EASTERN CREEK RESOURCE RECOVERY FACILITY

Noise and Vibration Assessment

Prepared for:

Hanson Heidelberg Cement Group
Level 10, 35 Clarence Street SYDNEY NSW 2000

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1 Introduction

SLR Consulting Australia Pty Ltd (SLR) has been engaged by Hanson Heidelberg Cement Group to prepare a Noise and Vibration Assessment of the proposed Hanson Eastern Creek Resource Recovery Facility (RRF). The RRF comprises a concrete recycling plant and material storage facility and is located off Honeycomb Drive, Eastern Creek in the Blacktown local government area. The site is located 36 kilometres west of Sydney's Central Business District (CBD), and described as Lots 3, 4 and 5 in Deposited Plan 1225803.

The site is bounded by warehouses to the north, followed the Genesis Waste Facility, with the M4 further to the north, and warehousing facilities to the east. The nearest residential dwellings are located approximately 800 metres (m) to the west of the site in Erskine Park, and 1 km to the north in Minchinbury. These nearest residential areas remain relatively unchanged since the Concept Plan Report (Heggies, 2006) with no new closer residential developments in the surrounding area since that time. **Figure 1** identifies these receivers with their historical identification as well as nearby commercial and industrial developments. These commercial and industrial developments were not present at the time of the Concept Plan.

Between 1950 and 2005, Hanson Construction Materials Pty Ltd (Hanson) operated a concrete and asphalt production facility and a hard rock quarry at the site. The quarry area ceased operations in 2005 and is now occupied by the Genesis Xero Waste Facility.

Hanson's previous activities at the site were approved in accordance with Project Approval (MP 06_0225 MOD4 Project) (as modified) dated 3 June 2010. This included the temporary ongoing use of the historical facilities including the asphalt plant and associated infrastructure (these uses have now ceased). The Project Approval also provided for subdivision of the site and associated subdivision works including earthworks and grading of the site, the construction of Hanson Place, and the installation stormwater infrastructure, services, and utilities for the site.

Hanson's proposed operations at the site are also approved in accordance with Concept Plan (MP 06_0225 Concept) (as modified) dated 3 June 2010 including the Asphalt and Concrete Production and Recycling Facility.

To place the current proposal in the historical context of the site development, **Appendix B** of this report presents **Figure 2**, the site layout as proposed for the Concept Plan of 2006, **Figure 3** *Appendix 1 of MP 06_0225 Concept* of 2010, **Figure 4**, updated *Appendix 1 of MP 06_0225 Concept Mod 3* of 2017, and **Figure 5** the current proposed Eastern Creek Resource Recovery Facility, with the concrete recycling plant and material storage facility (RRF) located in an enclosure.

Secretary's Environmental Assessment Requirements (SEARs) SSD 9774 were provided on 27 February 2019 with respect to the construction and operation of the RRF. The SEARS are provided in **Appendix C**.

SLR report 610.17937-L03 '*Hanson Eastern Creek Resource Recovery Facility Review of Noise Impacts*' of 2 March 2021 provided a review of the project, which compared the Concept Plan and proposed project fixed and mobile equipment. The review concluded that small changes in the predicted intrusive noise levels of less than 1 dB were recorded and were not significant to change the intrusive noise levels of Concept Plan Report.

In the '*Request Response to Submissions*' of 30 April 2021 the Department of Planning Industry and Environment (DPIE) requested a construction noise and vibration assessment for the RRF. The NSW Environment Protection Authority's (EPA) submission considered the application would warrant a fresh noise assessment and provided suggested operational noise limits (see **Section 4.2**). Accordingly, these issues have been addressed in this report. **Appendix A** presents the Acoustic terminology used in this report.

Figure 1 Residential Receivers and Adjacent Commercial and Industrial Developments

Key

Concrete Batch Plant

Resource Recovery Facility

Nearby Commercial and Industrial

Residential

2 Proposed Development

The RRF comprises two components of the Hanson Concrete Production & Recycling Facility (for which Concept Plan Approval was obtained in June 2010 under MP 06_0225), with a total intended capacity to produce up to 136,000 tonnes per annum of recovered aggregate.

The proposed operating hours for the RRF will be 24 hours per day, seven days per week and would comprise of the following main components:

- A sales building and an administration office building;
- An enclosed shed approximately 127 m x 89 m which will comprise of raw feed stockpiles, finished product stockpiles, a pugmill, a mobile crusher; front end loader and excavator; and
- An internal road system, including weighbridges, and car and truck parking facilities.

A plan of the site layout is presented in **Appendix B**, **Figure 5**.

2.1.1 Construction

The RRF would be constructed during EPA's Interim Construction Noise Guideline (ICNG) standard construction hours and involve the following major works:

- Enabling Works; and
- Building Construction

Construction noise modelling scenarios for the two (2) construction scenarios have been developed with the proposed equipment and associated sound power levels (SWL) presented in **Appendix E**.

3 Existing Noise Environment

3.1 Noise Environment

In order to characterise the existing noise environment at the nearest residences, unattended ambient noise monitoring is conducted at a location(s) representative of the residences.

3.1.1 Unattended Noise Monitoring

Ambient noise monitoring was conducted in 2003 and 2006 as part of the Concept Plan assessment, and at similar locations in October 2016 for the Fulton Hogan Asphalt plant located to the north-west of the site by SLR (and previously Heggies Australia Pty Ltd). Additionally ambient noise monitoring was conducted in 2015 by Pacific Environment for the Energy from Waste Facility, Eastern Creek noise impact assessment. The results of the surveys are summarised in **Table 1**.

Table 1 Unattended Ambient Noise Survey Results

Receiver Area / Location / Year [1,2]	ID	Measured RBL (dBA)		
		Day	Evening	Night
Minchinbury (South) - Barossa Drive - 2006	MB2	47	45	42
Minchinbury (South) - Barossa Drive - 2003	MB2	47	48	41
Erskine Park (South) – Fantail Crescent - 2006	ES2	43	50	44
Erskine Park (South) – Fantail Crescent 2003	ES2	37	39	33
Minchinbury (South) - Cobbler Crescent - 2016	MB1a	52	52	47
Erskine Park (North) - 38 Warbler Street - 2016	ES1a	44	52	45
Erskine Park (South) - 11 Sennar Road – 2016	ES2a	38	43	36
Minchinbury (South) - 2015	BG1	43	48	41
Erskine Park (South) - 2015	BG2	37	44	35

Notes: 1. Ambient noise monitoring at locations MB1a, MB2, ES1a, ES2, ES2a was conducted by SLR and Heggies.
2. Ambient noise monitoring at locations BG1 and BG2 was conducted by Pacific Environment.

Based on the historical noise survey results presented in **Table 1**, Rating Background Levels (RBLs) to be used to determine Construction Noise Management Levels (CNMLs) are presented in **Table 2**. These nominated RBLs are considered to be representative of the current ambient noise environment in these areas.

Table 2 Ambient Noise Survey Results for Assessment

Receiver Area / Location / Year	ID	Measured RBL (dBA)		
		Day	Evening	Night
Minchinbury (South)	MB1 and MB2	43	45	41
Erskine Park (North)	ES1	44	52	45
Erskine Park (South)	ES2	37	43	35

4 Noise Assessment Criteria

4.1 Construction Noise Assessment Criteria

The EPA's ICNG recommends that the $L_{Aeq(15minute)}$ noise levels arising from a construction project, at residences should not exceed the levels indicated in **Table 3**. The CNMLs are generally consistent with community reaction to construction noise. The ICNG also contains "highly noise affected" daytime CNMLs which are set at 75 dBA $L_{Aeq(15minute)}$.

