ACOUSTICS AND AIR

PORT BOTANY NOISE INVESTIGATION

NOISE CHARACTERISATION & SOURCE ANALYSIS

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VERSION A

JANUARY 2021

PREPARED FOR

NSW PORTS
LEVEL 2, BROTHERSON HOUSE
GATE B103, PENRHYN ROAD
PORT BOTANY NSW 2036

WILKINSON MURRAY

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GLOSSARY OF ACOUSTIC TERMS

dBA – 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 dBA.

dBZ – Unweighted decibels. No weighting or filter is applied. This descriptor is used where an analysis of the sound source is required rather than the effect the sound has on humans, such as in testing the frequency response of produced loudspeakers in a manufacturing process.

Maximum Noise Level (L_{Amax}) – The maximum noise level over a sample period is the maximum level, measured on fast response, during the sample period.

Low Frequency Noise (LF) – Noise within the lower end of the frequency range.

L_{ALF} – The L_{ALF} level is the A-weighted sum of the third octave band noise levels between the frequencies of 40Hz and 160Hz. This frequency range was identified to be most prominent when considering the impacts on residential areas surrounding the Botany Industrial and Transport Precinct.

L_{A10} – The L_{A10} level is the noise level which is exceeded for 10% of the sample period. During the sample period, the noise level is below the L_{A10} level for 90% of the time. The L_{A10} is a common noise descriptor for environmental noise and road traffic noise.

L_{A90} – The L_{A90} level is the noise level which is exceeded for 90% of the sample period. During the sample period, the noise level is below the L_{A90} level for 10% of the time. This measure is commonly referred to as the background noise level.

L_{Aeq} – The equivalent continuous sound level (L_{Aeq}) is the energy average of the varying noise over the sample period and is equivalent to the level of a constant noise which contains the same energy as the varying noise environment. This measure is also a common measure of environmental noise and road traffic noise.

Sound Pressure Level (SPL) – The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.

Day – The period from 7.00am to 6.00pm (Monday to Saturday) and 8.00am to 6.00pm (Sundays and public holidays).

Evening – The period from 6.00pm to 10.00m (Monday to Saturday).

Night – The period from 10.00pm to 7.00am (Monday to Saturday), and 10.00pm to 8.00am (Sundays and public holidays).

Industrial Noise – Industrial noise referred to in this report includes noise from all industrial premises such as port operations, extractive industry, warehousing, heating, ventilation, air conditioning and refrigeration, energy generation equipment, maintenance, and repair facility premises.

Port Botany – refers to area within the Port Botany lease area.

Botany Industrial and Transport Precinct – refers to all industry surrounding Port Botany, including Port Botany.

1 INTRODUCTION

NSW Ports has received an increased number of noise complaints in 2020 compared with previous years from residents of suburbs surrounding the Botany Industrial and Transport Precinct. The complainants primarily identified low frequency "throbbing" or "humming", generally experienced at night-time and early morning. A small number of residents have also complained about loud banging and beeping noises. Several complainants have reported that the low frequency noise is audible within indoor spaces of their homes.

The objectives of the study are to:

- Assess and characterise the noise experienced by residents;
- Identify and locate likely sources of noise that are causing complaint;
- Compare current and historical noise data to determine if problematic noise sources have increased or background noise has decreased such that noise has become more intrusive;
- Assess the significance of potential factors which may influence the transmission and perception of noise including wind speed and direction, temperature inversions, spectral characteristics (i.e. low frequency noise), impulsiveness, resonance, etc.

This report summarises the work undertaken to complete the noise study, which has included:

- an unattended noise monitoring program for approximately one month at four residences in suburbs which surround the Botany Industrial and Transport Precinct, including an external and internal location at one residence;
- attended noise monitoring at night-time at the unattended noise monitoring locations as well as visiting the Botany Industrial and Transport Precinct to correlate activity with the noise experienced;
- analysis of long-term data collected at three sites surrounding Port Botany, including on the roof of Brotherson House, at the boat ramp on Foreshore Road and at a site off Botany Road;
- review of meteorological conditions and the likelihood that noise propagation is enhanced in certain directions at certain times.

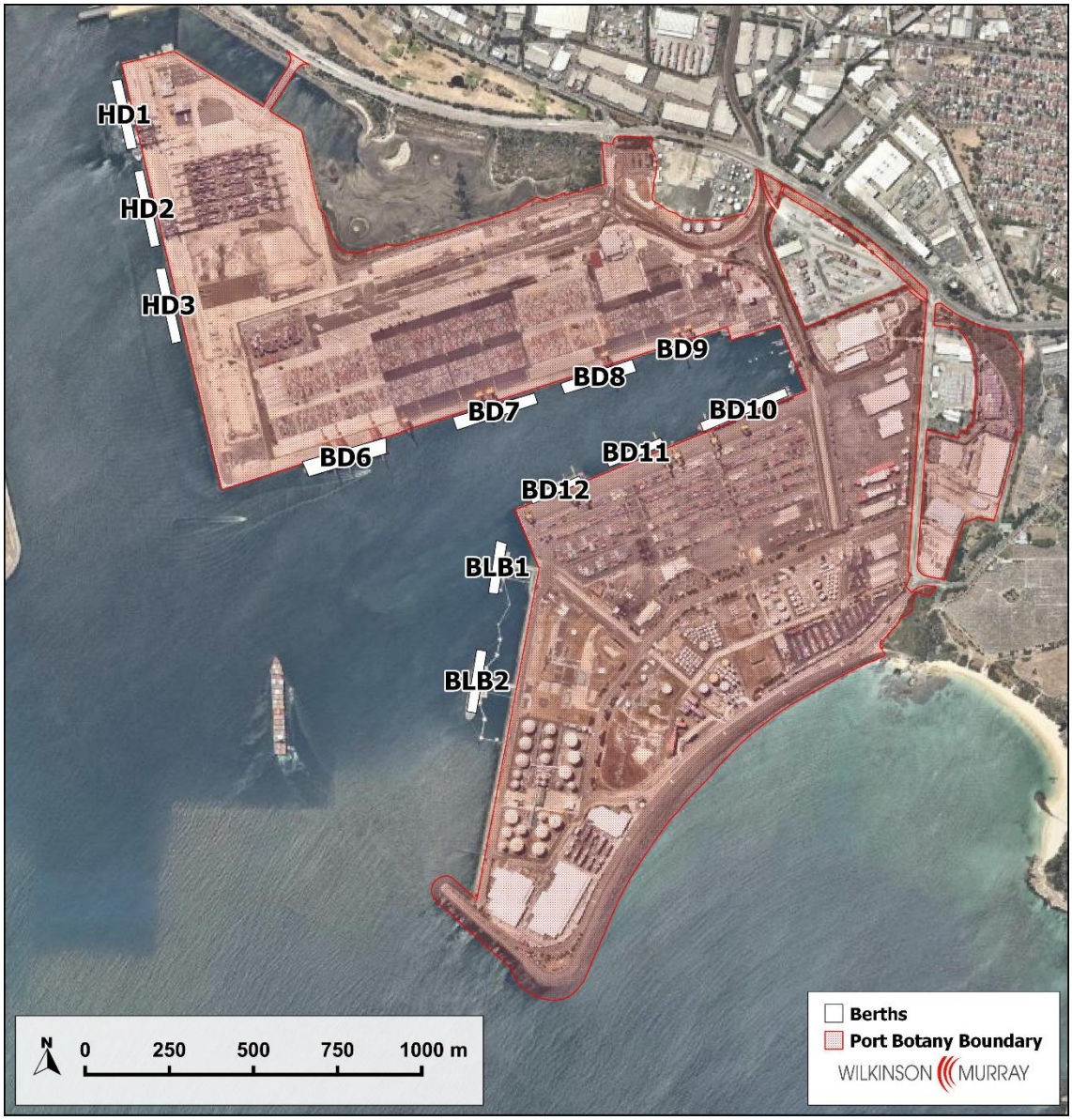
2 SITE DESCRIPTION & SHIPPING SCHEDULE

2.1 Port Botany Berths

Shipping berths at Port Botany are shown in **Figure 2-1** and summarised as follows:

- HD 1-3 Operated by Hutchison Ports Australia
- BD 6-9 Operated by Patrick Terminals
- BD 10-12 Operated by DP World Australia
- BLB 1-2 Bulk Liquid Berths, managed by NSW Ports

Figure 2-1 Port Botany shipping berths

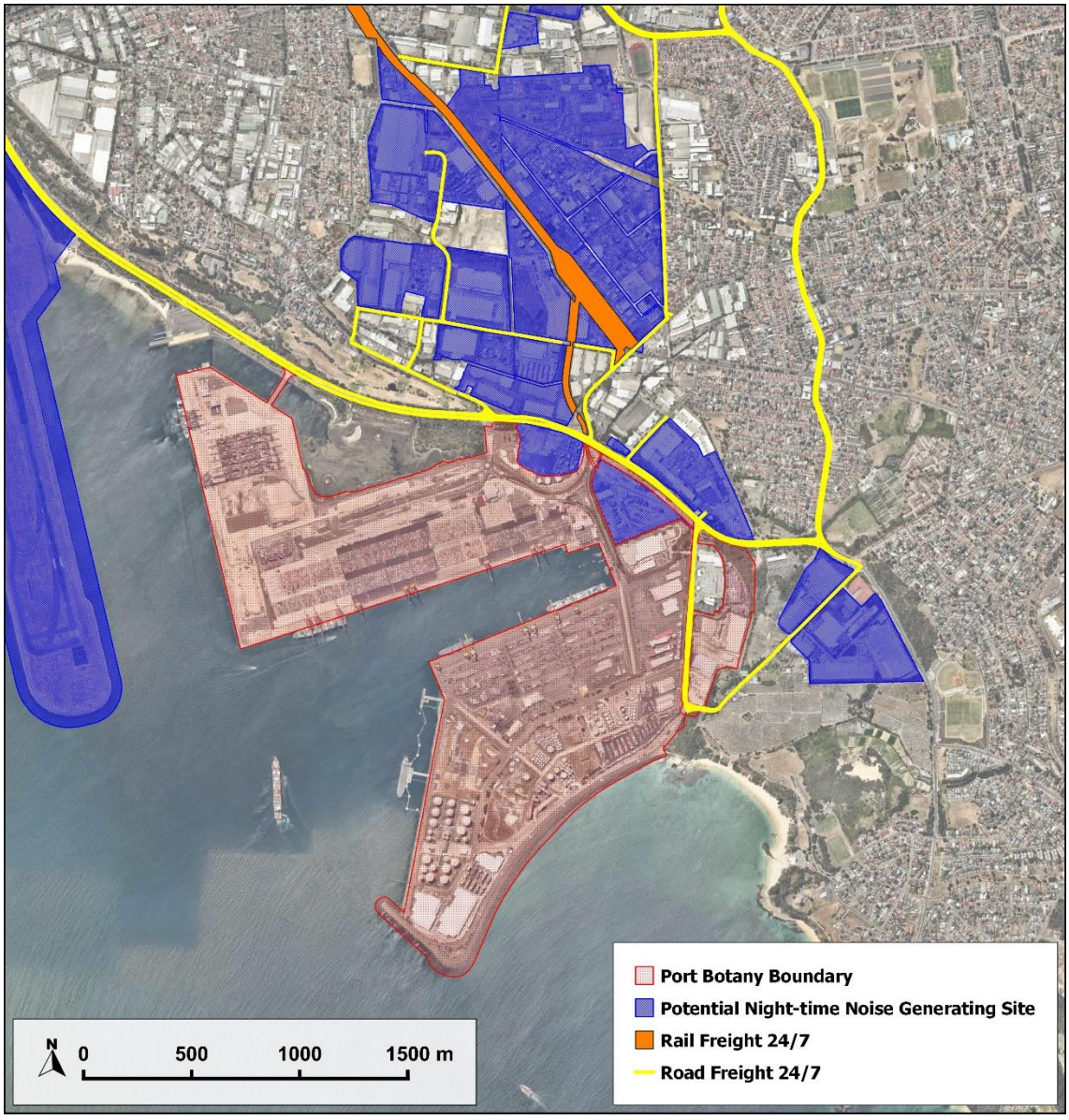


2.2 Surrounding Land Use

The majority of the land uses around Port Botany are industrial in nature and a number operate up to 24-hours per day, 7-days a week.

Figure 2-2 provides a map of the Port Botany boundary and surrounding potential night-time noise generating sites, including all 24-hour rail and truck haulage routes. In this report, "Port Botany" will refer to the area within the Port Botany lease area (red) and "Botany Industrial and Transport Precinct" will refer to all industry and freight routes surrounding and including Port Botany.

Figure 2-2 Port Botany and surrounding 24/7 industry



2.3 Port Botany Shipping Operations

NSW Ports provided a record of ship movements which is summarised in **Appendix A**. **Table 2-1** presents an example of the output. The terms "operation" refers to an arrival or departure and "side to" meaning which side of the vessel is alongside the berth. The "From" and "To" fields identify the berths at which the ship is moored as well as the ports of origin and destination for arrival and departure movements, respectively.

Table 2-1 Sample of records of ship movements to and from Port Botany, 27-29 August 2020

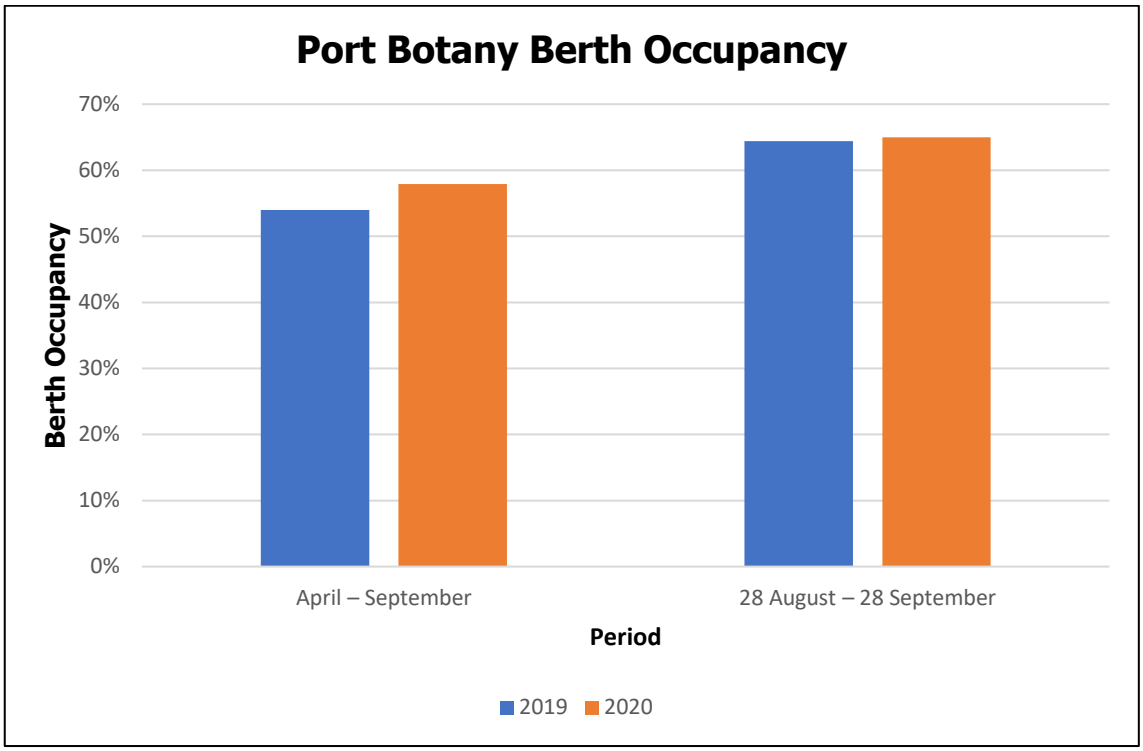
Datetime	Vessel Type	Operation[1]	From	To	SideTo[2]
27/08/2020 2:08	Container Vessel	d	BD7	nzwlg	S
27/08/2020 4:24	Container Vessel	a	aubne	BD7	S
27/08/2020 10:25	Container Vessel	d	BD6	aumel	S
27/08/2020 11:30	Container Vessel	d	HD1	aumel	S
27/08/2020 13:55	Container Vessel	a	aubne	BD6	S
27/08/2020 14:56	Container Vessel	a	aumel	BD9	P
27/08/2020 21:14	Container Vessel	a	aumel	HD1	S
27/08/2020 21:50	Bulk Liquid	d	BLB1	auntl	P
28/08/2020 1:25	Bulk Liquid	a	egsuz	BLB1	P
28/08/2020 6:15	Container Vessel	d	BD10	cnsha	P
28/08/2020 9:03	Container Vessel	a	aumel	BD10	S
28/08/2020 12:55	Tug	a	aupbt	STB	P
28/08/2020 14:03	Tug	d	STB	aupbt	P
28/08/2020 14:42	Container Vessel	a	aubne	HD2	P
29/08/2020 0:05	Container Vessel	d	BD8	aumel	S
29/08/2020 2:39	Container Vessel	a	cnytn	BD8	S
29/08/2020 3:07	Container Vessel	d	BD9	aubne	P
29/08/2020 8:08	Container Vessel	d	BD6	nztrg	S
29/08/2020 9:08	Container Vessel	d	BD12	aumel	S
29/08/2020 11:35	Container Vessel	a	aumel	BD6	S
29/08/2020 14:06	Container Vessel	a	ncnou	BD9	S
29/08/2020 14:44	Bulk Liquid	d	BLB1	auoff	P
29/08/2020 16:55	Bulk Liquid	a	aumel	BLB1	P

Note 1: d – departure, a – arrival
Note 2: S – Starboard, P – Port

2.4 Port Botany Berth Occupancy

NSW Ports has provided a summary of Port Botany operational data. This data provides a percentage of berth occupancy during the unattended noise monitoring period (i.e. 28 August – 28 September 2020) to the same period in 2019, and the percentage of berth occupancy for the entire period of elevated complaints (i.e. April to September 2020) to the same period in 2019. **Figure 2-3** presents this data.

Figure 2-3 Port Botany berth occupancy



Results from **Figure 2-3** indicates that Port Botany operations between the months of April and September have been comparable between 2019 and 2020.

Additionally, **Figure 2-3** indicates that Port Botany operations during the unattended noise monitoring period were above the average for the elevated complaint period and consistent with operations in 2019.

3 ATTENDED NOISE MONITORING

3.1 Attended Noise Monitoring Summary

Attended noise monitoring was conducted on several night-time periods as shown in **Table 3-1** and **Table 3-2**. **Figure 4-1** provides some context for these locations relative to Port Botany.

