Appendix R

Noise assessment for the revised WRP layout

Googong Township water cycle project

Environmental Assesment

November 2010

RENZO TONIN & ASSOCIATES
inspired to achieve

Consultants in Acoustics, Vibration & Structural Dynamics
email: sydney@renzotonin.com.au
website: www.renzotonin.com.au

GOOGONG WATER CYCLE INFRASTRUCTURE PROJECT

ASSESSMENT OF PROPOSED WATER RECYCLING FACILITY

TF007-01F02 (REV 2) NOISE IMPACT ASSESSMENT

16 SEPTEMBER 2010

Prepared for:

Manidis Roberts Pty Ltd

Level 9, 11-33 York Street

Sydney NSW 2000

Attention: Mr Paul Keighley

25 1982-2007 ACOUSTIC ENGINEERING EXCELLENCE

AAAC
Member of the Association of Australian Acoustical Consultants

Sydney (Head Office)
Renzo Tonin & Associates (NSW) Pty Ltd
ABN 29 117 462 861
1/418A Elizabeth St., SURRY HILLS, NSW 2010
PO Box 877 STRAWBERRY HILLS, NSW 2012
Ph (02) 8218 0500 Fax (02) 8218 0501

Melbourne
Brisbane
Gold Coast
Kuwait

DOCUMENT CONTROL

Date	Revision History	Non-Issued Revision	Issued Revision	Prepared By (initials)	Instructed By (initials)	Reviewed & Authorised by (initials)
07.09.2010	Generation of Draft Report	0	1	LS	MCH	MCH
16.09.2010	Revise report	-	2	LS	MCH	MCH

The work presented in this document was carried out in accordance with the Renzo Tonin & Associates Quality Assurance System, which is based on Australian Standard / NZS ISO 9001.

This document is issued subject to review and authorisation by the Team Leader noted by the initials printed in the last column above. If no initials appear, this document shall be considered as preliminary or draft only and no reliance shall be placed upon it other than for information to be verified later.

This document is prepared for our Client's particular requirements which are based on a specific brief with limitations as agreed to with the Client. It is not intended for and should not be relied upon by a third party and no responsibility is undertaken to any third party without prior consent provided by Renzo Tonin & Associates. The information herein should not be reproduced, presented or reviewed except in full. Prior to passing on to a third party, the Client is to fully inform the third party of the specific brief and limitations associated with the commission.

The information contained herein is for the purpose of acoustics only. No claims are made and no liability is accepted in respect of design and construction issues falling outside of the specialist field of acoustics engineering including and not limited to structural integrity, fire rating, architectural buildability and fit-for-purpose, waterproofing and the like. Supplementary professional advice should be sought in respect of these issues.

CONTENTS

EXECUTIVE SUMMARY 5

1 INTRODUCTION 7

2 PROJECT DESCRIPTION 8

3 EXISTING ACOUSTIC ENVIRONMENT 10

3.1 Noise Monitoring Location 10

4 NOISE CRITERIA 11

4.1 Operational Noise Criteria 11

4.2 Sleep Disturbance Noise Goals 11

5 OPERATIONAL NOISE ASSESSMENT 12

5.1 Operational Noise Sources 12

6 PREDICTED OPERATIONAL NOISE 14

6.1 Predicted Noise Levels 14

6.1.1 Operational Noise 14

6.1.2 Sleep Disturbance 15

7 CONSTRUCTION NOISE & VIBRATION ASSESSMENT 19

7.1 Construction Noise Criteria 19

7.2 Management Levels 20

7.2.1 Recommended Standard Work Hours 21

7.3 Proposed Construction Noise Sources 21

7.4 Estimated Noise Levels 22

7.5 Noise Mitigation Measures 23

7.5.1 General Engineering Noise Controls 23

7.5.2 Noise Management Measures 24

7.6 Construction Vibration 25

7.7 Blasting 26

8 CONCLUSION 27

APPENDIX A - GLOSSARY OF ACOUSTIC TERMS 28

List of Tables

Table 3.1 – Background Noise Levels in the Development Area 10

Table 4.1 – Development Project Specific Noise Levels (PSNL) 11

Table 4.2 – Sleep Disturbance Noise Goals 11

Table 5.1 –Sound Power Levels of Mechanical Plant & Equipment (dB re. 1pW) 12

Table 6.1 – Predicted Noise Levels from Modified & Reconfigured Water Recycling Plant at Existing Residential Receivers 15

Table 6.2 – Predicted Maximum Noise Levels at Night 16

Table 7.1 – Noise at Residences Using Quantitative Assessment 20

Table 7.2 – Summary of Construction Noise Management Levels, dB(A) 21

Table 7.3 – Typical Construction Equipment & Sound Power Levels, dB(A) re. 1pW 22

Table 7.4 – Predicted Earthworks Noise Levels at Receiver Locations, dB(A) 22

Table 7.5 – Predicted Building Works Noise Levels at Receiver Locations, dB(A) 22

Table 7.6 – Relative Effectiveness of Various Forms of Noise Control, dB(A) 23

EXECUTIVE SUMMARY

A water recycling plant is proposed to be constructed on the north eastern corner of the proposed Googong residential development adjacent to Googong Dam in Queanbeyan. This noise impact assessment assesses the environmental noise impact of the proposed construction and operation of the water recycling plant following modification and reconfiguration to the layout of the original water recycling plant.

The noise impact assessment for the original water recycling plant layout was previously undertaken by Heggies Pty Ltd (ref. 10-6690-R1 Revision 4, dated 7 December 2009) and this noise assessment report for the modified water recycling plant forms an amendment to the Heggies report.

Noise impacts were modelled using the SoundPLAN computer noise model software package under calm and isothermal meteorological conditions. Noise contours for typical operations of the proposed modified and reconfigured water recycling plant were produced and compared to the noise contours prepared by Heggies for the assessment of the original water recycling plant. The noise contour representing the modified and reconfigured water recycling plant indicated a decrease in noise level to the south and south-east of the site when compared to the noise contour prepared for the original water recycling plant.

Furthermore, the predicted noise contour indicated that the buffer distance of 45m from the site boundary, as recommended in the Heggies assessment, could still be achievable with the modified and reconfigured layout of the water recycling plant, provided that the noise mitigation measures discussed in Section 7.4.1 and 7.4.2 of the Heggies report are implemented.