The EPA's ICNG also recognises other kinds of receivers and provides recommended construction CNMLs for them. Those specific receiver types adjacent to the RRF and their recommended CNMLs are presented in **Table 4**.

Table 3 Residential CNMLs for Construction Works

Period of Noise Exposure	$L_{Aeq(15minute)}$ Construction NML
Recommended Standard Hours	Noise affected RBL + 10 dBA
	Highly noise affected 75 dBA [1]
Outside Recommended Standard Hours	Noise affected RBL + 5 dBA

Note 1: The highly noise affected level represents the point above which there may be some community reaction to noise.

Table 4 Commercial and Industrial Premises CNMLs for Construction Works

Land use	$L_{Aeq(15minute)}$ Construction NML
Offices, retail outlets	External noise level 70 dBA
Industrial premises	External noise level 75 dBA

As the RRF construction works would be limited to daytime only, the recommended CNMLs are as presented in **Table 5**.

Table 5 Intrusive $L_{Aeq(15minute)}$ Construction Noise Management Levels (dBA re 20 µPa)

Location	Daytime CNML (noise affected) RBL plus 10 dBA [1]	Daytime CNML (highly noise affected)
Minchinbury (South) – MB1 and MB2	53	75
Erskine Park (North) – ES1	54	
Erskine Park (South) - ES2	47	
Adjoining commercial (offices)	70	-
Adjoining industrial (warehouses)	75	

Note 1: ICNG - Recommended standard working hours: Monday to Friday: 7:00 am to 6:00 pm, Saturday 8:00 am to 1:00, no work on Sundays and Public Holidays.

4.2 Operational Noise Assessment Criteria

4.2.1 Residential Noise Limits

The EPA have proposed noise limits for operation at the premises in their letter '*Eastern Creek Resource Recovery Facility (SSI 9774) Advice on Environmental Impact Statement (EIS)'* of 22 April 2021. These noise limits are reproduced in **Table 6** below.

Table 6 EPA Proposed Noise Limits

Location	*Noise Limits in dB(A)*			
	Day	***Evening***	***Night***	
	LAeq(15 Minute)	*LAeq(15 Minute)*	*LAeq(15 Minute)*	*LA1(1 minute)*
Minchinbury (south) *MB3 Agrafe Place*	*45*	*45*	*45*	*57*
Erskine Park (north) *EN1 Warbler Street*	*40*	*37*	*37*	*57*
Erskine Park (south) *ES2 Fantail Crescent*	*40*	*39*	*39*	*57*

With reference to the EPA's proposed noise limits presented in **Table 6**, for the evening and night-time at EN1 and ES2, these correlate to predicted noise levels from the Heggies Australia Report 10-4912-R2 '*Concept Plan for the Redevelopment of Lot 11 DP558723, Lot 1 DP200697 and Lot 2 DP262213 Construction, Operating and Traffic Noise Assessment*' of November 2006. The Concept Plan Report predicted noise levels correspond to the total noise from all elements of the Concept Plan, including the Concrete Recycling Plant and Materials Storage and Transfer Depot (now the RRF), the Concrete Batching Plant (approved) and Asphalt Plant, Emulsion Plant and Spray Seal Depot and Logistics Operation and Workshop, and Office and Laboratory. These predicted noise levels also corresponded to a noise enhancing temperature inversion.

This report assesses the operational noise from the RRF, which is one component of the Concept Plan. Accordingly, RRF project specific noise limits have been determined to ensure the total noise from all Concept Plan elements meet those of **Table 6**, with RRF noise limits set at 5 dB below. This allows for an equal contribution from the RRF, Concrete Batch Plant, and other elements to produce the overall noise levels. RRF project specific noise levels (PSNLs) are presented in **Table 7**. Note LA1(1 minute) noise limits have not been set 5 dB below, as these refer to short term irregular events.

Table 7 RRF Project Specific Noise Levels

Location	RRF Project Specific Noise Levels in dB(A)			
	Day	**Evening**	**Night**	
	LAeq(15 Minute)	LAeq(15 Minute)	LAeq(15 Minute)	LA1(1 minute)
Minchinbury (south) MB3 Agrafe Place	40	40	40	57
Erskine Park (north) EN1 Warbler Street	35	32	32	57
Erskine Park (south) ES2 Fantail Crescent	35	34	34	57

4.2.2 Commercial Receiver Noise Limits

Noise limits for the adjoining commercial and industrial receivers have been based on the EPA's Noise Policy for Industry (NPfI). The recommended amenity noise level of 65 dBA and 70 dBA for commercial and industrial premises respectively has been adopted.

4.2.3 Meterological Conditions

The SEARs provide guidance on meteorological conditions to be applied for the assessment of noise as follows:

- wind speeds of up to 3 m/s at 10 metres above ground level; or
- temperature inversion conditions of up to 3°C/100m and wind speeds of up to 2 m/s at 10 metres above ground level.

Furthermore, the Concept Plan Report meteorological analysis determined a temperature and humidity resulting in the following noise model meteorological parameters as presented in **Table 8.**

Table 8 Calm (neutral) and Noise Enhancing Meteorological Modelling Parameters

Period	Assessable Condition	Air Temperature	Relative Humidity	Wind Velocity	Temperature Gradient
Daytime	Calm	21°C	59%	0 m/s	0°C/100 m
	Wind	21°C	59%	3 m/s	0°C/100 m
Evening	Calm	20°C	67%	0 m/s	0°C/100 m
	Wind	20°C	67%	3 m/s	0°C/100 m
Night-time[1]	Calm	17°C	75%	0 m/s	0°C/100 m
	Inversion+wind	17°C	75%	2 m/s	3°C/100 m

5 Vibration Assessment Criteria

5.1 Construction Vibration Objectives

5.1.1 Categories of Vibration in Structures

The effects of vibration in buildings can be divided into three main categories; those in which the occupants or users of the building are inconvenienced or possibly disturbed, those where the building contents may be affected and those in which the integrity of the building or the structure itself may be compromised.

For the RRF construction works, the nearest structures are the adjacent warehouse buildings, 26 m to the north, 6 m to the north-east and 28 m to the south-east.

5.1.2 Assessment Criteria

Most commonly specified 'safe' structural vibration limits are designed to minimise the risk of cosmetic damage such as surface cracks and are set well below the levels that have potential to cause structural damage. The British Standard BS 7385 Part 2-1993 *Evaluation and measurement for vibration in buildings Part 2,* provides frequency-dependent vibration limits related to the cosmetic damage risk.

The German Standard DIN 4150-3:2016 "*Structural Vibration Part 3: Effects of vibration in structures*" provides guideline values for evaluating the effect of vibration on buried pipework. In addition, SLR has identified appropriate vibration criteria for computer room floors and the operating of mechanical plant where applicable.

The EPA's "*Assessing Vibration: A Technical Guideline*" (DEC 2006) provides guideline building vibration levels associated with a low probability of annoyance from occupants. The applicable damage risk and annoyance risk vibration velocity criteria are further discussed in **Appendix E** and summarised in **Table 9**.

Table 9 Vibration Velocity Damage Risk and Annoyance Risk Criteria (mm/s)

Receiver Area	Damage Risk (mm/s)		Annoyance Risk (mm/s)	
	Horizontal	Vertical	Horizontal	Vertical
Residential/Dwellings	7.5	7.5	1.2	0.45
Commercial/Offices	25	25	1.6	0.6
Industrial/Workshops			3.2	1.2
Reinforced structures (ie concrete buildings)			-	-
Mechanical (On/Off)[1]	20/5	20/5	-	-
Subsurface structures	50-100	50-100	-	-

Note 1: 'On' refers to when machinery is turned on, and 'Off' is when machinery is off. Criteria are stricter for 'Off' as machinery is more likely to be damaged by vibration when it is not operating due to potential for brinelling.