Table 3-1 Summary of attended noise measurements

Day / Date	Weather	Locations Visited	Vessels in Berth		
			Berth	**Vessel Type**	**Side To**
Sun 30 / Mon 31 August	NW	Woonah St Wassell St Brotherson House	BD6	Container Vessel	S
			BD7	Container Vessel	S
			BD8	Container Vessel	S
			BD9	Container Vessel	S
			BD10	Container Vessel	S
			BD12	Container Vessel	P
			BLB1	Bulk Liquids	P
			BLB2	Bulk Liquids	P
			HD1	Container Vessel	S
Tue 22 / Wed 23 September	NNW to SW	Wassell St Chifley Oval Beauchamp St Brotherson House La Perouse School Woonah St Australia Ave Anthony St	**Berth**	**Vessel Type**	**Side To**
			BD6	Container Vessel	S
			BD8	Container Vessel	S
			BD12	Container Vessel	P
			BLB2	Bulk Liquids	P
			HD2	Container Vessel	S
Wed 23 / Thu 24 September	W to NW	Woonah St Chifley Oval Wassell St Port Botany	**Berth**	**Vessel Type**	**Side To**
			BD6	Container Vessel	S
			BD8	Container Vessel	S
			BD10	Container Vessel	P
			BD12	Container Vessel	P
			BLB2	Bulk Liquids	P
			HD2	Container Vessel	S

Table 3-2 Summary of attended noise measurements

Date/Time	Location	L_{Aeq}	L_{Amax}	L_{A90}	Comment
Sunday 30 August 2020 – Monday 31 August 2020					
11.10pm – 11.25pm	Woonah St	44	64	41	General low-level hum from NW. Almost constant movement alarm in first 5 min at 1.25kHz, intermittent clunks and crashes audible but not measurable. No dominant LF noise present 40Hz max SPL at 61-62dBZ.
11.26pm – 11.41pm	Woonah St	42	56	40	General low-level hum from NW. No dominant LF noise present 40Hz max SPL lower at 55-56dBZ. Port L_{Amax} 45dBA.
11.50pm – 00.10am	Brotherson House	-	-	-	Vessels in BD 6-9 1.25kHz movement alarm audible. Noise from other side of rail siding.
00.17am – 00.32am	Wassell St	49	63	46	Foreground traffic noise on Bunnerong Rd. 1.25kHz alarm audible. No dominant LF noise present 40Hz max SPL at 64-66dBZ.
00.32am – 00.37am	Wassell St	47	56	46	1.25kHz alarm audible. No dominant LF noise. 5 min with little other traffic so ambient dominated by general urban hum from west. Some LF noise present 40Hz max SPL at 64-66dBZ. Container handling type noise L_{Amax} 50dBA.
00.50am – 00.20am	Foreshore Rd Boat Ramp	-	-	-	Vessel at HD1 but limited activity.
Tuesday 22 September 2020 – Wednesday 23 September 2020					
9.50pm – 10.05pm	Wassell St	50	66	46	Roadworks occurring on Franklin Street generates intermittent noises from north. No LF content. Occasional clunks and clangs. Alarm from Port direction. 2 aircraft took off 40Hz max 63-65dBZ. Bunnerong Rd traffic occasional performance cars.
10.05pm – 10.20pm	Wassell St	48	60	45	Roadworks occurring on Franklin Street generates intermittent noises from north. No LF content. Little container handling or movement alarm noise. 1 aircraft took off 40Hz max 63-65dBZ. Bunnerong Rd traffic occasional performance cars.
10.27pm – 10.42pm	Chifley Oval	50	66	46	Traffic on Bunnerong Rd, bus along Hastings, aircraft take off. First time felt I could hear some LF noise 40Hz up to 70dBZ.
10.42pm – 10.47pm	Chifley Oval	48	57	46	Youths congregated at buildings so ceased measurements as voices audible. First time felt I could hear some LF noise 40Hz up to 70dBZ.

Date/Time	Location	L_{Aeq}	L_{Amax}	L_{A90}	Comment
11.01pm – 11.16pm	Moorina Ave	44	58	42	General noise from nearby industrial sites and traffic. Two aircraft noise take offs, Container handling L_{Amax} 53dBA. Movement alarm at 1.25kHz not present.
11.30pm – 11.32pm	Entrance to rail siding from Beauchamp / Perry	61	68	56	Constant noise from plant approx. 150m away. Unlikely source of LF noise at Little Bay etc.
11.32pm – 11.32pm	Entrance to rail siding from Beauchamp / Perry	57	63	55	Intermittent noise from recycling activities 100m away. Unlikely source of LF noise at Little Bay etc.
11.45pm – 11.55pm	Brotherson House	-	-	-	BD10-12 empty. BD6-9 not clear if vessel in dock, but containers stacked high on berth and gantry cranes operating.
00.00am – 00.15am	La Perouse Public School Yarra Road	45	54	43	No dominant LF noise audible. 1.25kHz movement alarm audible to 41dBZ.
00.23am – 00.38am	Woonah St	40	53	37	General low-level hum from direction of Port. No prominent LF throbbing noise audible - 40Hz up to 62dBZ. Occasional clunks and clangs 40-45dBA. No 1.25kHz alarm audible in this period.
00.39am – 00.40am	Woonah St	39	50	37	Quiet period with no obvious container handling or movement alarm noise or local extraneous noise.
00.41am – 00.56am	Woonah St	39	52	38	Occasional clunks and clangs from container handling 45-48dBA. 1.25kHz movement alarm at very end of period to 33dBZ.
01.46am – 01.51am	Anthony St	42	47	40	No audible container handling or movement alarm noise. 160Hz feint hum which pulses slowly on and off every 3-4 seconds – more localised than Port.
01.54am -01.55am	Anthony Ln	40	43	39	No audible container handling or movement alarm noise. 160Hz feint hum which pulses slowly on and off every 3-4 seconds– more localised than Port.
Wednesday 23 September 2020 – Thursday 24 September 2020					
1.00am – 1.15am	Woonah St	41	57	38	Industrial noise clearly audible, dominant frequencies 40-100Hz at about 50-60dBZ. Reversing alarms audible approx. 30dBZ at 1250Hz. Some contribution from roadworks on Little Bay Rd.
1.22am – 1.37am	Chifley Oval	45	58	41	Industrial noise clearly audible, up to 60dBZ at 40Hz. Two steam plumes visible, NW from measurement location – noticeable noise contribution from that direction (noise mostly mid-range character).

Date/Time	Location	L_{Aeq}	L_{Amax}	L_{A90}	Comment
1.46am – 2.01am	Wassell St	46	59	42	Industrial noise clearly audible, peaks of 60dBZ at 40 and 80Hz. Mid-range noise from last measurement identified to be from Opal exhausts. Noise at this location had a significant contribution from Opal site. Some road noise occasionally audible from Botany Rd.
2.17am – 2.20am	Botany Rd next to Opal Exhausts	65	69	63	Ambient noise dominated by Opal site exhausts, L_{Aeq} dominated by passing trucks.
2.34am – 2.39am	Cnr Bunborah Point Rd	56	66	53	Low frequency chugging from Port Botany audible from this location. Confirmed to not be from Opal site.
3.08am – 3.09am	Patricks Car Park	56	64	53	Low frequency chugging clearly audible, up to 78dBZ at 40Hz, source not visible from location.
3.21am – 3.24am	Brotherson House (smoking area)	57	67	54	Low frequency chugging clearly audible, up to 78dBZ at 40Hz. Chugging coming from BD10/BD12.
3.26am – 3.27am	Brotherson House (inside car)	34	44	31	Attempted to replicate internal experience. Low frequency chugging audible and physically noticeable.
3.29am – 3.30am	Brotherson House (car park)	53	57	51	Low frequency chugging clearly audible, up to 78dBZ at 40Hz. Chugging coming from BD10/BD12.
3.43am – 3.56am	Wassell St	47	61	43	Low frequency chugging faintly audible, masked by other noise. Horns and reversing alarms audible. Occasional road traffic on Botany Road audible.
4.03am – 4.10am	Chifley Oval	48	61	44	Low frequency chugging audible, Opal site exhausts clearly audible. Reversing alarms and road traffic noise audible.
4.15am – 4.20am	Woonah St	47	57	41	Industrial noise, low frequency chugging audible. Some contribution from roadworks on Little Bay Rd.

3.2 Discussion of Results

The attended noise monitoring surveys confirmed that the local noise environment at the residences surrounding Port Botany was controlled by a mixture of industrial noise (including port noise) and road traffic noise.

Industrial noise mostly consisted of a low frequency hum with occasional instances where crashes/bangs and movement alarms were audible. Where these events were loud enough to be measurable, the levels ranged between 40-50dBA when measured at the residential locations. The low frequency content of the industrial noise mostly focussed within the frequencies of 40Hz to 160Hz. As such, this assessment will implement a single value low frequency noise descriptor 'L_{ALF}' which represents the A weighted sum of these bands.

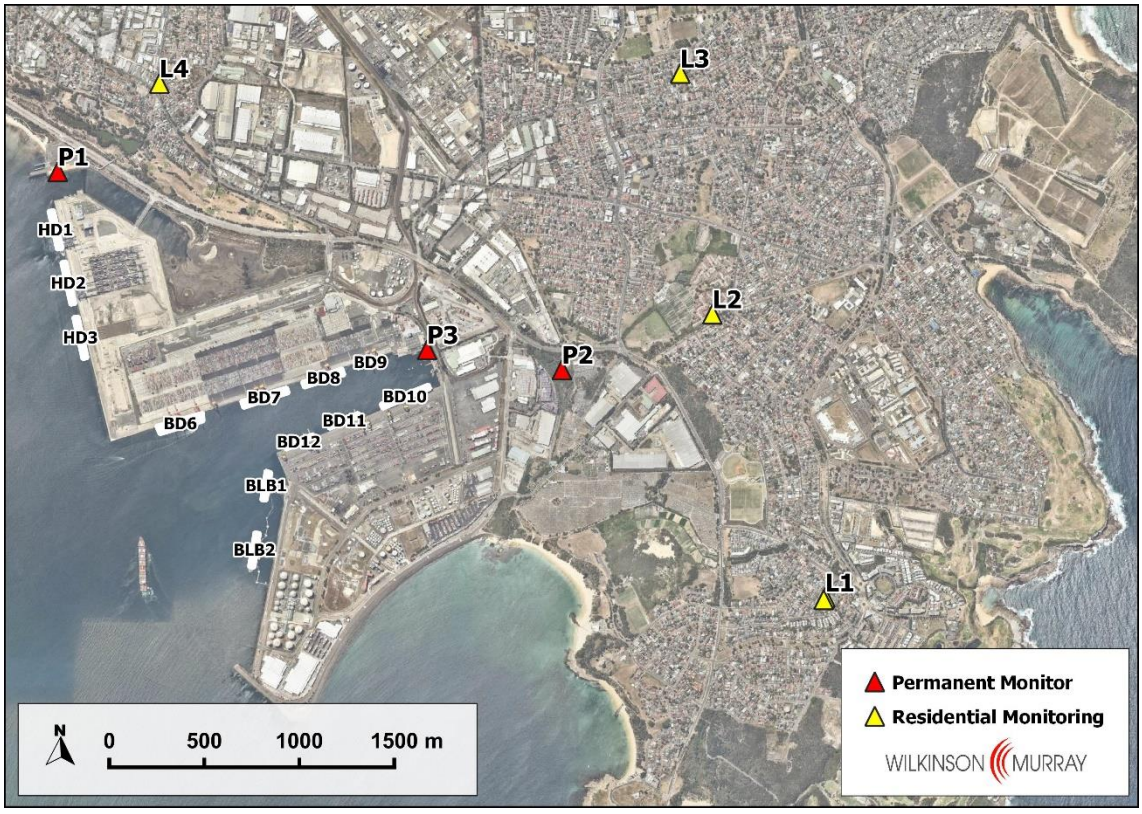
At Little Bay, there was significantly less influence from road traffic noise with the ambient noise levels mostly controlled by industrial noise from the Botany Industrial and Transport Precinct. The ambient noise levels in the Chifley/Matraville area had more contribution from road traffic noise due to being closer to Botany Road and Beauchamp Road. Audible road traffic noise typically consisted of semi-trailers travelling to and from the industrial premises in the Botany Industrial and Transport Precinct.

The industrial/low frequency noises measured at the residential locations were predominantly from the direction of the Botany Industrial and Transport Precinct. Site visits identified that a number of sources contributed to the industrial noise experienced at residential receivers. These sources included some of the industrial premises surrounding Port Botany. However, the dominant low frequency noise described by residents was observed to be predominantly from the ships berthed at Port Botany.

4 UNATTENDED NOISE MONITORING

Unattended noise monitoring was conducted at several locations surrounding the Botany Industrial and Transport Precinct. **Figure 4-1** presents the location of the three existing permanent monitoring locations (P1-P3) and the four unattended noise monitors for the trial, relative to the Botany Industrial and Transport Precinct.

Figure 4-1 Residential monitoring locations relative to Port



4.1 Permanent Noise Monitors

NSW Ports has had permanent monitors surrounding the site since 2017. A directional noise monitor (BarnOwl) is located centrally at Brotherson House and two monitors are located to the north and east of Port Botany. All monitors are capable of recording one-third octave band data and audio for downloading if required.

Table 4-1 summarises details relating to these noise monitors.

Table 4-1 Noise monitor details

Location ID	Description	Noise Monitor Type
P1	Foreshore Road	Norsonic 140
P2	Botany Road East	Norsonic 140
P3	Brotherson House	BarnOwl Directional

4.2 Residential Noise Monitoring

In addition, four residential receiver locations were selected to undertake monitoring representative of areas where complaints have arisen. At one location, both an external and internal noise monitor was installed. Monitoring was undertaken from Friday 28 August until Tuesday 28 September.

Table 4-2 summarises the details relating to these noise monitoring locations.

Table 4-2 Residential noise monitoring locations

Location ID	Location	Description
L1a	Woonah St, Little Bay	First floor study / bedroom
L1b	Woonah St, Little Bay	Front balcony on Level 1
L2	Wassell St, Chifley	Front first floor balcony
L3	Anthony St, Matraville	Rear garden on roof of shed
L4	Wilson St, Botany	Front garden

The residents were asked to keep diary notes and make an attempt to rank the noise on particular nights against their previous experience as either low, medium or high. A summary of the observations is shown in **Appendix B**.

The noise monitoring equipment used for this measurement consisted of Norsonic Sound Analyser Nor140 noise loggers set to fast response and continuously monitoring in 15-minute intervals.

This equipment is capable of remotely monitoring and storing one third octave band noise data (6.3Hz – 20kHz) for later detailed analysis. The logger determines L_{A10}, L_{A90} and L_{Aeq} levels of the ambient noise. L_{A10} and L_{A90} are the levels exceeded for 10% and 90% of the sample time respectively (see Glossary of Acoustic Terms for definitions).

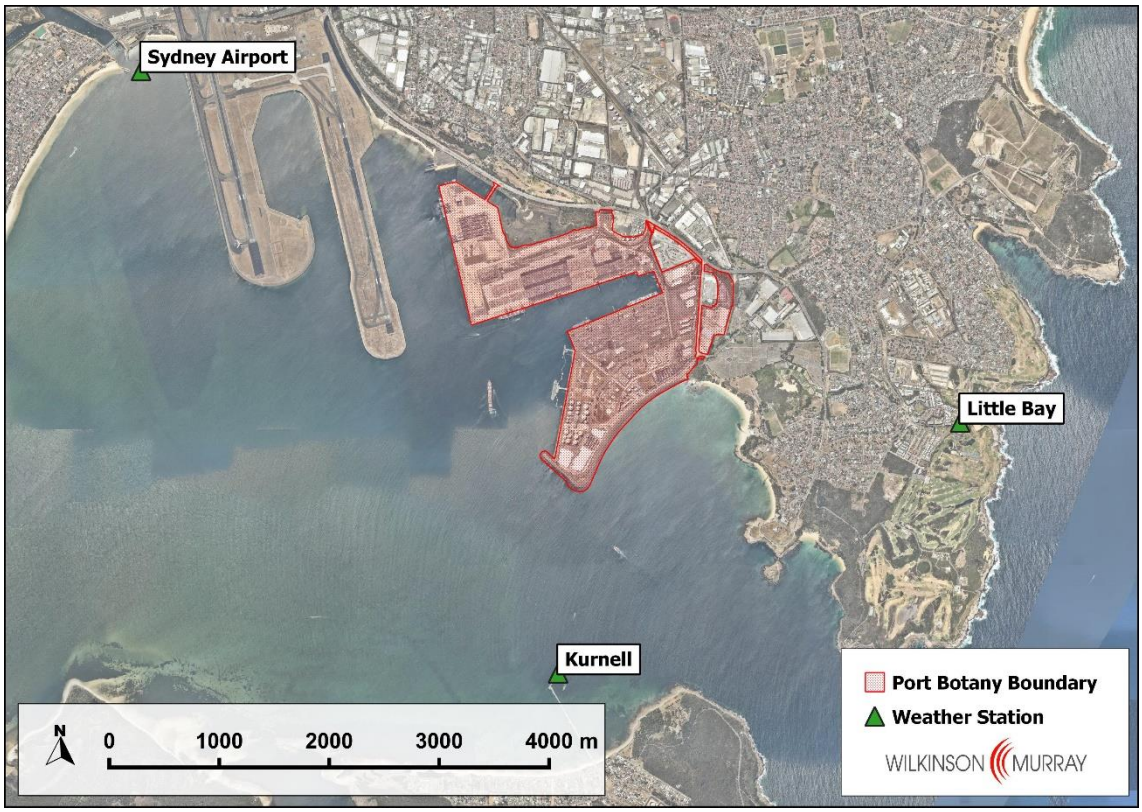
The equipment calibration was checked before and after the survey and no significant drift was noted.

5 ANALYSIS OF METEOROLOGICAL DATA

5.1 Historical Wind Data

A review of historical wind data was completed to understand the local meteorological conditions. The nearest automatic weather stations (AWS) to the study area include the Sydney Airport AWS and Little Bay AWS, which are Bureau of Meteorology weather stations, and Kurnell AWS, which is owned and operated by Caltex. **Figure 5-1** presents the location of these weather stations relative to the Port Botany.

Figure 5-1 Nearest weather stations



Appendix C presents wind rose plots for these AWS for the autumn and winter period of 2019 and 2020.

The plots show similar patterns of wind speed and wind direction between the two years, with westerly and/or north westerly winds being most prevalent at all locations for both autumn and winter in both 2019 and 2020. Although north westerly/westerly winds were still the most prevalent, there was a significant number of southerly winds during the autumn months for both 2019 and 2020. This was not the case in the winter months.

5.2 Frequency of Noise Enhancing Winds

The frequency of noise enhancing winds was determined in accordance with the methodology outlined in Appendix D2 of the *Noise Policy for Industry*. This essentially returns the proportion of time of which winds of up to 3m/s (at microphone height) blows from Port Botany to the receiver which would increase received noise levels. We have compared data from 2020 to the average of the previous 3 years (2017 to 2019). Weather data was extracted from the Sydney Airport and Little Bay BOM weather stations.

Table 5-1 presents the percentage of noise enhancing winds during the night-time period (10.00pm – 7.00am) which indicates that there has been marginal decrease in the frequency of noise enhancing winds for all locations during the autumn months (March to May) and moderate increases during the winter months (June to August). This does not necessarily correlate with the increase of complaints during the lockdown period but may support the continued increase of complaints over the winter months. **Table 5-1** also identifies that there is significantly more noise enhancing winds during winter compared to autumn.