Predicted noise emission levels were also assessed against the relevant noise criteria set out in the NSW Department of Environment, Climate Change and Water's (DECCW) 'Industrial Noise Policy' (INP) and 'Environmental Noise Control Manual' (ENCM), which were established previously in the Heggies report. Results indicate compliance with the project specific noise criteria at the nearest affected residential receiver locations.

The construction noise assessment undertaken by Heggies referred to superseded criteria. As part of the construction noise assessment presented in this report, the recently released 'NSW Interim Construction Noise Guideline' (ICNG) was referred to.

Results of the construction noise assessment indicated exceedance of the applicable noise management levels at the nearest sensitive receivers during earthworks and building works. Therefore, in-principle noise mitigation measures in the form of general engineering noise controls and noise management measures were presented to aid in mitigating construction noise impacts.

Construction vibration impacts have also been assessed; however, due to the large separation distances between the construction activities and the nearest affected residential receivers, vibration impacts causing human discomfort or structural damage were determined to be insiginifcant.

Blasting impacts and allowable maximum instantaneous charge (MIC) for the excavation phase of the modified and reconfigured water recycling plant were determined to be the same as those presented in the Heggies report prepared for the original water recycling plant.

1 INTRODUCTION

Renzo Tonin & Associates was engaged by Manidis Roberts Pty Ltd to conduct a desktop noise assessment of the proposed water recycling plant following modification and reconfiguration to the layout of the original water recycling plant.

The noise impact assessment for the original water recycling plant layout was previously undertaken by Heggies Pty Ltd (ref. 10-6690-R1 Revision 4, dated 7 December 2009) and this noise assessment report for the modified water recycling plant forms an amendment to the Heggies report.

The noise impact from the facility has been assessed in accordance with the NSW Department of Environment, Climate Change and Water's (DECCW) 'Industrial Noise Policy' (INP) 2000 and the 'Environmental Noise Control Manual' (ENCM) 1994.

The work documented in this report was carried out in accordance with the Renzo Tonin & Associates Quality Assurance System, which is based on Australian Standard / NZS ISO 9001.

2 PROJECT DESCRIPTION

The proposed water recycling plant is bound by Googong Dam Road to the north and is located on the north eastern corner of the proposed Googong residential development adjacent to Googong Dam in Queanbeyan.

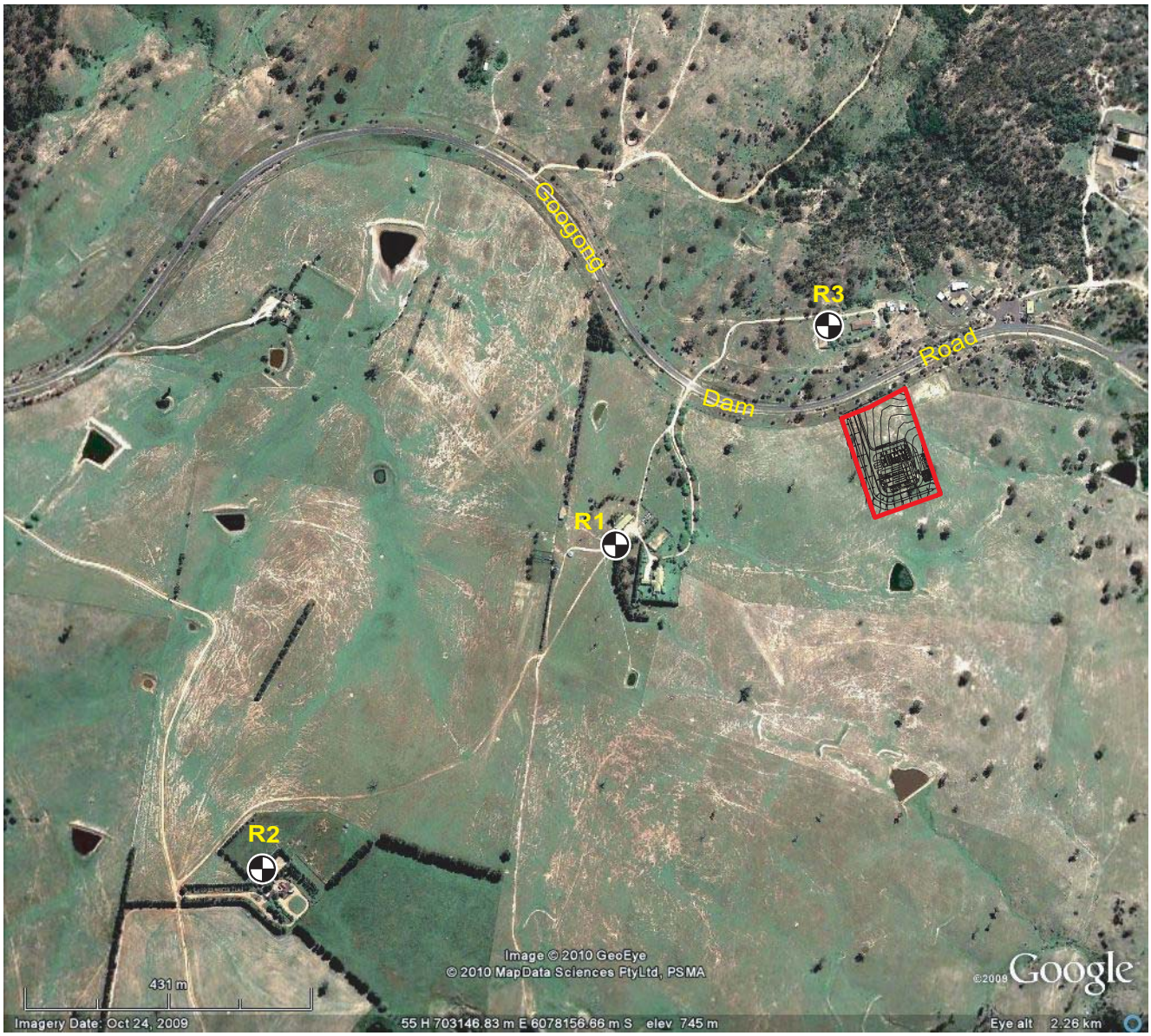
The water recycling plant will service the proposed Googong residential development and is considered to be the major source of noise from the Googong water cycle project.