6 Noise Modelling Methodology

6.1 Noise Modelling Procedure and Scenarios

In order to facilitate the computation of environmental noise emissions from the operation of the RRF at Eastern Creek, a three dimensional computer noise model has been developed, based on available ground topography and aerial photography of the study area.

Noise emission modelling was undertaken using SoundPLAN noise prediction software, based on utilising the CONCAWE algorithm, a commercial software system developed by Braunstein & Berndt International. The acoustical algorithms utilised by this software are endorsed by the NSW EPA as suitable for use. The noise modelling algorithms account for the octave band sound power levels of the sources, their heights, the distances to receivers, the natural topography, buildings, air absorption and ground effects.

The RRF operational noise modelling scenarios include the proposed mobile equipment and fix plant items operating concurrently to simulate the overall maximum energy equivalent ($L_{Aeq(15minute)}$) project intrusive noise level. A large proportion of the mobile equipment is operated in repeatable routines and a relatively smaller proportion of the emissions emanate from fixed plant items. The three (3) Facility operational noise modelling scenarios are presented in **Table 10**.

Table 10 Facility Daytime, Evening and Night-time Noise Modelling Operating Scenarios

Mobile Equipment and Fixed Plant	Peak hourly and Peak Period Movements (ie Arrival plus Departure)[1, 2]		
	Scenario 1 - Daytime	Scenario 2 - Evening	Scenario 3 - Night-time
Truck movements [1]	28	8	11
Primary Crusher	✓	✓	✓
Pug Mill	✓	✓	✓
FEL moving and loading materials	✓	✓	✓
Excavator moving and loading materials *or* breaking rock [2]	✓	✓	✓

Note 1 Peak hourly and peak period movements are based on the design capacity for RRF therefore a conservative estimate.

Note 2 The excavator would be either moving and loading material *or* breaking rock. For the modelled scenario rock breaking was assumed.

6.2 Noise Mitigation and Management Measures

6.2.1 Mobile Equipment and Fixed Plant Sound Power Levels

The potential for machinery to emit noise is quantified as the sound power level (SWL) measured on the A-weighted scale in decibels re 1 picowatt (dBA re 1ρW). At the receptor, the received noise is quantified as the sound pressure level (SPL) measured on the A-weighted scale in decibels re 20 micropascals (dBA re 20 µPa).

In general terms, any variation in the on-site mobile equipment, fixed plant and SWLs would produce a similar variation in the off-site SPL at the receiver (e.g. an increase of 5 dBA in the total sum SWL of equipment operating at a site may result in a corresponding 5 dBA increase in the SPL of intrusive noise at the receiver, when averaged over the same 15 minute period).

In accordance with NPfI Section 3.1, Hanson is obligated to consider to feasible and reasonable noise mitigation measures for the RRF. Noise mitigation requirements were identified during preliminary noise modelling, the resulting source and transmission noise control and management measures are presented in **Table 11**, together with the resulting mitigated SWL and or SPL adopted for noise modelling and associated prediction of the off-site environmental intrusive and amenity noise levels.

Table 11 RRF Noise Mitigation Measures and Sound Power Levels (SWLs) (dBA re 1ρW)

Plant and Equipment	Nominal Noise Control	Proposed Overall LAeq and LAmax SWL [1]
General	All fixed and mobile equipment located inside a purpose built shed with access on the southern façade	
Excavator	equipment maintained in good operating condition	SWL 114 dBA per unit
Excavator Breaking rock (20 tonne)	equipment maintained in good operating condition	SWL 119 dBA per unit
Front End Loader	equipment maintained in good operating condition	SWL 114 dBA per unit
Truck operation [1]	speed limited to 10 km/hr	SWL 108 dBA per unit SWL LAmax 113 dBA per unit
Truck handbrake [1] (air release)	assume normal air release	SWL LAmax 122 dBA per unit
Primary Crusher	equipment maintained in good operating condition	111 dBA
Pug Mill	equipment maintained in good operating condition	115 dBA

Note 1 LAmax SWLs are used for sleep disturbance assessment.

7 Construction Noise and Vibration Impact Assessment

7.1 Construction Noise Impact Assessment

The predicted daytime construction noise levels at the nearest residential localities are presented **Table 12** together with recommended the CNMLs (**Table 3**) during ICNG standard construction hours. The predictions are for the enabling and building scenarios as presented in **Appendix D**.

Table 12 Predicted Daytime Construction Intrusive $L_{Aeq(15minute)}$ Noise Levels (dBA re 20 µPa)

Location	Enabling	Building	CNML (noise affected)	CNML (highly noise affected)
Minchinbury (South) – MB1 and MB2	29	28	53	75
Erskine Park (North) – ES1	23	22	54	
Erskine Park (South) - ES2	26	25	47	
Com1 Loading Dock	66	65	75	-
Com1 Office	70	69	70	
Com2 Office	60	59	70	
Com3 Loading Dock	68	61	75	
Com3 Office	45	42	70	
Com4 Loading Dock	**77**	63	75	
Com4 Office	50	48	70	
Com5 Office	56	53	70	

Note 1 The highest noise levels from residences located in the streets is shown.

The predicted daytime construction noise levels comply with the relevant CNML (noise affected) at the nearest residences. At the Com4 loading dock there is a minor exceedance of 2 dB, due to the close proximity to the warehouse. This exceedance occurs during roadworks when adjacent to the boundary, and for other construction works noise levels will be lower.

7.2 Construction Vibration Impact Assessment

The predicted safe working distances to comply with both the vibration damage risk and annoyance risk criteria (**Table 9**) are presented in **Table 13** due to the use of an auger (<800 mm) and/or a vibratory roller (<200 kN – typically 4-6 tonnes) on the construction site.

Table 13 Predicted Safe Working Distances to Comply with Damage Risk and Annoyance Risk Criteria

Receiver Area	Damage Risk Safe Distance (m)		Annoyance Risk Safe Distance (m)	
	Auger	Vibratory Roller	Auger	Vibratory Roller
Residential/Dwellings	2 m (nominal)	12 m	n/a	40 m
Commercial/Offices				30
Industrial/Workshops	0.5 m	3 m	n/a	20
Reinforced structures (ie concrete buildings)				-

Based on the predicted safe working distances presented in **Table 13**, it is concluded that residential dwelling vibration damage and occupant annoyance risks are negligible, as the nearest residential dwellings are beyond 1 km from the Facility construction site.

Similarly, commercial and industrial property vibration damage risks are minimal, as whilst there are adjacent commercial properties they are further than 6 m from the expected location of excavation equipment. In order to eliminate the potential for damage and annoyance risk at these properties it is recommended a CNVMP be prepared in accordance with ICNG requirements with particular reference to Section 7 be prepared

8 Operating Noise Impact Assessment

8.1 Predicted $L_{Aeq(15minute)}$ Noise Levels

The predicted $L_{Aeq(15minute)}$ operating intrusive noise levels from the RRF's three (3) operating scenarios (**Section 6.1**) to the nearest residential localities are presented **Table 14** and **Table 15** together with resulting PSNLs (from **Table 7**).

For the adjacent commercial receivers operating intrusive noise levels are presented in **Table 16**, noting enhancing meteorological have not been considered for these receivers due to the close proximity to the proposed facility.

