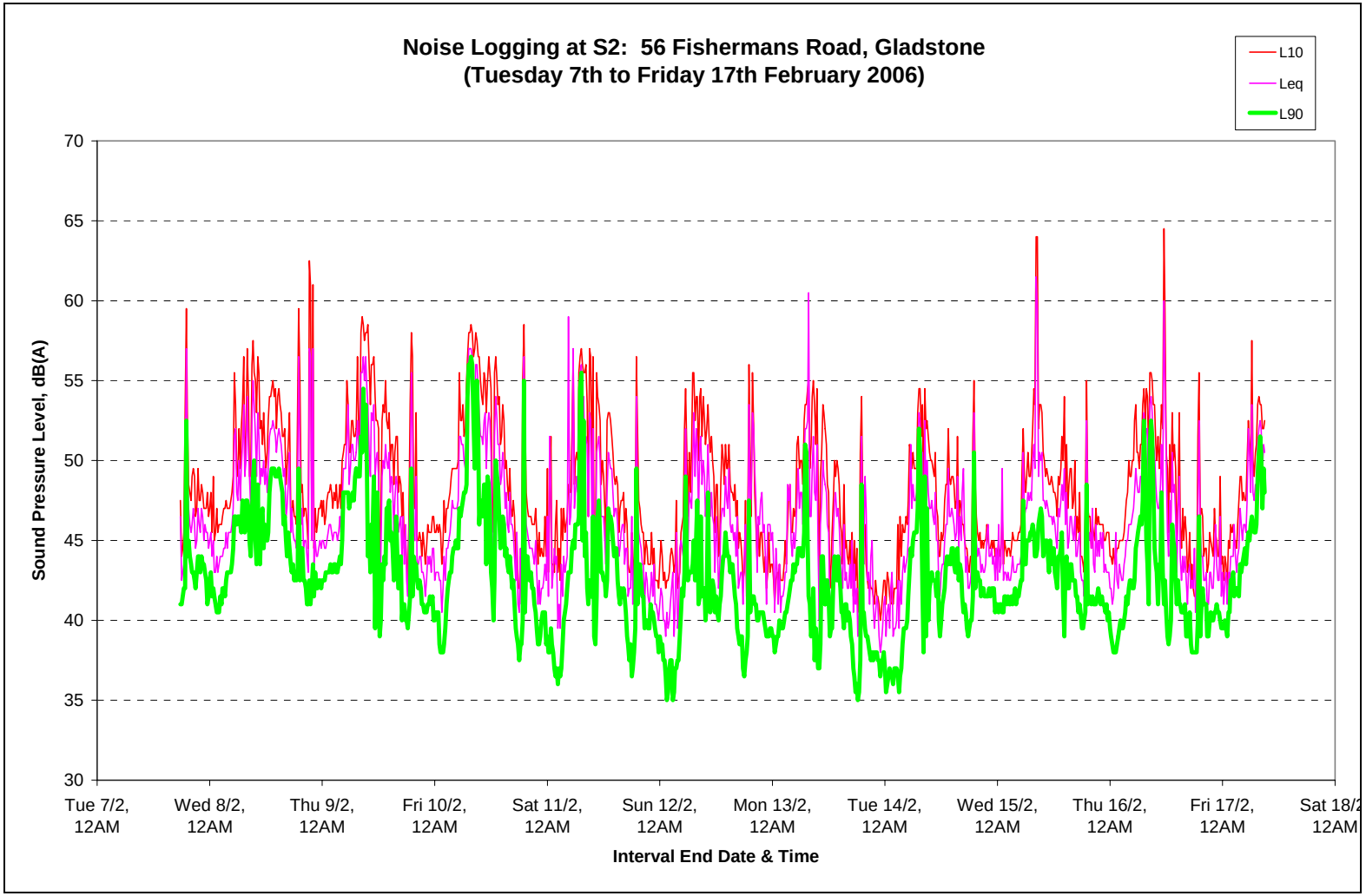
Connell Wagner

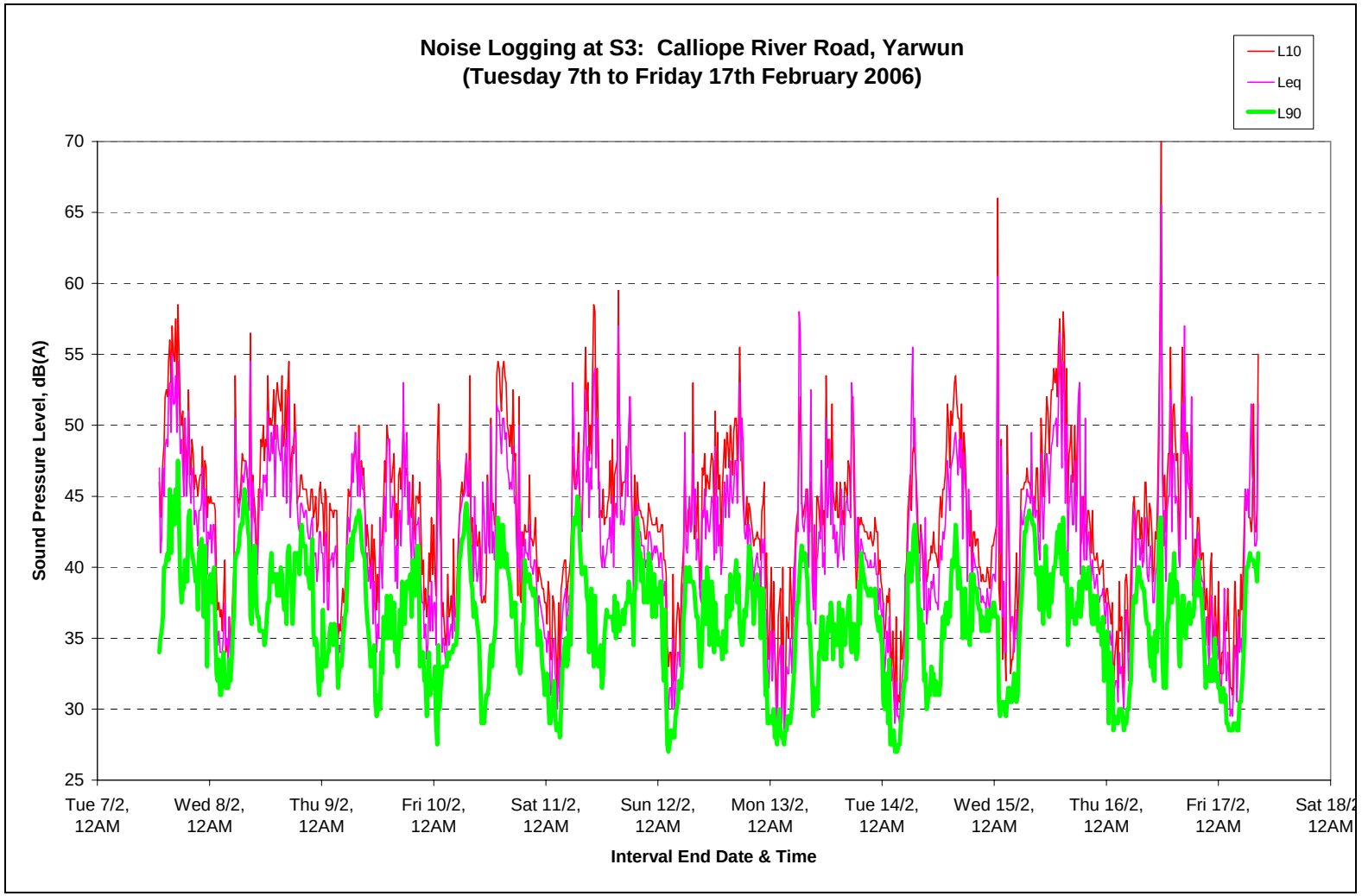
Figure 3
Stage 1 Process Flow Sheet

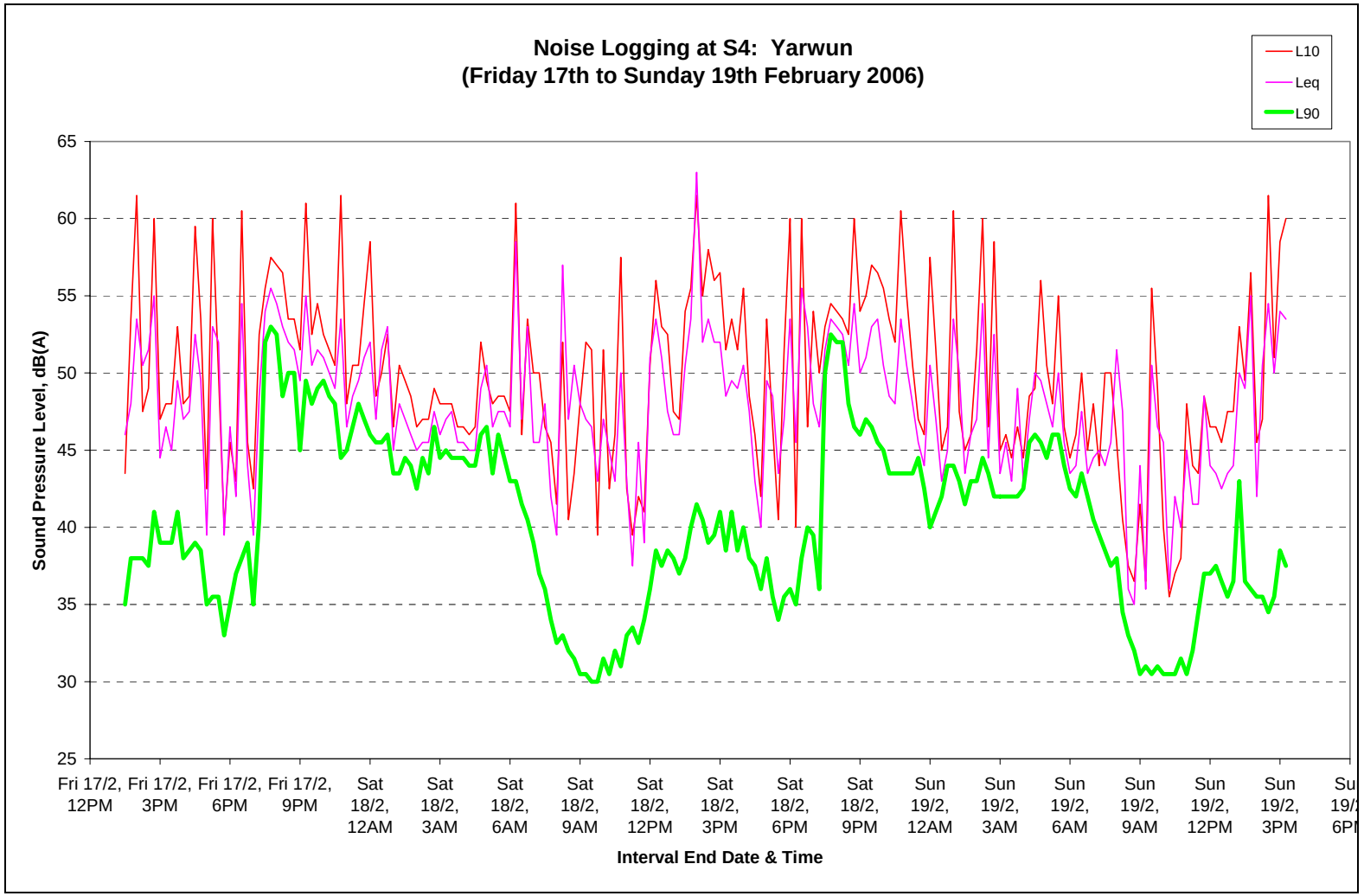
Q:graphics\graphics\jobs\E35103nz

Appendix B: Measured Noise Levels at S1 – S4


Noise Logging at S1: 2B Linhum Crescent, Gladstone
(Tuesday 7th to Friday 17th February 2006)
L10
Leq
L90
Sound Pressure Level, dB(A)
70
65
60
55
50
45
40
35
30
Mon 6/2, 12AM
Tue 7/2, 12AM
Wed 8/2, 12AM
Thu 9/2, 12AM
Fri 10/2, 12AM
Sat 11/2, 12AM
Sun 12/2, 12AM
Mon 13/2, 12AM
Tue 14/2, 12AM
Wed 15/2, 12AM
Thu 16/2, 12AM
Fri 17/2, 12AM
Sat 18/2 12AM
Interval End Date & Time


Noise Logging at S2: 56 Fishermans Road, Gladstone
(Tuesday 7th to Friday 17th February 2006)
L10
Leq
L90
Sound Pressure Level, dB(A)
70
65
60
55
50
45
40
35
30
Tue 7/2, 12AM
Wed 8/2, 12AM
Thu 9/2, 12AM
Fri 10/2, 12AM
Sat 11/2, 12AM
Sun 12/2, 12AM
Mon 13/2, 12AM
Tue 14/2, 12AM
Wed 15/2, 12AM
Thu 16/2, 12AM
Fri 17/2, 12AM
Sat 18/2 12AM
Interval End Date & Time