It is anticipated that noise from the facility will essentially emanate from continuous noise generated by various mechanical plant and equipment to be installed as part of the water recycle plant facility.

The nearest affected residential receivers potentially affected by noise from the proposed water recycling plant were presented in Table 1 of the Heggies report. These receivers were as follows:

- **Receiver R1 –** Gorman Property
- **Receiver R2** – Gorman Property
- **Receiver R3** – Talpa

Figure 1 below shows the location of the proposed water recycling plant and the nearest affected receiver locations.



Notes

Receiver Locations

RENZO TONIN & ASSOCIATES
inspired to achieve
Consultants in Acoustics, Vibration and Structural Dynamics
Email: acoustics@rtagroup.com.au www.renzotonin.com.au
Sydney - Ph: (02) 8218 0500 Fax: (02) 8218 0501
Melbourne - Ph: (03) 9606 0041 Fax: (03) 9606 0042
Brisbane - Ph: (07) 3211 9155 Fax: (07) 3211 9188
Gold Coast - Ph: (07) 5593 5633 Fax: (07) 5593 5635
Kuwait - Ph: +0011 965 653 1520
Member of the Association of Australian Acoustical Consultants

Title : Figure 1 - Site, Surrounds, Reciever Locations & Schematics of Proposed Water Recycling Plant

Project: Googong Water Cycle Project

Date : 07/09/10 | **Scale:** NTS | **Ref** : TF007-01P01 (rev 1)

3 EXISTING ACOUSTIC ENVIRONMENT

Background noise varies over the course of any 24 hour period, typically from a minimum at 3am in the morning to a maximum during morning and afternoon traffic peak hours. Therefore, the NSW 'Industrial Noise Policy' (INP) requires that the level of background and ambient noise be assessed separately for the daytime, evening and night-time periods. The INP defines these periods as follows:

- **Day** is defined as 7:00am to 6:00pm, Monday to Saturday and 8:00am to 6:00pm Sundays & Public Holidays.
- **Evening** is defined as 6:00pm to 10:00pm, Monday to Sunday & Public Holidays.
- **Night** is defined as 10:00pm to 7:00am, Monday to Saturday and 10:00pm to 8:00am

3.1 Noise Monitoring Location

Long term unattended noise monitoring and short term attended noise surveys were previously undertaken by Heggies and the results of the noise monitoring are reported in Section 5.1 of the Heggies report.

Monitored background noise levels were presented in Table 10 of the Heggies report and were presented as follows:

Table 3.1 – Background Noise Levels in the Development Area

Location	Description	Background L_{A90} Noise Level, dB(A) - RBL
R1	Day	30
	Evening	30
	Night	30
R2	Day	30
	Evening	30
	Night	30

Notes: 1. Results taken from Heggies noise assessment report (ref. 10-6690-R1 Revision 4, dated 7 December 2009)

4 NOISE CRITERIA

4.1 Operational Noise Criteria

The assessment for operational noise emission from the proposed water recycling plant has been assessed in accordance with the requirements of the NSW INP. The noise criteria were previously established in Section 6.1 of the Heggies report based on the requirements of the INP and the monitored background noise monitoring results. Table 16 of the Heggies report presents the applicable criteria and is reproduced below.

Table 4.1 – Development Project Specific Noise Levels (PSNL)

Location	Period	Intrusive Criteria, dB(A) $L_{Aeq(15minute)}$	Amenity Criteria, dB(A) $L_{Aeq(period)}$	Project Specific Noise Level (PSNL), dB(A)
All existing and proposed residential locations	Day	35	50	35
	Evening	35	45	35
	Night	35	40	35

Notes: 1. For Monday to Saturday, Daytime 7.00am – 6.00pm; Evening 6.00pm – 10.00pm; Night-time 10.00pm to 7.00am. On Sundays and Public Holidays, Daytime 8.00am – 6.00pm; Evening 6.00pm to 10.00pm; Night-time 10.00pm – 8.00am

2. Results taken from Heggies noise assessment report (ref. 10-6690-R1 Revision 4, dated 7 December 2009)

4.2 Sleep Disturbance Noise Goals

Section 6.2 of the Heggies report presents the applicable noise goals for the assessment of sleep disturbance for all residential areas based on the requirements of the ENCM. Table 17 of the Heggies report presents the sleep disturbance noise goals and is reproduced below.

Table 4.2 – Sleep Disturbance Noise Goals

Location	Period	Sleep Disturbance Criteria, $L_{A1(1minute)}$
All existing and proposed residential locations	Night	45dB(A)

Notes: 1. Results taken from Heggies noise assessment report (ref. 10-6690-R1 Revision 4, dated 7 December 2009)

5 OPERATIONAL NOISE ASSESSMENT

5.1 Operational Noise Sources

The main sources of noise from the reconfigured proposed water recycling plant are as follows:

- Blower Room
- Plant Room
- Bioreactor Ventilation stack
- Odour Ventilation Stack
- Small Diaphragm pumps
- Inlet Sieves
- Pumping Stations

The sound power level for the operational noise sources were previously established and presented in Appendix B of the noise assessment report prepared by Heggies Pty Ltd (ref. 10-6690-R1 Revision 4, dated 7 December 2009). The sound power level of the operational noise sources are shown below and have been used for noise predictions as part of this assessment for the modified and reconfigured water recycling plant.

As discussed in Section 7.3 of the Heggies report noise mitigation measures need to be implemented in order to meet the minimum buffer distance of 45m from the site boundary. Therefore, the following sound power levels of the associated mechanical plant and equipment are based on the assumption that noise mitigation measures discussed in Section 7.4.1 and 7.4.2 of the Heggies report have been implemented.

