Appendix P – Noise and Vibration Impact Assessment

Hunter Water Corporation

Belmont Drought Response Desalination Plant
Noise and Vibration Assessment

November 2019

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Glossary

Ambient noise	The all-encompassing noise associated within a given environment. It is the composite of sounds from many sources, both near and far.
Background noise	The underlying level of noise present in the ambient noise when extraneous noise is removed. This is described using the L_{A90} descriptor (see also Rating background level).
Decibel	Decibel, which is 10 times the logarithm (base 10) of the ratio of a given sound pressure to a reference pressure; used as a unit of sound.
Ground-borne vibration	Ground-borne vibration is transmitted from source to receiver through the ground.
L_{AN}	Statistical sound measurement recorded on the 'A' weighted scale.
$L_{A1\ (period)}$	The sound pressure level that is exceeded for 1% of the measurement period.
$L_{A90\ (period)}$	The A-weighted sound pressure level that is exceeded for 90 per cent of the time over which a given sound is measured. This is considered to represent the background noise e.g. $L_{A90\ (15\ min)}$.
$L_{Aeq(period)}$	Equivalent sound pressure level: the steady sound level that, over a specified period of time, would produce the same energy equivalence as the fluctuating sound level actually occurring.
L_{Amax}	The maximum sound level recorded during the measurement period.
L_{Amin}	The minimum sound level recorded during the measurement period.
Mitigation	Reduction in severity
Noise sensitive receiver	An area or place potentially affected by noise including residential dwellings, schools, child care centres, places of worship, health care institutions and active or passive recreational areas.
Peak Particle Velocity	Current practices for assessments of the risk of structural damage to buildings use measurements of Peak Particle Velocity (PPV) in millimetres per second.
Rating background level	The overall single-figure background level representing each assessment period (day/evening/night) over the whole monitoring period. This is the level used for assessment purposes.
Receiver	A noise modelling term used to describe a map reference point where noise is predicted.
Short-term vibration	Vibration that occurs so infrequently that it does not cause structural fatigue nor does it produce resonance in the structure.
Sound Pressure Level (SPL)	20 times the logarithm to the base 10 of the ratio of the RMS sound pressure level to the reference sound pressure level of 20 micropascals.
Tonality	Noise containing a prominent frequency or frequencies characterised by a definite pitch.
Vibration dose value	As defined in BS6472 – 1992, the vibration dose value is given by the fourth root of the integral of the fourth power of the frequency weighted acceleration.
Vibration	The variation of the magnitude of a quantity which is descriptive of the motion or position of a mechanical system, when the magnitude is alternately greater and smaller than some average value or reference. Vibration can be measured in terms of its displacement, velocity or acceleration. The common units for velocity are millimetres per second (mm/s).

List of abbreviations

AVTG	Assessing Vibration: A Technical Guideline
CoRTN	Calculation of Road Traffic Noise
CNMLs	Construction Noise Management Levels
CNVG	Construction Noise and Vibration Guideline (RMS 2016)
dB	Decibel
dB(A)	Unit used to measure 'A-weighted' sound pressure levels
DEC	Department of Environment and Conservation (former)
DECCW	NSW Department of Environment, Climate Change and Water (former)
EPA	Environment Protection Authority
ICNG	Interim Construction Noise Guideline
NPI	Noise Policy for Industry
OOHW	Outside of hours work
RBL	Rating background level
REP	Passive recreational receiver
RES	Residential receiver
REA	Active recreational receiver
rms	Root Mean Square
RNP	Road Noise Policy
VDV	Vibration dose value
V_{rms}	The vibration velocity presented as a root mean square value.
PPV	Peak particle velocity
m	Metres
mm	Millimetres
s	Seconds
kHz	Kilohertz
Hz	Hertz

1. Introduction

1.1 Introduction

The Lower Hunter has sufficient water to meet its needs in average climate conditions in the medium term. However, the region's reliance on rain-fed dams and groundwater supplies makes it vulnerable to severe drought.

The Lower Hunter Water Plan (LHWP) was developed in 2014 with the aim to ensure that the Lower Hunter is able to withstand a severe drought as well as meeting community needs in the medium term. Within the plan, desalination is proposed in conjunction with other staged drought response measures in the event of an extreme drought. A drought response desalination plant would help make the water supply system more resilient to climate variability, with the primary benefit being that it would provide a drought contingency measure that is not dependant on rainfall.

Following a number of options assessments, a drought response desalination plant (also referred to as the temporary desalination plant) to be located within the existing wastewater treatment works site at Belmont was selected as the preferred option. Hunter Water submitted a State Significant Infrastructure (SSI) application for the proposal to the Department of Planning and Environment in November 2017 and received the Secretary's Environmental Assessment Requirements (SEARs) in December 2017 (SSI 8896). These SEARs outline the requirements for the preparation of an Environmental Impact Statement (EIS) to assess the future construction and operation of the proposal, with particular requirements for the assessment of noise and vibration.

1.2 Purpose and scope of this report

Construction of the proposal would take longer than three weeks, triggering the requirement to undertake a construction noise impact assessment in accordance with the *Interim Construction Noise Guideline* (ICNG) (DECC 2009).

The scope of work includes:

- Initial review of project information including construction methodology, design plans and proximity of identified sensitive receivers.
- Background noise monitoring for a period of one week at a residential locations near the proposal. Background noise monitoring was conducted to capture existing ambient noise levels from sources such as road traffic and enable site-specific noise goals to be set for the construction and operations of the proposal.
- Noise data was assessed and filtered to remove extraneous noise or adverse weather conditions. Weather data over the monitoring period was obtained from the nearest Bureau of Meteorology Automatic Weather Station.
- The noise monitoring data was used to establish the Project Specific Noise Level (PSNL) for the construction (based on the *Interim Construction Noise Guideline* (ICNG) (DECC, 2009)) and the operational (based on the Noise Policy for Industry (NPI) (EPA 2017)) noise generated.
- A noise model was developed for the proposal based on site layout, plant and equipment sound power levels, and topography. The noise model provided an indication of noise impacts (construction and operational) on the identified nearby noise sensitive receivers.

- Based on the noise model results, the predicted construction noise and operational noise at nearby noise sensitive receivers were compared to the established PSNLs. Where exceedances were predicted, in-principle advice was provided on possible noise attenuation measures to mitigate operational impacts from the site.
- Desktop traffic noise assessment was conducted based on site, delivery and staff vehicle movements on public roads with respect to the established RNP criteria.
- Desktop assessment of construction and operational vibration impacts, with recommendations for noise management and control measures, if warranted.

1.2.1 Secretary's Environmental Assessment Requirements

Hunter Water submitted a State Significant Infrastructure (SSI) application for the proposal with the Department of Planning and Environment (DPE) in November 2017 and received Secretary's Environmental Assessment Requirements (SEARs) in December 2017.

A revised SEARs was issued following comment and discussed between Hunter Water and DPE on 24 January 2018. The SEARs relevant to noise and vibration issues are reproduced in Table 1-1 below.

Table 1-1 SEARs (SSI 8896) – Noise and Vibration

Requirements	Where addressed in Report
An assessment of the likely construction noise impacts of the proposed development in accordance with Interim Construction Noise Guideline (DECC, 2009)	Section 5
An assessment of the likely vibration amenity and structure impacts of the project under the Assessment Vibration: A Technical Guideline i(DECC, 2006) and German Standard DIN 4150-3 Structural Vibration – Effects of vibration on structures	Sections 5.4, 6.4
An assessment of the likely operational noise impacts of the proposed development in accordance with the Noise Policy for Industry (EPA, 2017)	Section 6
Measures to be implemented to minimise noise impacts during both construction and operational phases	Section 7

1.2.2 Limitations

This report has been prepared by GHD for the Hunter Water Corporation and may only be used and relied on by Hunter Water Corporation for the purpose agreed between GHD and Hunter Water Corporation as set out in Section 1.1 of this report.

GHD otherwise disclaims responsibility to any person other than Hunter Water Corporation arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The noise monitoring results outlined in this report represent the findings apparent at the date and time of the monitoring survey and the conditions of the subject area at the time. It is the nature of environmental assessments that all variations in environmental conditions cannot be accessed and all uncertainty concerning the conditions of the ambient noise environment cannot be eliminated. Professional judgement must be exercised in the investigation and interpretation of observations.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

1.2.3 Assumptions

GHD has undertaken this assessment based on the following assumptions:

- Intake dewatering will be conducted outside of standard construction hours. All other construction work will be during standard day time construction hours only, as specified in the ICNG. If any additional construction work needs to be carried out outside of standard hours, additional assessments will need to be conducted.
- The source sound power and vibration levels of the construction plant and equipment are similar or less than those levels stated in this report.
- The assessment has been conducted based on information from the concept design phase. The assessment will be updated at detailed design phase, if detail changes substantiates it.
- Belmont wastewater treatment works, being part of Hunter Water Corporation operations, does not need to be assessed as a sensitive receiver.

2. The Project

2.1 Project location

The drought response desalination plant is proposed to be located on the southern portion of the current wastewater treatment works (WWTW) site, off Ocean Park Road, to the east of the Pacific Highway. The proposed plant is located to the east of the Belmont Lagoon and to the west of the coastal dunes along Nine Mile Beach, as shown in Figure 2-1.

2.2 Project description

2.2.1 Objectives

The key objectives of the Project are to:

- Provide a rainfall independent water source in the event of an extreme drought
- Slow the depletion of existing water storages in the event of an extreme drought

The Project would address these objectives while considering the environmental, social and economic impacts, with the options assessment process considering these factors.

2.2.2 Key features

The Project is for the construction and operation of a drought response desalination plant, designed to produce up to 15 ML/day of potable water, with key components including:

- **Seawater intakes** – The central intake structures would be a concrete structure (referred to as a caisson) of approximately nine to 11 metres diameter, installed to a depth up to 20 m below existing surface levels. The intake structures will be finished above the existing surface (0.5 m to 1 m) to prevent being covered by dune sands over time. The raw feed water (seawater) input is proposed to be extracted from a sub-surface saline aquifer. This would be extracted by intake pipes located approximately eight to 15 m below ground level radiating out from the central structure. Pipelines and pumps are required to transfer the seawater to the desalination plant.
- **Water treatment process plant** – The water treatment process plant would comprise a range of equipment potentially in containerised form. Services to and from the process equipment (e.g. power, communications, and raw feed water (seawater)) would comprise a mix of buried and overhead methods. The general components of the water treatment process would comprise:
  - Pre-treatment: a pre-treatment system is required to remove micro-organisms, sediment, and organic material from the seawater.
  - Desalination: a reverse osmosis (RO) desalination system made up of pressurising pumps and membranes. These would be comprised of modular components. In addition, a number of tanks and internal pipework would be required.
  - Post treatment: desalinated water would be treated to drinking water standards and stored prior to pumping to the potable water supply network.
- **Brine disposal system** – The desalination process would produce around 28 ML/day of wastewater, comprising predominantly brine, as well as a small amount of pre-treatment and RO membrane cleaning waste. The waste brine from the desalination process would be transferred via a pipeline to the existing nearby Belmont WWTW for disposal via the existing ocean outfall pipe.

- **Power supply** – Power requirements of the plant would be met by a minor upgrade to the existing power supply network in the vicinity of Hudson and Marriot Streets. A power line extension from the existing line along Ocean Park Road into a new substation within the proposed drought response desalination plant would also be required.
- **Ancillary facilities** – including a tank farm, chemical storage and dosing, hardstand areas, stormwater and cross drainage, access roads, and fencing, signage and lighting.

A description of each of the key components of the Project is provided in Section 4 of the EIS.

The potable water pipelines connecting the Project to the potable water network do not form part of the Project and would be constructed separately. The construction and operation of the potable water pipeline would be part of a separate design and approvals process.

Paper Size ISO A4

0 50 100 150 200

Metres

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

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Hunter Water Corporation
Belmont Temporary Desalination Plant
Noise and Vibration Impact Assessment

The Project

Project No. **22-19573**
Revision No. **0**
Date **10/10/2019**

Figure 2-1

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Print date: 10 Oct 2019 - 11:33

Data source: LPI: DTDB / DCDB, 2017; public_NSW_Imagery: . Created by: TMorton

3. Existing environment

3.1 Sensitive receivers

There are sensitive receivers near the Project area, which may be impacted by noise from the construction works and operation of the proposed plant. Figure 3-1 shows the Project and construction impact areas relative to the surrounding area. The nearby sensitive receivers identified, via aerial imagery, are categorised as:

- Residential
- Commercial/Retail
- Hotel/Motel (Belmont Executive Apartments, Lakeview Motor Inn, Squid's Ink Motel, Gunyah Hotel)
- Active recreation (Belmont Golf Club, Nine Mile Beach, Belmont South Playground)
- Passive recreation (Belmont Cemetery)
- Education (St Francis Xavier's Primary School, Creative Kids Preschool, Belmont TAFE)

3.2 Noise levels

Baseline unattended noise monitoring was conducted in accordance with the procedures in the *Noise Policy for Industry* (NPI, 2017) guideline at one location. The noise logger was deployed at 24 Beach Street, South Belmont.