Table 14 Residential Predicted Operating Intrusive Noise Levels Calm

Location	Predicted Intrusive $L_{Aeq(15minute)}$ Noise Levels (dBA)			Recommended PSNLs $L_{Aeq(15minute)}$		
	Daytime	Evening	Night-time	Daytime	Evening	Night-time
Minchinbury (South) – MB1 and MB2	24	23	24	40	40	40
Erskine Park (North) – EN1	22	22	22	35	32	32
Erskine Park (South) - ES2	27	27	27	35	34	34

Table 15 Residential Predicted Operating Intrusive Noise Levels Wind and/or Temperature Inversion

Location	Predicted Intrusive $L_{Aeq(15minute)}$ Noise Levels (dBA)			Recommended PSNLs $L_{Aeq(15minute)}$		
	Daytime	Evening	Night-time	Daytime	Evening	Night-time
Minchinbury (South) – MB1 and MB2	29	29	28	40	40	40
Erskine Park (North) – EN1	26	27	27	35	32	32
Erskine Park (South) - ES2	32	32	32	35	34	34

Table 16 Commercial Predicted Operating Intrusive Noise Levels

Location	Predicted Intrusive $L_{Aeq(15minute)}$ Noise Levels (dBA)	Recommended PSNLs $L_{Aeq(15minute)}$
	Daytime	Daytime
Com1 Loading Dock	55	70
Com1 Office	56	65
Com2 Office	46	65
Com3 Loading Dock	58	70
Com3 Office	36	65
Com4 Loading Dock	61	70
Com4 Office	43	65
Com5 Office	50	65

The predicted intrusive $L_{Aeq(15minute)}$ noise levels from the RRF's three (3) operating scenarios comply with the PNLs at the nearest residences, and also at the adjoining commercial and industrial receivers.

8.2 Tonal and Intermittent Noise Corrections

The EPA's NPfI Fact Sheet C provides guidance on the application of modifying factor adjustments and includes potential modifying factors for tonal noise, low frequency noise, and intermittent noise, each of which are further discussed below.

Tonal noise: Tonality is defined in the NPfI as *"noise containing a prominent frequency and characterised by a definite pitch"*. The occurrence of tonal noise (if any) is typically associated with stationary plant (i.e. pumps, fans, drives, and the like) where rotating equipment operates at a constant frequency. **Table 11** lists the major items of stationary plant (and mobile equipment) and the associated sound power levels (SWL) for the Facility. A one third octave band analysis of the SWLs for the RRF does not indicate any tonal noise sources, hence no tonal noise modifying factor is applicable.

Low frequency noise (LFN): Low frequency noise is defined in the NPfI as *"noise containing major components in the low-frequency range (10 hertz [Hz] to 160 Hz) of the frequency spectrum"*. **Table 14** and **Table 15** presents the predicted intrusive noise levels from the RRF to the nearest receivers. One-third octave noise levels been determined, and are well below the low frequency noise thresholds of Table C2 of the NPfI. Hence compliance with the requirements of Table C1 would be achieved, and no LFN noise modifying factor is applicable.

Intermittent noise: Is defined in the NPfI, as *"noise where the level suddenly drops/increases several times during the assessment period, with a noticeable change in source noise level of at least 5dB(A)",* which is subjectively assessed but should be assisted with measurement to gauge the extent of change in noise level. Intermittent noise is not typically a characteristic of RRF, as a large proportion of the mobile equipment is operated in repeatable routines, and fixed plant would be operated continuously. In addition residences are distant and predicted noise levels at residences would be below existing L_{Aeq} ambient noise levels, hence no intermittent noise modifying factor is applicable.

Furthermore, the major items of plant and equipment would be subject to procurement specifications to ensure that the major items are designed, installed, and operated in the absence of annoying characteristics.

8.3 Predicted Maximum Sleep Disturbance Noise Levels

The predicted night-time project maximum sleep disturbance noise levels from the RRF's three (3) operating scenarios (**Section 6.1**) to the nearest residential localities are presented **Table 17** together with night-time $L_{A1(1minute)}$ noise limit (**Table 7**). Maximum noise levels predicted are for short term effects such as truck start-up, parking brake with compressed air release.

Table 17 Predicted RRF Operating Maximum Sleep Disturbance Noise Levels (dBA re 20 µPa)

Location	Predicted Maximum Noise Level	Sleep Disturbance $L_{A1(1 minute)}$
Minchinbury (South) – MB1 and MB2	40	57
Erskine Park (North) – EN1	34	57
Erskine Park (South) - ES2	38	57

Note 1 The higher noise level from receivers at the Streets is shown

The predicted night-time maximum sleep disturbance noise levels comply with the relevant $L_{A1(1 minute)}$ sleep disturbance noise level.

9 Conclusion

SLR Consulting Australia Pty Ltd (SLR) has been engaged by Hanson to prepare a Noise and Vibration Assessment of the proposed Hanson Eastern Creek Resource Recovery Facility (RRF). The study provides a construction noise and vibration assessment, and an updated operational noise assessment as requested by the DPIE and the EPA. The results of the study are summarised as follows:

- Construction noise targets were determined based on ambient noise survey results at the nearest residential areas and with guidance from the EPA's ICNG. Construction vibration targets were set based on relevant guidelines.
- Operational noise criteria were determined in accordance with the recommended noise levels provided by the EPA in their advice on the RRF EIS of April 2021.
- Predicted noise levels from construction complies the noise targets at the nearest residential areas. At the adjoining commercial and industrial receivers, there is a minor exceedance of 2 dB during associated on site roadworks construction. A minimal risk from construction vibration has been identified at the adjoining industrial receivers.
- Predicted operational noise levels comply with the operational criteria at the nearest residences, and also at the adjoining commercial and industrial receivers.

APPENDIX A

Acoustic Terminology

1. Sound Level or Noise Level

The terms 'sound' and 'noise' are almost interchangeable, except that 'noise' often refers to unwanted sound.

Sound (or noise) consists of minute fluctuations in atmospheric pressure. The human ear responds to changes in sound pressure over a very wide range with the loudest sound pressure to which the human ear can respond being 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 LP are commonly used to represent Sound Pressure Level. The symbol LA represents A-weighted Sound Pressure Level. The standard reference unit for Sound Pressure Levels expressed in decibels is 2 x 10^{-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 4,000 Hz), and less sensitive at lower and higher frequencies. Different sources having the same dBA level generally sound about equally loud.

A change of 1 dB or 2 dB in the level of a sound is difficult for most people to detect, whilst a 3 dB to 5 dB change corresponds to a small but noticeable change in loudness. A 10 dB 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	Heavy rock concert	Extremely noisy
110	Grinding on steel	
100	Loud car horn at 3 m	Very noisy
90	Construction site with pneumatic hammering	
80	Kerbside of busy street	Loud
70	Loud radio or television	
60	Department store	Moderate to quiet
50	General Office	
40	Inside private office	Quiet to very quiet
30	Inside bedroom	
20	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

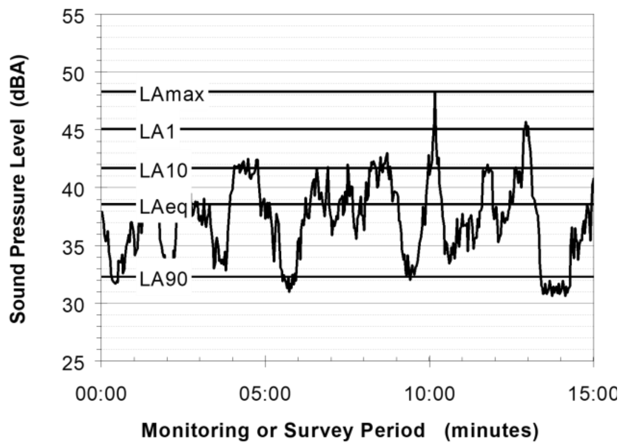
The Sound Power of a source is the rate at which it emits acoustic energy. As with Sound Pressure Levels, Sound Power Levels are expressed in decibel units (dB or dBA), but may be identified by the symbols SWL or LW, or by the reference unit 10^{-12} W.