Table 5.1 –Sound Power Levels of Mechanical Plant & Equipment (dB re. 1pW)

Noise Source	Overall Level dB	Octave Band Centre Frequencies, Hz – dB(lin)								
		31.5	63	125	250	500	1k	2k	4k	8k
Outside Blower Room – Acoustic Louvres	78	70	63	67	77	58	54	53	47	46
Odour Vent Fans (Enclosed)	52	23	37	45	46	47	43	41	33	25
Small Diaphragm pumps (Enclosed)	49	28	35	42	42	42	38	40	40	34
Actuator Valves (Enclosed)	65	62	56	60	49	39	31	30	41	45
Vent Stack Pipe (With Attenuator)	68	40	53	60	65	63	55	51	47	60
Flygt pumps (Enclosed)	42	22	32	35	36	36	31	25	22	32
Inlet Sieve – (Enclosed)	77	77	66	58	50	42	37	37	36	38
Blower Room Roller Door	70	43	48	64	68	52	50	48	51	45
Blower Room Door	62	35	40	56	60	44	41	39	42	37
Blower Room Roof	70	50	54	68	65	47	39	33	29	24

Notes: Source noise levels based on noise levels reported by Heggies Pty Ltd

The noise level for the water pumping station at the water recycling plant are based on the sound power level presented in Table 25 of Section 7.5 of the Heggies report and is as follows:

- Recycle Water Pumping Station Sound Power Level – **93dB(A) re. 1pW**

As stated in the noise assessment prepared by Heggies, the operational hours of the water recycling plant is currently not known, therefore for noise modelling purposes a worst-case scenario where the water recycling plant will operate continuously 24 hours a day was assumed.

6 PREDICTED OPERATIONAL NOISE

Industrial noise emissions from typical operations at the water recycling plant are determined by modelling the noise sources and topographical features of the surrounding area using the SoundPLAN (software version 6.2) computer noise model. The program calculates the contribution of each noise source and allows for the prediction of the total noise from the site.

The SoundPLAN computer program is accepted by the DECCW and its environmental noise predictions have been verified on many past occasions in the field.

The noise prediction model takes into account the following:

- Ground Topography
- Distance Attenuation
- Attenuation from barriers (natural and purpose built)

In accordance with the methodology undertaken by Heggies in the previous noise assessment, the noise predictions were prepared based on the following meteorological scenarios:

- Calm & isothermal conditions (acoustically neutral) – no wind and no temperature inversion.

For calm-isothermal (acoustically neutral) conditions the following parameters were assumed:

  - Temperature = 20°C
  - Humidity = 65%
  - Wind Speed = 0 to 0.5m/s
  - Wind Direction = N/A
  - Temperature Gradient = N/A

6.1 Predicted Noise Levels

6.1.1 Operational Noise

Noise predictions were based on an architectural drawing of the reconfigured water recycling plant provided by MWH (drawing no. A1081402 – SK705), and other information provided within the noise assessment report prepared by Heggies Pty Ltd (ref. 10-6690-R1 Revision 4, dated 7 December 2009), including source noise levels, which were reproduced in Section 5 above.

Figure 2 below presents the noise contours representing L_{Aeq} noise generated by the proposed water recycling plant following the modification and reconfiguration of the site layout.

A comparison between the noise contour generated by Renzo Tonin & Associates and that of the Heggies assessment, as presented in Appendix C of the report (ref. 10-6690-R1 Revision 4, dated 7 December 2009) has also been carried out. The noise contour representing the modified and reconfigured water recycling plant shows a decrease in noise level to the south and south-east of the site when compared to the noise contour prepared for the original water recycling plant.

Furthermore, the predicted noise contour in Figure 2 indicates that the buffer distance of 45m from the site boundary, as recommended in the Heggies assessment, can still be achievable with the modified and reconfigured layout of the water recycling plant, provided that the noise mitigation measures discussed in Section 7.4.1 and 7.4.2 of the Heggies report are implemented.

Predicted noise levels at the nearest receivers were also calculated based on the modified and reconfigured water recycling plant. Results of the predictions are presented in Table 6.1 below.

Table 6.1 – Predicted Noise Levels from Modified & Reconfigured Water Recycling Plant at Existing Residential Receivers

Location	Period (Day/Evening/Night)	Project Specific Noise Criteria $L_{Aeq(15minute)}$	Complies?
R1	< 35dB(A)	35dB(A)	Yes
R2	< 35dB(A)	35dB(A)	Yes
R3	< 35dB(A)	35dB(A)	Yes

From the above table it can be seen that noise emissions from the modified and reconfigured water recycling plant are predicted to comply with the project specific noise criteria at the nearest affected residential receiver locations.