This logger location was selected to capture noise characteristics considered representative of the proposal area. Selection considerations included location of sensitive receivers, land topography and contribution from other noise activities, such as road noise. The logger location used for the assessment was considered to be representative of the existing background and ambient noise environment in the study area and can be seen in Figure 3-1.

The objectives of the monitoring were to measure the existing background noise levels in the areas surrounding the proposal area.

The noise logger was programmed to accumulate L_{A90}, L_{A10}, L_{Aeq} and L_{Amax} noise descriptors continuously over sampling periods of 15 minutes for the entire monitoring period. An attended noise measurement was also conducted for a 15 minute duration to identify ambient noise sources and validate unattended logger data. Instantaneous noise levels for operator-identified noise sources were observed and noted during the measurements.

Prior to deployment, a calibration check was performed on the noise monitoring equipment using a Bruel and Kjaer 4231 sound level calibrator (serial number 2542101). Upon completion of the measurements, the equipment was re-checked to ensure the sensitivity of the noise monitoring equipment had not varied. The noise loggers were found to be within the acceptable tolerance of ± 0.5 dB(A).

The data collected by the logger was downloaded and analysed and any invalid data removed. Invalid data generally refers to periods of time where average wind speeds were greater than 5 m/s, or when rainfall occurred in accordance with the NPI. Concurrent half hourly weather data was sourced from the Bureau of Meteorology's (BoM) automatic weather station at Marrangaroo (ID 063308) to identify any periods of weather which may have affected the monitoring results.

All sampling activities were undertaken with consideration to the specifications outlined in AS 1055 (2018) *Acoustics - Description and Measurement of Environmental Noise* and the *Noise Policy for Industry* (NPI, 2017). Table 3-1 provides details of the noise logger utilised for unattended monitoring.

Table 3-1 Unattended noise logger details

Noise Logger	L01
Location	24 Beach Street, South Belmont
Equipment type (serial)	SVAN 955 (s/n 27625)
Measurement started	23/9/19 11:30 pm
Measurement ceased	30/9/19 12:00 pm
Frequency weighting	A-weighted
Photo	

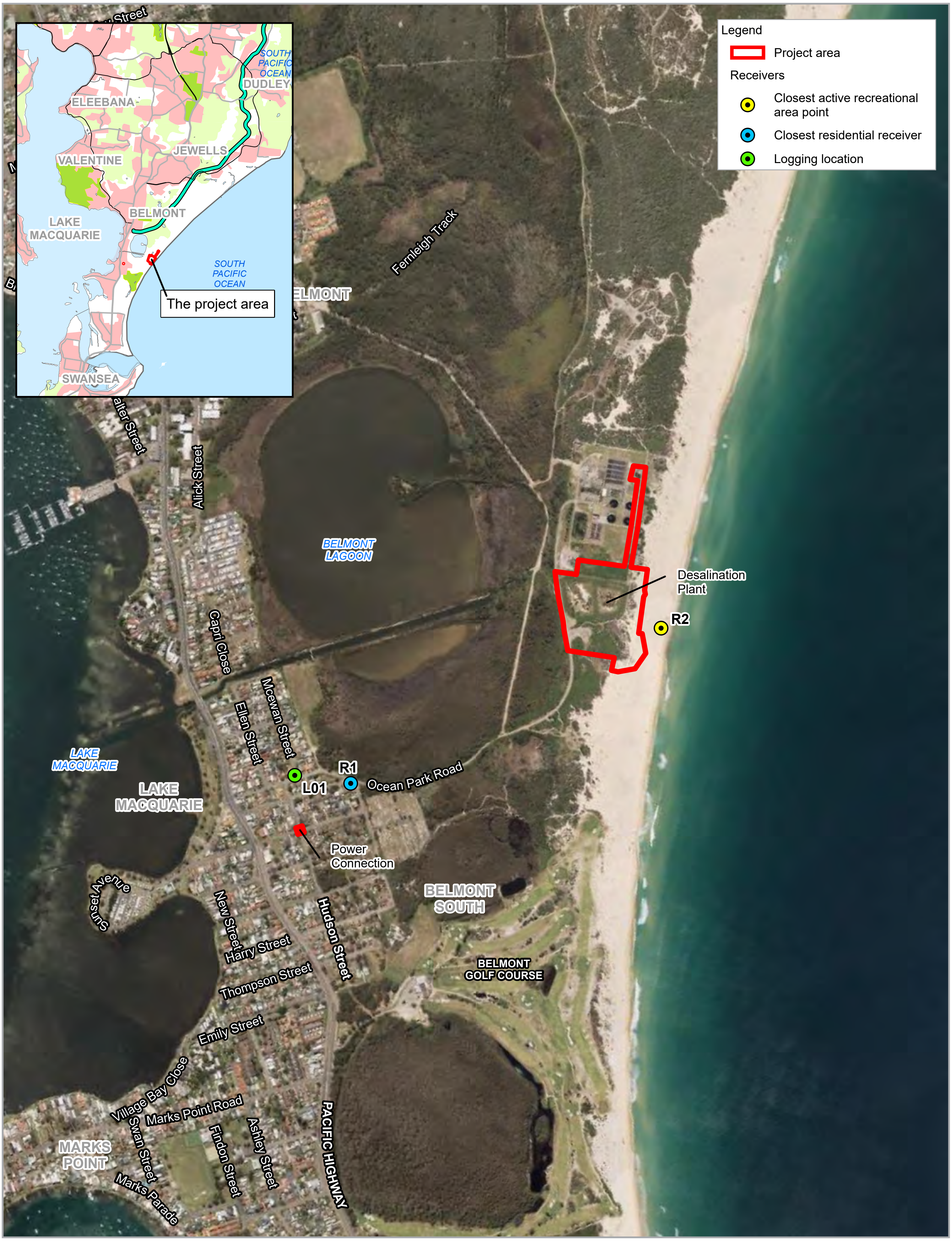
The rating background levels (RBL) and ambient noise levels are summarised in Table 3-2.

Table 3-2 Unattended Noise Monitoring Results

Location	L_{A90} RBL noise levels dB(A)			L_{Aeq} ambient noise levels dB(A)		
	Day	Evening	Night	Day	Evening	Night
24 Beach St, Belmont	38	37	33	55	50	47

Note: Day time: 7:00 am to 6:00 pm Monday to Saturday; or 8:00 am to 6:00 pm on Sundays and Public Holidays. Evening: 6:00 pm to 10:00 pm. Night time: remaining period (NSW Noise Policy for Industry (NPI), 2017)

The background and ambient noise levels of the area are influenced by road traffic from the Pacific Highway. Natural white noise from South Pacific Ocean and Belmont Bay are also audible during quieter periods when traffic volumes drop.



Paper Size ISO A4

0 110 220 330 440

Metres

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

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Belmont Temporary Desalination Plant
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Project location and surrounding area

Project No. **22-19573**
Revision No. **0**
Date **10/10/2019**

Figure 3-1

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Print date: 10 Oct 2019 - 11:30

Data source: LPI: DTDB / DCDB, 2017; public_NSW_Imagery: . Created by: TMorton

4. Regulatory requirements

4.1 Construction noise

4.1.1 General

Construction noise criteria were developed in accordance with the *Interim Construction Noise Guideline* (ICNG) (DECC, 2009) for each noise catchment area. Standard hours defined in the guideline are:

- 7:00 am to 6:00 pm Monday to Friday
- 8:00 am to 1:00 pm on Saturday
- No work on Sundays or public holidays

The proposed construction activities are expected to generally occur during the standard construction hours. However, dewatering activities during the intake construction will need to occur continuously to remove water from the well.

The ICNG acknowledges that the following activities can be justified to be conducted outside the recommended construction hours:

- The delivery of oversized plant or structure
- Emergency work
- Works for which it can be demonstrated that there is a need to operate outside the recommended standard hours
- Works which maintain noise levels at receivers below the night time noise affected construction noise management levels

For recommended standard hours, the following terms are used in relation to establishment of construction noise criteria:

- The 'noise affected level' represents the point above which there may be some community reaction to noise. For standard construction hours this level is established with reference to the measured rating background level (RBL) (described in Table 4-1) plus 10 dB(A). Outside standard construction hours this level is the RBL plus 5 dB(A).
- The 'highly noise affected level' represents the point above-which there may be strong community reaction to noise. This level is set at $L_{Aeq(15min)}$ 75 dB(A).

The construction noise management levels (CNMLs) that apply to sensitive receivers within each noise catchment area during construction of the Project are presented in Table 4-1.

Table 4-1 ICNG CNMLs at identified receivers, dB(A)

Receiver Type	ICNG Management Level $L_{Aeq(15min)}$ dB(A)[1]			
	Highly affected noise level	During standard construction hours	Outside standard construction hours (day[1])	Outside standard construction hours (night[2])
Residential	75 dB(A)	48 dB(A)	43 dB(A)	38 dB(A)[3]
School	-	45 dB(A) Internal (When in use)	-	-
Retail outlets	-	70 dB(A) External	70 dB(A) External	70 dB(A) External
Active recreation area	-	65 dB(A) External	65 dB(A) External	65 dB(A) External

[1]Outside standard construction hours (day) is defined as 7:00 am to 8:00 am and 1:00 pm to 6:00 pm on Saturdays, 8:00 am to 6:00 pm Sundays and public holidays.

[2] Outside standard construction hours (night) is defined as 6:00 pm to 7:00 am Monday to Friday and 6:00 pm to 8:00 am on Saturdays, Sundays and public holidays.

[3] Criteria based on night time RBL.

4.1.2 Construction traffic noise criteria

The Road Noise Policy (DECCW, 2011) provides traffic noise target levels for receivers in the vicinity of existing roads. These levels are applied to construction works to identify potential construction traffic impacts and the subsequent need for reasonable and feasible mitigation measures. Table 4-2 presents the applicable criteria relating to noise due to additional traffic generated during construction of the Project.

Table 4-2 Construction traffic noise criteria – L_{Aeq} dB(A)

Type of receiver	Assessment criteria - Day (7:00 am – 10:00 pm)
Existing residences affected by additional traffic on existing arterial roads generated by land use developments*	60 $L_{Aeq(15hr)}$ dB(A) (external)
Existing residences affected by additional traffic on existing local roads generated by land use developments*	55 $L_{Aeq(1hr)}$ dB(A) (external)

* Under the RNP this is any land use that causes additional traffic. Construction is considered a land use.

Based on the Road Noise Policy (DECCW, 2011) it is considered that where road traffic noise levels already exceed the assessment criteria, an increase of less than 2 dB(A) represents a minor impact that is barely perceptible to the average person.

4.1.3 Construction vibration criteria

Human comfort

Vibration criteria for human comfort have been established with consideration to the, *Assessing Vibration: A Technical Guideline* (AVTG) (February 2006) for guidance on human exposure to vibration.

The AVTG separates sources of vibration into continuous, impulsive and intermittent and explains that each category should be assessed differently. Vibration from construction work, passing heavy vehicles, and piling is provided as an example of an intermittent source of vibration which is to be assessed using the vibration dose value (VDV) method.

While the AVTG recommends that for intermittent vibration VDV is used as the primary indicator for human comfort, the British Standard BS 5228-2:2009 *Code of practice for noise and vibration on construction and open sites – Part 2: Vibration* guidance can be used as an additional indicator of perceptibility. BS 5228-2 recommends the guidance values presented in Table 4-3. These values are often more suitable for construction works as available information for construction activities and equipment is typically in the form of a peak particle velocity value rather than a dose value.

Table 4-3 Guidance on effects of vibration levels

Vibration Level	Effect
0.14 mm/s	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.
0.30 mm/s	Vibration might be just perceptible in residential environments.
1.00 mm/s	It is likely that vibration of this level in residential environments will cause complaint, but can be tolerated if prior warning and explanation has been given to residents.
10.0 mm/s	Vibration is likely to be intolerable for any more than a very brief exposure to this level.

Cosmetic damage

Vibration criteria for cosmetic damage have been established with consideration to:

- British Standard BS 7385:1993 *Evaluation and Measurement for Vibration in Buildings – Part 2: Guide to Damage Levels from Ground Borne Vibration* for guidance on cosmetic damage to residential buildings.
- German Standard DIN 4150-3: 2016 *Vibrations in buildings – Part 3: Effects on structures* for guidance on cosmetic damage to heritage buildings.