The relationship between Sound Power and Sound Pressure is similar to the effect of 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 LAN, where LAN is the A-weighted sound pressure level exceeded for N% of a given measurement period. For example, the LA1 is the noise level exceeded for 1% of the time, LA10 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:

LA1 The noise level exceeded for 1% of the 15 minute interval.

LA10 The noise level exceeded for 10% of the 15 minute interval. This is commonly referred to as the average maximum noise level.

LA90 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.

LAeq 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.

5. Frequency Analysis

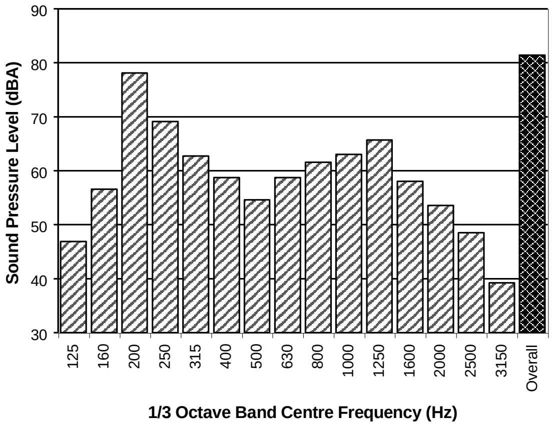
Frequency analysis is the process used to examine the tones (or frequency components) which make up the overall noise or vibration signal.

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 (three 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.



6. Annoying Noise (Special Audible Characteristics)

A louder noise will generally be more annoying to nearby receivers than a quieter one. However, noise is often also found to be more annoying and result in larger impacts where the following characteristics are apparent:

- **Tonality** - tonal noise contains one or more prominent tones (ie differences in distinct frequency components between adjoining octave or 1/3 octave bands), and is normally regarded as more annoying than 'broad band' noise.
- **Impulsiveness** - an impulsive noise is characterised by one or more short sharp peaks in the time domain, such as occurs during hammering.
- **Intermittency** - intermittent noise varies in level with the change in level being clearly audible. An example would include mechanical plant cycling on and off.
- **Low Frequency Noise** - low frequency noise contains significant energy in the lower frequency bands, which are typically taken to be in the 10 to 160 Hz region.

7. 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 (ie vertical, longitudinal 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/Vo), where Vo is the reference level (10^{-9} m/s). Care is required in this regard, as other reference levels may be used.

8. Human Perception of Vibration

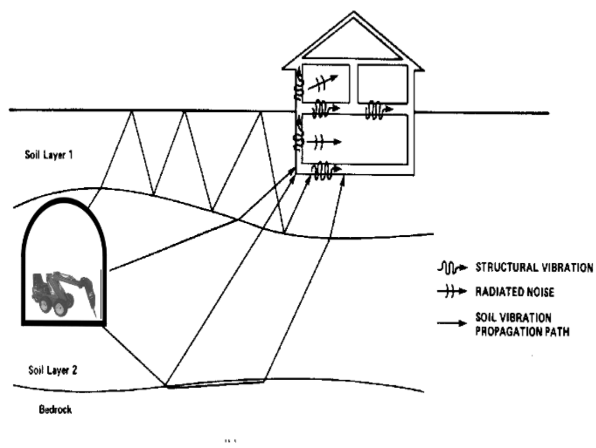
People are able to 'feel' vibration at levels lower than those required to cause even superficial damage to the most susceptible classes of building (even though they may not be disturbed by the motion). An individual's perception of motion or response to vibration depends very strongly on previous experience 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.

9. Ground-borne Noise, Structure-borne Noise and Regenerated Noise

Noise that propagates through a structure as vibration and is radiated by vibrating wall and floor surfaces is termed 'structure-borne noise', 'ground-borne noise' or 'regenerated noise'. This 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 ground-borne or structure-borne noise include tunnelling works, underground railways, excavation plant (eg rockbreakers), and building services plant (eg fans, compressors and generators).

The following figure presents an example of the various paths by which vibration and ground-borne noise may be transmitted between a source and receiver for construction activities occurring within a tunnel.



The term 'regenerated noise' is also used in other instances where energy is converted to noise away from the primary source. One example would be a fan blowing air through a discharge grill. The fan is the energy source and primary noise source. Additional noise may be created by the aerodynamic effect of the discharge grill in the airstream. This secondary noise is referred to as regenerated noise.