6.1.2 Sleep Disturbance

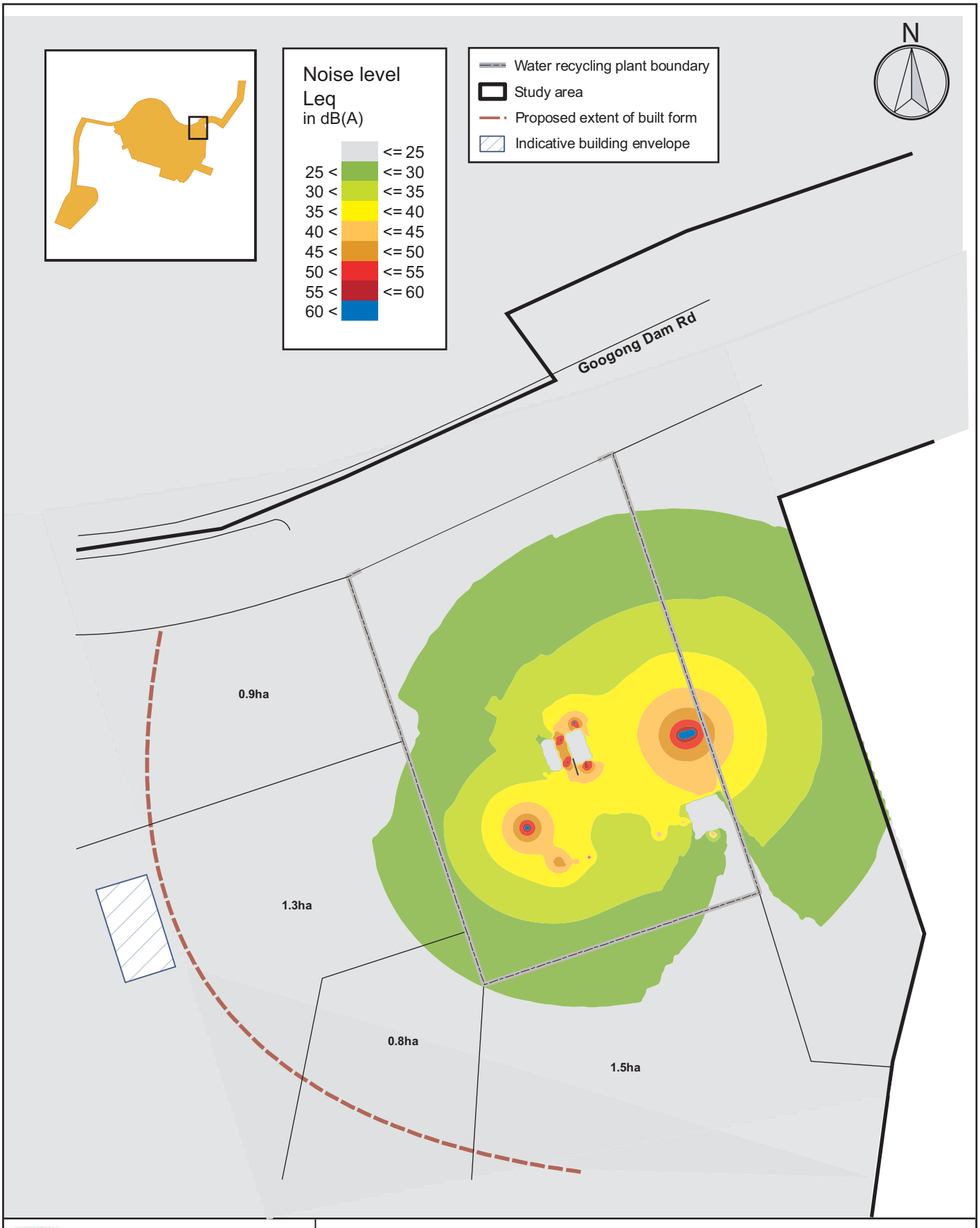
The methodology of predicting L_{max} noise levels with the potential to cause sleep disturbance was based on the methodology described in Section 7.4.4 of the Heggies report. As stated in the Heggies report, the maximum noise levels modelled were based on noise associated with air actuator valves and the receiver being located at 45m from the site boundary, representing the buffer distance established in the Heggies report.

Therefore, the predicted maximum noise level during the night period from the modified and reconfigured water recycling plant, at a distance of 45m from the site boundary, is presented in Table 6.2 below.

Table 6.2 – Predicted Maximum Noise Levels at Night

Location	Period	Predicted Sleep Disturbance Noise Level	Sleep Disturbance Criteria $L_{1(1minute)}$	Complies?
Residential locations at buffer distance of 45m from site boundary[1]	Night	35dB(A)	45dB(A)	Yes

Notes: 1. Buffer distance previously established in the Heggies noise assessment report (ref. 10-6690-R1 Revision 4, dated 7 December 2009)