BS 7385:1993 provides guidance on vibration level likely to cause cosmetic damage to residential buildings or reinforced structures. The guide is reproduced below in Table 4-4.

Table 4-4 Transient vibration guide for cosmetic damage (BS 7385:1993)

Type of building	Peak component particle velocity in frequency range of predominant pulse	
	4 Hz to 15 Hz	15 Hz and above
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
Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	

Table 4-5 Guideline values for short term vibration on structures (DIN 4150-3)

Type of structure	Guideline values for velocity, (mm/s)		
	1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz
Buildings used for commercial purposes, industrial buildings, and buildings of similar design	20	20 to 40	40 to 50
Dwellings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20
Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2 and are of great intrinsic value (for example heritage listed buildings)	3	3 to 8	8 to 10

4.2 Operational noise

4.2.1 Project noise trigger level

The *Noise Policy for Industry* (EPA, 2017) provides guidance on the assessment of operational noise impacts. Operational noise impacts from a development is assessed against a Project noise trigger level that, if exceeded, indicates a potential noise impact on the community. The Project noise trigger level is the lower value of the intrusiveness noise level and the amenity noise level.

Project intrusiveness noise level

The intrusiveness noise level aims to protect against significant changes in noise levels. Typically, this will be the Project noise trigger level in areas with low existing background noise levels. The intrusiveness noise level is determined by a 5 dBA addition to the measured background noise level. The NPI (EPA, 2017) recommends that the intrusive noise criteria for the evening period should not exceed the day-time period and the night-time period should not exceed the evening period. The intrusive noise criteria are only applicable to residential receivers.

Project amenity noise level

The recommended amenity noise level is the noise level objective for total industrial noise at a receiver and are determined based on the overall acoustic characteristics of the receiver area, the receiver type and the existing level of industrial noise.

The Project amenity noise level represents the noise level objective for noise from a single development. It aims to limit the cumulative noise impacts from other industries and developments on all receiver types. The Project amenity noise level is determined by a 5 dBA subtraction from the recommended amenity noise level for receivers that are not impacted by more than four individual industrial noise sources.

To standardise the time periods for the intrusiveness and amenity noise levels, the Project amenity noise level is corrected using a 3 dBA addition such that noise is assessed over a 15 minute period and not over the standard day, evening and night-time periods.

The Project amenity noise level may be modified in the following cases:

- Developments within high traffic noise levels
- Developments located near or inside an existing or proposed industrial cluster
- Where the project amenity noise level is at least 10 dBA lower than the existing industrial noise level
- Where there are no other existing or proposed industries within the development area

The NPI amenity criteria for the identified receiver types surrounding the Project area are provided in Table 4-6.

Table 4-6 Noise Policy for Industry amenity noise levels

Receiver type	Time of day	Recommended amenity $L_{Aeq(period)}$ noise level, dBA
Residential – suburban	Day	55
	Evening	45
	Night	40
Hotels/motels		5 dB(A) above residential amenity noise level
Commercial	All	65
School Classroom - internal	Noisiest 1-hour	35
Active recreation	All	55

Maximum noise level events

The NPI recommends a maximum noise level assessment to assess the potential for sleep disturbance impacts which include awakenings and disturbance to sleep stages. An initial screening test for the maximum noise levels events should be assessed to the following levels.

- $L_{Aeq(15min)}$ 40 dBA or the prevailing RBL plus 5 dB, whichever is greater, and/or
- L_{AFmax} 52 dBA or the prevailing RBL plus 15 dB, whichever is greater

If the screening test indicates there is a potential for sleep disturbance then a detailed maximum noise level assessment should be undertaken. The detailed assessment should cover the maximum noise level, the extent to which the maximum noise level exceeds the rating background noise level, and the number of times this happens during the night-time period.

Project noise trigger levels

The Project noise trigger levels for the sensitive receivers identified are provided in Table 4-7.

Table 4-7 Project noise trigger levels, dBA

Receiver	Time period	Project amenity noise level[1,2], $L_{Aeq(15 min)}$	Intrusiveness noise level, $L_{Aeq(15 min)}$[3]	Project noise trigger level, dBA
Residential – suburban	Day	53	43	43 $L_{Aeq(15 min)}$
	Evening	43	42	42 $L_{Aeq(15 min)}$
	Night	38	38	38 $L_{Aeq(15 min)}$
				52 L_{AFMax} 40 $L_{Aeq(15min)}$ (*Sleep disturbance*)
Hotels/motels	Day	58	-	58 $L_{Aeq(15 min)}$
	Evening	48	-	48 $L_{Aeq(15 min)}$
	Night	43	-	43 $L_{Aeq(15 min)}$
Commercial	All	63	-	63 $L_{Aeq(15 min)}$
School Classroom - internal	When in use	35 ($L_{Aeq,1hr}$)	-	35 $L_{Aeq(1hr)}$
Active Recreation	When in use	53		53 $L_{Aeq(15 min)}$

Note 1: The project amenity noise levels have been calculated by subtracting 5 dBA from the recommended amenity noise levels as the identified receivers are not impacted by more than four individual industrial noise sources.

Note 2: The NPI recommends applies a 3 dBA addition to the $L_{Aeq(period)}$ noise level to convert the amenity noise level to a $L_{Aeq(15 min)}$

Note 3: Intrusiveness noise level is equal to the recommended RBL plus 5 dB(A).

4.2.2 Low frequency, tonal and impulsive noise

The NPI (EPA, 2017) requires that modifying factor adjustments are added to the measured or predicted noise levels if the noise sources contain tonal, low frequency or impulsive noise characteristics These noise characteristics can cause greater annoyance to the community than other noise at the same noise level. The modifying factor adjustments are summarised in Table 4-8 and are assessed at the receiver.

Low frequency noise is assessed through a comparison between the measured or predicted C and A weighted levels at each receiver. The A-weighting curve is used to approximate the sensitivity of the human ear at low levels. The C-weighting curve is designed to be more responsive to low-frequency noise.

Table 4-8 Modifying factor adjustments

Factor	Assessment/ measurement	When to apply	Correction[1,2]
Tonal noise	One-third octave or narrow band analysis	Level of one-third octave band exceeds the level of the adjacent bands on both sides by: • 5 dB or more if the centre frequency of the band containing the tone is in the range 500 – 10,000 Hz • 8 dB or more if the centre frequency of the band containing the tone is in the range 160 – 400 Hz • 15 dB or more if the centre frequency of the band containing the tone is in the range 25 – 125 Hz	5 dBA[2]
Low frequency noise	Measurement of C-weighted and A-weighted level	Measure/assess C and A weighted levels over same time period. Correction to be applied if the difference between the two levels is 15 dB or more and: • Where any of the one-third octave noise threshold level are exceeded by up to and including 5 dB and cannot be mitigated, a 2-dBA positive adjustment to measured/predicted A-weighted levels applies for the evening/night period • Where any of the one-third octave noise threshold levels are exceeded by more than 5 dB and cannot be mitigated, a 5-dBA positive adjustment to measured/predicted A-weighted levels applies for the evening/night period and a 2-dBA positive adjustment applies for the daytime period.	5 dBA[2]
Impulsive noise	A-weighted fast response and impulse response	If the difference in A-weighted maximum noise levels between fast response and impulse response is greater than 2 dB.	Apply the difference in measured noise levels as the correction up to a maximum of 5 dBA

Factor	Assessment/ measurement	When to apply	Correction[1,2]
Intermittent noise	Subjectively assessed	The source noise heard at the receiver varies by more than 5 dBA and the intermittent nature of the noise is clearly audible. This adjustment is applied to the night-time period only.	5 dBA
Duration[3]	If the duration of the noise event in any 24 hour period is as follows: • 1.0 to 2.5 hours then increase the noise criteria by 2 dBA day and 0 dBA night • 15 minutes to 1 hour then increase the noise criteria by 5 dBA day and 0 dBA night • 6 minutes to 15 minutes then increase the noise criteria by 7 dBA day and 2 dBA night • 1.5 minutes to 6 minutes then increase the noise criteria by 15 dBA day and 5 dBA night • less than 1.5 minutes then increase the noise criteria by 20 dBA day and 10 dBA night		

Note 1: Where two or more modifying factors are present the maximum correction is limited to 10 dBA.

Note 2: Where a source emits a tonal and low-frequency noise, only one 5 dB correction should be applied if the tone is in the low frequency range.

Note 3: Duration correction is a negative correction which increases the noise criteria.

4.2.3 Operational traffic

The *Road Noise Policy* (RNP) (DECCW, 2011) provides traffic noise criteria for residential receivers in the vicinity of existing roads (Table 4-9). The criteria is applied to operational and construction traffic on public roads to identify potential road traffic impacts and the requirement for feasible and reasonable mitigation measures.

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

If road traffic noise increases during operation are within 2 dBA of current levels then the objectives of the RNP are met and no specific mitigation measures are required.

Table 4-9 Road traffic noise criteria, $L_{Aeq(period)}$, dBA

Type of Development	Day 7:00 am to 10:00 pm	Night 10:00 pm to 7:00 am
Existing residence affected by additional traffic on arterial roads generated by land use developments	60 $L_{eq(15\ hour)}$	55 $L_{eq(9\ hour)}$
Existing residence affected by additional traffic on local roads generated by land use developments	55 $L_{eq(1\ hour)}$	50 $L_{eq(1\ hour)}$

5. Construction impact assessment

5.1 Construction works noise

The construction works are expected to take more than three weeks to complete. According to the ICNG, a quantitative assessment method has been applied to evaluate the potential noise impact from the construction activities. The construction activities associated to the Project are:

- Planning, mobilisation and preparation
- Pipeline and civils
  – Desalination plant earthworks and hardstand
  – Desalination plant pipeline connection
- Intakes
  – Caisson installation
  – Intake installation
  – Commissioning
- Treatment Plant
  – Tank installation
  – Concrete components
  – Containerised equipment
- Power Upgrades

The assessment of the different construction scenarios are detailed in the following sections.

5.1.1 Methodology

Acoustic modelling was undertaken using SoundPLAN (Version 8.0) software to predict noise levels at the nearest sensitive receivers due to construction activities, as described above.

SoundPLAN is a computer program for the calculation, assessment and prognosis of noise propagation. SoundPLAN calculates sound propagation according to ISO 9613-2, "*Acoustics – Attenuation of sound during propagation outdoors*". The ISO 9613-2 algorithm also takes into account the presence of a well-developed moderate ground based temperature inversion, such as commonly occurs on clear, calm nights or 'downwind' conditions which are favourable to sound propagation.

Ground absorption, reflection, and terrain are taken into account in the calculations. Shielding from buildings and other structures have not been taken into account, which provides a measure of conservatism in the predictions.

The noise model inputs and assumptions for the construction assessment are provided in Table 5-1.

Table 5-1 Construction noise modelling assumptions

Modelling component	Assumption
Prediction algorithm	*ISO 9613 – 2 Acoustics – Attenuation of sound during propagation outdoors*
Modelling period	Typical worst case 15 minute period of operation where all listed equipment are running simultaneously at full power.
Meteorology	ISO 9613 considers the presence of a well-developed moderate ground based temperature inversion, such as commonly occurs on clear, calm nights or 'downwind' conditions which are favourable to sound propagation.