APPENDIX B

Concept Plan Layout, Appendices of MP 06_0225 and Current Proposed Layout Plan

Figure 2 Site Layout Concept Plan - 2006

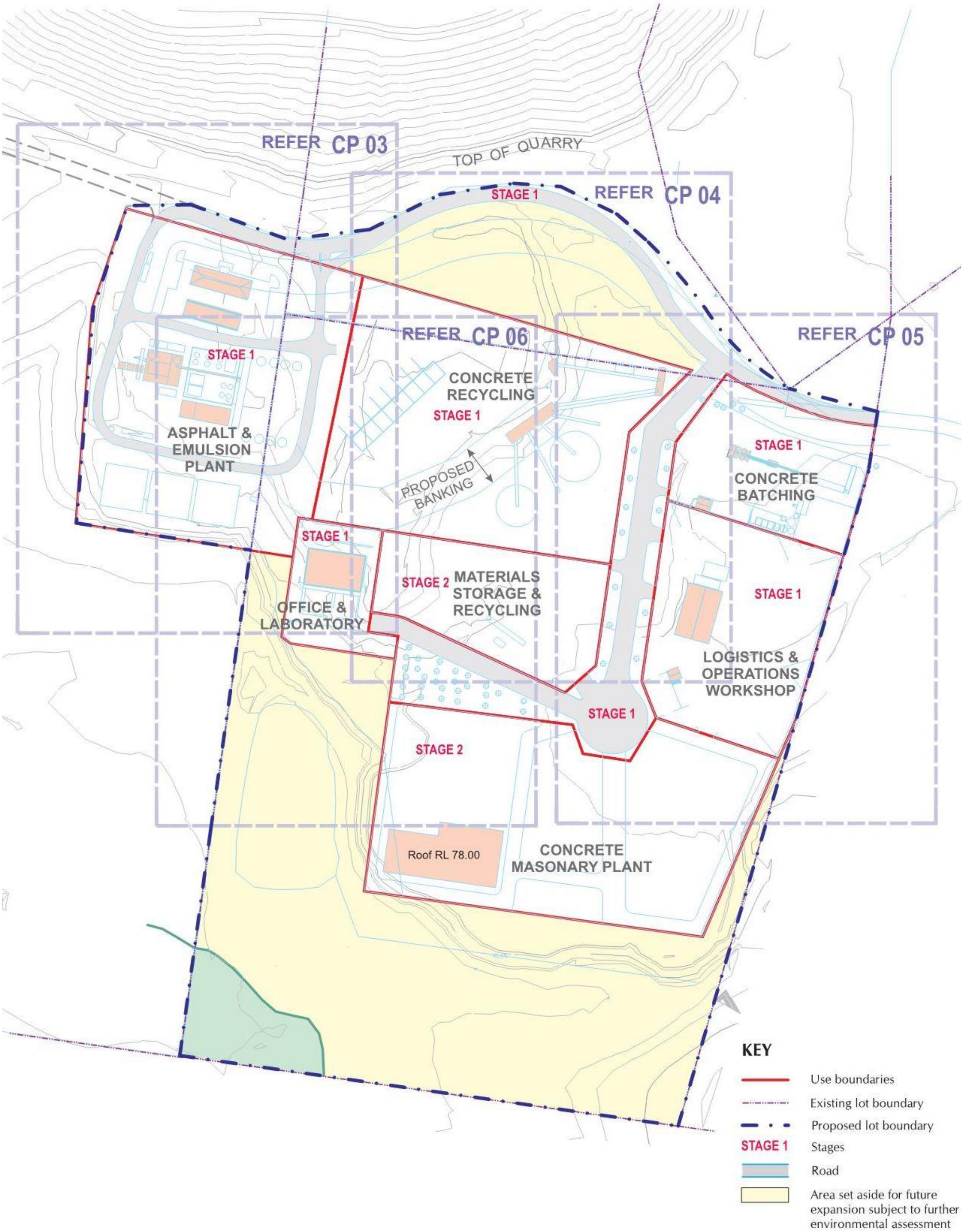


Figure 3 Appendix 1 - MP 06_0225 Concept of 2010

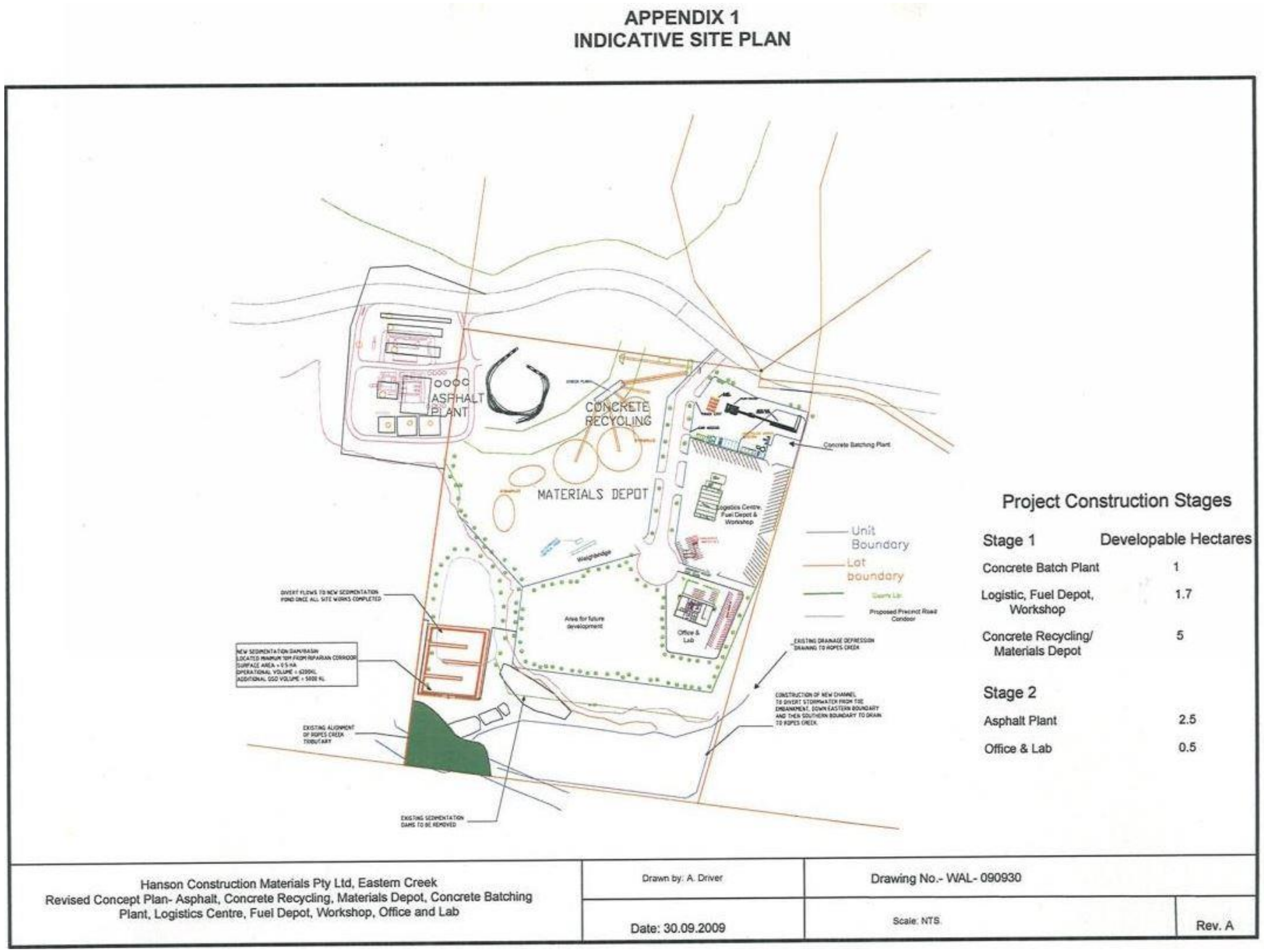


Figure 4 Appendix 1 - MP 06_0225 Concept (Mod 3) of 2017

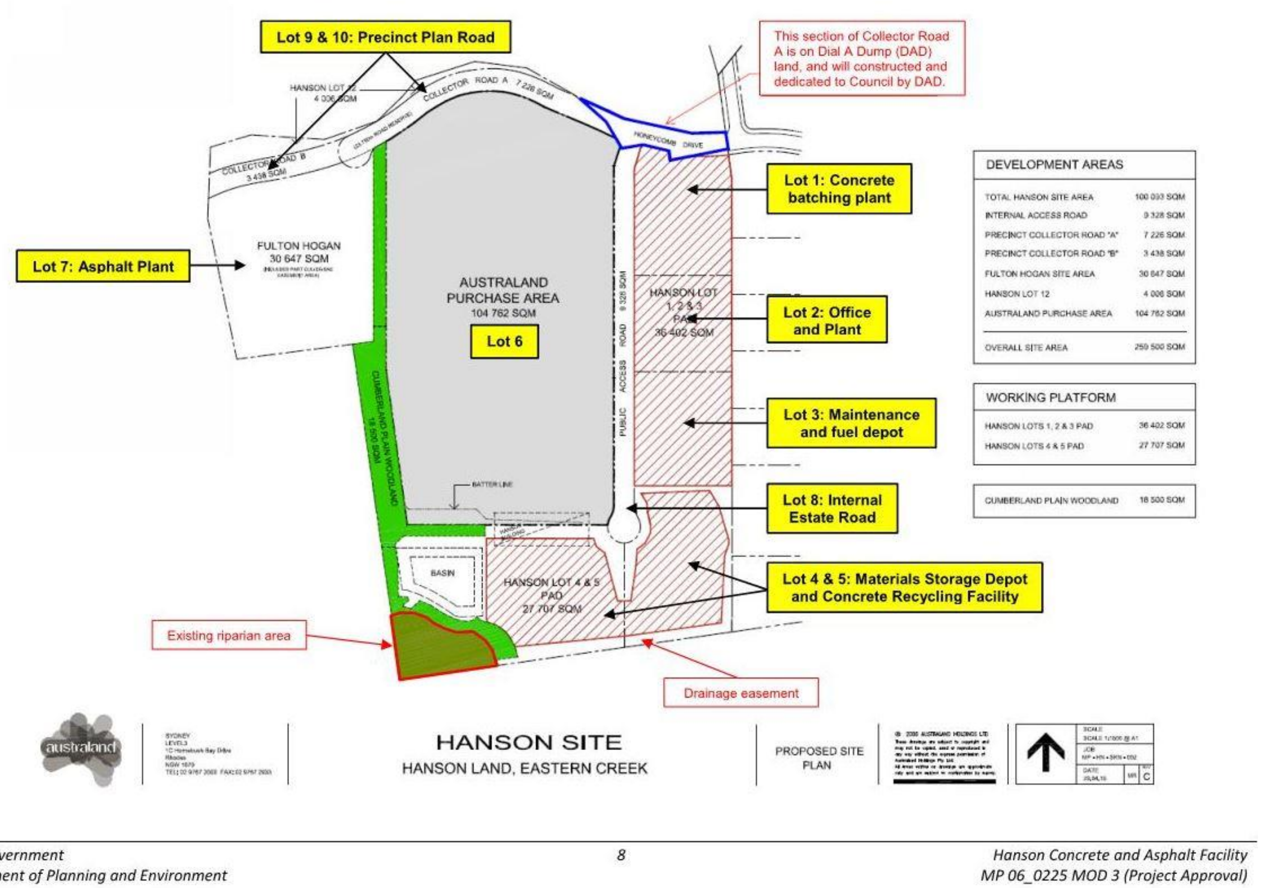
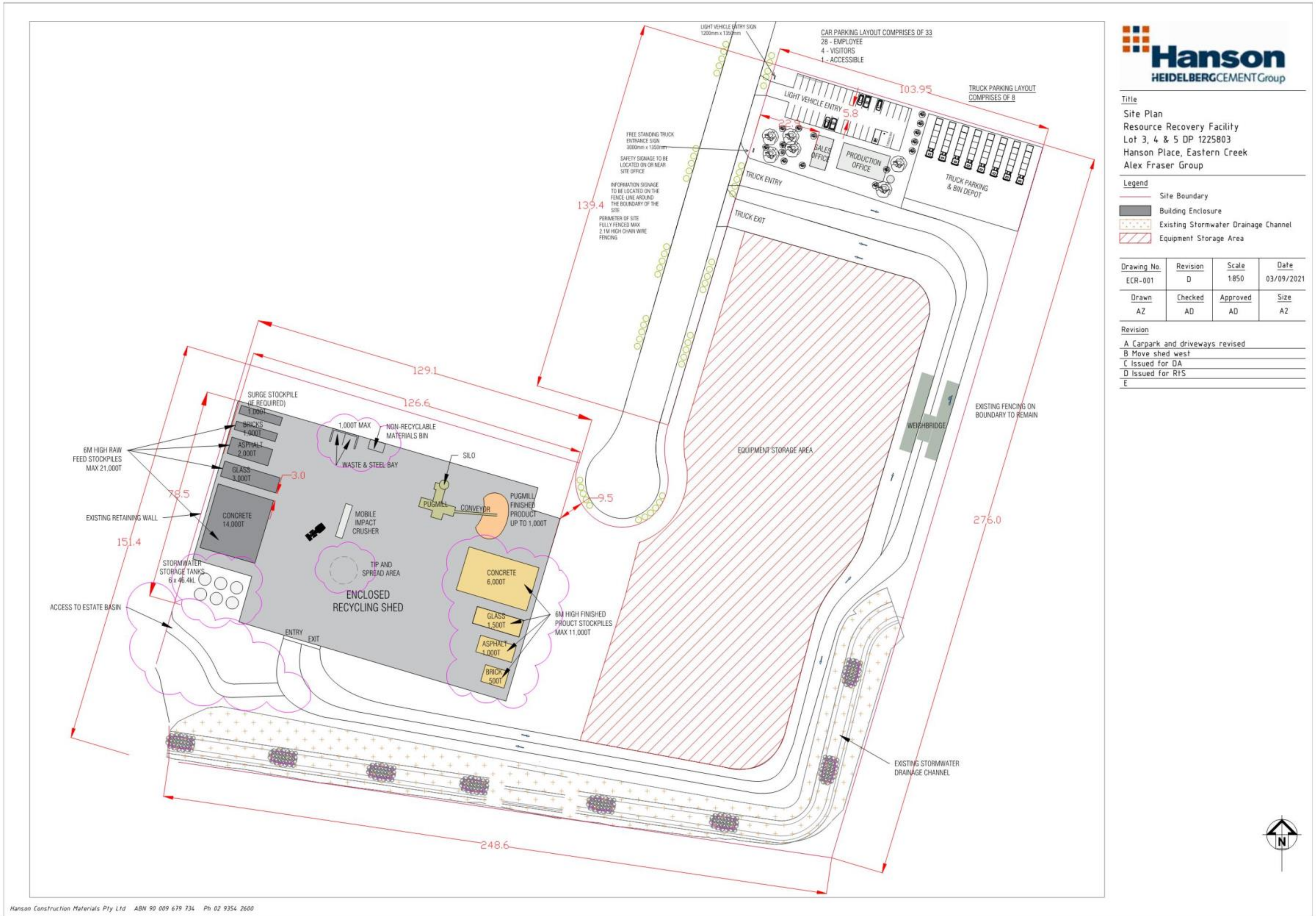


Figure 5 Hanson - Site Plan Resource Recovery 2021



APPENDIX C

Secretary's Environmental Assessment Requirements (SEARs)

The SEARs for the Project specify - *a demonstration the proposal is consistent with the requirements, development standards and environmental impact envelope of the Hanson Concrete and Asphalt Facility Concept Plan, as modified (if at all) (MP 06_0225)*', where under Schedule 3: Project Requirements Item 2(i), it states:

(j) a noise assessment of the proposed development in accordance with NSW Industrial Noise Policy including:

- *demonstration that the operational noise generated by the proposed development and any other development on the project site would not exceed the noise criteria detailed in the Project Approval (MP 06_225 Project); and*
- *demonstration that the traffic noise generated by the proposed development and any other development on the site would not exceed the noise criteria in the DECCW's Environmental Criteria for Road Traffic Noise;*