Noise Logging at S3: Calliope River Road, Yarwun
(Tuesday 7th to Friday 17th February 2006)
L10
Leq
L90
Sound Pressure Level, dB(A)
70
65
60
55
50
45
40
35
30
25
Tue 7/2, 12AM
Wed 8/2, 12AM
Thu 9/2, 12AM
Fri 10/2, 12AM
Sat 11/2, 12AM
Sun 12/2, 12AM
Mon 13/2, 12AM
Tue 14/2, 12AM
Wed 15/2, 12AM
Thu 16/2, 12AM
Fri 17/2, 12AM
Interval End Date & Time


Noise Logging at S4: Yarwun
(Friday 17th to Sunday 19th February 2006)
L10
Leq
L90
Sound Pressure Level, dB(A)
65
60
55
50
45
40
35
30
25
Fri 17/2, 12PM
Fri 17/2, 3PM
Fri 17/2, 6PM
Fri 17/2, 9PM
Sat 18/2, 12AM
Sat 18/2, 3AM
Sat 18/2, 6AM
Sat 18/2, 9AM
Sat 18/2, 12PM
Sat 18/2, 3PM
Sat 18/2, 6PM
Sat 18/2, 9PM
Sun 19/2, 12AM
Sun 19/2, 3AM
Sun 19/2, 6AM
Sun 19/2, 9AM
Sun 19/2, 12PM
Sun 19/2, 3PM
Interval End Date & Time

Appendix C: Weather Recordings at Gladstone Nickel for February 2006

Gladstone, Queensland
February 2006 Daily Weather Observations

Australian Government
Bureau of Meteorology

Date	Day	Temps		Rain	Evap	Sun	Max wind gust			9am						3pm					
		Min	Max				Dirn	Spd	Time	Temp	RH	Cld	Dirn	Spd	MSLP	Temp	RH	Cld	Dirn	Spd	MSLP
		°C	°C	mm	mm	hours		km/h	local	°C	%	eighths		km/h	hPa	°C	%	eighths		km/h	hPa
1	We	23.4	33.7	0			E	39	15:35	28.9	58		ESE	19	1007.4	32.0	57		ENE	26	1005.1
2	Th	23.8	34.7	0			ENE	44	20:20	29.9	56		ESE	15	1008.8	32.3	51		ENE	24	1006.7
3	Fr	23.6	34.7	0			E	54	16:54	30.1	56		ESE	22	1010.2	31.6	55		E	35	1007.5
4	Sa	24.9	35.4	0.4			ESE	43	22:42	31.5	55		E	19	1010.7	32.9	56		ENE	24	1008.0
5	Su	25.4	36.1	0			E	54	17:39	31.0	57		SE	22	1012.1	32.6	58		ENE	30	1009.3
6	Mo	24.5	34.5	1.2			ESE	46	00:04	30.2	67		E	22	1011.9	32.0	54		ENE	26	1009.2
7	Tu	23.9	35.9	0			E	48	22:27	29.4	52		SSE	6	1011.5	32.0	50		ENE	28	1007.9
8	We	23.2	33.4	0.8			E	54	13:18	26.5	71		SE	15	1015.1	31.1	48		E	35	1012.0
9	Th	21.8	33.6	4.0			SE	33	03:22	26.2	71		SSE	17	1014.6	31.1	57		ENE	24	1010.2
10	Fr	23.7	34.8	0			ENE	39	14:54	28.0	59		NW	2	1011.0	31.9	52		NE	24	1007.7
11	Sa	25.3	34.4	0			ENE	39	21:32	30.3	54		NE	19	1012.4	32.6	44		NE	20	1011.0
12	Su	24.8	34.8	0			ENE	37	15:42	29.9	52		ENE	24	1013.8	32.5	47		ENE	24	1011.9
13	Mo	24.0	35.2	0			NNE	31	13:15	31.6	59		ENE	19	1014.1	33.3	54		NE	17	1010.9
14	Tu	25.1	35.2	0			E	43	20:37	31.1	58		E	17	1015.7	31.9	53		ENE	28	1013.4
15	We	24.4	34.2	1.6			E	46	01:01	28.9	73		ESE	22	1016.2	32.3	53		ENE	30	1014.2
16	Th	24.3	34.1	0			ENE	46	11:17	31.4	56		E	19	1014.9	32.4	48		ENE	24	1011.8
17	Fr	23.8	34.9	0			NE	35	15:50	31.3	52		ENE	13	1013.4	32.1	51		ENE	24	1010.1
18	Sa	24.2	34.6	0			ENE	39	13:15	29.1	58		E	9	1012.2	32.5	50		ENE	26	1009.2
19	Su	23.9	35.4	0			ENE	44	17:02	30.1	55		ESE	17	1011.6	32.7	50		ENE	26	1009.5
20	Mo	24.1	34.9	0			NE	44	16:06	31.2	55		E	20	1012.4	32.4	50		ENE	30	1009.4
21	Tu	22.1	32.8	9.4			ESE	61	19:42	28.2	72		ESE	20	1012.9	28.9	59		E	33	1010.7
22	We	22.6	33.3	0			ESE	57	19:19	28.1	58		SE	24	1013.8	29.6	58		E	35	1010.9
23	Th	22.1	32.7	2.6			ESE	63	18:37	28.1	64		ESE	26	1014.5	30.8	51		E	39	1011.6
24	Fr	22.3	32.5	0.2			E	67	11:59	28.2	56		ESE	24	1015.1	29.8	55		E	43	1012.1
25	Sa	22.4	33.0	0			E	54	13:07	28.3	56		ESE	30	1013.9	30.0	49		E	37	1010.8
26	Su	22.7	34.2	0			E	48	15:04	28.3	59		ESE	22	1013.1	30.5	56		ENE	31	1010.2
27	Mo	23.1	27.9	0			E	54	11:39	27.5	66		ESE	20	1013.7	25.0	82		ESE	20	1012.7
28	Tu	21.7	30.5	15.0			ESE	63	14:59	25.8	80		ESE	20	1014.7	25.5	80		ESE	44	1012.4
Statistics for February 2006																					
	Mean	23.6	34.0							29.3	60			18	1012.9	31.2	54			28	1010.2
	Lowest	21.7	27.9							25.8	52		NW	2	1007.4	25.0	44		NE	17	1005.1
	Highest	25.4	36.1	15.0			E	67		31.6	80		ESE	30	1016.2	33.3	82		ESE	44	1014.2
	Total			35.2																	