Modelling component	Assumption
Atmospheric absorption	Average temperature of 10ºC and an average humidity of 70%.
Ground absorption coefficient	G = 0.75 (where G=0 represents hard reflective ground and G=1 represents soft porous ground)
Receiver heights	1.5 m above building ground level (ground floor)

5.1.2 Noise sources

The equipment anticipated to be used for the different construction scenarios are summarised in Table 5-2. The sound power levels are sourced from BS 5228-1:2009 *Code of practice for noise and vibration control on construction and open sites.*

Table 5-2 Construction equipment – Standard construction hours

Scenario	Equipment name	Sound power level, dB(A)	Qty	Adopted Sound Power Level, dB(A)	Location
Planning, mobilisation and preparation.	15t Excavator	107	1	111	Desalination plant site; and Hudson Street and Marriott Street intersection
	Hand tools	102	1		
	Heavy vehicles	107	1		
	Light vehicles	78	2		
Desalination plant earthworks and hardstand	Dozer	107	1	117	Desalination plant site
	15t Excavator	107	1		
	Compressor	101	1		
	Generator	99	1		
	Concrete pump	108	1		
	Vibratory roller	108	1		
	Grader	110	1		
	Water cart	101	1		
	Concrete truck	109	1		
	Heavy vehicles	107	2		
	Light vehicles	78	2		
Desalination plant pipeline connections	15t Excavator	107	1	111	Desalination plant site
	Generator	99	1		
	Franna Crane	104	1		
	Hand tools	102	2		
	Welding equipment	105	1		
Caisson installation	Pump	97	1	114	Desalination plant site
	Generator	99	1		
	Compressor	101	1		
	15t Excavator	107	1		
	30t Crane	104	1		
	Concrete truck	109	1		
	Heavy vehicles	107	1		

Scenario	Equipment name	Sound power level, dB(A)	Qty	Adopted Sound Power Level, dB(A)	Location
Intake installation	Pump	97	1	120	Desalination plant site
	Generator	99	1		
	Welding equipment	105	1		
	15t Excavator	107	1		
	30t Crane	104	1		
	Microtunnel/drilling rig	114	1		
	Concrete saw	117	1		
	Heavy vehicles	107	1		
Commissioning	Pump	97	1	108	Desalination plant site
	Generator	99	1		
	Heavy vehicles	107	1		
Tank Installation	30t Crane	104	1	118	Desalination plant site
	Generator	99	1		
	Compressor	101	1		
	Pneumatic tools	116	1		
	Welding equipment	105	1		
	Heavy vehicles	107	2		
Concrete components	Concrete truck	109	1	113	Desalination plant site
	Concrete pump	108	1		
	Generator	99	1		
	Light vehicles	78	1		
	Hand tools	102	2		
Containerised equipment	30t Crane	104	1	118	Desalination plant site
	Generator	99	1		
	Compressor	101	1		
	Pneumatic tools	116	1		
	Welding equipment	105	1		
	Heavy vehicles	107	2		
Power upgrade	15t Excavator	107	1	118	Hudson Street and Marriott Street intersection
	Cherry picker	105	1		
	Concrete/asphalt	109	1		
	Compactor	113	1		
	Hand tools	102	1		
	Horizontal directional drill	117	1		
	Heavy vehicles	107	1		

To construct the subsurface seawater intake, a deep well needs to be excavated to install the central well (caisson). The well will require dewatering 24 hours per day, 7 days per week and needs to be assessed for construction noise impacts outside of standard hours.

Table 5-3 Construction equipment - Outside of standard construction hours

Scenario	Equipment name	Sound power level, dB(A)	Qty	Adopted Sound Power Level, dB(A)	Location
Intake dewatering	Generator	97	1	101	Desalination plant site; and Hudson Street and Marriott Street intersection
	Pump	99	1		

5.1.3 Predicted noise impact

Construction activities take place in two areas; the temporary desalination plant site and the intersection of Hudson Street and Marriott Street. Refer to Figure 2-1 for location.

Desalination plant site

Sensitive receivers - Active recreational areas

The temporary desalination plant is located adjacent to Nine Mile Beach (active recreational area), which would be the most susceptible to noise impacts from the construction activities. Table 5-4 shows the predicted noise level at the nearest point of Nine Mile Beach.

Table 5-4 Construction noise impact – Nine Mile Beach

Construction Scenario	Construction Noise Management Level (CNML) dB(A)	Predicted noise level, dB(A)
Standard construction hours		
Planning, mobilisation and preparation.	65	48
Desalination plant earthworks and hardstand		57
Desalination plant pipeline connections		55
Caisson installation		54
Intake installation		61
Commissioning		48
Tank Installation		56
Concrete components		52
Containerised equipment		56
Outside of standard construction hours		
Intake dewatering	65	43

Sensitive receivers – All other receivers

The site is near a suburban area with a range of different sensitive receivers. The next closest sensitive receiver is a residential receiver, which has the most stringent criteria compared to other sensitive receivers. Compliance at this residential receiver would imply compliance for all other sensitive receivers nearby.

The nearest residential receiver to the desalination plant is 33 Williams Street, Belmont. Table 5-5 shows the predicted noise level at the nearest residential receiver. The noise contours for construction activities during standard construction hours are provided in Appendix A. Noise contours for construction activities outside of standard hours are provided in Appendix B.

Table 5-5 Construction noise impact – 33 Williams Street, Belmont

Construction Scenario	Construction Noise Management Level (CNML) dB(A)	Predicted contribution noise level, dB(A)
Standard construction hours		
Planning, mobilisation and preparation.	48	31
Desalination plant earthworks and hardstand		39
Desalination plant pipeline connections		37
Caisson installation		36
Intake installation		39
Commissioning		31
Tank Installation		37
Concrete components		33
Containerised equipment		37
Outside of standard construction hours		
Intake dewatering	38	22

All construction activities associated with the construction of the temporary desalination plant are predicted to comply with the CNML.

5.1.3.1 Hudson Street and Marriott Street intersection

The construction works at this location is in close proximity to residential receivers, with the nearest receiver being within 20 metres of the works. The worst case construction scenario is from the Power upgrade works. It is predicted that these works will have a noise impact on nearby receivers.

- The noise impact on residential receivers within 45 metres of the work will be above the 75 dB(A) "Highly Affected" noise level.
- The noise impact on residential receivers within 500 metres of the work will be above the 48 dB(A) CNML noise level.

The predicted noise contours can be found in Appendix A. It should be noted that the noise assessment has been on a worst case scenario where all anticipated equipment are operating at maximum levels simultaneously.

The construction activities at Hudson Street and Marriott Street intersection are expected to take less than three weeks. Although the works will be conducted during standard construction work hours and have short term noise impacts on the surrounding sensitive receivers; it is recommended that mitigation methods outlined in Section 7 are implemented, where reasonable and feasible.

5.2 Site compound

A quantitative construction noise assessment was undertaken to evaluate potential noise impacts from site compounds. Works at site compounds would take place during standard construction hours (7:00 am to 6:00 pm Monday to Friday and 8:00 am to 1:00 pm on Saturday) and would include activities such as deliveries, temporary stockpile and storage or material and parking of plant and equipment.

5.2.1 Methodology

Acoustic modelling was undertaken using SoundPLAN (Version 8.0) software to predict noise levels at the nearest sensitive receivers due to construction compounds.

SoundPLAN is a computer program for the calculation, assessment and prognosis of noise propagation. SoundPLAN calculates sound propagation according to ISO 9613-2, "*Acoustics – Attenuation of sound during propagation outdoors*". The ISO 9613-2 algorithm also takes into account the presence of a well-developed moderate ground based temperature inversion, such as commonly occurs on clear, calm nights or 'downwind' conditions which are favourable to sound propagation.

Ground absorption, reflection, terrain and relevant shielding objects are taken into account in the calculations.

The noise model inputs and assumptions for the construction assessment are provided in Table 5-6.

Table 5-6 Construction noise modelling assumptions

Modelling component	Assumption
Prediction algorithm	*ISO 9613 – 2 Acoustics – Attenuation of sound during propagation outdoors*
Modelling period	Typical worst case 15 minute period of operation where all listed equipment are running simultaneously at full power
Meteorology	ISO 9613 considers the presence of a well-developed moderate ground based temperature inversion, such as commonly occurs on clear, calm nights or 'downwind' conditions which are favourable to sound propagation
Atmospheric absorption	Average temperature of 10ºC and an average humidity of 70%
Ground absorption coefficient	G = 0.75
Receiver heights	1.5 m above building ground level (ground floor)

5.2.2 Noise sources

The indicative compound will be located in the south west corner of the Project area. It is expected that all the construction activities being assessed will use that compound. The noise assessment has been based on this location as it will be closest to the nearest residential receiver to present a worst case scenario.

The equipment anticipated to be used for the compounds are summarised in Table 5-7.

Table 5-7 Construction equipment - Compounds

Scenario	Equipment name	Sound power level, dB(A)	Qty	Adopted Sound Power Level, dB(A)	Location
Compounds	Excavator	107	1	112	South west of desalination plant site
	Delivery trucks	107	2		
	Light vehicles	78	2		

5.2.3 Predicted noise impact

Sensitive receivers - Active recreational areas

The Project would be located adjacent to Nine Mile Beach, which is considered as an active recreational area. Table 5-8 shows the predicted compound noise impact level at the nearest point of the beach.

Sensitive receivers – All others

The Project is near a suburban area with a range of different sensitive receivers. The next closest sensitive receiver (after Nine Mile Beach) is a residential receiver, which has the most stringent criteria. Compliance at this residential receiver would imply compliance for all other sensitive receivers nearby.

The nearest residential receiver to the temporary desalination plant is 33 Williams Street, Belmont, which is approximately 800 metres away. Table 5-8 shows the predicted compound noise impact level at the nearest residential receiver.

Table 5-8 Predicted compound noise at nearest receivers dB(A)

Receiver address	Construction Noise Management Level (CNML) dB(A)	Predicted contribution noise level, dB(A)
Nine Mile Beach	65	52
33 Williams Street, Belmont	48	36

This is a conservative assessment with all equipment operating at the same time. It should be noted that the use of the compound site is intermittent (with the bulk of activity expected to occur at start of the working day and end of the working day), any impact from the compounds on sensitive receivers is expected to exist only for short periods on days where construction activities are scheduled.

Based on the model results, the compounds are not predicted to exceed the CNML. The predicted noise contours can be found in Appendix A.

5.3 Construction traffic noise assessment

It is expected that there will be additional traffic generated on nearby roads due to the construction activities. The increase in traffic volumes can potentially increase the noise generated from local road traffic.

5.3.1 Methodology

Road traffic was estimated by creating a simplified noise model in CadnaA using the CoRTN algorithm. The model predicted the noise levels based on existing volumes and then predicted the noise levels with the construction traffic volumes included.

5.3.2 Access and volumes

Vehicle movements due to construction activity only occur during standard hours and will be on the following roads:

Table 5-9 Construction traffic access roads

Activity	Access road(s)
Planning, mobilisation and preparation	Pacific Highway Beach Street Ocean Park Road Hudson Street
Civils	Pacific Highway Beach Street Ocean Park Road
Intake	Pacific Highway Beach Street Ocean Park Road
Treatment plant	Pacific Highway Beach Street Ocean Park Road
Power upgrades	Pacific Highway Beach Street Hudson Street

It is assumed that the worst case peak hour traffic would be 22 vehicles movements, which would consist of the following:

- 12 heavy vehicle movements (6 inbound and 6 outbound).
- 10 light vehicle movements (inbound at start of day and outbound at end of day).

This volume would not be applicable to all the construction activity and every day, but represents the worst case amongst them. The heavy vehicle movements are primarily from trucks entering and leaving the site to deliver supplies or remove soil. The assessment approach is considered to be conservative.

The existing and construction traffic volumes are summarised in Table 5-10. For the assessment, it assumed that Ocean Park Road, and Hudson Street will have similar traffic volumes as Beach Street.

Table 5-10 Road traffic volumes

Access Road	Existing[1]		Existing + Construction	
	Total vehicles	% Heavy Vehicle	Total vehicles	% Heavy Vehicle
Pacific Highway	1116	5	1132	6
	1931	4	1937	4
Beach Street	11	9	27	26
	88	2	94	9

5.3.3 Noise impact

The increase in traffic due to construction works on Pacific Highway represents are predicted to result in a negligible increase in noise levels. This is due to the existing volume of traffic on the road being significantly higher than that generated due to construction activities.

[1] Traffic survey conducted by Trans Traffic Survey 19/6/19

The traffic volume due to construction works on Hudson Street, Beach Street and Ocean Park Road is a substantial increase to the existing. The individual construction traffic movements will be noticeable with the increase in heavy vehicles. However, the overall noise (L_{eq}) increase due to the construction traffic on the local roads will be largely masked by the road traffic noise generated by the nearby arterial road (Pacific Highway) during high traffic times.

Table 5-11 Construction traffic noise impacts

Location	Predicted road traffic noise (existing) L_{eq} (dBA)	Predicted road traffic noise (existing + construction) L_{eq} (dBA)	Difference (dBA)
Cnr Pacific Highway and Beach Street	76	76	0
Cnr Beach Street and Hudson Street	61	62	1
Cnr Beach Street and Ocean Park Road	60	63	3
Cnr Williams Street and Ocean Park Road	58	60	2

The model results shown in Table 5-11 indicate construction traffic noise levels are predicted to increase by up to 3 dB at assessed receiver locations. Generally, the smallest change (increase or decrease) in decibels that the human ear can detect is about 2 to 3 dB but this varies with individual sensitivity; however, a change of 5 dB is considered noticeable by most people. A 5 dB change is often used as a target objective when considering the potential for noise nuisance. Therefore, the predicted increase in traffic noise due to construction traffic generation is expected to be acceptable to the majority of people.