The Project Approval (MP 06_0225 Project) MOD 3 dated 24 March 2017 specifies the relevant Noise criteria in accordance Schedule 4: Specific Environmental Conditions with replacement Condition 15, as follows:

1. With the exception of proposed Lot 6, noise generated by the project must not exceed the noise limits identified in the table below. The noise limits represent the noise contribution from the project site.

Noise Limits (dB(A))

Location	*Day*	*Evening*	*Night*	
	LAeq(15 Minute)	*LAeq(15 Minute)*	*LAeq(15 Minute)*	*LA1(1 minute)*
Minchinbury (south) MB3 Agrafe Place	*45*	*45*	*45*	*57*
Erskine Park (north) EN1 Warbler Street	*35*	*35*	*35*	*57*
Erskine Park (south) ES2 Fantail Crescent	*35*	*35*	*35*	*57*

Notes:

(a) Noise from the development is to be measured at the most affected point within the residential boundary, or at the most affected point within 30 metres of a dwelling (rural situations) where the dwelling is more than 30 metres from the boundary, to determine compliance with the $L_{Aeq(15\ minute)}$ noise limits in the above table. Where it can be demonstrated that direct measurement of noise from the project is impractical, the EPA may accept alternative means of determining compliance (see Chapter 11 of the NSW Industrial Noise Policy). The modification factors in Section 4 of the NSW Industrial Noise Policy shall also be applied to the measured noise levels where applicable.