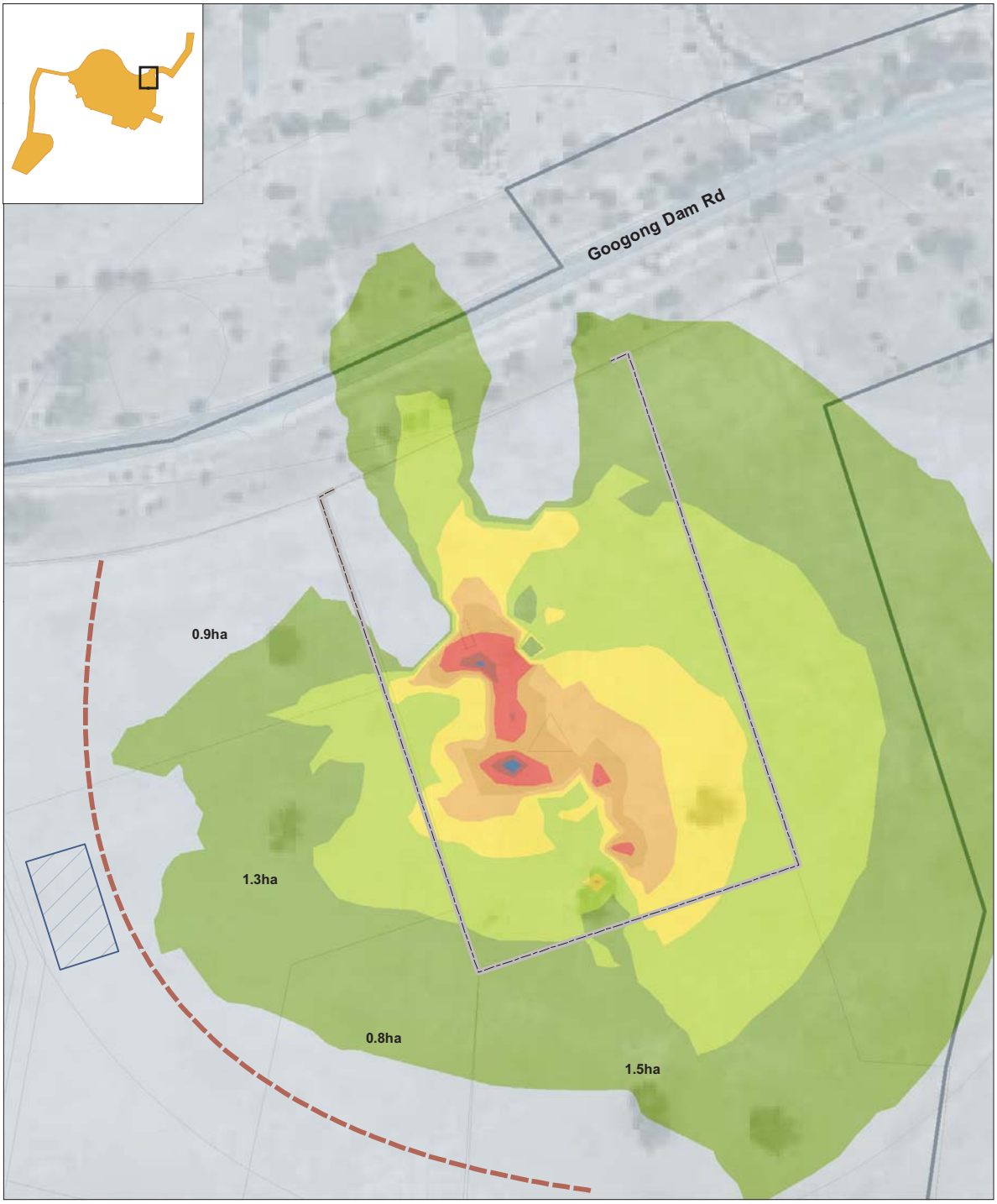


RENZO TONIN & ASSOCIATES
inspired to achieve
Consultants in Acoustics, Vibration and Structural Dynamics
Email: acoustics@rtagroup.com.au www.renzotonin.com.au
Sydney - Ph: (02) 8218 0500 Fax: (02) 8218 0501
Melbourne - Ph: (03) 9606 0041 Fax: (03) 9606 0042
Brisbane - Ph: (07) 3211 9155 Fax: (07) 3211 9188
Gold Coast - Ph: (07) 5593 5633 Fax: (07) 5593 5635
Kuwait - Ph: +0011 965 653 1520
Member of the Association of Australian Acoustical Consultants

Title : Figure 2 - Noise Contours - Modified and Reconfigured Water Recycling Plant

Project: Googong Water Cycle Project

Date : 02/09/10	**Scale:** NTS	**Ref** : TF007-01P02 (rev 0)



Googong Environmental Assessment

Proponent Canberra Investment Corporation

Date 8 February 2010

Drawing no. 08003g_ea_fig07-15

Source Heggies, Brown Consulting, MWH

Noise level - Leq in dB(A)

.	<= 25
25 <	<= 30
30 <	<= 35
35 <	<= 40
40 <	<= 45
45 <	<= 50
50 <	<= 55
55 <	<= 60
60 <	.

Water recycling plant boundary
Study area
Proposed extent of built form
Indicative building envelope

1:1,500

0 10 20 30 40m

Figure 7.15 Indicative noise contours - water recycling plant

Manidis Roberts

RENZO TONIN & ASSOCIATES
inspired to achieve
Consultants in Acoustics, Vibration and Structural Dynamics
Email: acoustics@rtagroup.com.au www.renzotonin.com.au
Sydney - Ph: (02) 8218 0500 Fax: (02) 8218 0501
Melbourne - Ph: (03) 9606 0041 Fax: (03) 9606 0042
Brisbane - Ph: (07) 3211 9155 Fax: (07) 3211 9188
Gold Coast - Ph: (07) 5593 5633 Fax: (07) 5593 5635
Kuwait - Ph: +0011 965 653 1520
Member of the Association of Australian Acoustical Consultants

Title : Figure 3 - Indicative Noise Contours - Original Water Recycling Plant (Provided by Manidis Roberts)

Project: Googong Water Cycle Project

Date : 07/09/10 | **Scale:** NTS | **Ref** : TF007-01P03 (rev 0)

7 CONSTRUCTION NOISE & VIBRATION ASSESSMENT

7.1 Construction Noise Criteria

The assessment of noise from the proposed construction activities were previously presented in Section 4.6 of the noise assessment report prepared by Heggies Pty Ltd (ref. 10-6690-R1 Revision 4, dated 7 December 2009).

The Heggies assessment refers to Chapter 171 of the NSW *Environmental Noise Control Manual* (ENCM, Environment Protection Authority 1994), which provides guidelines for assessing noise generated during the construction phase of the development. However, the Department of Environment, Climate Change and Water (DECCW) has recently released its *NSW Interim Construction Noise Guideline* (ICNG). This document is the DECCW's standard policy for assessing construction noise. This new guideline supersedes Chapter 171 of the ENCM.

The key components of the guideline that could be incorporated into this assessment include:

1. Use of L_{Aeq} as the descriptor for measuring and assessing construction noise.

   In recent years NSW noise policies including DECCW's NSW Industrial Noise Policy (INP) and the NSW Environmental Criteria for Road Traffic Noise (ECRTN) have moved to the primary use of L_{Aeq} over any other descriptor. As an energy average, L_{Aeq} provides ease of use when measuring or calculating noise levels since a full statistical analysis is not required as when using, for example, the L_{A10} descriptor.

   Consistent with the ICNG we recommend the use of L_{Aeq} as the key descriptor for measuring and assessing construction noise.

2. Application of reasonable and feasible noise mitigation measures

   As stated in the ICNG, a noise mitigation measure is feasible if it is capable of being put into practice, and is practical to build given the project constraints.

   Selecting reasonable mitigation measures from those that are feasible involves making a judgement to determine whether the overall noise benefit outweighs the overall social, economic and environmental effects.

3. Quantitative and qualitative assessment

   The ICNG provides two methods for assessment of construction noise, being either a quantitative or a qualitative assessment.

   A quantitative assessment is recommended for major construction projects of significant duration, and involves the measurement and prediction of noise levels, and assessment against set criteria.

A qualitative assessment is recommended for small projects with duration of less than three weeks and focuses on minimising noise disturbance through the implementation of reasonable and feasible work practices, and community notification.

Given the significant scale of the construction works proposed for the development, a quantitative assessment is carried out herein, consistent with the ICNG's requirements.

7.2 Management Levels

Table 7.1 below (reproduced from Table 2 of the ICNG) sets out the noise management levels and how they are to be applied for residential receivers. The guidelines intend to provide respite for residents exposed to excessive construction noise outside the recommended standard hours whilst allowing construction during the recommended standard hours without undue constraints.

In Table 7.1 below, the rating background level (RBL) is used when determining the management level. The RBL is the overall single-figure background noise level measured in each relevant assessment period (during or outside the recommended standard hours).

Table 7.1 – Noise at Residences Using Quantitative Assessment

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

Time of Day	Management Level $L_{Aeq\ (15\ min)}$*	How to Apply

** Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.*

Unattended long term monitoring to obtain the background noise levels for existing residence surrounding the proposed water recycling plant was previously undertaken by Heggies and are presented in Section 5 of the Heggies report (ref. 10-6690-R1 Revision 4, dated 7 December 2009) and reproduced in Section 3 of this report.

Based on the rating background noise level presented in Table 3.1 above and a quantitative assessment in accordance with the ICNG, the applicable construction noise management levels for the existing residential receivers are summarised below.