Despite predictions indicating construction road traffic noise is expected to be acceptable, the following measures are provided to assist in reducing potential impacts:

- Ensure traffic movements, especially heavy vehicles, are limited to standard construction hours
- Avoid the use of engine compression brakes
- Advocate appropriate driver behaviour
- Ensure the road surface is maintained to assist with minimising banging/bumping noise from vehicles as they travel to and from the site, particularly when they are unloaded
- Keep truck drivers informed of designated vehicle routes, parking locations and delivery hours

5.4 Construction vibration assessment

Construction activities would result in a short-term increase in localised vibration levels, as energy from equipment is transmitted into the ground and transformed into vibration, which attenuates with distance. The magnitude and attenuation of ground vibration is dependent on a range of factors including the method of energy transfer, the vibration frequency and type and the characteristics of the ground and surrounding topography. Due to complicated ground conditions and other variables associated with construction vibration, an exact vibration assessment result is generally not expected from available prediction methods.

Exact details of the equipment sizing and type were not known at the time of writing this report. This is generally selected by the construction contractor. For reference, an extract of the safe working buffer distances to comply with human comfort and cosmetic damage for standard dwellings were sourced from the Construction Noise and Vibration Strategy (Transport for NSW, 2018). Note that construction will require use of other plant and equipment, but excavators and vibratory rollers are some of the typical equipment that generate the most vibration.

Table 5-12 Vibration safe working distances

Activity	Approx. size/weight/model	Human comfort (OE&H Vibration Guideline)	Cosmetic damage in Standard dwelling (BS 7385)
Vibratory Roller	1-2 tonne	15 m to 20 m	5 m
	2-4 tonne	20 m	6 m
	4-6 tonne	40 m	12 m
	7-13 tonne	100 m	15 m
	13-18 tonne	100 m	20 m
	> 18 tonne	100 m	25 m
Small Hydraulic Hammer	300 kg (5 to 12 t excavator)	7 m	2 m
Medium Hydraulic Hammer	900 kg (12 to 18 t excavator)	23 m	7 m
Large Hydraulic Hammer	1600 kg (18 to 34 t excavator)	73 m	22 m
Pile Driver - Vibratory	Sheet piles	20 m	2 m to 20 m
Jackhammer	Handheld	Avoid contact with structure	1 m

These safe working distances are indicative only and may vary depending on the specific equipment used and the ground conditions. Based on the indicative type of equipment that is going to be used for construction and the distance between construction areas and receivers, it is not expected that there will be vibrational impacts on nearby sensitive receivers.

6. Operation impact assessment

6.1 Operational noise

6.1.1 Methodology

Operational noise has been modelled using SoundPLAN (version 8.0). SoundPLAN is a computer program for the calculation, assessment and prognosis of noise exposure. SoundPLAN calculates environmental noise propagation according to '*ISO 9613-2: Acoustics – Attenuation of sound during propagation outdoors*' algorithm.

Table 6-1 Construction noise modelling assumptions

Modelling component	Assumption
Prediction algorithm	*ISO 9613 – 2 Acoustics – Attenuation of sound during propagation outdoors*
Modelling period	Typical worst case 15 minute period of operation where all listed equipment are running simultaneously at full power
Meteorology	ISO 9613 considers the presence of a well-developed moderate ground based temperature inversion, such as commonly occurs on clear, calm nights or 'downwind' conditions which are favourable to sound propagation
Atmospheric absorption	Average temperature of 10ºC and an average humidity of 70%
Ground absorption coefficient	G = 0.75
Receiver heights	1.5 m above building ground level (ground floor)
Shielding	The modelled scenario does not take into account the shielding effect from surrounding buildings and structures on and adjacent to the site. This approach can result in a slightly conservative assessment.

6.1.2 Noise sources

Table 6-2 lists the indicative equipment for the temporary desalination plant and their associated sound power levels.

Table 6-2 Operational noise sources

Equipment	Quantity	Operation Cycle	SWL
High pressure (HP) pumps	4	Continuous	103 dBA
Energy recovery devices (ERD)	4	Continuous	103 dBA
Air compressor	1	Intermittent	Negligible
Intake pumps	6	Continuous	Negligible - Submerged
Various pumps	6	Continuous	75 dBA
Screen and filters	-	Intermittent	Negligible

The assessment will be based on the HP pumps and energy recovery units as it is expected that these equipments will have the highest noise impact. The various pumps on site are smaller in size and some are submerged in water. Air compressor, screens and filters operate intermittently and will be shielded in containers.

It is anticipated that the HP pumps will be 500kW and the energy recovery units will have similar Sound power level and frequency characteristics to the pumps.

6.1.3 Predicted noise levels

Sensitive receivers - Active recreational areas

The temporary desalination plant is located adjacent to Nine Mile beach area, which is considered as an active recreational area. Table 6-3 shows the predicted noise level at the nearest point of the beach.

Sensitive receivers – All others

The Project area is near a suburban area with a range of different sensitive receivers. The next closest sensitive receiver is a residential receiver, which has the most stringent criteria. Compliance at this residential receiver would imply compliance for all other sensitive receivers nearby.

The nearest residential receiver to the temporary desalination plant is 33 Williams Street, Belmont. Table 6-3 shows the predicted noise level at the nearest residential receiver. The Project will be operating continuously and hence it is assessed against the most stringent period (night time).

Table 6-3 Predicted operational noise at nearest receivers dB(A)

Receiver address	Project noise trigger level, $L_{Aeq(15min)}$ dB(A)	Predicted contribution noise level, $L_{Aeq(15min)}$ dB(A)
Nine Mile Beach	53	53
33 Williams Street, Belmont	38	33

Based on the noise model results, the operational noise is predicted to comply with the Project Noise Trigger Level (PNTL) during the night-time period. Noise contours for the operational noise is provided in Appendix C.

Although noise levels are predicted to comply with the environmental noise levels specified, the following design strategies are recommended to be incorporated into the detailed design of the desalination plant:

- Selection of equipment and plant items to limit noise emissions. Where practical and feasible, motor drives, gear boxes, pumps, etc. would be specified and selected to achieve a noise level of less than 85 dB(A) at a distance of 1 m, consistent with occupational health and safety requirements.
- Purpose built acoustic enclosures to be provided where required for large plant items in order to achieve noise levels of less than 85 dB(A) at 1 m.

6.2 Sleep disturbance impacts

No sleep disturbance noise impacts are predicted as the predicted noise levels at all residential receivers are below the screening criteria of $L_{Aeq(15\ min)}$ 40 dBA.

6.2.1 Annoying characteristics

Any annoying characteristics (such as tonality, low frequency, impulsiveness, etc.) generated by the site will need to have corrections factors applied, as per the NPI. This will need to be assessed as part of the detailed design stage where specific operational equipment are selected.

6.3 Operational traffic

Operational traffic generation to and from the Project would include staff movements with an occasional heavy vehicle accessing the site. The primary site access route would be off Ocean Park Road via Beach Street.

The operational daily traffic generated is expected to be within the daily fluctuations of the existing daily traffic movements. Therefore, no traffic noise impacts are expected from traffic due to the operation of the Project.

6.4 Operational vibration

Given the large distances between the proposed operational equipment and the nearest sensitive receivers, vibration impacts are not expected during operation of the Project.

7. Noise and vibration mitigation measures

7.1 In-principle noise and vibration control methods

In principle, there are three approaches to controlling construction noise and vibration:

- Control at the source
- Control on the source-to-receiver pathway
- Control at the receiver

7.1.1 Control at the source

Control at the source is considered to be the most cost-effective in the reduction of noise and vibration levels and as such should be given highest priority when considering mitigation options. The solutions available include:

- Substitution of equipment:
  – Substitution involves where reasonably practicable the use of less noisy or vibration-generating equipment. This should be considered at the beginning of the construction phase, prior to any work being carried out. Equipment should be selected to meet the needs of the project or process it is required for and not be excess.
- Modification of existing equipment:
  – Modification of equipment involves the addition of acoustic treatments to parts of the machinery. These include but are not limited to improved mufflers, stiffening of panels and surface coating of resonance dampening material. These options would often require discussion with the supplier and manufacturer of the equipment.
- Use and siting of equipment:
  – Plant should always be used in accordance with the manufacturer’s instructions. Where possible the location of equipment should be away from noise sensitive areas. This includes taking into consideration the emission direction of equipment and directing this away from noise sensitive receivers. Plant used intermittently should be shut down during the intervening periods or throttled down to a minimum. Dropping of material from height should be limited where possible, particularly the loading and unloading of scaffolding.
- Regular and effective maintenance:
  – Maintenance should be carried out to ensure equipment is running at optimal conditions.

7.1.2 Control along the path

There are two ways of mitigating noise along the transmission path:

- Increasing the distance between the source and receiver.
- Where distance is limited, screening of noise may be considered. In some circumstances it may also be possible to enclose the equipment during the operation.

Table 7-1 provides typical noise attenuation provided by noise control methods.

Table 7-1 Typical attenuations for source to receiver noise control methods

Control by	Nominal noise reduction possible, in total A-weighted sound pressure level LpA dB
Distance	Approximately 6 for each doubling of distance
Screening	Normally 5 to 10, maximum of 15
Enclosure	Normally 15 to 25, maximum of 50

7.1.3 Control of noise at the receiver

Reasonable and feasible mitigation measures at the receivers for this Project are limited to effective community consultation.

7.2 Mitigation measures

The noise and vibration mitigation measures detailed in Section Table 7-2 are recommended where reasonable and feasible to reduce the impact on the surrounding receivers and sensitive land uses during construction.

Table 7-2 Mitigation measures for construction noise and vibration

Action required	Details
General controls	
Site inductions	All employees, contractors and subcontractors are to receive an environmental induction. The induction should include: • All relevant project specific and standard noise and vibration mitigation measures • Relevant licence and approval conditions • Permissible hours of work • Location of nearest sensitive receivers • Construction employee parking areas • Designated loading/unloading areas and procedures • Site opening/closing times (including deliveries) • Environmental incident procedures
Behavioural practices	No swearing or unnecessary shouting or loud stereos/radios on site. No dropping of materials from height, throwing of metal items and slamming of doors.
Implement community consultation measures	Contact will be established with the local residents and the construction program and progress communicated on a regular basis, particularly when noisy or vibration-generating activities are planned. Affected receivers will be notified of the intended work, its duration and times of occurrence. This may include a local community update letters for specific construction activities and a Project info line.

<table>
<tr><th>Action required</th><th>Details</th></tr>
<tr><td>Implement complaints management measures</td><td>Complaints will be managed in accordance with the procedure outlined below. Signage at each site will clearly and visibly provide a contact number and name to receive complaints and enquiries about construction.
Potential complaints specific to these works could include:
• Vibration impacts from works that significantly affect structures or dwellings
• A cluster of noise and/or vibration complaints
In this instance the response would be to:
• Verbally respond to complainant
• Provide a written response within seven calendar days if the complaint cannot be resolved verbally
• Log the complaint, and any actions taken with regards to the complaint within a complaints register
• Undertake monitoring at the complainant's residence(s)
• Investigate the nature and reasons of the impact
• Investigate and implement further mitigation measures to minimise the impact</td></tr>
<tr><td>Compliance vibration measurements</td><td>This assessment assumes compacting activities will be conducted.
Vibration monitoring will be undertaken where compacting works are to be undertaken at a distance of less than 30 m from a building or when a complaint is received. Vibration monitoring should be conducted during these activities at the most susceptible buildings close to the construction sites.
Where exceedances of the relevant vibration criteria outlined in Section 4.1.3 are recorded, the situation should be reviewed in order to identify the measures that can be taken to minimise the impacts to sensitive equipment and prevent structural damage. The review may result in a requirement to modify work practices or use alternative, low-vibration methods and equipment.
Any vibration measurement will be undertaken by a qualified professional and with consideration to the ICNG guidelines.</td></tr>
<tr><td colspan="2">Source controls</td></tr>
<tr><td>Construction hours and scheduling</td><td>Comply with the recommended standard construction hours outlined in Section 4.1.1, unless out of hours work has been approved.
No truck movements before 7.00 am or after 6.00 pm.
For any work that would take place outside of normal construction hours:
• Undertake an assessment of the potential noise and vibration impacts associated with the proposed activities and outline specific mitigation measures.
• Residents potentially affected by such activities will be notified at least five days before hand.
• Minimise consecutive night activities in the same locality and provide periods of quiet if activities occur for extended periods during the night.
• Conduct activities in a manner that eliminates or minimises the need for audible warning alarms.</td></tr>
</table>

Action required	Details
Construction respite period	High noise and vibration generating activities may only be carried out in continuous blocks, not exceeding three hours each, with a minimum respite period of one hour between each block. High noise refers to construction noise impacts which exceed the highly affected noise management level of 75 dB(A) $L_{Aeq(15\text{-}min)}$ during standard construction hours.
Equipment selection	Use quieter and less vibration emitting construction methods where reasonable and feasible.
Use and siting of plant	Simultaneous operation of noisy plant within discernible range of a sensitive receiver is to be avoided. The offset distance between noisy plant and adjacent sensitive receivers is to be maximised. Plant used intermittently to be throttled down or shut down. Noise-emitting plant to be directed away from sensitive receivers.
Plan worksites and activities to minimise noise and vibration	Plan traffic flow, parking and loading unloading areas to minimise reversing movements within the site.
Minimise disturbance arising from delivery of goods to construction sites	Loading and unloading of materials/deliveries is to occur during standard construction hours. Contractors are to avoid dropping materials from height where practicable, during loading and unloading. Delivery vehicles to be fitted with straps rather than chains for unloading, wherever possible.
Path controls	
Use of safe distances	The safe working distances outlined in Table 7-1 will be observed when reasonable and feasible to minimise adverse vibration impacts.