(b) The noise emission limits identified in the above table apply under meteorological conditions of:

- *wind speeds of up to 3 m/s at 10 metres above ground level; or*
- *temperature inversion conditions of up to 3°C/100m and wind speeds of up to 2 m/s at 10 metres above ground level.*

APPENDIX D

Construction Scenarios

CONSTRUCTION NOISE MODELLING SCENARIOS

Construction Component	Construction Period	Equipment Involved at each Work Site	
		Equipment Type	Number of Items
Enabling Works	Daytime	15t excavator	1
		12-15t Trucks	3
		Vibratory roller	1
		Hand tools	1
		Watercart	1
		FEL	1
Building Construction	Daytime	Auger Drill Rig	1
		100t Mobile Crane	2
		12-15t Trucks	2
		Concrete Trucks / Agitator	1
		Concrete Vibrators	1
		Hand Tools	4

Note The equipment corresponds to that operational in the worst case 15 minutes

APPENDIX E

Construction Vibration Assessment Criteria

Vibration - Building Structures Cosmetic Damage Risk

Most commonly specified ‘safe’ structural vibration limits are designed to minimise the risk of cosmetic damage such as surface cracks, and are set well below the levels that have potential to cause structural damage. British Standard BS 7385 Part 2-1993 *Evaluation and measurement for vibration in buildings Part 2,* provides frequency-dependent vibration limits related to the cosmetic damage risk. Noting, cosmetic damage is very minor in nature, is readily repairable and does not affect the structural integrity of the building.

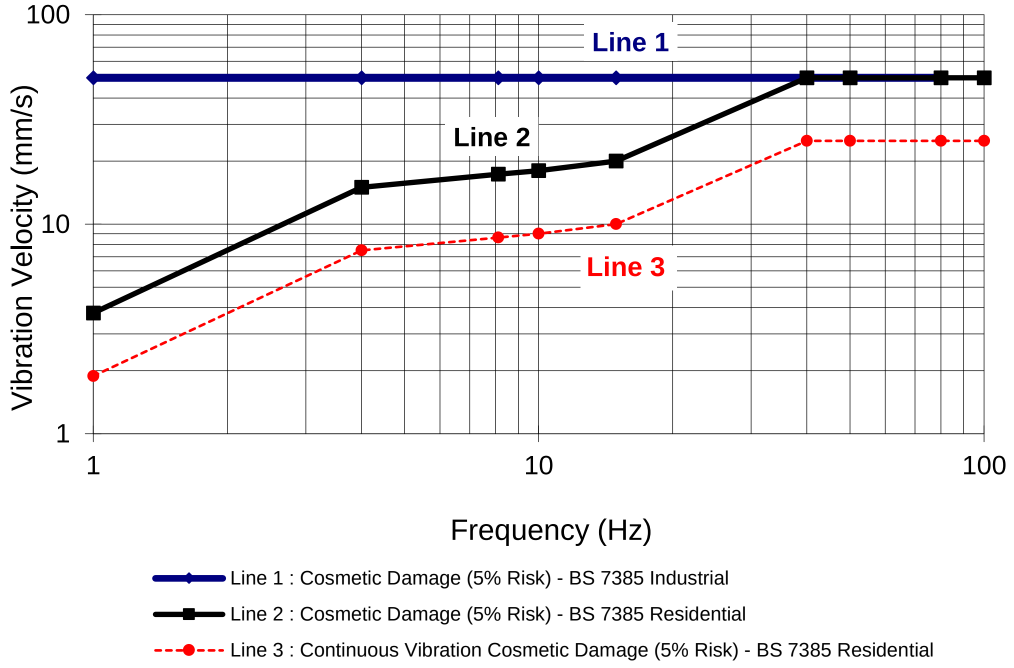
The BS 7385 Part 2-1993 sets guide values for building vibration based on the lowest vibration levels above which damage has been credibly demonstrated. These levels are judged to give a minimum risk of vibration-induced damage, where minimal risk for a named effect is usually taken as a 95% probability of no effect. Sources of vibration that are considered in the standard include demolition, blasting (carried out during mineral extraction or construction excavation), piling, ground treatments (eg compaction), construction equipment, tunnelling, road and rail traffic and industrial machinery.

The recommended limits (guide values) for transient vibration to ensure minimal risk of cosmetic damage to residential and industrial buildings are presented numerically in **Table E1** and graphically in **Figure E1**.

Table E1 Transient Vibration Guide Values - Minimal Risk of Cosmetic Damage

Line	Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
		4 Hz to 15 Hz	15 Hz and Above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

Figure E1 Graph of Transient Vibration Guide Values for Cosmetic Damage



BS 7385 Part 2-1993 goes on to state that cosmetic damage is possible at vibration magnitudes which are greater than twice those given in **Table E1**, and damage to a building structure may occur at values greater than four times the tabulated values. It is also noteworthy that extra to the guide values nominated in **Table E1**, the BS 7385 Part 2-1993 states that:

> *"Some data suggests that the probability of damage tends towards zero at 12.5 mm/s peak component particle velocity. This is not inconsistent with an extensive review of the case history information available in the UK."*

Also that:

> *"A building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive."*

BS 7385 Part 2-1993 states that the guide values in **Table E1** relate predominantly to transient vibration which does not give rise to resonant responses in structures and low-rise buildings. Where the dynamic loading caused by continuous vibration (ie rock breaking or sheet piling) may give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values in **Table E1** may need to be reduced by up to 50%.

For construction activities involving intermittent vibration sources such as rock breakers, piling rigs, vibratory rollers, excavators and the like, the predominant vibration energy occurs at frequencies greater than 4 Hz (and usually in the 10 Hz to 100 Hz range). On this basis, a conservative vibration damage screening level per receiver type is given below:

- Unreinforced or light framed structures: **7.5 mm/s**.
- Reinforced or framed structures: **25.0 mm/s**

Vibration - Computer Rooms

Based on previous experience, SLR has found a peak particle velocity (ppv) criterion of 5 mm/s to be appropriate for computer room floors (based on vibration requirements for hard drives). If it is determined that more sensitive equipment is stored in these rooms, this criterion may need to be revised.

Vibration - Mechanical Plant

The criteria in Table E2 are based on previous experience at port facilities.

Table E2 Guideline Values for Vibration - Effect of Short Term Vibration on Mechanical Plant

Situation	Vibration Measured on Support Structure (ppv mm/s)
Mechanical Plant (ie conveyors, drive assemblies) **In Operation**	20
Mechanical Plant (ie conveyors, drive assemblies) **Not In Operation**	5

Vibration - Buried Pipework

The German Standard DIN 4150-3:2016 "Structural Vibration Part 3: Effects of vibration in structures" provides guideline values for evaluating the effect of vibration on buried pipework. The values are based on the assumption that pipes have been manufactured and laid using current technology. Additional considerations may be required at junctions. The recommended limits for short term vibration to ensure minimal risk of damage are presented numerically in **Table E3**.

Table E3Guideline Values for Vibration - Effects of Short Term Vibration on Buried Pipework

Pipe Material	Vibration Measured on the Pipe[1] (ppv mm/s)
Steel (including welded pipes)	100
Clay, concrete, reinforced concrete, pre-stressed concrete, metal (with or without flange)	80
Masonry, plastic	50

Note 1: Mounting equipment directly onto pipes may not be possible. If the vibration source is not immediately next to the pipework, measurements can be made on the ground surface to obtain an estimate. Generally, this vibration level will be greater than the level measured directly on the pipework.

Vibration - Human Comfort

EPA's "*Assessing Vibration: A Technical Guideline*" (DEC 2006) is based on the information set out in British Standard 6472-1992 "*Evaluation of Human Exposure to Vibration in Buildings (1 Hz to 80 Hz)"*. This standard defines levels of building vibration associated with a "low probability of adverse comment" from occupants. The applicable levels for continuous daytime activities are shown in **Table E4**.

Table E4 Vibration Levels with "Low Probability of Adverse Comment" (1 Hz to 80 Hz)

Building Type	Peak Floor Vibration	Peak Floor Vibration (Z Vertical)
Residential	0.8 mm/s to 1.6 mm/s	0.3 mm/s to 0.6 mm/s
Commercial/Offices	1.6 mm/s	0.6 mm/s
Industrial/Workshops	3.2 mm/s	1.2 mm/s

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