Table 5-1 Percentage of night-time noise enhancing winds

Location	Bearing from Port	Autumn		Winter	
		2017-2019	2020	2017-2019	2020
Sydney Airport weather station					
L1 – Woonah St, Little Bay	102.5°	29.8%	27.3%	36.5%	41.4%
L2 – Wassell St, Chifley	79.5°	19.4%	17.2%	20.4%	26.1%
L3 – Anthony St, Matraville	58.8°	13.4%	11.3%	12.9%	16.1%
L4 – Wilson St, Botany	340.8°	4.2%	4.4%	2.0%	2.1%
Little Bay weather station					
L1 – Woonah St, Little Bay	102.5°	48.1%	43.0%	60.7%	62.8%
L2 – Wassell St, Chifley	79.5°	46.0%	40.3%	58.0%	62.5%
L3 – Anthony St, Matraville	58.8°	24.6%	19.8%	28.7%	30.9%
L4 – Wilson St, Botany	340.8°	6.5%	6.1%	3.4%	3.6%

5.3 Frequency of Temperature Inversions

The frequency of temperature inversions was determined using meteorological data acquired from the Kurnell AWS. A temperature inversion is an atmospheric condition in which temperature increases with height above the ground. The temperature gradient results in sound, which was travelling away from the ground, being refracted back to the ground. This ultimately increases the range that sound would typically travel.

This weather station is installed at the end of the wharf and records wind speed, wind direction, and sigma theta. The data was processed to determine the Pasquill-Gifford (PG) stability category using the sigma-theta methodology. This methodology determines the stability category based off the standard deviation of horizontal wind direction. **Table 5-2** presents the percentage of time during the evening and night periods where temperature inversions occurred.

It should be noted that the meteorological conditions at the location may not be completely representative of the conditions at Port Botany and surrounds. However, the data may be indicative of any significant changes between 2019 and 2020 which may contribute to the increased number of complaints.

Table 5-2 Frequency of temperature inversions

	Autumn		Winter	
	2019	**2020**	**2019**	**2020**
Percentage of Time F or G at Evening and Night combined	16.5%	15.3%	16.5%	14.2%
Percentage of Time F or G at Evening	10.4%	11.1%	19.5%	12.2%
Percentage of Time F or G at Night	19.2%	17.1%	15.2%	15.0%

Note: Evening is defined as the period from 6.00pm to 10.00m (Monday to Saturday) and Night is defined as the period from 10.00pm to 7.00am (Monday to Saturday), and 10.00pm to 8.00am (Sundays and public holidays).

Review of **Table 5-2** indicates that there were no significant increases in the frequency of temperature inversions in 2020 when compared to 2019. Generally, there were less temperature inversions in 2020 with a highest decrease of about 7% during the Winter Evening period.

From the data, the increase of complaints would not be directly due to increases in the occurrence of temperature inversions which would increase received noise levels.

6 ANALYSIS OF NOISE MONITORING DATA

6.1 Long-Term Noise Monitoring at Permanent Sites

The purpose of this analysis was to compare data from the years 2017 to 2019 to the same periods in 2020, specifically the April-May period (Autumn) during the lockdown and also the winter months of June, July, and August (Winter). This is to compare periods to see if any trends existed in relation to background noise (which may mask local industrial noise), the noise generation from Port Botany, and the winter months when complaints have historically been higher.

A statistical analysis of L_{A90} and L_{Aeq} data was undertaken over the three periods; day 7.00am to 6.00pm, evening 6.00pm to 10.00pm, and night 10.00pm to 7.00am. The L_{A90} levels would best represent the background noise level and the L_{Aeq} levels would best represent the ambient noise level which would include road traffic noise and nearby industrial noise.

For each year, the median of these descriptors has been compared. Analysis was completed for both overall broadband noise levels and low frequency noise levels. The low frequency noise level is the A-weighted sum of the key low frequency one third octave bands (40Hz to 160Hz) which were identified from attended noise monitoring.

Data from the noise monitor at Brotherson House has not been reviewed for this assessment. This monitor is a near source monitor designed to detect noise contribution from areas near the end of Brotherson Dock. As such, the measured noise levels are not representative of the entirety of Port noise which would be experienced by the residential receivers.

Appendix D presents the annual, lockdown (autumn), and winter medians for the years 2017 to 2020.

6.1.1 Overall Broadband Noise

Table 6-1 presents a summary of the overall broadband noise levels in Appendix D which compares the average of the years 2017 to 2019 with the 2020. The difference in both L_{A90} and L_{Aeq} descriptors over these two time periods are shown for both lockdown (in autumn) and winter.

Table 6-1 Comparison of overall broadband noise levels in autumn and winter – dBA

Season	Location	Period	7am-6pm		6pm-10pm		10pm-7am	
			L_{A90}	L_{Aeq}	L_{A90}	L_{Aeq}	L_{A90}	L_{Aeq}
Autumn	Botany Rd East	Average 2017-2019	49.2	53.9	46.9	51.5	48.3	51.2
		2020	49.5	53.0	47.8	51.5	48.4	51.1
		Difference	0.3	-0.9	0.9	0.0	0.1	-0.1
	Foreshore Rd	Average 2017-2019	53.5	61.8	53.0	60.3	50.8	55.1
		2020	51.3	55.3	50.6	54.5	49.3	53.7
		Difference	-2.2	-6.5	-2.4	-5.8	-1.5	-1.4
Winter	Botany Rd East	Average 2017-2019	50.6	55.0	49.3	53.3	49.1	52.4
		2020	50.4	53.7	48.9	51.8	50.5	55.0
		Difference	-0.2	-1.3	-0.4	-1.5	1.4	2.6
	Foreshore Rd	Average 2017-2019	54.6	63.7	54.4	63.6	51.2	55.3
		2020	52.3	56.3	52.4	56.5	50.4	55.0
		Difference	-2.3	-7.4	-2.0	-7.1	-0.8	-0.3

At the Botany Road East permanent noise monitor, the 2020 L_{A90} and L_{Aeq} noise levels were relatively consistent with the average of the previous three years during the Autumn period. During the winter period, day and evening noise levels were 1-2dB less than previous years and 1-3dB higher in the night period.

At the Foreshore Road permanent noise monitor, the 2020 L_{A90} noise levels were 1-2dB less than previous years for all periods in both Autumn and Winter. The L_{Aeq} noise levels were 5-7dB less than previous years in the day and evening periods. In the night period, the 2020 levels were approximately 1.5dB less than previous years in Autumn and up to 0.8dB less in Winter.

From **Table 6-1**, it is very clear that there was a reduction in ambient noise levels due to the lockdown and COVID19. This is clearly apparent in the day and evening period data at Foreshore Road, which is in proximity to the Sydney Airport and major roadways. These transportation noise sources would heavily influence the L_{Aeq} descriptor which would explain the larger differences when compared to the L_{A90} level.

At the Botany Road East location, almost no changes were recorded during the autumn period and minor changes were recorded during the winter period. The location of this noise monitor is less impacted by airport and road traffic noise and so the reduction in those transport activities is not represented in the noise levels. The measured noise at this location would be more representative of industrial noise from the Botany Industrial and Transport Precinct.

Reviewing the data from the winter months, a reduction in noise levels during the daytime and evening periods is still apparent at the Botany Road East and Foreshore noise monitors. This may be the result of less road traffic due to a considerable portion of people continuing to work from home and travelling less even after lockdown restrictions eased. Increases of up to 2.6dB were recorded in the night period at the Botany Road East location.

6.1.2 Low Frequency Noise

Table 6-2 presents a summary of the low frequency noise levels in Appendix D which compares the average of the years 2017 to 2019 with the 2020. The difference in both low frequency L_{A90} and L_{Aeq} descriptors over these two time periods are shown for both lockdown (in autumn) and winter.

Table 6-2 Comparison of low frequency noise levels in autumn and winter – dBA

Season	Location	Period	7am-6pm		6pm-10pm		10pm-7am	
			L_{A90}	L_{Aeq}	L_{A90}	L_{Aeq}	L_{A90}	L_{Aeq}
Autumn	Botany Rd East	Average 2017-2019	34.6	41.3	32.4	39.1	34.2	38.5
		2020	35.8	41.5	34.8	40.1	36.2	40.6
		Difference	1.2	0.1	2.4	1.0	2.0	2.2
	Foreshore Rd	Average 2017-2019	42.1	53.2	40.5	51.2	38.4	44.9
		2020	39.1	46.3	37.9	44.8	37.2	44.2
		Difference	-3.0	-6.9	-2.6	-6.4	-1.2	-0.7
Winter	Botany Rd East	Average 2017-2019	35.9	42.2	34.5	40.6	34.7	39.2
		2020	38.0	43.3	36.4	41.4	38.0	42.3
		Difference	2.1	1.1	1.9	0.8	3.3	3.1
	Foreshore Rd	Average 2017-2019	42.5	54.5	41.0	53.5	38.2	45.0
		2020	40.1	47.0	39.3	46.4	38.1	45.2
		Difference	-2.4	-7.5	-1.7	-7.2	-0.1	0.2

At the Botany Road East permanent noise monitor, the 2020 L_{A90} noise levels were generally 1-3dB higher than previous years for both Autumn and Winter, with the highest increase of 3.3dB during the Winter night period. Similarly, the 2020 L_{Aeq} noise levels were generally 1-3dB higher than previous years for both Autumn and Winter, with the highest increase of 3.1dB during the Winter night period.

At the Foreshore Road permanent noise monitor, the 2020 L_{A90} noise levels were generally 1-3dB less than previous years for all periods in both Autumn and Winter, except for the Winter night period where no difference was measured. The 2020 L_{Aeq} noise levels were generally 6-7dB less than previous years for both Autumn and Winter during the day and evening periods. No significant difference was measured for the night period for both Autumn and Winter.

At the Botany Road East location, increases of 1-3dB were recorded across all periods in both Autumn and Winter seasons. Based on the location of this monitor, the increases in low frequency noise would be due to increased industrial activity. Wind roses for these periods show winds were predominantly from the west or north west which means the source of the noise would be Port Botany.

The differences in low frequency noise at the Foreshore Road location were consistent with the differences in overall broadband noise, as presented in **Table 6-1**. This would mean that the source of low frequency noise at this location would be primarily from road traffic and airport operations during daytime and evening.

6.2 Unattended Noise Monitoring

The purpose of this analysis was to consider the correlation between the diary notes relating to Port noise, the prevailing weather conditions, and the vessels in berth at the time. **Appendix B** shows a summary over the monitoring period. In this table, the "side to" information has been transposed to the direction the stern of a vessel is facing (east and north being the directions which generally face residences).

For the core of the night-time period (12.00 midnight to 6.00am) when extraneous noise, such as traffic, is considered to be at its lowest, we have analysed data from nights with minimal to no complaints to determine baseline levels. These nights included, 31 August, 1-2 September, 8 September, 12 September, 14-17 September, 20 September, 22 September, 27-28 September. The baseline data was then compared with levels on nights where a number of complaints were received.

Baseline levels in each third octave band have been determined by identifying the 10^{th}, 50^{th} and 90^{th} percentile of measured levels in each of the respective third octave bands during each of the two-hour periods between 12.00 midnight and 6.00am (12.00 midnight to 2.00am, 2.00am to 4.00am, 4.00am to 6.00am).

Our assessment has focused on the L_{A10} descriptor, which is the 90^{th} percentile of measured levels over a 15-minute period. The L_{A10} descriptor represents a statistical value and removes the impact of short-term high-energy events which would elevate and skew the logarithmic average (L_{Aeq}).

Considering noise mostly affects residents inside their properties at night, we have reviewed data from the internal noise monitor at Woonah Street (L1a) to determine which third octave bands are significant in dominating the low frequency energy which is common amongst complaints.

Table 6-3 presents the 50^{th} baseline values for the noise monitors and **Appendix E** presents the 10^{th} and 90^{th} percentile values. The difference between the 90^{th} percentile and 10^{th} percentile is often used to give a quantitative measure of how intermittent or how much fluctuation there is in the noise. The overall L_{A10} (6.3-20kHz) values have also been presented for reference.

The levels in **Appendix E** show a range of 10-15dB for L_{A10} and L_{ALF} (A-weighted sum of the 40Hz-160Hz third octave bands) for the external noise monitors. A larger range is exhibited for the internal noise monitor at Woonah St with a range of up to 19dB for the L_{ALF} descriptor.

Table 6-3 50th percentile baseline octave band levels

Location	Period	L_{A10}	L_{ALF}	Third Octave Band Values – dBZ						
				40Hz	50Hz	63Hz	80Hz	100Hz	125Hz	160Hz
L1a Woonah St Inside	12am – 2am	23	18	36	38	31	31	33	27	21
	2am – 4am	23	19	38	41	32	32	34	27	22
	4am – 6am	24	20	39	42	33	34	36	27	23
L1b Woonah St Outside	12am – 2am	44	37	51	53	52	47	48	46	46
	2am – 4am	44	37	50	54	53	47	49	46	46
	4am – 6am	48	38	51	56	55	49	50	47	47
L2 Wassell St	12am – 2am	42	35	44	50	46	44	46	45	45
	2am – 4am	43	36	44	51	47	45	47	46	46
	4am – 6am	47	38	50	53	50	47	49	48	48
L3 Anthony St	12am – 2am	43	33	44	45	43	43	44	43	44
	2am – 4am	42	34	44	44	43	42	44	42	45
	4am – 6am	48	37	49	49	48	47	47	46	48
L4 Wilson St	12am – 2am	43	33	44	45	43	42	44	42	45
	2am – 4am	42	35	44	45	44	43	44	43	47
	4am – 6am	48	37	49	49	48	47	47	46	48
P1 Foreshore Rd	12am – 2am	54	44	65	61	58	58	57	53	51
	2am – 4am	54	44	66	61	60	59	57	54	52
	4am – 6am	56	47	66	64	64	63	59	57	55
P2 Botany Road East	12am – 2am	51	41	63	62	57	56	55	49	46
	2am – 4am	49	41	63	62	57	55	54	50	45
	4am – 6am	52	43	64	64	60	57	57	51	48

There were several nights which resulted in the greatest response from residents. These include but are not limited to:

- 27 August – 28 August 2020
- 28 August – 29 August 2020
- 3 September – 4 September 2020
- 4 September – 5 September 2020
- 23 September – 24 September 2020

For each of these nights, the third octave bands were compared to the median baseline level in each of the respective third octave bands to determine the relative increase and to understand what may be contributing to complaints. For reference, the noise level differences from the night of 31 August – 1 September and the night of 14 September – 15 September, where no complaints were reported, has also been presented.

Appendix F presents the windspeed, wind direction, and stability class records and the measured noise level differences to the median baseline data for these nights. Meteorological data used in this analysis was obtained from the Sydney Airport AWS.

6.2.1 31 August – 1 September – Low Perceived Noise

On this night there were seven ships in Port Botany, four of which had their funnels facing east. The wind that night had speeds around 3-5m/s and was predominantly southerly and south-easterly. The permanent monitors P1 and P2 were recording levels generally close to the baseline.

The noise level differences show that receivers south-east, east, and north-east of Port Botany were experiencing noise levels less than baseline levels. The receiver to the north-west (L4) was experiencing levels that were up to 6dB greater than the baseline levels in the L_{A10} descriptor, however, the L_{ALF} was relatively consistent with the baseline values. This would mean that the local noise environment at this location was influenced by another source of noise. Review of audio recordings have confirmed that the noise at this location was impacted by passing trucks which would be on Botany Road. No ship noise or industrial noise was audible from the audio recording.

6.2.2 14 September – 15 September – Low Perceived Noise

On this night there were eight ships berthed at Port Botany, five of which had exhausts facing the east. The winds on this night were mainly south easterly and had speeds ranging from 1 to 2m/s.

On this night, the noise level differences were less than baseline levels at all locations, with the exception of L4 where occasional increases of up to 8dB was measured in the L_{A10} descriptor. The low frequency noise at this location was less than baseline levels for most of the night. This would indicate that the noise environment at this location would be dominated by intermittent noise sources such as passing road traffic.

6.2.3 27 August – 28 August – High Perceived Noise

On 27 August – 28 August, there were only six ships in Port Botany, three of which had funnels facing east towards the residential areas. Winds were northerly to north-westerly in the first half of the night with wind speeds around 3m/s. After approximately 3.30am, the wind changed direction to a south-westerly with winds speeds between 2-5m/s.

The noise level differences indicate that the measured noise levels were above the baseline levels at all locations until about 3.30am. Higher noise levels were exhibited at locations L1a, L1b, and L2 which are south-east and east of Port Botany. The audio at these locations confirmed the noise during this period consisted of low frequency industrial noise. As the wind changed direction after approximately 3.30am, the noise levels dropped to about baseline levels. The permanent noise monitors (P1 at Foreshore Road and P2 at Botany Road East also exhibited a similar reduction in noise levels after 3.30am.

From the data, it is clear that the wind was a controlling factor in the received noise levels, with receivers downwind from Port Botany experiencing elevated noise levels and a reduction in noise levels once the locations were no longer downwind.

6.2.4 28 August – 29 August – High Perceived Noise

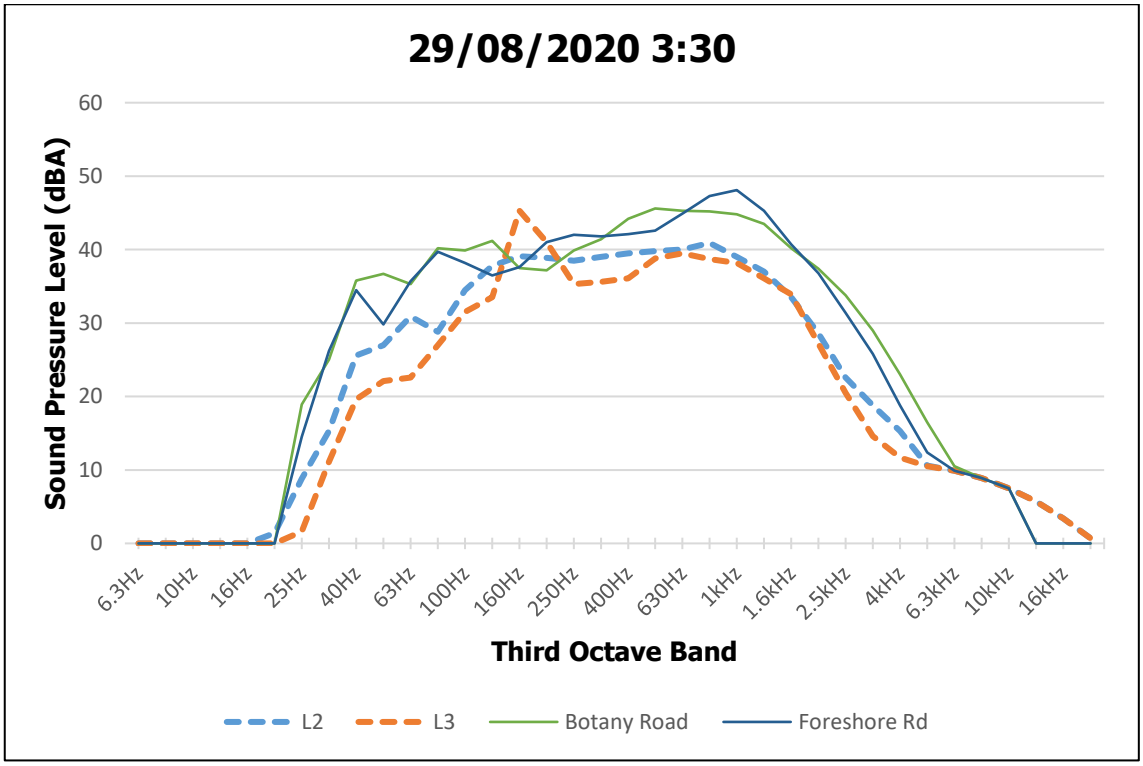
On 28 August – 29 August, there were eight ships in Port Botany with one arriving at BD8 at approximately 2.30am and one leaving BD9 at approximately 3.00am. The wind speeds were below 3m/s were north-westerly for most of the night.