8. Conclusions

This noise and vibration assessment has led to the following conclusions, which are subject to the limitations outlined in Section 1.2.2

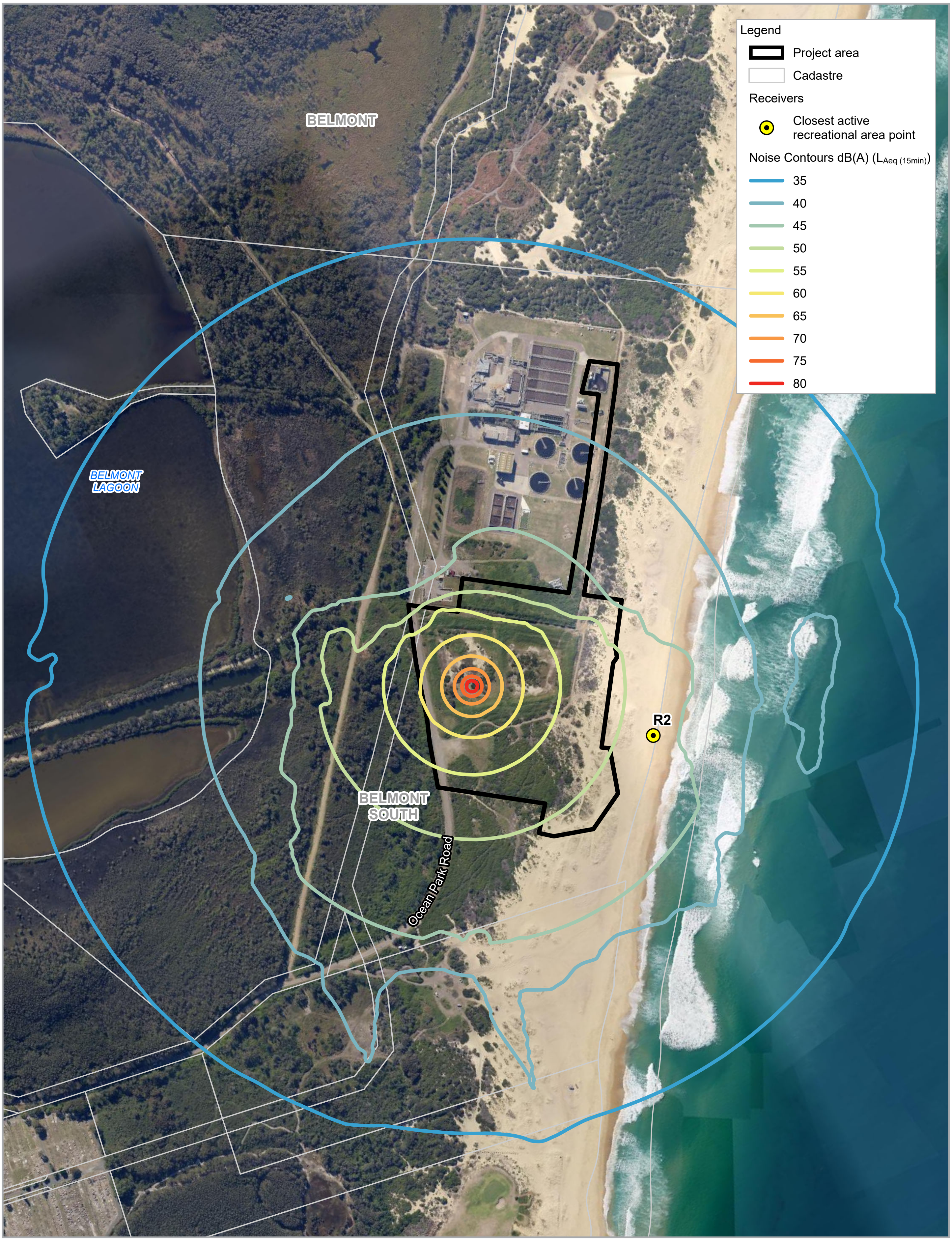
- For construction activities associated to the Project:
  - All construction activities associated with the construction of the desalination plant are not predicted to exceed the Construction Noise Management Level (CNML).
  - The power upgrades works are predicted to have a significant noise impact on the nearby sensitive receivers.
    - Residential receivers within 45 metres of the work will be above the 75 dB(A) “Highly Affected” noise level.
    - Residential receivers within 160 metres of the work will be above the 62 dB(A) CNML noise level.
  - The additional construction related traffic is predicted to have a noticeable but acceptable impact on current traffic noise levels. The following noise management measures are still recommended.
    - Ensure traffic movements, especially heavy vehicles, are limited to standard construction hours.
    - Avoid the use of engine compression brakes.
    - Advocate appropriate driver behaviour.
    - Ensure the road surface is maintained to assist with minimising banging/bumping noise from vehicles as they travel to and from the site, particularly when they are unloaded.
    - Keep truck drivers informed of designated vehicle routes, parking locations and delivery hours.
  - Based on the indicative construction equipment and distances involved between the construction areas and the nearest sensitive receivers, vibration impacts are not expected during construction of the Project.
  - It is recommended, where reasonable and feasible, that the mitigation measures outlined in Section 7 be used to minimise noise impacts due to construction activities.
- For operational activities associated to the Project:
  - The noise levels due to operation of the Project are expected to meet the adopted noise criteria at all assessed sensitive receivers.
  - The following mitigation measures are recommended to minimise noise contribution to the surrounding area.
    - Selection of equipment and plant items to limit noise emissions. Where practical and feasible, motor drives, gear boxes, pumps, etc. would be specified and selected to achieve a noise level of less than 85 dB(A) at a distance of 1 m, consistent with occupational health and safety requirements.
    - Purpose built acoustic enclosures to be provided where required for large plant items in order to achieve noise levels of less than 85 dB(A) at 1 m.

– The operational daily traffic generated is expected to be within the daily fluctuations of the existing daily traffic movements. Therefore, no traffic noise impacts are expected from traffic due to the operation of the temporary desalination plant.

– The operation of the temporary desalination plant is not expected to have any vibrational impacts.

Appendices

Appendix A – Construction noise contours – standard construction hours



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

Hunter Water Corporation
Belmont Temporary Desalination Plant
Noise and Vibration Impact Assessment

Planning, mobilisation and preparation - Desalination plant

Project No. 22-19573
Revision No. 0
Date 10/10/2019

Appendix A-1

\\ghdnet\ghd\AU\Newcastle\Projects\22\19573\Design\04 Deliverables\02 Other \2219573_NoiseAssess_0.aprx
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Grid: GDA 1994 MGA Zone 56

N

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Hunter Water Corporation
Belmont Temporary Desalination Plant
Noise and Vibration Impact Assessment

Planning, mobilisation and preparation - Hudson Street and Marriott Street Intersection

Project No. 22-19573
Revision No. 0
Date 10/10/2019

Appendix A-2

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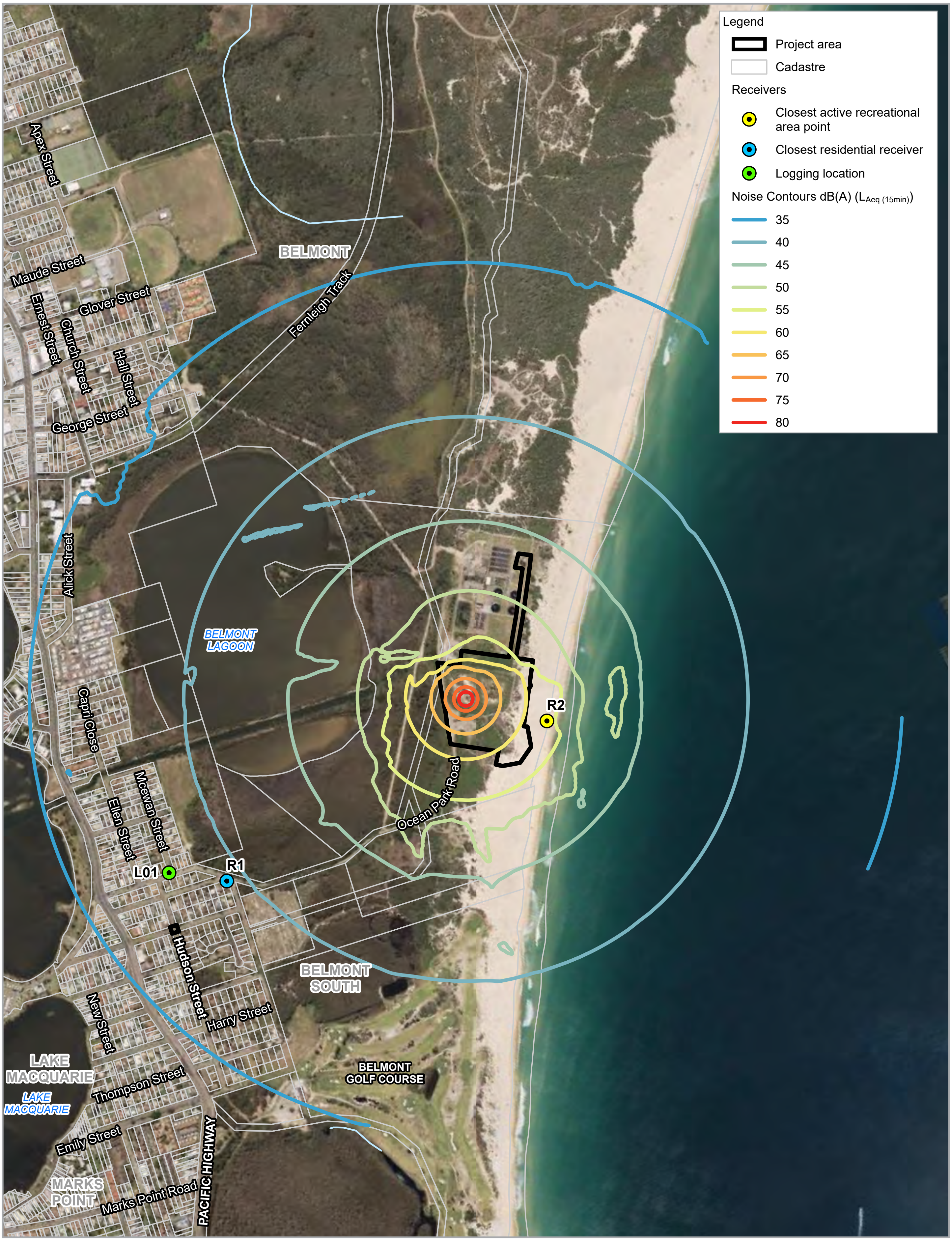

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Grid: GDA 1994 MGA Zone 56

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Hunter Water Corporation
Belmont Temporary Desalination Plant
Noise and Vibration Impact Assessment

Desalination plant earthworks and hardstand

Project No. **22-19573**
Revision No. **0**
Date **10/10/2019**

Appendix A-3

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Grid: GDA 1994 MGA Zone 56

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Hunter Water Corporation
Belmont Temporary Desalination Plant
Noise and Vibration Impact Assessment