Observations were drawn from Gladstone Radar {station 039123}

IDCJDW4049.200602 Prepared at 13:20 GMT on 6 Aug 2006
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http://www.bom.gov.au/climate/dwo/IDCJDW0000.pdf

Appendix D: EcoAccess Calculation Sheet

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	Measured Background Noise Levels, from Logging Data (lowest 10th %)			Acceptable Background Noise Levels, from Logging Data (lowest 10th %) - Minimum 25 dB(A)			Recommended Background Noise Levels, Table 1			Maximum Planning Level, L90			Acceptable Existing Noise Levels, from Logging Data, Leq			Noise Area Category	Existing Noise Level Likely to Decrease in Future ?*	Maximum PNL, Leq			Lowest Criteria			Specific Noise Limit (Equation 1), I.e. component noise limit, Leq, dB(A)		
Receptor	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night		(y/n)	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
S1	41	42	40	41	42	40	45	40	35	43	30	25	50	48	45	z6	n	70	65	60	43	30	25	46	33	28
S2	40	39	39	40	39	39	55	50	45	45	44	44	48	46	45	z7	n	75	70	65	45	44	44	48	47	47
S3	33	35	29	33	35	29	40	35	30	38	25	25	45	42	39	z2	n	48	42	34	38	25	25	41	28	28
S4	31	34	29	31	34	29	45	40	35	36	39	34	47	51	48	z6	n	70	65	60	36	39	34	39	42	37
S5	36	33	29	36	33	29	40	35	30	38	30	25	45	45	38	z2	n	48	37	36	38	30	25	41	33	28
S6	38	37	33	38	37	33	40	35	30	35	25	25	43	46	39	z3	n	55	48	44	35	25	25	38	28	28
S7	42	45	36	42	45	36	40	35	30	30	25	25	53	57	44	z3	n	51	47	39	30	25	25	33	28	28
S8	34	34	33	34	34	33	40	35	30	39	26	25	48	46	42	z2	n	46	36	32	39	26	25	42	29	28

Receptor	Receiver Land Use	Receiver Area Dominant Land Use
S1	Res near industry	Res
S2	Res near industry	Light Industry
S3	Purely Res	rural res
S4	Res near industry	Res
S5	Purely Res	rural res
S6	Purely Res	Res
S7	Purely Res	Res
S8	Purely Res	rural res

Appendix E: Noise Contours

0 2 km

SCALE 1 : 40 000

North

Contour Levels

60.0	36.0
57.0	33.0
54.0	30.0
51.0	27.0
48.0	24.0
45.0	21.0
42.0	18.0
39.0	15.0

Figure E.1

Noise Levels - Neutral

(Zero Wind Speed)