The noise level differences indicate that noise levels were above baseline levels from midnight to about 4.00am at all locations. The greatest increases were exhibited at locations L2 and L3 which are east and north-east of Port Botany, respectively. From reviewing the audio recording at location L2, the received noise at this location consisted of low frequency industrial noise as well as consistent instances of reversing alarms.

Audio recordings were not available at location L3 and so a similar analysis could not be completed at this location. In lieu of audio analysis, the third octave band data for these locations were compared.

Figure 6-1 presents the measured A-weighted third octave band levels for locations L2 and L3 and the permanent monitors at Botany Road East and Foreshore Road from the 3.30am period on this night.

Figure 6-1 A-weighted third octave band spectrum, 29/08/2020 3.30am



From **Figure 6-1**, it can be seen that there is a peak at 160Hz at location L3, which is not seen at location L2 or either of the permanent noise monitors. This peak at 160Hz can be seen throughout the night and drops off after about 6.30am. As this peak is not found at any of the other locations, the source of this noise would be from a localised source that only affected the noise monitor at location L3.

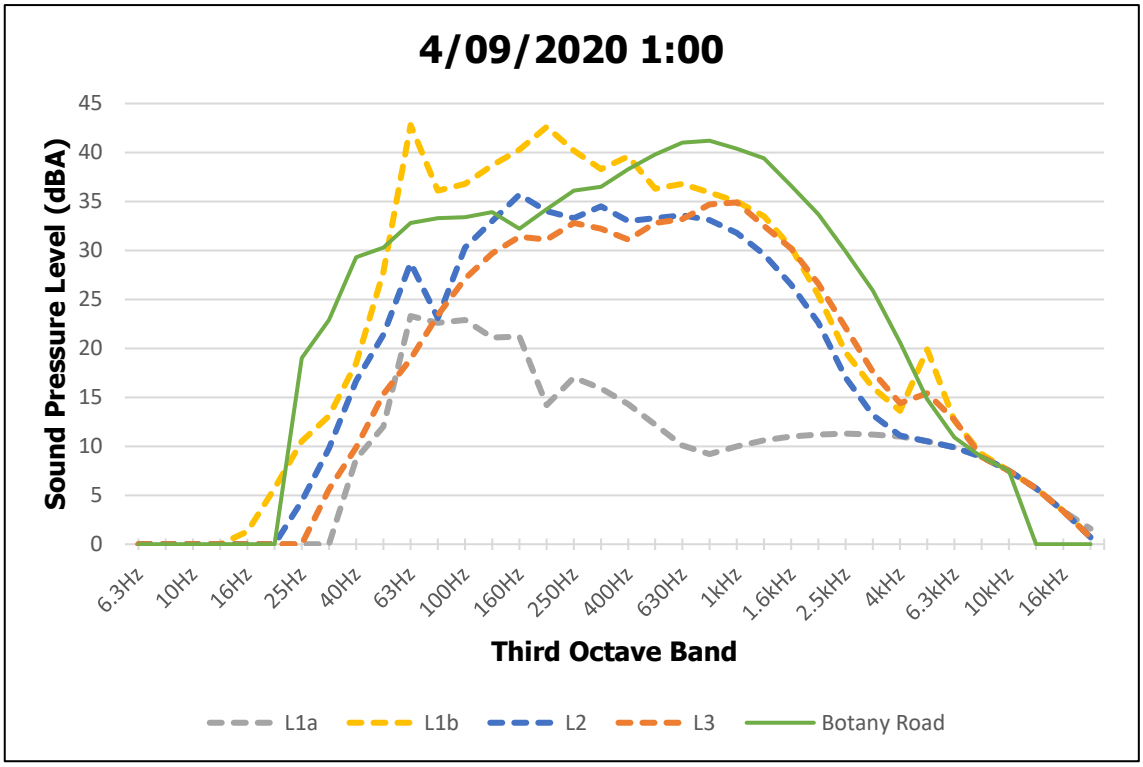
On this night, the elevated noise levels are unlikely due to noise enhancing winds and more likely due to increased activity. However, based on the noise levels at other locations and wind speed and direction, the source of the activity may be more localised to locations L2 and L3 and not from ships at Port Botany.

6.2.5 3 September – 4 September – High Perceived Noise

On this night, there were eight ships berthed at Port Botany, with six having funnels facing east. Winds were mainly north and north easterly with speeds between 1m/s and 3m/s. Large increases on baseline levels were measured at locations L1a and L1b where increases of up to 12dB was measured in the L_{ALF} descriptor at approximately 1am. During this period temperature inversions were present. Lesser increases of up to 6dB were recorded at locations L2 and L4, and marginal increases of up to 4dB were recorded at location L3.

Analysis of the third-octave band spectrum for this period was completed to understand the nature of the noise. **Figure 6-2** presents the measured third-octave band levels for locations L1a, L1b, L2, L3, and P2.

Figure 6-2 A-weighted third octave band spectrum, 4/09/2020 1.00am



From **Figure 6-2**, a distinct peak can be seen at 63Hz at locations L1b and L2, although the noise at location L2 had more influence from the higher frequencies of 100Hz to 800Hz. Audio recordings were reviewed to further understand the noise at these locations. At both locations, mechanical plant noise was audible and dominating the local noise environment.

The shared peak at 63Hz would indicate that location L1b and L2 are impacted by the same source of mechanical plant noise, and the higher levels at L1b when compared to L2 would indicate that the source would be closer to L1b.

The noise levels at location L1b were higher than what was measured at P2. Based on the location of these monitors relative to Port Botany (L1 is 2.7km south east and P2 is 1km east, relative to Port Botany) and the wind direction that night, the measured noise at location L1b would have been influenced by a source other than Port Botany.

6.2.6 4 September – 5 September – High Perceived Noise

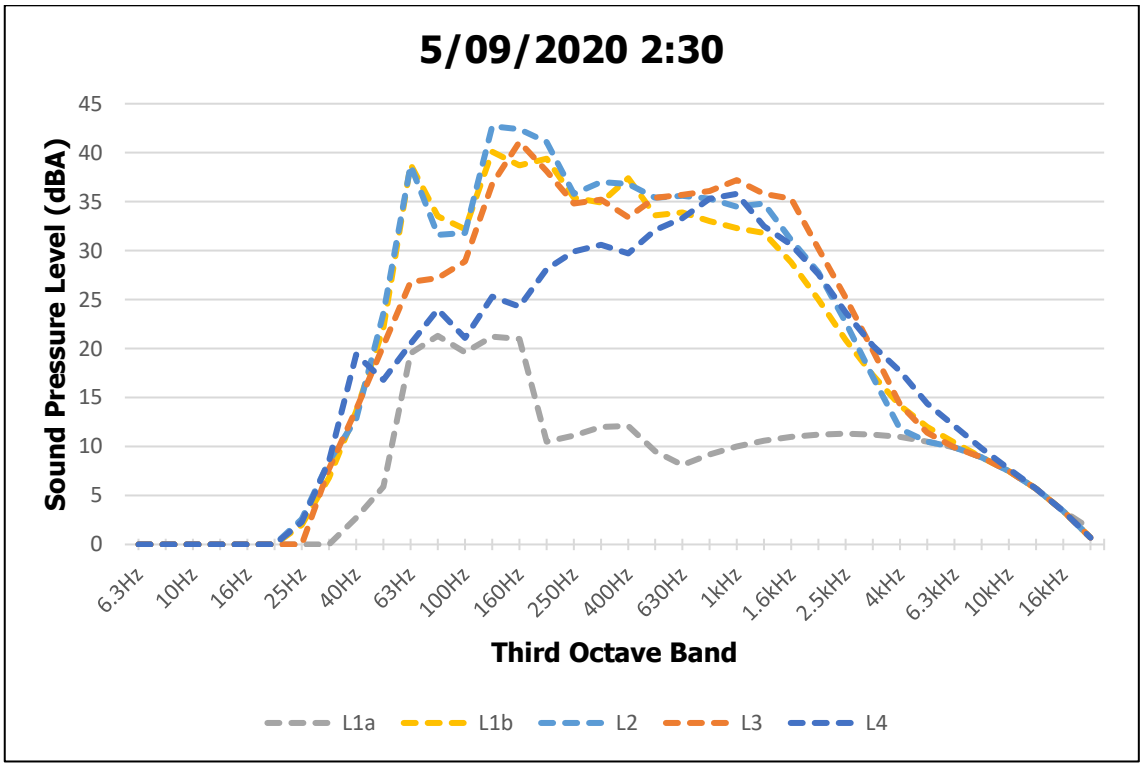
On 4 September – 5 September, there were nine ships in Port Botany, six of which had funnels facing east. Winds were generally north-westerly and westerly with speeds below 2m/s. Additionally, temperature inversions were present between 2.00am and 5.00am.

The noise level differences indicate considerable increases in noise levels with noise levels up to 12dB above baseline levels in the L_{ALF} descriptor at about 1.30am. Higher low frequency noise levels were measured up until about 5.15am. Audio recordings were reviewed for this location and confirmed that the noise experienced in the room was a low frequency chugging from industrial noise.

In the 2.15am measurement period, there were brief periods where activity in the house was audible. This can be seen by the 12dB relative increase in the measured L_{A10} level. During all other periods, the noise was clearly a low frequency chugging from industrial noise.

Figure 6-3 presents the measured third octave band spectrum for all five residential locations. were compared to identify if the source of the noise at these locations were consistent. The third octave band spectrum was taken for the 2.30am measurement period. There was no audible activity inside at Location 1a during this period.

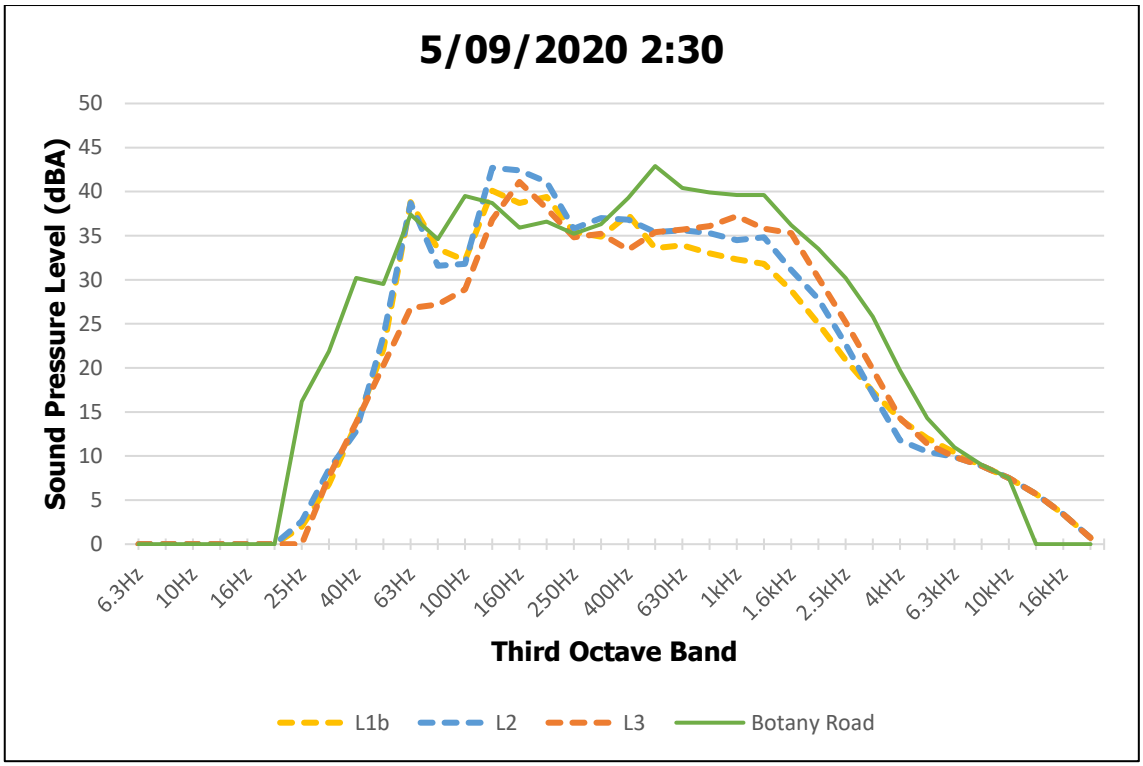
Figure 6-3 A-weighted third octave band spectrum, 05/09/2020 2.30am



From **Figure 6-3**, similar peaks are observed at locations L1b, L2, and L3, although the 63Hz peak at L3 was not as apparent as the other two locations. At location L1a, inside the bedroom, there was no single octave band peak with the frequencies 63Hz to 160Hz measuring similar levels. At location L4, the noise had little low frequency content, this would be expected as this location was upwind of the Botany Industrial and Transport Precinct.

Figure 6-4 below, compares the third octave band spectra at locations L1b, L2, and L3 with the measured spectra at the Botany Road permanent noise monitor.

Figure 6-4 A-weighted third octave band spectrum, 05/09/2020 2.30am



A similar peak at 63Hz is shared at locations L1b, L2, and the Botany Road East monitor. The residential monitors also measured a peak at 125Hz to 200Hz. This peak is not apparent at the Botany Road location. This would mean that the measured levels at the residential monitors were also influenced by noise from a source other than Port Botany.

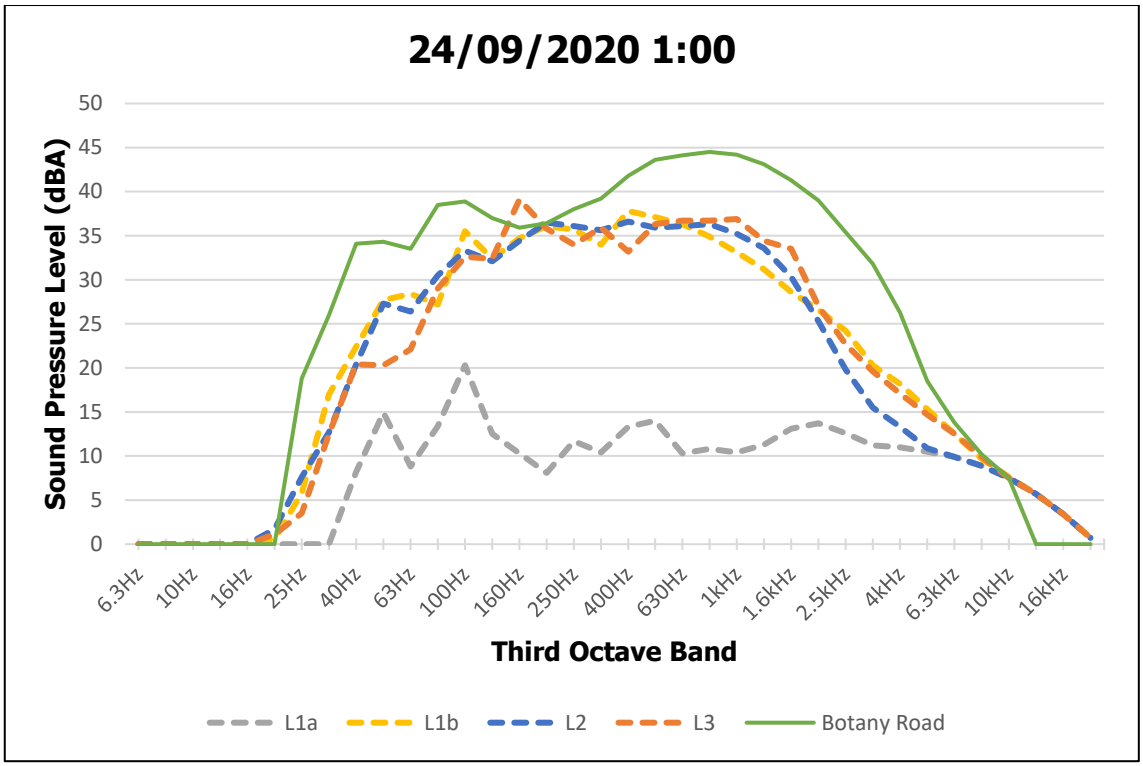
On this night, the temperature inversions would have elevated noise levels from other industrial noise sources as well as ships berthed in Port Botany. The combination of these factors would have resulted in the high levels experienced by residents.

6.2.7 23 September – 24 September – High Perceived Noise

On 23 September – 24 September, there were five ships in Port Botany, three of which had funnels facing east. Winds were generally westerly throughout the night. Noise levels above the baseline were exhibited at Locations L1a, L1b, L2, and L3.

Figure 6-5 below presents the measured third-octave band levels with the noise monitors. At location P2 (Botany Rd East), a peak can be seen at 50Hz and 100Hz. These peaks are also apparent at location L1a, L1b, L2, and L3 to varying degrees. However, at location L3, the largest peak was measured at 160Hz with a level higher than measured at 160Hz at P2. Based on the location of these monitors and the wind direction this night, the noise at location L3 would have been influenced by a source other than Port Botany.

Figure 6-5 A-weighted third octave band spectrum, 24/09/2020 1.00am



The noise levels at location P1 were up to 5dB below baseline levels in the L_{A10} descriptor. Interestingly, the levels at location L4, which is in the same direction as P1 relative to Port Botany, had levels up to 6dB greater than baseline in the L_{A10} descriptor. This indicates that the measured noise levels at this location may be controlled by more localised noise sources. From review of audio recordings, the noise levels at this location were dominated by occasional passing road traffic. No low frequency or industrial noise was audible from the audio recordings.

7 REVIEW OF DATA

7.1 Historical Meteorological Data

Analysis of historical meteorological data indicated that the conditions during the April/May COVID19 lockdown period were not significantly different from previous years and unlikely to be the cause of the increase in the number of complaints. There were no increases in the number of noise-enhancing winds carrying noise from Port Botany to the residential receivers as well as no increases in the occurrence of temperature inversions in 2020 compared to previous years.

However, monitoring results from the residential locations were able to demonstrate a correlation between wind speed and direction on the received noise levels. This was apparent on the night of 27 August – 28 August, where the noise levels at the receivers downwind of the Botany Industrial and Transport Precinct decreased once the wind changed direction. Additionally, on the two low perceived nights analysed, 31 August – 1 September and 14 September – 15 September, the winds were predominantly south easterly, i.e., the residents were upwind of the Botany Industrial and Transport Precinct.

Noise enhancement from temperature inversions was also demonstrated on the night of 4 September – 5 September. On this night, there were nine ships berthed in Port Botany. It should be noted that the temperature inversions would also elevate noise from other industrial premises in the Botany Industrial and Transport Precinct. The combination of these factors resulted in elevated noise levels which had a large response from the community.