Desalination plant pipeline connections

Project No. **22-19573**
Revision No. **0**
Date **10/10/2019**

Appendix A-4

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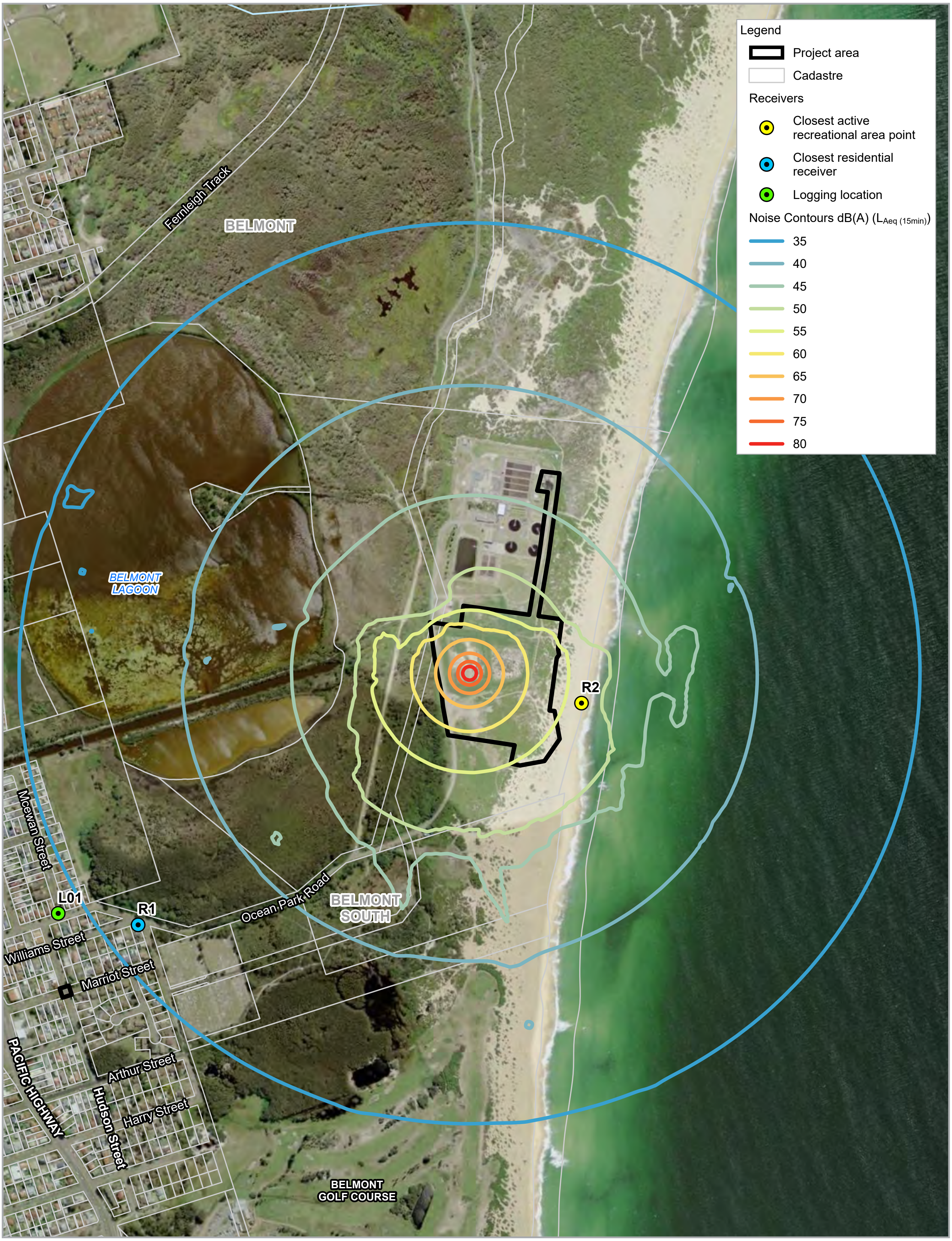

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Grid: GDA 1994 MGA Zone 56

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Belmont Temporary Desalination Plant
Noise and Vibration Impact Assessment

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Revision No. **0**
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Caisson installation

Appendix A-5

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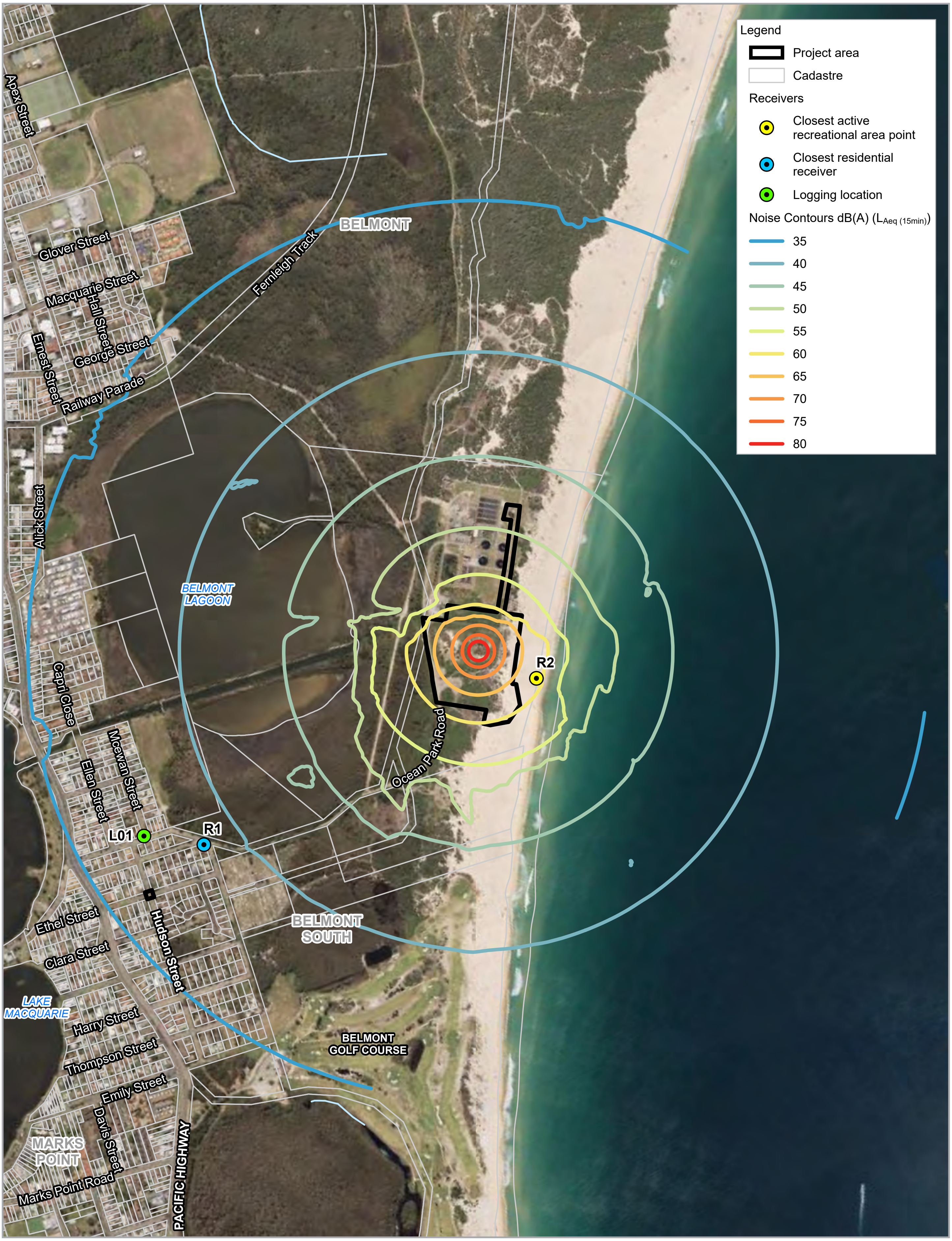

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Belmont Temporary Desalination Plant
Noise and Vibration Impact Assessment

Project No. 22-19573
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Intake installation

Appendix A-6

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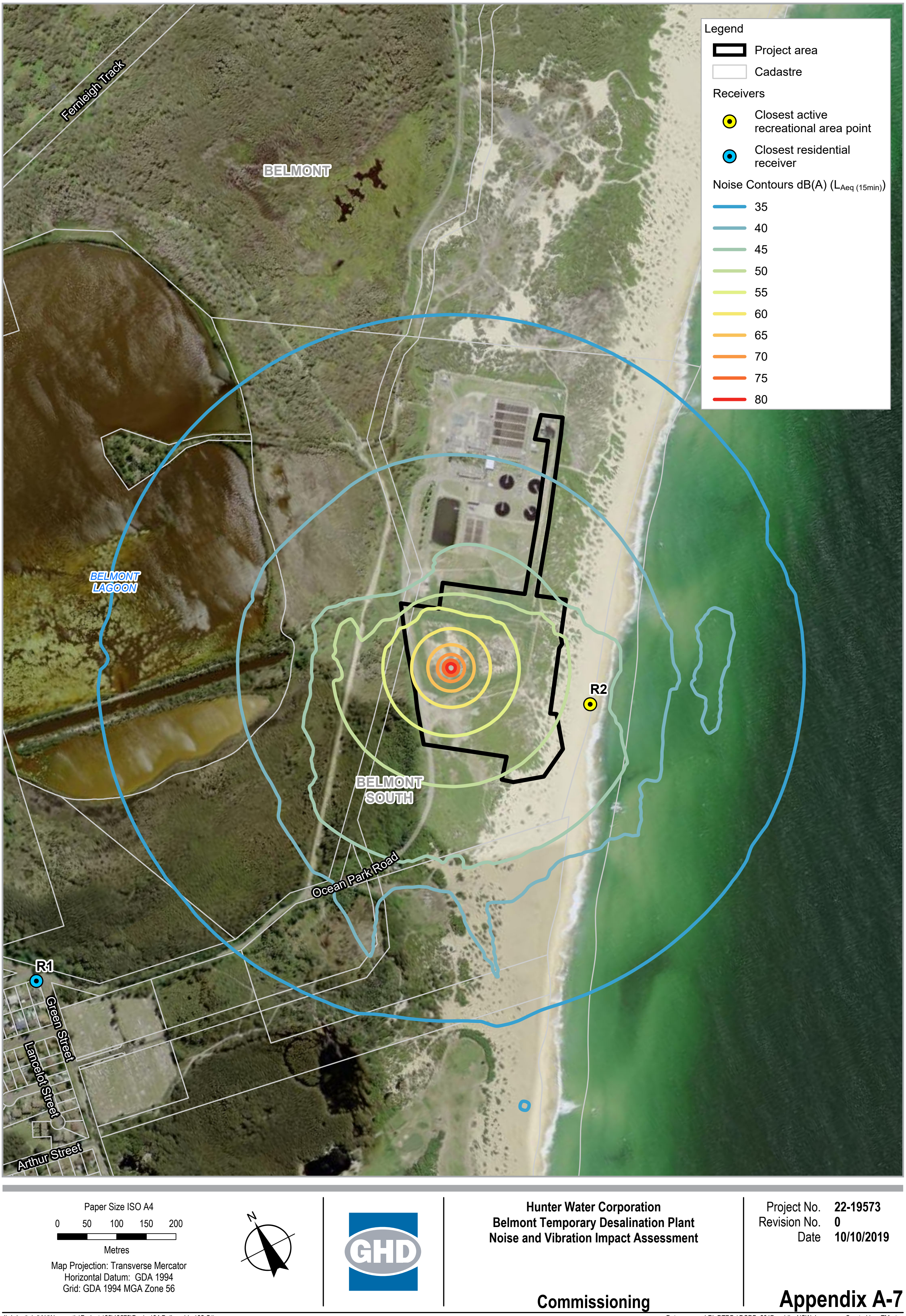

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Belmont Temporary Desalination Plant
Noise and Vibration Impact Assessment

Project No. **22-19573**
Revision No. **0**
Date **10/10/2019**

Commissioning

Appendix A-7

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Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Hunter Water Corporation
Belmont Temporary Desalination Plant
Noise and Vibration Impact Assessment