Scale 1:40000 Paper Size A3

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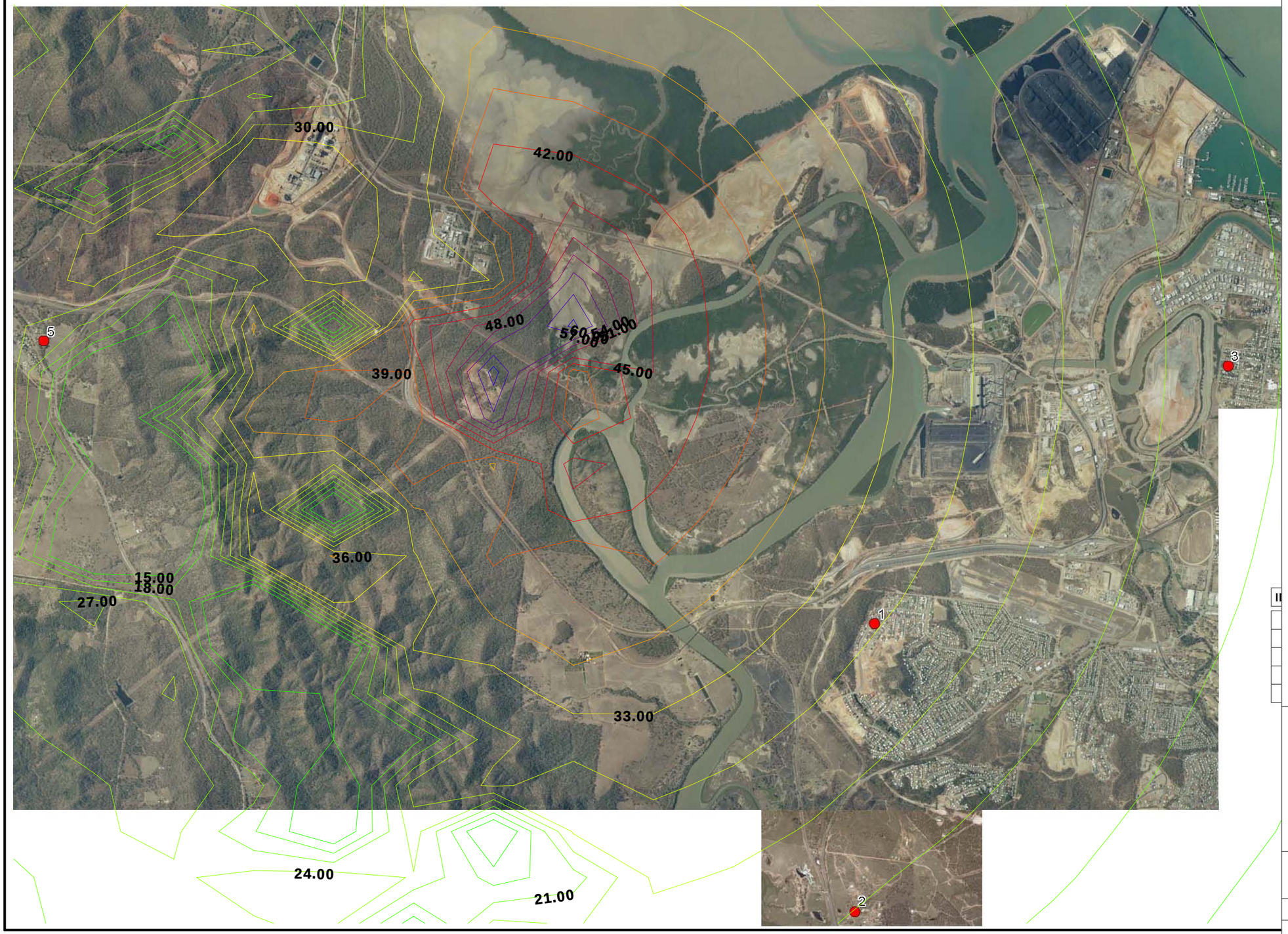

0 2 km

SCALE 1 : 40 000

North

Contour Levels

60.0	36.0
57.0	33.0
54.0	30.0
51.0	27.0
48.0	24.0
45.0	21.0
42.0	18.0
39.0	15.0

Figure E.2

Noise Levels - Inverson

(Zero Wind Speed)

Scale 1:40000 Paper Size A3

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