7.2 Historical Noise Levels

A review of historical noise data measured at permanent noise monitoring locations was completed. The review involved comparing the measured noise levels during the high complaint period of April/May 2020 to historical levels. The review indicated that there was a significant decrease in overall broadband noise levels and low frequency noise levels at Location P1 which was the Foreshore Road location. At location P2 – Botany Road East, minor differences were seen in the overall broadband levels and increases of up to 3dB were seen in the low frequency noise levels.

7.3 Noise Characteristics

The attended noise monitoring confirmed that the received noise at the residential locations was an industrial hum that is low frequency in nature, predominantly between the frequencies of 40Hz to 160Hz. Reversing alarms, which were audible at some residential locations, were generally around 1.25kHz.

From the statistical analysis of monitoring data from the four residential locations, a large difference of up to 20dB was identified between the 10^{th} and 90^{th} percentiles of measured noise levels during the night period over the four-week duration of unattended noise monitoring. As other noise sources such as road traffic noise were minimal during this period, the ambient noise at these locations was controlled by 24-hour industrial activity in the vicinity. The large difference in the 10^{th} and 90^{th} percentiles would indicate that noise from these activities was intermittent and varied by a considerable amount based on the operation.

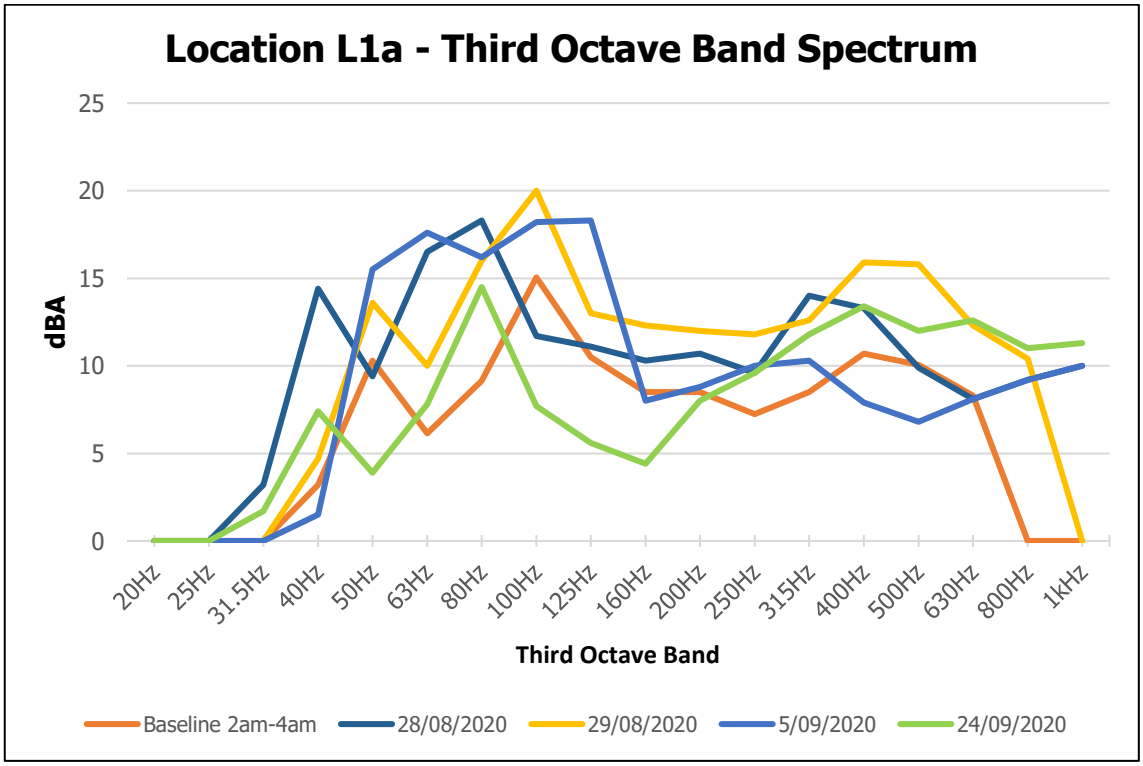
7.3.1 Internal Noise Characteristics

When comparing internal and external noise levels at Location L1, the data shows that changes in internal noise levels were represented similarly at the external location – this suggests that reporting low frequency externally will be sufficient for predicting the internal impacts. On nights when the perceived noise levels were high, the relative increase above baseline in the internal location was typically higher than the measured relative increase at the external location. This would be a function of lower baseline levels in the bedroom and less sound reduction performance in the low frequencies from typical building construction.

The size and shape of a room, its internal furnishings, and the position of a person's head in the sleeping position all can have a significant influence on how low frequency noise can be perceived by a resident. If the room dimensions have a direct relationship to the low frequency noise, standing waves can exist which essential amplify the perceived noise at specific locations (antinodes) within the room. If this is close to the head position greater annoyance is possible. Additionally, the construction of the dwelling may also factor into the amount of low frequency noise transmission. Sound transmission loss in glazing and lightweight construction (walls/roof), which is seen at Location L1, typically have lower performance in the lower frequencies when compared to masonry constructions. This is apparent when comparing the internal and external levels at this location where an outside to inside attenuation of 20dB was measured.

Spectral noise data from Location L1a, which was internal, was reviewed. **Figure 7-1** presents the measured third octave band levels between 20Hz to 1kHz during the 2am-4am period. This period has been selected as this period would have the least potential for influence from other noise sources, such as local road traffic, or any activity within the home. Spectra are provided for the four high complaint nights, and the baseline level for this period.

Figure 7-1 Location L1a – Third Octave Band Spectrum



Reviewing **Figure 7-1**, it can be seen that in the low frequency range there are peaks between 50Hz and 100Hz. It appears that the baseline and 29/08 spectra have peaks at 50Hz and 100Hz. The spectra for 28/08 and 24/09 have peaks at 40Hz and 80Hz. Note that on the night with greatest increase in L_{ALF} (5/09), noise levels were elevated from 50Hz to 125Hz with minor peaks at 63Hz and 100/125Hz. The differing peaks could be due to influence from other noise sources or different dominant frequencies from different ships berthed in Port Botany. Audio recordings for these periods were reviewed and can confirm that the nature of the noise mostly consisted of low frequency industrial noise.

7.4 Noise Sources

Site visits identified that a number of sources contributed to the industrial noise experienced at residential receivers. These sources included some of the industrial premises surrounding Port Botany. However, the low frequency noise described by residents was observed to be predominantly from the ships berthed at Port Botany.

Additionally, there are many other factors involved which may control the noise from the ships. This could include the number of ships berthed in Port Botany, ship type, capacity, orientation, usage of auxiliary engine/systems in berth, and exhaust systems. Results from this study have not been able to present any clear correlations between these factors and noise levels at the receivers. Additional investigation would be required to understand how or if these factors might influence noise emissions.

Review of port operations based on NSW Ports data confirmed that the usage of Port Botany has not changed substantially between 2019 and 2020. The berth occupancy data indicates that Port Botany activities during April to September 2020 were comparable to the previous year. Therefore, no perceivable increase in noise emissions from Port Botany would be expected.

Noise from other 24/7 industrial premises from the Botany Industrial and Transport Precinct also contribute to noise levels at surrounding residential receivers. Analysis of spectral data and audio recordings has identified instances where the noise at the residences was influenced by noise sources other than Port Botany. This was seen when analysis of third-octave band data was completed which identified dominant frequencies at residential locations which were not seen that permanent monitors near Port Botany. For example, at location L3 there were several nights where there was a peak at 160Hz which was not seen at the P2 monitor.

7.5 Summary

- The period of increased noise complaints (April – September 2020) was representative of normal port activity, with berth occupancy during this period comparable with the year prior.
- Berth occupancy during the noise monitoring period (28 August – 28 September 2020) was higher than the average across the April – September 2020 period and consistent with occupancy levels in 2019, meaning that the noise monitoring period was also representative of normal port activity.
- Residential premises surrounding Port Botany are impacted by a range of noise sources including road traffic, construction works, industrial activities and port operations.
- There was a significant decrease in background and low frequency noise levels at Foreshore Road in 2020 compared to previous years – likely due to impacts of COVID-19 'lock-down'. At Botany Road (east), broadband noise level differences were minor while increases in low frequency noise of up to 3dB were measured. This logger is less impacted by airport and road traffic noise and more representative of industrial noise from the precinct.
- Based on attended measurements at locations near industrial and port facilities, the predominant source of the low frequency noise was ships berthed at Port Botany. There were other sources of low frequency noise from the industrial precinct surrounding Port Botany which have localised impacts. Intermittent crashes and bangs are also audible at some residences, but not all are attributable to the Port.
- The strongest correlation between nights with high perceived noise levels was noise enhancing weather conditions (generally low winds with speeds 0.5 – 3m/s and temperature inversions).
- There was no observable correlation between high perceived noise levels and number of vessels at berth.
- While most noise complaints were registered during evening/night hours, noise levels at the residential areas surrounding Port Botany typically decrease at night when compared to daytime.
- Light weight housing construction has poorer noise attenuation in low frequencies when compared to mid and high frequencies – meaning external low frequency noise sources can appear louder internally. Additionally, the size and shape of a room, its internal furnishings, and the position of a person's head in the sleeping position can all influence the perception of noise by the resident.

7.6 Recommendations & Additional Investigations

Based on the work conducted in this study, the following recommendations can be made:

- The location of the permanent noise monitors should be reviewed. It is strongly recommended that a permanent noise monitor be installed towards the south east to capture noise levels in the Little Bay area.
- Noise measurements be conducted to confirm the source noise levels of the ships in Port Botany. The NEPTUNES noise measurement protocol for moored ships which was developed by the Environmental Ship Index organisation should be considered for as the measurement procedure.

APPENDIX A

SHIP OUTPUT RECORDS

Datetime	Vessel Type	Operation	From	To	SideTo	Agent
27/08/2020 2:08	Container Vessel	d	BD7	nzwlg	S	MSC
27/08/2020 4:24	Container Vessel	a	aubne	BD7	S	MSC
27/08/2020 10:25	Container Vessel	d	BD6	aumel	S	GAC
27/08/2020 11:30	Container Vessel	d	HD1	aumel	S	FIV
27/08/2020 13:55	Container Vessel	a	aubne	BD6	S	ISS
27/08/2020 14:56	Container Vessel	a	aumel	BD9	P	NEP
27/08/2020 21:14	Container Vessel	a	aumel	HD1	S	GAC
27/08/2020 21:50	Bulk Liquid	d	BLB1	auntl	P	ISS
28/08/2020 1:25	Bulk Liquid	a	egsuz	BLB1	P	WSP
28/08/2020 6:15	Container Vessel	d	BD10	cnsha	P	ISS
28/08/2020 9:03	Container Vessel	a	aumel	BD10	S	FIV
28/08/2020 12:55	Tug	a	aupbt	STB	P	SVZ
28/08/2020 14:03	Tug	d	STB	aupbt	P	SVZ
28/08/2020 14:42	Container Vessel	a	aubne	HD2	P	ISS
29/08/2020 0:05	Container Vessel	d	BD8	aumel	S	MSC
29/08/2020 2:39	Container Vessel	a	cnytn	BD8	S	GAC
29/08/2020 3:07	Container Vessel	d	BD9	aubne	P	NEP
29/08/2020 8:08	Container Vessel	d	BD6	nztrg	S	ISS
29/08/2020 9:08	Container Vessel	d	BD12	aumel	S	ISS
29/08/2020 11:35	Container Vessel	a	aumel	BD6	S	GAC
29/08/2020 14:06	Container Vessel	a	ncnou	BD9	S	MSC
29/08/2020 14:44	Bulk Liquid	d	BLB1	auoff	P	WSP
29/08/2020 16:55	Bulk Liquid	a	aumel	BLB1	P	ISS
30/08/2020 2:00	Container Vessel	d	BD7	nzmap	S	MSC
30/08/2020 4:45	Container Vessel	a	aumel	BD7	S	ISS
30/08/2020 10:16	Container Vessel	a	nztrg	BD12	P	ISS
30/08/2020 13:08	Bulk Liquid	a	aubtb	KUR1	P	WSP
30/08/2020 15:42	Bulk Liquid	a	krons	BLB2	P	ISS
31/08/2020 0:10	Container Vessel	d	HD2	aumel	P	ISS
31/08/2020 5:01	Bulk Liquid	d	BLB1	aumel	P	ISS
31/08/2020 9:00	Container Vessel	d	BD12	aumel	P	ISS
31/08/2020 10:08	Container Vessel	d	BD9	aubne	S	MSC
31/08/2020 8:13	Bulk Liquid	a	auwep	BLB1	P	ISS
31/08/2020 12:18	Container Vessel	a	aumel	BD11	P	ISS
31/08/2020 14:10	Container Vessel	a	aumel	HD2	S	GAC
31/08/2020 18:17	Container Vessel	d	BD6	aubne	S	GAC
31/08/2020 20:40	Container Vessel	d	HD1	BD6	S	GAC
31/08/2020 20:42	Container Vessel	d	BD8	aumel	S	GAC
31/08/2020 21:46	Bulk Liquid	d	BLB2	auadl	P	ISS
1/09/2020 0:07	Container Vessel	a	hkhkg	BD8	S	GAC
1/09/2020 1:57	Bulk Liquid	d	BLB1	auwep	P	ISS
1/09/2020 3:03	Container Vessel	d	BD10	aubne	S	FIV

Datetime	Vessel Type	Operation	From	To	SideTo	Agent
1/09/2020 5:30	Container Vessel	a	twkhh	BD10	P	ISS
1/09/2020 7:37	Container Vessel	a	aubel	BD9	S	MSC
1/09/2020 8:35	Container Vessel	d	HD2	aubne	S	GAC
1/09/2020 8:58	Bulk Liquid	a	aubne	BLB1	P	ISS
1/09/2020 10:05	Container Vessel	d	BD7	auadl	S	ISS
1/09/2020 13:52	Container Vessel	a	aumel	BD7	S	MSC
1/09/2020 23:59	Container Vessel	d	BD11	nztiu	P	ISS
2/09/2020 2:17	Container Vessel	a	aubne	BD11	P	ISS
2/09/2020 2:32	Container Vessel	d	BD6	aubne	S	GAC
2/09/2020 4:49	Container Vessel	a	aumel	BD6	S	ISS
2/09/2020 11:46	Bulk Liquid	d	BLB1	aupkl	P	ISS
2/09/2020 13:53	Container Vessel	d	BD8	aumel	S	GAC
2/09/2020 14:00	Bulk Liquid	a	cnntg	BLB1	P	ISS
2/09/2020 21:11	Container Vessel	a	nzakl	BD8	S	ISS
2/09/2020 21:21	Container Vessel	d	BD6	BD6	S	ISS
2/09/2020 22:39	Container Vessel	d	BD10	aumel	P	ISS
3/09/2020 2:32	Container Vessel	a	twkhh	BD10	P	GAC
3/09/2020 7:04	Container Vessel	a	hkhkg	HD2	S	ISS
3/09/2020 10:00	Container Vessel	d	BD7	nzwlg	S	MSC
3/09/2020 12:16	Container Vessel	a	aubne	BD7	S	MSC
3/09/2020 19:29	Bulk Liquid	a	auntl	BLB2	P	BWL
3/09/2020 20:03	Container Vessel	d	BD11	aumel	P	ISS
3/09/2020 22:12	Container Vessel	a	cnsha	BD11	P	ISS
3/09/2020 22:30	Bulk Liquid	d	BLB1	cnzap	P	ISS
4/09/2020 16:46	Bulk Liquid	a	aubne	BLB1	P	WSP
4/09/2020 19:59	Bulk Liquid	d	BLB2	aurdn	P	BWL
4/09/2020 21:54	Container Vessel	d	BD8	aumel	S	ISS
5/09/2020 3:36	Container Vessel	a	aumel	BD8	S	GAC
5/09/2020 5:48	Bulk Liquid	a	auwep	BLB2	P	WSP
5/09/2020 6:15	Container Vessel	d	BD6	aupae	S	ISS
5/09/2020 11:14	Container Vessel	a	nztrg	BD12	P	ISS
5/09/2020 12:01	Container Vessel	d	HD2	aumel	S	ISS
5/09/2020 13:18	Container Vessel	d	BD10	aumel	P	GAC
5/09/2020 14:01	Container Vessel	d	BD9	aubne	S	MSC
5/09/2020 17:37	Container Vessel	a	aubne	BD10	P	ISS
5/09/2020 19:50	Container Vessel	a	hkhkg	HD2	S	ISS
5/09/2020 22:13	Container Vessel	a	aumel	BD6	S	ISS
5/09/2020 23:18	Container Vessel	a	aumel	BD9	S	CNC
6/09/2020 9:02	Container Vessel	d	BD11	aubne	P	ISS
6/09/2020 10:14	Container Vessel	d	BD12	aumel	P	ISS
6/09/2020 14:44	Container Vessel	a	aumel	BD11	P	GAC
6/09/2020 15:17	Bulk Liquid	d	BLB1	sgsin	P	WSP

Datetime	Vessel Type	Operation	From	To	SideTo	Agent
6/09/2020 21:42	Container Vessel	a	aubne	HD1	P	FIV
7/09/2020 0:06	Container Vessel	d	BD7	nzblu	S	MSC
7/09/2020 2:17	Bulk Liquid	d	BLB2	sgsin	P	WSP
7/09/2020 15:00	Bulk Liquid	a	autsv	BLB2	P	WSP
7/09/2020 16:00	Container Vessel	d	BD10	aumel	P	ISS
7/09/2020 17:00	Container Vessel	a	aubne	BD10	P	ISS
7/09/2020 19:00	Bulk Liquid	a	krons	BLB1	P	BWL
7/09/2020 22:00	Container Vessel	d	BD8	aubne	S	GAC
10/09/2020 2:55	Container Vessel	d	BD9	aubel	S	MSC
10/09/2020 5:14	Container Vessel	a	nztrg	BD12	P	ISS
10/09/2020 18:00	Bulk Liquid	d	BLB1	sgsin	P	GAC
10/09/2020 19:00	Bulk Liquid	a	aubne	BLB1	P	ISS
10/09/2020 22:00	Container Vessel	d	BD7	nztrg	S	ISS
11/09/2020 2:00	Container Vessel	d	BD10	aubne	S	ISS
11/09/2020 3:00	Container Vessel	a	nztrg	BD11	P	ISS
11/09/2020 4:00	Container Vessel	a	aumel	BD8	S	ISS
11/09/2020 5:00	Container Vessel	a	twkhh	BD10	P	NEP
11/09/2020 10:00	Bulk Liquid	d	BLB2	aukwi	P	WSP
11/09/2020 15:00	Bulk Liquid	d	BLB1	aucns	P	ISS
11/09/2020 18:00	Bulk Liquid	a	auntl	BLB1	P	ISS
11/09/2020 22:00	Container Vessel	d	BD11	aumel	P	ISS
12/09/2020 4:00	Container Vessel	a	cnshk	BD11	P	ISS
12/09/2020 6:00	Container Vessel	d	BD12	aumel	P	ISS
12/09/2020 12:00	Container Vessel	a	twkhh	BD10	P	ISS
12/09/2020 12:00	Container Vessel	d	HD2	aumel	S	ISS
12/09/2020 13:00	Container Vessel	a	aubne	HD2	P	GAC
12/09/2020 18:00	Bulk Liquid	a	auntl	BLB2	P	ISS
12/09/2020 20:00	Container Vessel	a	hkhkg	HD2	S	FIV
12/09/2020 22:00	Bulk Liquid	d	BLB1	aumel	P	ISS
13/09/2020 2:00	Bulk Liquid	a	audpo	BLB1	P	ISS
13/09/2020 6:00	Container Vessel	d	BD10	aumel	P	NEP
13/09/2020 7:37	Container Vessel	a	aubel	BD9	S	MSC
13/09/2020 8:00	Bulk Liquid	a	pgnap	BLB1	P	ISS
13/09/2020 18:00	Bulk Liquid	d	BLB1	BLB1	P	ISS
13/09/2020 23:00	Container Vessel	d	HD2	aumel	P	GAC
14/09/2020 3:10	Container Vessel	a	aubel	BD7	S	MSC
14/09/2020 4:40	Container Vessel	a	aumel	BD6	S	ISS
14/09/2020 4:59	Bulk Liquid	d	BLB2	phbtg	P	ISS
14/09/2020 6:58	Bulk Liquid	a	pgnap	BLB1	P	ISS
15/09/2020 0:25	Container Vessel	d	BD8	aubne	S	ISS
15/09/2020 5:13	Container Vessel	a	aumel	BD9	S	NEP
15/09/2020 6:01	Container Vessel	d	BD7	aubne	S	MSC