Table 7.2 – Summary of Construction Noise Management Levels, dB(A)

Receiver Locations	Time of Day	Management Level $L_{Aeq(15min)}$
All existing residential receivers	During recommended standard hours	30 + 10 = **40**
	Outside recommended hours	30 + 5 = **35**

7.2.1 Recommended Standard Work Hours

In accordance with the ICNG, the recommended standard work hours are:

- Monday to Friday, 7am to 6pm.
- Saturday, 8am to 1pm.
- No construction work to take place on Sundays or Public Holidays.

7.3 Proposed Construction Noise Sources

The construction of the proposed water recycling plant will be conducted in two main phases. Phase one of the construction consists mainly of earthworks which involves constructing the access road and foundation works. The second phase of the construction relates to building works and involves the construction of the proposed water recycling plant.

Actual construction plant and equipment to be used during the construction phases are not yet known. Therefore, typical plant and equipment likely to be used during these construction phases are extracted from the Heggies report and are reproduced Table 7.3 below.

Table 7.3 – Typical Construction Equipment & Sound Power Levels, dB(A) re. 1pW

Plant Item	Plant Description	L_{A10} Sound Power Levels	L_{Aeq} Sound Power Levels[1]
Earthworks			
1	Trucks as required	102	99
2	Excavator Loading	104	101
3	Rock Breaker	116	113
4	Dozer D9	111	108
5	Grader D9	110	107
6	Water truck	109	106
7	Compactor	110	107
8	Backhoe	103	100
Building works			
9	Trucks	102	99
10	Concrete transit mixer	111	108
11	Backhoe	103	100
12	Crane	101	98

Notes: 1. 3dB(A) has been subtracted from L_{A10} source noise levels to obtain equivalent L_{Aeq} source noise levels

7.4 Estimated Noise Levels

The estimated noise levels at the nearest receiver locations affected by construction activities was previously predicted and reported in Section 8.2.1 of the Heggies report. The results in the Heggies report are presented as L_{A10} noise levels; however, the ICNG assesses construction noise based on L_{Aeq} noise levels. Therefore, a correction of -3dB(A) has been applied to the predicted L_{A10} noise levels to obtain the equivalent L_{Aeq} noise levels. The predicted construction noise levels are presented in Table 7.4 below

Table 7.4 – Predicted Earthworks Noise Levels at Receiver Locations, dB(A)

Location	Management Level	Predicted $L_{Aeq(15minutes)}$ Noise Level	Complies?
R1	*40*	**55**	**No**
R2		**48**	**No**
R3		**59**	**No**

Table 7.5 – Predicted Building Works Noise Levels at Receiver Locations, dB(A)

Location	Management Level	Predicted $L_{Aeq(15minutes)}$ Noise Level	Complies?
R1	*40*	**52**	**No**
R2		**45**	**No**
R3		**56**	**No**

From Table 7.4 and Table 7.5 above, it can be seen that noise emission from construction activities will exceed the set noise management levels at the nearest sensitive receivers. Noise

mitigation measures should therefore be considered to minimise noise impact at the residential receivers during construction activities.

7.5 Noise Mitigation Measures

7.5.1 General Engineering Noise Controls

Implementation of noise control measures, such as those suggested in Australian Standard 2436-1981 *Guide to Noise Control on Construction, Maintenance and Demolition Sites* are expected to reduce predicted construction noise levels. Reference to Australian Standard 2436-1981, Appendix E, Table E1 suggests possible remedies and alternatives to reduce noise emission levels from typical construction equipment. Table E2 in Appendix E presents typical examples of noise reductions achievable after treatment of various noise sources. Table E3 in Appendix E presents the relative effectiveness of various forms of noise control treatment.

Table 7.6 below presents noise control methods, practical examples and expected noise reductions according to AS2436 and according to Renzo Tonin & Associates' opinion based on experience with past projects.

Table 7.6 – Relative Effectiveness of Various Forms of Noise Control, dB(A)

Noise Control Method	Practical Examples	Typical noise reduction possible in practice		Maximum noise reduction possible in practice	
		AS 2436	Renzo Tonin & Assoc.	AS 2436	Renzo Tonin & Assoc.
Screening	Acoustic barriers such as earth mounds, temporary or permanent noise barriers	7 to 10	5 to 10	15	15
Acoustic Enclosures	Engine casing lagged with acoustic insulation and plywood	15 to 30	10 to 20	50	30
Engine Silencing	Residential class mufflers	5 to 10	5 to 10	20	20
Substitution by alternative process	Use electric motors in preference to diesel or petrol	15 to 25	15 to 25	60	40

The Renzo Tonin & Associates' listed noise reductions are conservatively low and should be referred to in preference to those of AS2436.

To ensure efficient noise attenuation performances are achieved using any of the methods listed above, it is recommended acoustic engineers work closely with the construction contractors and carry out noise testing of works.

Typical noise treatment options that may be considered for the demolition and excavation activities on the site are summarised below. Note that the ability to implement these measures is subject to site practicality.

1. ***Noise Control Kits*** Where possible, 'noise control kits' could be fitted to plant engines to reduce noise level emissions. Such 'noise control kits' comprise:

- high performance 'residential-grade' exhaust mufflers,
- additional engine cowling / enclosure lined inside with sound absorbent industrial-grade foam, and
- air intake and discharge silencers / louvres.

2. Partial Acoustic Enclosures

Where noise exceedances occur, partial acoustic enclosures may be constructed around noisy plant and equipment, for example air compressors. A partial enclosure can be constructed from 10mm plywood, located on site as close as practical to the plant. The inner face of the plywood enclosure should be lined with 50mm acoustic insulation (eg. Tontine AcoustiSorb2 or TBL 32/50, hydrophobic mineral wool, or equivalent).

Acoustic enclosures should be checked by a suitable acoustic engineer once it is constructed.

3. Hoarding

Where stationary equipment (ie. non-transient activities) are used on site, temporary hoarding between the source and receiver may be erected. The hoarding should be constructed from any durable material with sufficient mass to prevent direct noise transmission eg. steel, aluminium, fibrous-cement, timber, polycarbonate, or any combination of such materials, provided they withstand the weather elements.

Hoarding should be checked by a suitable acoustic engineer once erected.