Tank Installation

Project No. 22-19573
Revision No. 0
Date 10/10/2019

Appendix A-8

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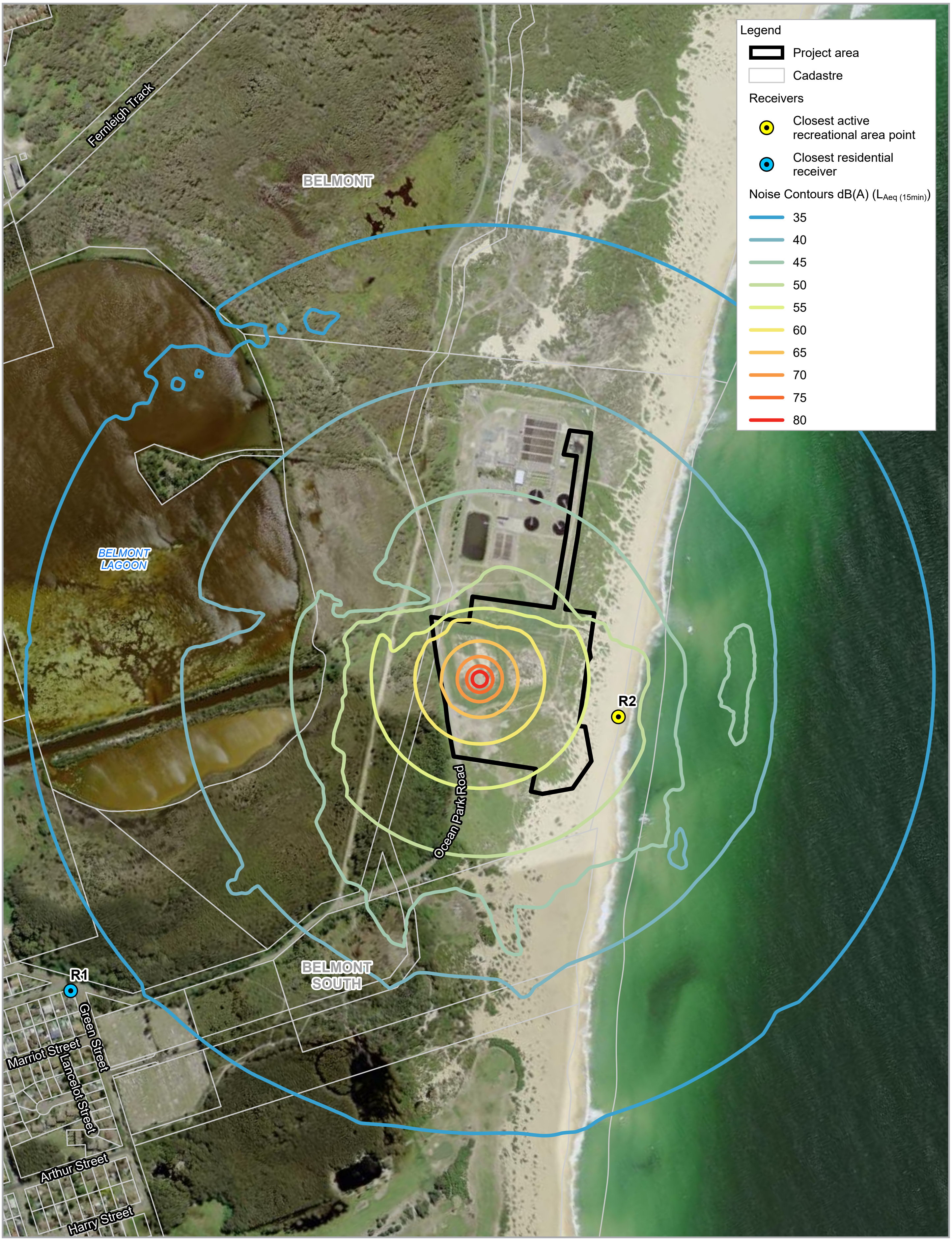

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Grid: GDA 1994 MGA Zone 56

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Belmont Temporary Desalination Plant
Noise and Vibration Impact Assessment

Concrete components

Project No. 22-19573
Revision No. 0
Date 10/10/2019

Appendix A-9

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Grid: GDA 1994 MGA Zone 56

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Belmont Temporary Desalination Plant
Noise and Vibration Impact Assessment

Project No. 22-19573
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Date 10/10/2019

Containerised equipment

Appendix A-10

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Grid: GDA 1994 MGA Zone 56

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Belmont Temporary Desalination Plant
Noise and Vibration Impact Assessment

Project No. **22-19573**
Revision No. **0**
Date **10/10/2019**

Power upgrades

Appendix A-11

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Grid: GDA 1994 MGA Zone 56

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Noise and Vibration Impact Assessment

Project No.	22-19573
Revision No.	0
Date	10/10/2019

Compounds

Appendix A-12

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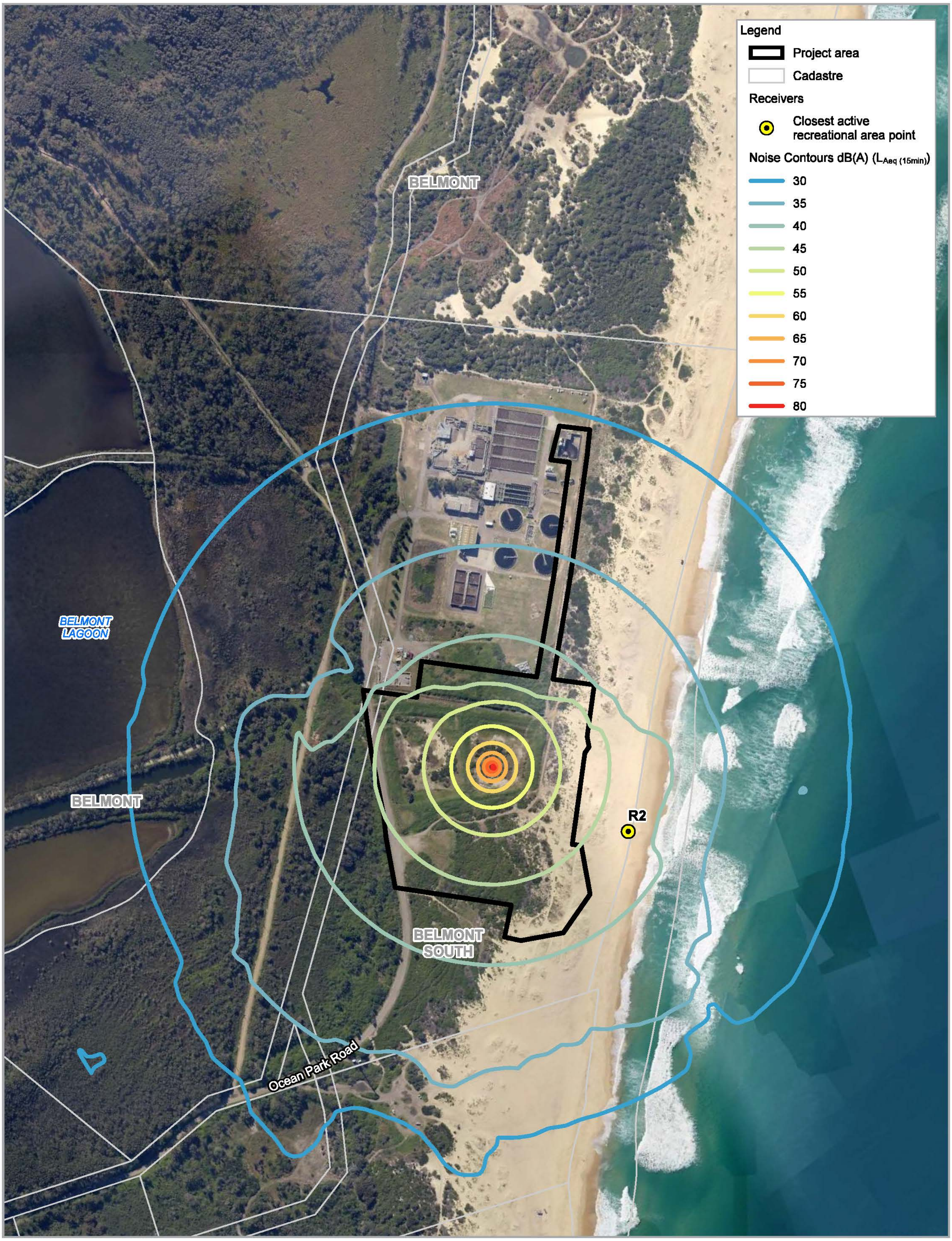
Data source: LPI: DTDB / DCDB, 2017; public_NSW_Imagery: . Created by: TMorton

Appendix B – Construction noise contours – outside of standard hours



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Hunter Water Corporation
Belmont Temporary Desalination Plant
Noise and Vibration Impact Assessment

Project No. 22-19573
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Date 10/10/2019

Intake dewatering

Appendix B-1

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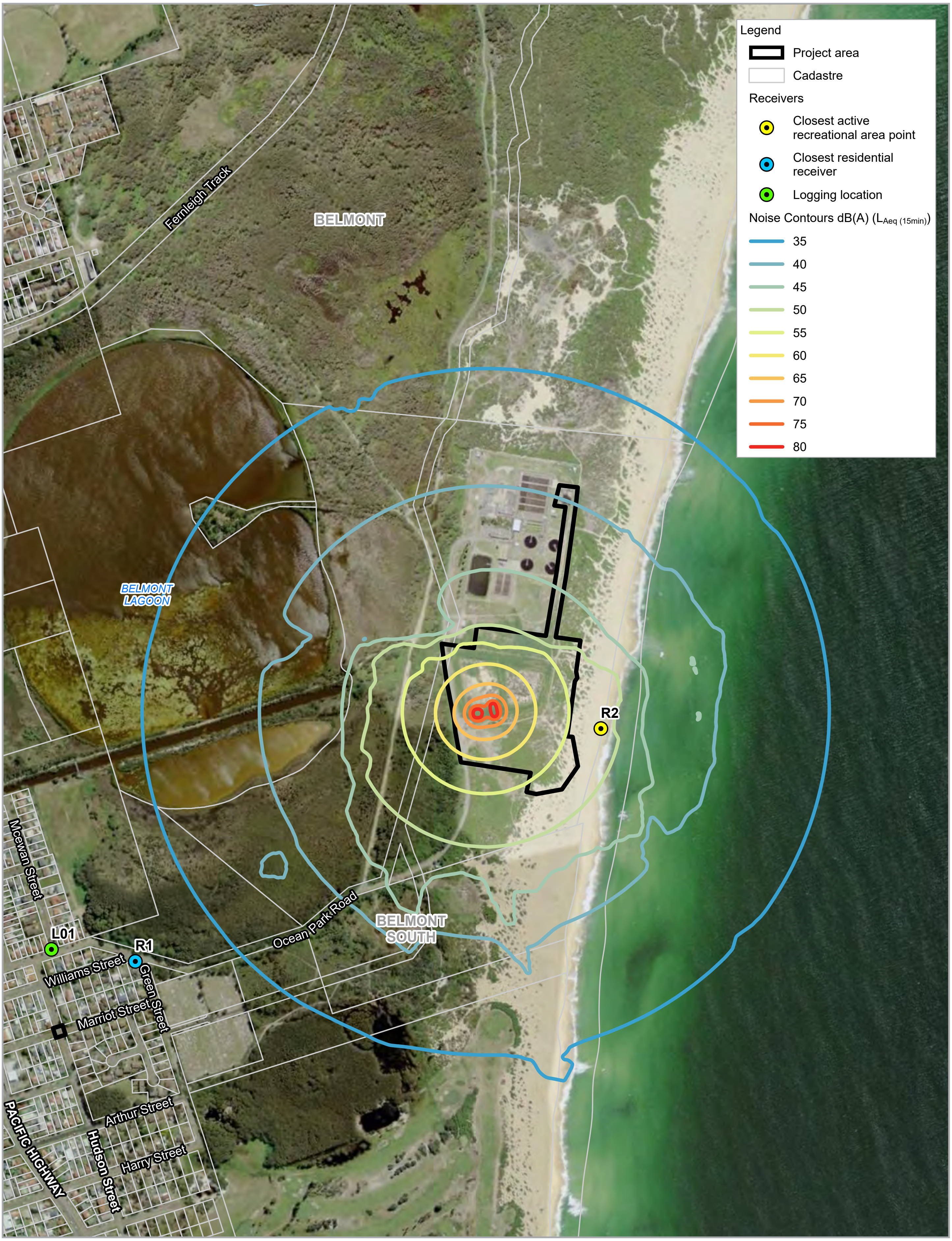
Data source: LPI: DTDB / DCDB, 2017; public_NSW_Imagery: . Created by: TMorton

Appendix C – Operational noise contours



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Belmont Temporary Desalination Plant
Noise and Vibration Impact Assessment

Project No. 22-19573
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Date 10/10/2019

Operational noise impact

Appendix C-1

\\ghdnet\ghd\AU\Newcastle\Projects\22\19573\Design\04 Deliverables\02 Other \2219573_NoiseAssess_0.aprx
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GHD
Level 3 GHD Tower 24 Honeysuckle Drive Newcastle NSW 2300
PO BOX 5403 Hunter Region Mail Centre NSW 2310
Newcastle NSW 2300
T: 61 2 4979 9999 F: 61 2 4979 9988 E: ntlmail@ghd.com

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Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	A Cheung	C Evenden	[signature]	N Malcolm	[signature]	11/10/2019

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