Datetime	Vessel Type	Operation	From	To	SideTo	Agent
15/09/2020 7:26	Container Vessel	d	BD12	BD7	S	ISS
15/09/2020 9:41	Container Vessel	a	aumel	BD12	P	FIV
15/09/2020 10:07	Bulk Liquid	d	BLB1	fjltk	P	ISS
15/09/2020 12:38	Bulk Liquid	a	sgsin	BLB1	P	ISS
15/09/2020 14:24	Bulk Liquid	a	jpsak	BLB2	P	ISS
15/09/2020 21:08	Container Vessel	a	aumel	BD8	S	ISS
16/09/2020 6:06	Container Vessel	d	BD10	aubne	P	ISS
16/09/2020 9:20	Container Vessel	a	aumel	HD2	P	GAC
16/09/2020 9:33	Bulk Liquid	d	BLB1	aumel	P	ISS
16/09/2020 13:47	Container Vessel	a	aumel	BD10	P	ISS
16/09/2020 18:08	Container Vessel	d	BD6	aubne	S	ISS
16/09/2020 20:49	Bulk Liquid	a	aubne	BLB1	P	ISS
16/09/2020 21:16	Container Vessel	d	BD9	aubne	S	NEP
17/09/2020 4:48	Container Vessel	a	aumel	BD6	S	GAC
17/09/2020 12:15	Bulk Liquid	d	BLB1	aubne	P	ISS
17/09/2020 15:55	Container Vessel	d	BD12	BD12	P	FIV
17/09/2020 22:56	Container Vessel	d	BD8	nztrg	S	ISS
18/09/2020 1:22	Container Vessel	a	aumel	BD8	S	GAC
18/09/2020 7:34	Container Vessel	d	HD1	aumel	P	FIV
18/09/2020 9:35	Bulk Liquid	d	BLB2	augex	P	ISS
18/09/2020 12:04	Bulk Liquid	a	krons	BLB2	P	BWL
18/09/2020 13:00	Container Vessel	d	BD12	aubne	P	FIV
18/09/2020 15:18	Container Vessel	a	aumel	BD11	P	ISS
18/09/2020 18:25	Container Vessel	a	nztrg	BD12	P	ISS
18/09/2020 18:56	Container Vessel	d	BD7	cnsha	S	ISS
18/09/2020 23:43	Bulk Liquid	a	aucns	BLB1	P	ISS
19/09/2020 9:02	Container Vessel	d	BD6	aubne	S	GAC
19/09/2020 15:42	Container Vessel	a	aubne	BD6	S	MSC
19/09/2020 20:03	Bulk Liquid	d	BLB1	auglt	P	ISS
19/09/2020 23:34	Bulk Liquid	d	BLB2	nznpl	P	BWL
20/09/2020 1:57	Bulk Liquid	a	aubne	BLB2	P	BWL
20/09/2020 2:05	Container Vessel	d	BD10	auadl	P	ISS
20/09/2020 5:17	Container Vessel	a	aubne	BD10	P	ISS
20/09/2020 17:00	Container Vessel	d	BD12	aumel	P	ISS
20/09/2020 18:00	Container Vessel	d	HD2	auadl	P	GAC
21/09/2020 5:10	Bulk Liquid	d	BLB2	aumel	P	BWL
21/09/2020 14:10	Bulk Liquid	a	sgsin	BLB2	P	ISS
21/09/2020 16:27	Container Vessel	d	BD8	aubne	S	GAC
21/09/2020 18:53	Container Vessel	a	aumel	BD8	S	ISS
21/09/2020 21:59	Container Vessel	a	hkhkg	HD2	S	FIV
21/09/2020 22:30	Container Vessel	d	BD11	aubne	P	ISS
22/09/2020 0:57	Container Vessel	a	cnngb	BD12	P	FIV

Datetime	Vessel Type	Operation	From	To	SideTo	Agent
22/09/2020 14:03	Container Vessel	d	BD6	nzblu	S	MSC
22/09/2020 17:06	Bulk Liquid	d	BLB2	aumel	P	ISS
22/09/2020 20:56	Bulk Liquid	a	cnqzj	BLB2	P	GAC
22/09/2020 22:04	Container Vessel	d	BD10	aumel	P	ISS
23/09/2020 5:22	Container Vessel	a	aumel	BD6	S	FIV
23/09/2020 6:51	Container Vessel	a	nztrg	BD10	P	ISS
23/09/2020 17:58	Bulk Liquid	d	BLB2	aubtb	P	GAC
23/09/2020 20:22	Bulk Liquid	a	sgsin	BLB2	P	BWL
24/09/2020 13:43	Container Vessel	d	BD12	aumel	P	FIV
24/09/2020 15:50	Container Vessel	a	aubne	BD11	P	ISS
24/09/2020 17:02	Container Vessel	a	twkhh	BD12	P	ISS
25/09/2020 9:36	Container Vessel	d	HD2	aumel	S	FIV
25/09/2020 10:15	Container Vessel	d	BD8	BD8	S	ISS
25/09/2020 11:06	Container Vessel	d	BD6	aufre	S	FIV
25/09/2020 11:42	Bulk Liquid	d	BLB2	aumel	P	BWL
25/09/2020 14:05	Container Vessel	a	aubne	BD9	S	MSC
25/09/2020 14:20	Container Vessel	d	BD10	aumel	P	ISS
25/09/2020 17:10	Bulk Liquid	a	aubtb	BLB2	P	GAC
25/09/2020 21:57	Container Vessel	d	BD11	aumel	P	ISS
26/09/2020 0:18	Container Vessel	a	nzpoe	BD6	S	ISS
26/09/2020 18:50	Container Vessel	a	aubne	HD1	S	ISS
26/09/2020 21:37	Container Vessel	a	aumel	BD10	P	ISS
26/09/2020 22:20	Container Vessel	d	BD6	mytpp	S	ISS
27/09/2020 1:28	Container Vessel	a	aumel	BD7	S	GAC
27/09/2020 3:41	Container Vessel	a	aubne	HD2	S	GAC
27/09/2020 5:59	Container Vessel	d	BD12	aumel	P	ISS
27/09/2020 10:20	Container Vessel	a	nztrg	BD11	P	ISS
27/09/2020 12:02	Bulk Liquid	d	BLB2	krons	P	GAC
27/09/2020 14:37	Bulk Liquid	a	auntl	BLB2	P	WSP
27/09/2020 16:20	Bulk Liquid	a	aubne	BLB1	P	ISS
27/09/2020 16:43	Container Vessel	d	BD8	auadl	S	ISS
28/09/2020 9:00	Bulk Liquid	d	BLB1	aucns	P	ISS
28/09/2020 10:00	Bulk Liquid	a	aupkl	BLB1	P	ISS
28/09/2020 12:00	Bulk Liquid	d	BLB2	aubne	P	WSP
28/09/2020 13:00	Bulk Liquid	a	nznsn	BLB2	P	ISS
28/09/2020 16:00	Container Vessel	d	BD11	aumel	P	ISS
28/09/2020 17:00	Container Vessel	a	cnshk	BD11	P	ISS
28/09/2020 22:00	Container Vessel	d	BD7	aubne	S	GAC
28/09/2020 22:00	Container Vessel	a	aubne	BD7	S	MSC

APPENDIX B

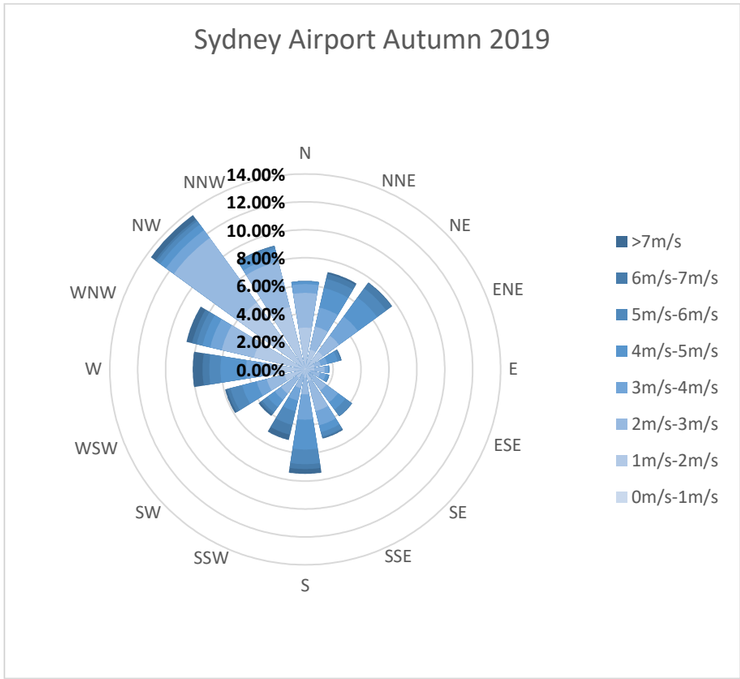
COMPLAINTS AND SHIP BERTHING SCHEDULE

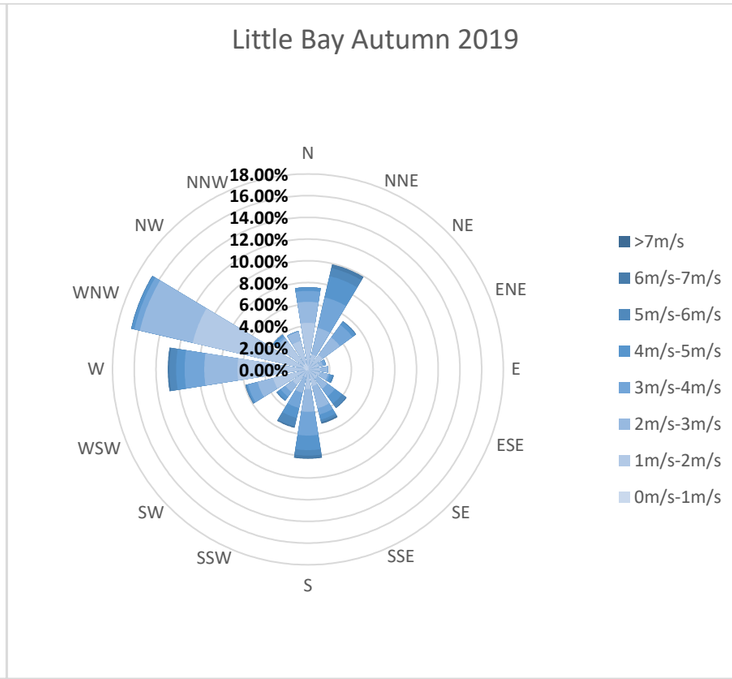
Date	Wind Direction	Wind Speed	L1 - Woonah St **South East** Little Bay Philip Bay La Perouse	L2 - Wassell St **East** Chifley Malabar	L3 - Anthony St **North East** Hillsdale Eastgardens Matraville	L4 - Wilson St **North West** Botany Pagewood	No of Complaints **NSW Ports**	 **EPA**	Berth and Exhaust Orientation Patrick BD6	 BD7	 BD8	DP World BD9	 BD10	 BD11	 BD12	Hutchinson HD1	 HD2	 HD3	Bulk Liquid BLB1	 BLB2
27/08/2020	NW	0-3 m/s	High				0	0		E										
28/08/2020	WSW	2-5 m/s	Medium	Medium	Low		3	1	E	E		W	E			S			N	
29/08/2020	NW	0-3 m/s	Low	Medium	Low		0	0	E	E	E	W	W			S	N		N	
30/08/2020	NNW	1-2 m/s	Medium	Medium	Low		1	0	E	E	E	E	W			S	N	N		
31/08/2020	NW	2-3 m/s	Low	Low	Low		0	0	E	E	E	E	W		E	S	N		N	N
1/09/2020	SSE	2-5 m/s	High	Low	Low		0	0		E	E		E	E			S		N	
2/09/2020	NW	2-3 m/s	Medium	Low	Low		0	0	E	E	E	E	E	E					N	
3/09/2020	WSW	1-4 m/s	High		Low		1	0	E	E	E	E	E	E					N	
4/09/2020	NNE	0-3 m/s			Medium	Low	3	4	E	E	E	E	E	E			S			N
5/09/2020	WSW	0-3 m/s			High		2	8	E	E	E	E	E	E			S		N	N
6/09/2020	SSW	1-2 m/s			Medium		0	1	E	E	E	E	E	E	E		S		N	
7/09/2020	WNW	0-2 m/s		Medium			0	3	E	E	E	E	E			N	S			N
8/09/2020	NW	1-5 m/s		Medium			0	0	E	E	E	E	E			N	S		N	N
9/09/2020	S	1-8 m/s		Medium		Low	1	1	E	E		E	W			N	S		N	N
10/09/2020	SE	4-5 m/s		Medium			1	0		E		E	W		E		S		N	N
11/09/2020	SSE	3-4 m/s	Low	Medium			0	2	E	E	E		W	E	E		S		N	N
12/09/2020	NW	2 m/s	Medium	Medium			0	0	E		E		E	E	E		S		N	
13/09/2020	NW	0-3 m/s		Medium			0	2	E		E		E		W	N	S		N	N
14/09/2020	NW	0-3 m/s	Low	Medium			0	0	E	E	E		E		W	N				N
15/09/2020	SSE	1-2 m/s	Low	High			0	0	E	E	E	E	E		W	N			N	
16/09/2020	NNE	1-4 m/s		High			0	0	E		E	E	E			N			N	
17/09/2020	W	0-3 m/s		Medium			0	0	E		E					N	N		N	
18/09/2020	S	2-6 m/s	Low	Medium			0	0	E	E	E		E		E	N	N			N
19/09/2020	WNW	0-2 m/s	Low	Medium			1	0	E		E		E	E	E		N		N	N
20/09/2020	NNE	3-6 m/s	Low	Low			0	0	E		E		E	E	E		N			N
21/09/2020	WSW	0-2 m/s	Low	Medium			1	0	E		E		E	E						N
22/09/2020	NW	2-5 m/s	Low	Medium			0	0	E				E		E		S			N
23/09/2020	SW	0-3 m/s	Low	High			1	0	E						E		S			N
24/09/2020	WNW	1-4 m/s	Medium				2	0	E				E		E		S			N
25/09/2020	N	2-3 m/s	Low				1	0	E				E	E	E		S			N
26/09/2020	WNW	4-9 m/s	Low	Medium	Low		1	0	E		E				E					
27/09/2020	W	3-5 m/s	Low	High	Low		0	0		E	E				E		S			N
28/09/2020	NW	1-2 m/s												E					N	N

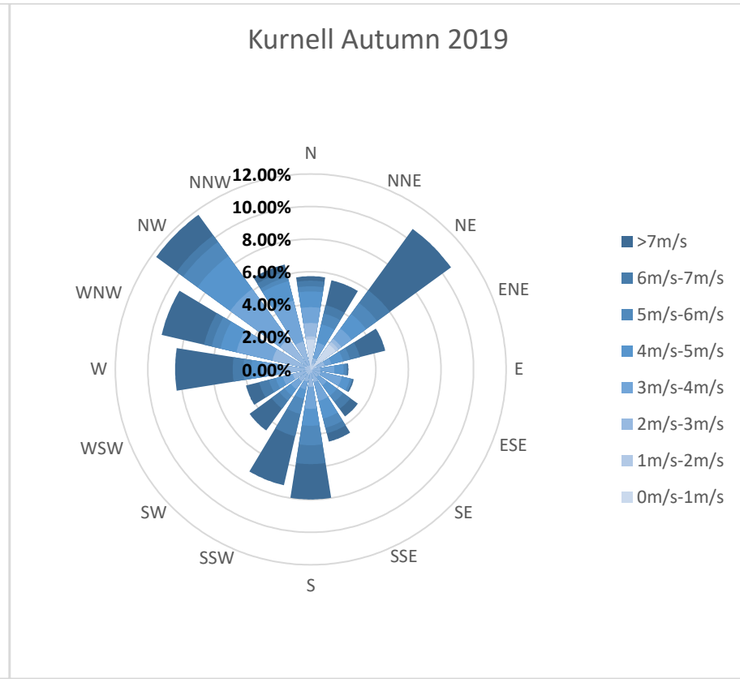
TO:	SIDE TO:	FACING:	TO:	SIDE TO:	FACING:
BD6-9	S	E	HD1-3	S	S
	P	W		P	N
BD10-12	S	W	BLB1-2	S	S
	P	E		P	N