4. Truck Movement

Potential noise impact from truck movement will be limited by managing the movement of trucks on site. The number of trucks on site should be kept to a minimum, where possible.

7.5.2 Noise Management Measures

In addition to physical and engineering mitigation measures described above, the following noise management measures shall be considered to minimise adverse noise impacts to nearby receivers.

1. Time Management

Where noise level exceedances cannot be avoided or where physical noise control measures are not reasonable or feasible, then consideration should be given to implementing time restrictions and/or providing periods of repose for neighbours. That is, daily periods of respite from noisy activities may be scheduled for building occupants during business hours.

Some items of plant may exceed noise limits even after noise treatment is applied. To reduce the overall noise impact, the use of noisy plant should be restricted to within certain time periods, to be negotiated with stakeholders.

2. General

- Plant and equipment should be properly maintained.
- Provide special attention to the use and maintenance of 'noise control' or 'silencing' kits fitted to machines to ensure they perform as intended.
- Using less noisier plant and equipment.
- Strategically position plant on site to reduce the emission of noise to the surrounding neighbourhood and to site personnel.
- Avoid any unnecessary noise when carrying out manual operations and when operating plant.
- Any equipment not in use for extended periods should be switched off.
- Good relations with people living and working in the vicinity of the construction site should be established at the beginning of the works and be maintained throughout the works, as this is of paramount importance.
- Keep stakeholders informed of progress.
- Take complaints seriously and deal with them expeditiously. The person selected to liaise with the stakeholders should be adequately trained and experienced in such matters.

3. Regular Periodic Noise Monitoring

Noise monitoring should be undertaken at the commencement of works and regular periods at all affected receiver locations identified in this study to provide feedback to management on any noise exceedances, so necessary actions can be taken.

7.6 Construction Vibration

Vibration due to construction activities were previously assessed in Section 8.3 of the Heggies report. Due to the large separation distances between the construction activities and the nearest affected residential receivers, vibration impacts causing human discomfort or structural damage were determined in the Heggies report to be insignificant.

Given that the construction activities associated with the modified and reconfigured water recycling plant will be within the same areas as the original water recycling plant, vibration impacts will also be insignificant and are not expected to cause human discomfort or structural damage at the nearest affected receiver locations.

7.7 Blasting

Geotechnical surveys of the site have indicated the presence of rock near the ground surface at the proposed water recycling plant site, as reported in the Heggies assessment. Due to the presence of rock, blasting may be required as part of the excavation phase of the construction works. Section 8.4 of the Heggies report presents an assessment of blasting by predicting the allowable maximum instantaneous charge (MIC) in order to comply with the blasting requirements for ground vibration and airblast overpressure.

Given that any blasting activities associated with the modified and reconfigured water recycling plant will be within the same areas as the original water recycling plant, blasting impacts and recommended MIC and management measures presented in the Heggies report for the original water recycling plant would also be applicable to the modified and reconfigured water recycling plant.

8 CONCLUSION

Renzo Tonin & Associates have completed an assessment of impacts from the operation and construction of proposed water recycling plant following the modification and reconfiguration to the layout of the water recycling plant. The noise assessment presented in this report has been based on a previous noise assessment undertaken by Heggies Pty Ltd (ref. 10-6690-R1 Revision 4, dated 7 December 2009).

Noise contours from the operation of the modified and reconfigured water recycling plant have been produced and were compared to noise contours previously prepared by Heggies for the original water recycling plant.

The operational noise impacts at the nearest affected residential receivers, following the modification and reconfiguration of the water recycling plant, were found to have decreased and the buffer distance of 45m from the site boundary, as determined by the Heggies assessment for the original water recycling plant, was still applicable.

Noise generated by construction activities is expected to potentially exceed the NSW ICNG requirements for construction noise at the residential receivers. In-principle recommendations are provided in Section 7.5 to limit the potential impact of noise generated by construction activities to acceptable levels.

Vibration and blasting impacts from the modified and reconfigured water recycling plant were determined to be the same as those presented in the Heggies report prepared for the original water recycling plant.

APPENDIX A - GLOSSARY OF ACOUSTIC TERMS

The following is a brief description of the technical terms used to describe noise to assist in understanding the technical issues presented.

Adverse Weather — Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter).

Ambient Noise — The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.

Assessment Period — The period in a day over which assessments are made.

Assessment Point — A point at which noise measurements are taken or estimated. A point at which noise measurements are taken or estimated.

Background Noise — Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the $\mathbf{L_{90}}$ noise level (see below).

Decibel [dB] — The units that sound is measured in. The following are examples of the decibel readings of every day sounds:

0dB The faintest sound we can hear

30dB A quiet library or in a quiet location in the country

45dB Typical office space. Ambience in the city at night

60dB Martin Place at lunch time

70dB The sound of a car passing on the street

80dB Loud music played at home

	90dB The sound of a truck passing on the street
	100dB The sound of a rock band
	115dB Limit of sound permitted in industry
	120dB Deafening
dB(A):	A-weighted decibels The ear is not as effective in hearing low frequency sounds as it is hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter switched on is denoted as dB(A). Practically all noise is measured using the A filter.
Frequency	Frequency is synonymous to pitch. Sounds have a pitch which is peculiar to the nature of the sound generator. For example, the sound of a tiny bell has a high pitch and the sound of a bass drum has a low pitch. Frequency or pitch can be measured on a scale in units of Hertz or Hz.
Impulsive noise	Having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
Intermittent noise	The level suddenly drops to that of the background noise several times during the period of observation. The time during which the noise remains at levels different from that of the ambient is one second or more.
L_{max}	The maximum sound pressure level measured over a given period.
L_{min}	The minimum sound pressure level measured over a given period.
L_1	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L_{10}	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
L_{90}	The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L_{90} noise level expressed in units of dB(A).

L_{eq}	The "equivalent noise level" is the summation of noise events and integrated over a selected period of time.
Reflection	Sound wave changed in direction of propagation due to a solid object obscuring its path.
SEL	Sound Exposure Level (SEL) is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
Sound	A fluctuation of air pressure which is propagated as a wave through air.
Sound Absorption	The ability of a material to absorb sound energy through its conversion into thermal energy.
Sound Level Meter	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound Pressure Level	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound Power Level	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Tonal noise	Containing a prominent frequency and characterised by a definite pitch.