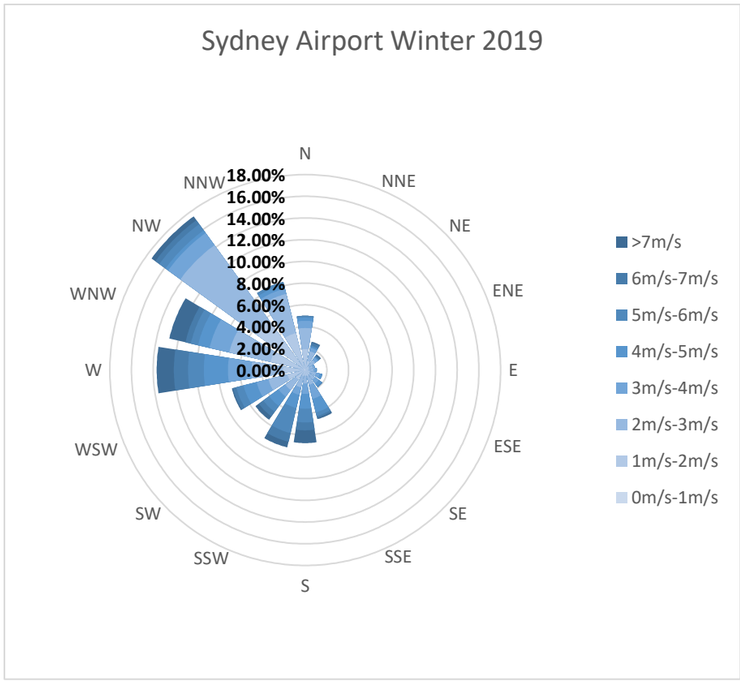
APPENDIX C

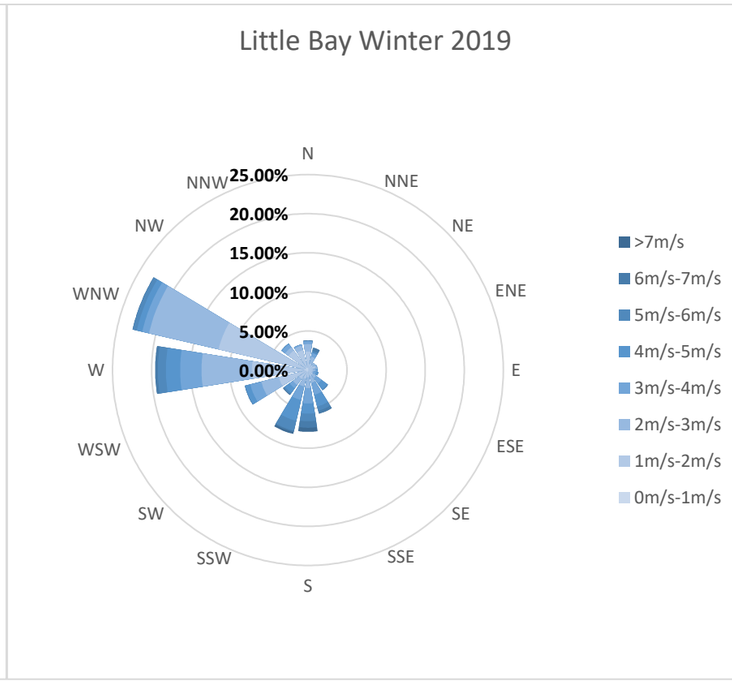
WIND ROSE PLOTS

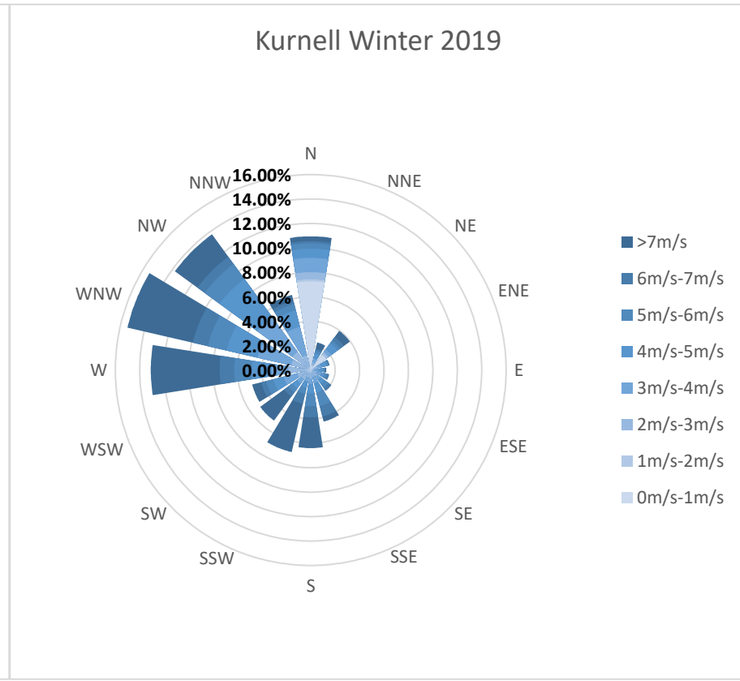

Sydney Airport Autumn 2019
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
14.00%
12.00%
10.00%
8.00%
6.00%
4.00%
2.00%
0.00%
>7m/s
6m/s-7m/s
5m/s-6m/s
4m/s-5m/s
3m/s-4m/s
2m/s-3m/s
1m/s-2m/s
0m/s-1m/s

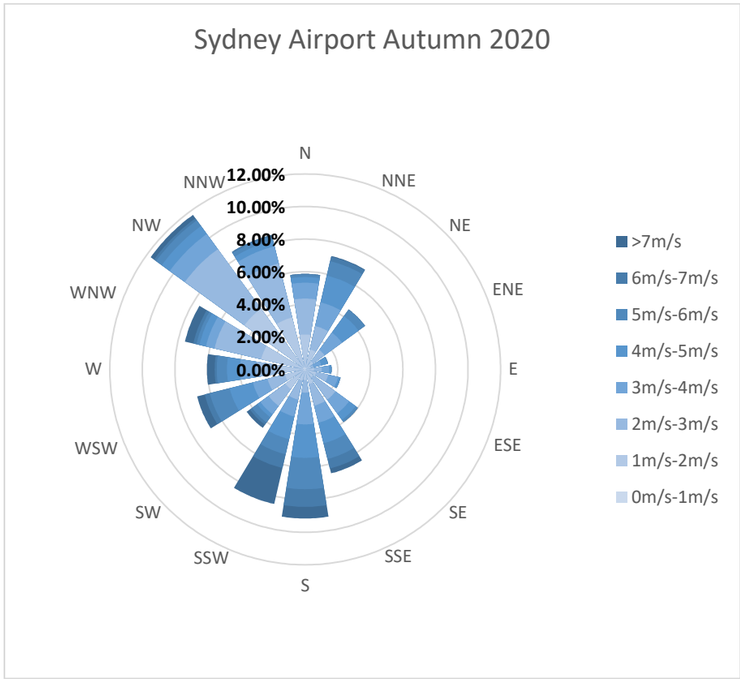

Little Bay Autumn 2019
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
18.00%
16.00%
14.00%
12.00%
10.00%
8.00%
6.00%
4.00%
2.00%
0.00%
>7m/s
6m/s-7m/s
5m/s-6m/s
4m/s-5m/s
3m/s-4m/s
2m/s-3m/s
1m/s-2m/s
0m/s-1m/s

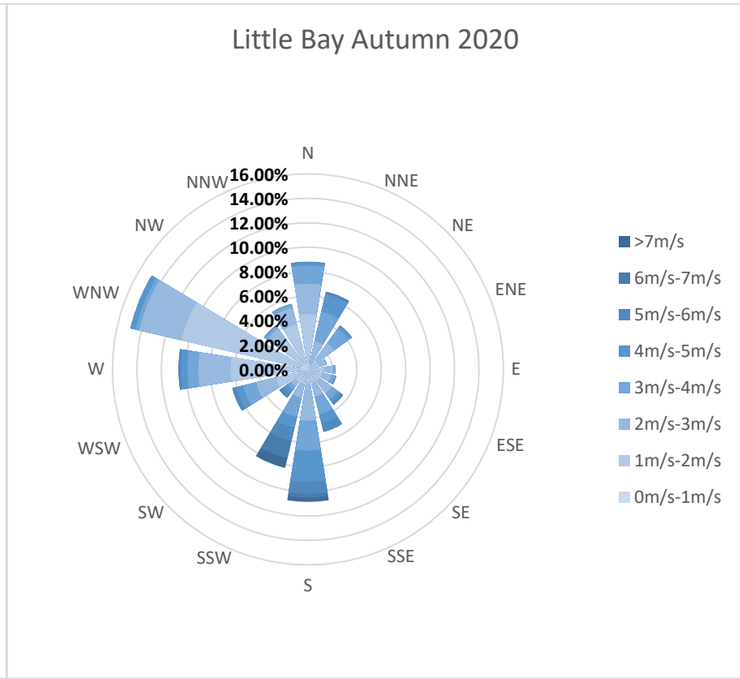

Kurnell Autumn 2019
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
12.00%
10.00%
8.00%
6.00%
4.00%
2.00%
0.00%
>7m/s
6m/s-7m/s
5m/s-6m/s
4m/s-5m/s
3m/s-4m/s
2m/s-3m/s
1m/s-2m/s
0m/s-1m/s

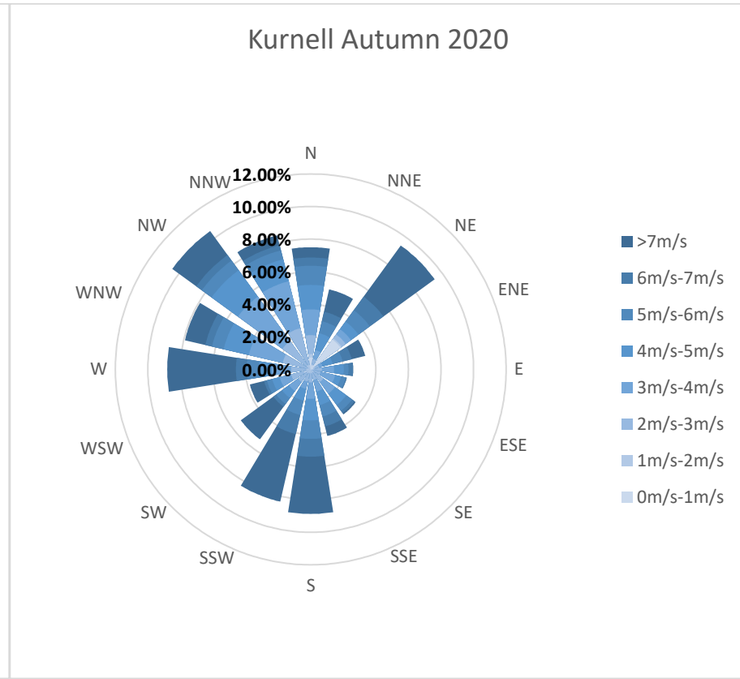

Sydney Airport Winter 2019
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
18.00%
16.00%
14.00%
12.00%
10.00%
8.00%
6.00%
4.00%
2.00%
0.00%
>7m/s
6m/s-7m/s
5m/s-6m/s
4m/s-5m/s
3m/s-4m/s
2m/s-3m/s
1m/s-2m/s
0m/s-1m/s

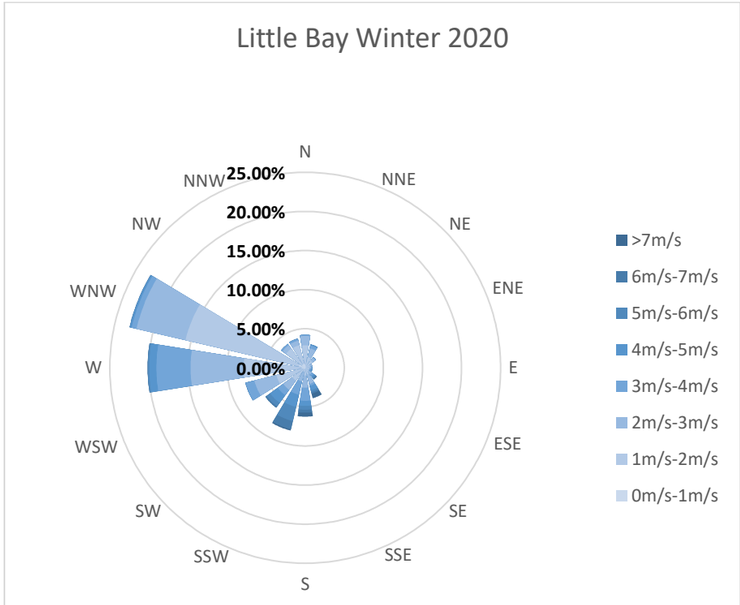

Little Bay Winter 2019
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
25.00%
20.00%
15.00%
10.00%
5.00%
0.00%
>7m/s
6m/s-7m/s
5m/s-6m/s
4m/s-5m/s
3m/s-4m/s
2m/s-3m/s
1m/s-2m/s
0m/s-1m/s

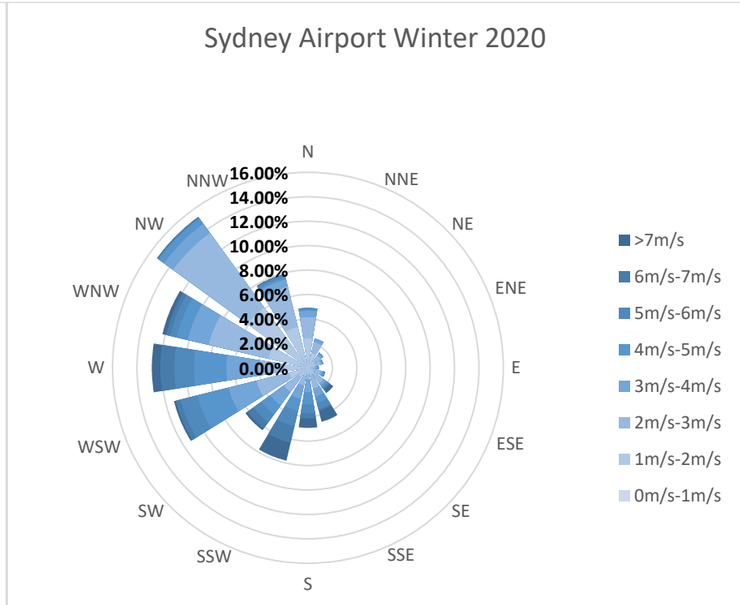

Kurnell Winter 2019
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
16.00%
14.00%
12.00%
10.00%
8.00%
6.00%
4.00%
2.00%
0.00%
>7m/s
6m/s-7m/s
5m/s-6m/s
4m/s-5m/s
3m/s-4m/s
2m/s-3m/s
1m/s-2m/s
0m/s-1m/s

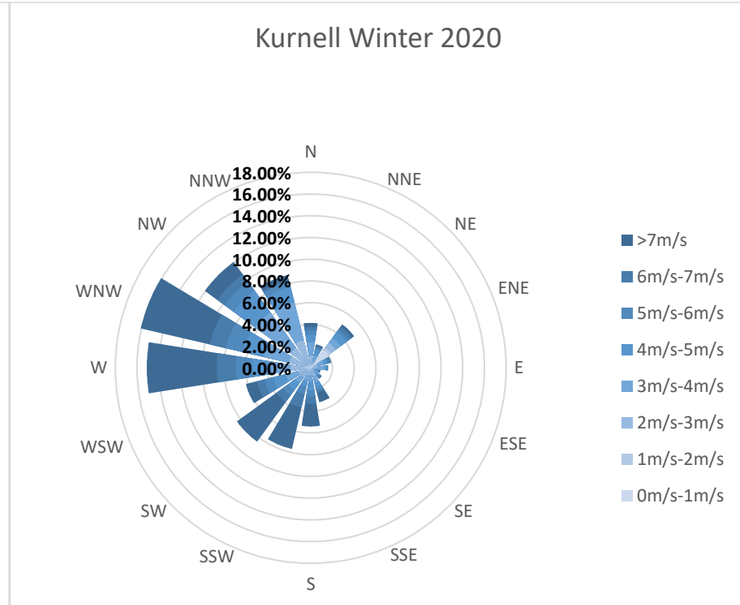

Sydney Airport Autumn 2020
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
12.00%
10.00%
8.00%
6.00%
4.00%
2.00%
0.00%
>7m/s
6m/s-7m/s
5m/s-6m/s
4m/s-5m/s
3m/s-4m/s
2m/s-3m/s
1m/s-2m/s
0m/s-1m/s


Little Bay Autumn 2020
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
16.00%
14.00%
12.00%
10.00%
8.00%
6.00%
4.00%
2.00%
0.00%
>7m/s
6m/s-7m/s
5m/s-6m/s
4m/s-5m/s
3m/s-4m/s
2m/s-3m/s
1m/s-2m/s
0m/s-1m/s


Kurnell Autumn 2020
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
12.00%
10.00%
8.00%
6.00%
4.00%
2.00%
0.00%
>7m/s
6m/s-7m/s
5m/s-6m/s
4m/s-5m/s
3m/s-4m/s
2m/s-3m/s
1m/s-2m/s
0m/s-1m/s


Little Bay Winter 2020
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
25.00%
20.00%
15.00%
10.00%
5.00%
0.00%
>7m/s
6m/s-7m/s
5m/s-6m/s
4m/s-5m/s
3m/s-4m/s
2m/s-3m/s
1m/s-2m/s
0m/s-1m/s


Sydney Airport Winter 2020
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
16.00%
14.00%
12.00%
10.00%
8.00%
6.00%
4.00%
2.00%
0.00%
>7m/s
6m/s-7m/s
5m/s-6m/s
4m/s-5m/s
3m/s-4m/s
2m/s-3m/s
1m/s-2m/s
0m/s-1m/s


Kurnell Winter 2020
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
18.00%
16.00%
14.00%
12.00%
10.00%
8.00%
6.00%
4.00%
2.00%
0.00%
>7m/s
6m/s-7m/s
5m/s-6m/s
4m/s-5m/s
3m/s-4m/s
2m/s-3m/s
1m/s-2m/s
0m/s-1m/s

APPENDIX D

HISTORICAL DATA AT PERMANENT NOISE MONITORS

Overall Broadband Noise – Annual

Location	Year	Period	7am-6pm		6pm-10pm		10pm-7am	
			L_{A90}	L_{Aeq}	L_{A90}	L_{Aeq}	L_{A90}	L_{Aeq}
Botany Rd East	2017	Annual	49.0	54.1	46.8	51.6	47.1	50.8
		Apr/May	48.0	53.1	45.4	50.7	47.3	50.2
		Winter	50.3	54.7	48.3	52.4	48.3	51.6
	2018	Annual	49.6	54.9	47.6	52.6	47.7	52.6
		Apr/May	48.6	53.8	46.7	51.5	48.0	51.4
		Winter	50.8	55.6	49.8	53.9	49.4	53.0
	2019	Annual	50.4	54.7	48.4	52.5	48.1	51.3
		Apr/May	51.1	54.7	48.6	52.4	49.5	52.0
		Winter	50.8	54.6	49.7	53.6	49.7	52.5
Foreshore Rd	2017	Annual	54.6	62.7	54.0	61.3	51.5	55.7
		Apr/May	53.8	62.6	52.9	60.5	50.7	54.9
		Winter	54.8	64.4	54.5	64.1	51.4	55.7
	2018	Annual	54.1	61.8	53.6	60.5	51.0	55.0
		Apr/May	52.5	60.8	51.7	58.9	49.4	53.7
		Winter	54.7	63.4	54.6	63.4	51.3	55.5
	2019	Annual	53.9	61.7	53.7	60.6	50.5	54.6
		Apr/May	51.1	54.7	48.6	52.4	49.5	52.0
		Winter	54.4	63.3	54.1	63.4	50.8	54.8

Overall Broadband Noise – April/May

Location	Period	7am-6pm		6pm-10pm		10pm-7am	
		L_{A90}	L_{Aeq}	L_{A90}	L_{Aeq}	L_{A90}	L_{Aeq}
Botany Rd East	Apr/May 2017	48.0	53.1	45.4	50.7	47.3	50.2
	Apr/May 2018	48.6	53.8	46.7	51.5	48.0	51.4
	Apr/May 2019	51.1	54.7	48.6	52.4	49.5	52.0
	Average 2017-2019	49.2	53.9	46.9	51.5	48.3	51.2
	Apr/May 2020	49.5	53.0	47.8	51.5	48.4	51.1
	Difference	0.3	-0.9	0.9	0.0	0.1	-0.1
Foreshore Rd	Apr/May 2017	53.8	62.6	52.9	60.5	50.7	54.9
	Apr/May 2018	52.5	60.8	51.7	58.9	49.4	53.7
	Apr/May 2019	54.3	62.1	54.4	61.6	52.2	56.7
	Average 2017-2019	53.5	61.8	53.0	60.3	50.8	55.1
	Apr/May 2020	51.3	55.3	50.6	54.5	49.3	53.7
	Difference	-2.2	-6.5	-2.4	-5.8	-1.5	-1.4

Overall Broadband Noise – Winter

Location	Period	7am-6pm		6pm-10pm		10pm-7am	
		L_{A90}	L_{Aeq}	L_{A90}	L_{Aeq}	L_{A90}	L_{Aeq}
Botany Rd East	Winter 2017	50.3	54.7	48.3	52.4	48.3	51.6
	Winter 2018	50.8	55.6	49.8	53.9	49.4	53.0
	Winter 2019	50.8	54.6	49.7	53.6	49.7	52.5
	Average 2017-2019	50.6	55.0	49.3	53.3	49.1	52.4
	Winter 2020	50.4	53.7	48.9	51.8	50.5	55.0
	Difference	-0.2	-1.3	-0.4	-1.5	1.4	2.6
Foreshore Rd	Winter 2017	54.8	64.4	54.5	64.1	51.4	55.7
	Winter 2018	54.7	63.4	54.6	63.4	51.3	55.5
	Winter 2019	54.4	63.3	54.1	63.4	50.8	54.8
	Average 2017-2019	54.6	63.7	54.4	63.6	51.2	55.3
	Winter 2020	52.3	56.3	52.4	56.5	50.4	55.0
	Difference	-2.3	-7.4	-2.0	-7.1	-0.8	-0.3

Low Frequency Noise – Annual

Location	Year	Period	7am-6pm		6pm-10pm		10pm-7am	
			L_{A90}	L_{Aeq}	L_{A90}	L_{Aeq}	L_{A90}	L_{Aeq}
Botany Rd East	2017	Annual	32.9	39.9	31.0	38.0	31.7	36.5
		Apr/May	32.5	39.7	30.2	37.4	32.5	36.8
		Winter	34.6	40.9	32.8	39.1	32.9	37.4
	2018	Annual	34.1	41.2	32.3	39.2	32.8	37.8
		Apr/May	33.5	40.6	32.0	38.5	33.2	37.5
		Winter	35.8	42.1	34.5	40.4	34.6	39.1
	2019	Annual	36.1	42.7	34.3	40.8	35.1	39.9
		Apr/May	37.8	43.7	35.1	41.2	36.9	41.0
		Winter	37.3	43.5	36.2	42.3	36.7	41.2
Foreshore Rd	2017	Annual	43.0	54.1	41.3	52.1	39.3	46.0
		Apr/May	42.5	53.8	40.5	51.5	38.8	45.4
		Winter	42.9	55.2	41.3	53.9	39.0	45.6
	2018	Annual	42.4	53.1	41.1	51.6	38.9	45.5
		Apr/May	41.0	52.3	39.1	50.1	37.1	43.8
		Winter	42.5	54.3	41.0	53.5	38.1	45.1
	2019	Annual	42.3	53.2	41.0	51.5	38.2	44.7
		Apr/May	42.8	53.5	41.9	52.0	39.3	45.5
		Winter	42.1	54.2	40.8	53.3	37.5	44.4

Low Frequency Noise – April/May

Location	Period	7am-6pm		6pm-10pm		10pm-7am	
		L_{A90}	L_{Aeq}	L_{A90}	L_{Aeq}	L_{A90}	L_{Aeq}
Botany Rd East	Apr/May 2017	32.5	39.7	30.2	37.4	32.5	36.8
	Apr/May 2018	33.5	40.6	32.0	38.5	33.2	37.5
	Apr/May 2019	37.8	43.7	35.1	41.2	36.9	41.0
	Average 2017-2019	34.6	41.3	32.4	39.1	34.2	38.5
	Apr/May 2020	35.8	41.5	34.8	40.1	36.2	40.6
	Difference	1.2	0.1	2.4	1.0	2.0	2.2
Foreshore Rd	Apr/May 2017	42.5	53.8	40.5	51.5	38.8	45.4
	Apr/May 2018	41.0	52.3	39.1	50.1	37.1	43.8
	Apr/May 2019	42.8	53.5	41.9	52.0	39.3	45.5
	Average 2017-2019	42.1	53.2	40.5	51.2	38.4	44.9
	Apr/May 2020	39.1	46.3	37.9	44.8	37.2	44.2
	Difference	-3.0	-6.9	-2.6	-6.4	-1.2	-0.7

Low Frequency Noise – Winter

Location	Period	7am-6pm		6pm-10pm		10pm-7am	
		L_{A90}	L_{Aeq}	L_{A90}	L_{Aeq}	L_{A90}	L_{Aeq}
Botany Rd East	Winter 2017	34.6	40.9	32.8	39.1	32.9	37.4
	Winter 2018	35.8	42.1	34.5	40.4	34.6	39.1
	Winter 2019	37.3	43.5	36.2	42.3	36.7	41.2
	Average 2017-2019	35.9	42.2	34.5	40.6	34.7	39.2
	Winter 2020	38.0	43.3	36.4	41.4	38.0	42.3
	Difference	2.1	1.1	1.9	0.8	3.3	3.1
Foreshore Rd	Winter 2017	42.9	55.2	41.3	53.9	39.0	45.6
	Winter 2018	42.5	54.3	41.0	53.5	38.1	45.1
	Winter 2019	42.1	54.2	40.8	53.3	37.5	44.4
	Average 2017-2019	42.5	54.5	41.0	53.5	38.2	45.0
	Winter 2020	40.1	47.0	39.3	46.4	38.1	45.2
	Difference	-2.4	-7.5	-1.7	-7.2	-0.1	0.2

APPENDIX E

BASELINE THIRD OCTAVE BAND LEVELS

Location	Period	Percentile	L_{A10}	L_{ALF}	Third Octave Band Values – dBZ						
					40Hz	50Hz	63Hz	80Hz	100Hz	125Hz	160Hz
L1a Woonah St Inside	12am - 2am	10th	21	6	22	26	18	20	21	13	12
		50th	23	18	36	38	31	31	33	27	21
		90th	25	22	43	44	35	36	38	30	24
	2am - 4am	10th	20	5	22	26	17	19	19	13	10
		50th	23	19	38	41	32	32	34	27	22
		90th	25	23	43	45	36	38	38	31	25
	4am - 6am	10th	21	6	24	26	19	20	20	13	12
		50th	24	20	39	42	33	34	36	27	23
		90th	27	25	44	46	38	39	40	33	27
L1b Woonah St Outside	12am - 2am	10th	35	23	39	35	36	33	36	32	33
		50th	44	37	51	53	52	47	48	46	46
		90th	47	41	62	60	57	54	54	49	48
	2am - 4am	10th	32	22	37	34	35	31	34	33	31
		50th	44	37	50	54	53	47	49	46	46
		90th	46	41	58	59	58	53	54	49	48
	4am - 6am	10th	44	24	42	38	39	36	35	34	34
		50th	48	38	51	56	55	49	50	47	47
		90th	53	43	59	62	60	54	55	52	51
L2 Wassell St	12am - 2am	10th	39	28	39	47	40	37	39	38	38
		50th	42	35	44	50	46	44	46	45	45
		90th	47	39	53	55	52	49	50	48	49
	2am - 4am	10th	38	28	39	46	41	37	40	36	37
		50th	43	36	44	51	47	45	47	46	46
		90th	47	40	53	58	53	48	52	50	50
	4am - 6am	10th	43	28	42	47	43	42	40	38	37
		50th	47	38	50	53	50	47	49	48	48
		90th	52	42	53	57	54	51	53	52	52
L3 Anthony St	12am - 2am	10th	38	28	39	41	38	39	40	38	39
		50th	43	33	44	45	43	43	44	43	44
		90th	46	40	53	50	47	49	48	47	51
	2am - 4am	10th	36	27	38	40	38	37	38	37	38
		50th	42	34	44	44	43	42	44	42	45
		90th	46	41	51	52	49	48	49	49	52
	4am - 6am	10th	42	30	42	43	42	41	42	40	39
		50th	48	37	49	49	48	47	47	46	48
		90th	52	41	54	54	51	51	51	50	52

Location	Period	Percentile	L_{A10}	L_{ALF}	Third Octave Band Values – dBZ						
					40Hz	50Hz	63Hz	80Hz	100Hz	125Hz	160Hz
L4 Wilson St	12am - 2am	10th	38	28	39	41	38	39	40	38	38
		50th	43	33	44	45	43	42	44	42	45
		90th	46	40	52	50	47	49	49	47	52
	2am - 4am	10th	37	28	37	40	38	39	40	39	38
		50th	42	35	44	45	44	43	44	43	47
		90th	46	41	51	52	49	48	49	49	52
	4am - 6am	10th	42	30	42	43	42	41	42	40	39
		50th	48	37	49	49	48	47	47	46	48
		90th	52	41	54	54	51	51	51	50	52
P1 Foreshore Rd	12am - 2am	10th	51	41	61	57	56	55	54	50	48
		50th	54	44	65	61	58	58	57	53	51
		90th	57	46	70	66	60	61	58	55	54
	2am - 4am	10th	49	39	61	56	54	52	52	48	46
		50th	54	44	66	61	60	59	57	54	52
		90th	59	49	72	66	64	64	60	58	56
	4am - 6am	10th	53	43	63	58	57	56	55	51	51
		50th	56	47	66	64	64	63	59	57	55
		90th	61	51	72	67	68	66	62	60	57
P2 Botany Rd East	12am - 2am	10th	47	37	59	57	54	52	51	45	42
		50th	51	41	63	62	57	56	55	49	46
		90th	53	45	67	64	60	58	59	53	50
	2am - 4am	10th	45	36	58	57	53	50	49	44	39
		50th	49	41	63	62	57	55	54	50	45
		90th	53	44	65	65	59	57	59	52	48
	4am - 6am	10th	49	37	60	59	55	52	49	45	41
		50th	52	43	64	64	60	57	57	51	48
		90th	55	47	67	67	63	61	61	55	51

APPENDIX F

THIRD OCTAVE BAND LEVEL DIFFERENCES

31 August – 1 September 2020 – Low Perceived Noise Night

Date & Time	Wind Speed m/s	Wind Direction	Stability Class	L1a Woonah Inside SE		L1b Woonah Outside SE		L2 Wassell St E		L3 Anthony St NE		L4 Wilson St NW		P1 Foreshore NW		P2 Botany Rd E	
				L_{A10}	L_{ALF}	L_{A10}	L_{ALF}	L_{A10}	L_{ALF}	L_{A10}	L_{ALF}	L_{A10}	L_{ALF}	L_{A10}	L_{ALF}	L_{A10}	L_{ALF}
1/09/2020 0:15	4.9	SSE	D	-3	-14	-8	-14	-1	-7	-1	-2	6	1	4	1	-1	-3
1/09/2020 0:30				-1	-5	-6	-7	-2	-4	-3	-1	5	2	5	3	2	0
1/09/2020 0:45	4.2	SSE	D	-1	-11	-8	-12	-3	-7	-4	-3	4	1	6	3	0	-3
1/09/2020 1:00				-3	-12	-9	-14	-3	-8	-4	-3	5	2	4	2	3	-1
1/09/2020 1:15	4.2	SSE	D	-2	-13	-8	-13	-3	-8	-5	-3	5	2	1	1	0	-3
1/09/2020 1:30				-1	-14	-10	-14	-4	-8	-6	-4	5	1	2	3	0	-4
1/09/2020 1:45	4.2	SSE	D	-3	-15	-11	-16	-4	-8	-7	-5	4	1	3	10	0	-2
1/09/2020 2:00				-3	-15	-10	-15	-4	-9	-5	-5	4	-2	-2	-2	2	-2
1/09/2020 2:15	4.9	S	D	-4	-15	-11	-15	-5	-9	-5	-5	4	-2	-2	-1	0	-4
1/09/2020 2:30				-5	-14	-9	-13	-3	-7	-5	-3	5	-1	4	10	3	-2
1/09/2020 2:45	4.2	SSE	D	-5	-14	-12	-15	-3	-8	-3	-2	6	0	0	2	0	-3
1/09/2020 3:00				-4	-10	-9	-10	-2	-6	-3	-2	6	2	2	3	4	1
1/09/2020 3:15	3.5	S	D	-5	-13	-11	-14	-2	-6	-2	-2	5	1	0	2	4	1
1/09/2020 3:30				-5	-12	-10	-11	-2	-5	-2	-1	5	0	0	3	2	0
1/09/2020 3:45	3.0	S	D	-5	-13	-12	-14	-2	-7	-2	-2	6	1	1	5	3	1
1/09/2020 4:00				-6	-15	-15	-15	-7	-9	-10	-6	2	-1	-2	0	0	-1
1/09/2020 4:15	3.0	SSE	D	-6	-16	-14	-15	-7	-10	-9	-6	2	-2	0	0	1	-2
1/09/2020 4:30				-6	-16	-13	-15	-8	-11	-10	-7	3	-3	1	-1	-4	-6
1/09/2020 4:45	2.6	SSE	D	-6	-15	-14	-16	-8	-11	-3	-5	5	-1	2	0	1	-1
1/09/2020 5:00				-6	-16	-10	-15	-5	-8	-4	-5	4	-2	1	1	0	-2
1/09/2020 5:15	2.3	WSW	D	-4	-15	-4	-12	-6	-6	-1	-4	5	1	3	2	2	1
1/09/2020 5:30				-4	-13	-3	-8	0	-7	0	-5	6	1	2	2	3	4
1/09/2020 5:45	2.3	W	E	-4	-13	-3	-10	1	-7	2	-3	6	1	3	3	3	2
1/09/2020 6:00				-2	-13	1	-12	5	-3	3	-3	8	3	1	2	2	2

31 August – 1 September 2020 – Ships in Port

Vessel Type	Berth	Side To	Funnel Facing
Container Vessel	BD10	S	W
Container Vessel	BD10	P	E
Container Vessel	BD11	P	E
Container Vessel	BD7	S	E
Container Vessel	BD8	S	E
Bulk Liquids	BLB1	P	N
Container Vessel	HD2	S	S

14 September – 15 September 2020 – Low Perceived Noise Night

Date & Time	Wind Speed m/s	Wind Direction	Stability Class	L1a Woonah Inside SE		L1b Woonah Outside SE		L2 Wassell St E		L3 Anthony St NE		L4 Wilson St NW		P1 Foreshore NW		P2 Botany Rd E	
				L_{A10}	L_{ALF}	L_{A10}	L_{ALF}	L_{A10}	L_{ALF}	L_{A10}	L_{ALF}	L_{A10}	L_{ALF}	L_{A10}	L_{ALF}	L_{A10}	L_{ALF}
15/09/2020 0:15	1.6	SW	E	-1	-9	-4	-8	-3	-5	-2	-3	4	0	0	1	-3	-2
15/09/2020 0:30				-1	-13	-8	-13	-2	-4	-3	-3	2	-2	4	0	-1	-1
15/09/2020 0:45	1.2	SSW	E	-1	-12	-8	-12	-3	-4	-2	-2	5	0	3	1	-1	-2
15/09/2020 1:00				-1	-8	-6	-9	-4	-5	-2	-1	0	-1	1	0	-1	-2
15/09/2020 1:15	1.2	S	E	-2	-11	-9	-12	-3	-5	-5	-4	1	-1	4	0	1	-1
15/09/2020 1:30				-3	-14	-13	-17	-4	-6	-6	-4	2	0	4	0	-2	-3
15/09/2020 1:45	1.2	ESE	D	-3	-12	-13	-20	-5	-7	-8	-5	2	-1	4	1	-2	-2
15/09/2020 2:00				-2	-13	-10	-14	-7	-9	-6	-7	1	-2	-3	0	2	0
15/09/2020 2:15	1.6	SE	D	-3	-15	-12	-20	-9	-12	-10	-8	1	-3	-5	-2	-5	-5
15/09/2020 2:30				-3	-15	-15	-21	-13	-13	-11	-12	2	-2	-5	-2	-1	-3
15/09/2020 2:45	1.6	S	E	-3	-10	-17	-21	-13	-14	-12	-13	2	-2	-1	0	-5	-5
15/09/2020 3:00				-3	-15	-18	-20	-10	-15	-15	-14	2	-1	0	1	-2	-4
15/09/2020 3:15	1.2	SSW	E	-3	-15	-11	-15	-11	-14	-14	-12	4	-1	-1	0	-2	-3
15/09/2020 3:30				-3	-16	-12	-20	-16	-17	-14	-15	3	-2	-1	1	-5	-4
15/09/2020 3:45	1.6	SSE	D	-3	-17	-16	-20	-11	-17	-11	-15	5	-2	0	1	-2	-4
15/09/2020 4:00				-4	-18	-17	-21	-13	-18	-14	-17	1	-3	-3	-2	-4	-5
15/09/2020 4:15	2.3	ESE	D	-4	-17	-15	-20	-11	-18	-13	-18	-1	-4	0	-2	-8	-7
15/09/2020 4:30				-3	-17	-9	-16	-10	-13	-7	-11	2	-1	1	-1	-8	-5
15/09/2020 4:45	2.3	ESE	D	-2	-18	-11	-18	-5	-15	-6	-10	6	1	1	-1	-6	-6
15/09/2020 5:00				-3	-18	-5	-19	0	-17	-3	-12	4	-1	2	0	-5	-7
15/09/2020 5:15	2.3	ESE	D	-2	-15	-2	-13	0	-17	0	-8	5	1	1	-1	-2	-2
15/09/2020 5:30				-2	-15	-2	-13	6	-5	2	-7	5	0	1	0	0	0
15/09/2020 5:45	1.9	E	D	-2	-13	0	-11	-5	-10	1	-7	6	2	2	1	-1	-2
15/09/2020 6:00				-2	-13	1	-11	-4	-10	4	-6	8	5	-1	0	0	0

14 September – 15 September 2020 – Ships in Port

Vessel Type	Berth	Side To	Funnel Facing
Container Vessel	BD6	S	E
Container Vessel	BD7	S	E
Container Vessel	BD8	S	E
Container Vessel	BD9	S	E
Container Vessel	BD12	P	E
Bulk Liquids	BLB1	P	N
Container Vessel	HD1	S	S

27 August – 28 August 2020 – High Perceived Noise Night

Date & Time	Wind Speed m/s	Wind Direction	Stability Class	Location & Direction from Port													
				L1a Woonah Inside SE		L1b Woonah Outside SE		L2 Wassell St E		L3 Anthony St NE		L4 Wilson St NW		P1 Foreshore NW		P2 Botany Rd E	
				L_{A10}	L_{ALF}	L_{A10}	L_{ALF}	L_{A10}	L_{ALF}	L_{A10}	L_{ALF}	L_{A10}	L_{ALF}	L_{A10}	L_{ALF}	L_{A10}	L_{ALF}
28/08/2020 0:15	3.0	NW	E	6	10	4	8	4	7	3	5	7	4	5	6	5	5
28/08/2020 0:30				6	10	3	7	4	6	1	5	5	1	3	3	6	6
28/08/2020 0:45	3.0	NNW	D	7	10	4	7	6	8	3	7	2	0	3	2	2	4
28/08/2020 1:00				6	9	4	6	4	7	1	6	7	4	4	4	2	4
28/08/2020 1:15	3.3	N	D	6	10	3	7	4	7	1	6	7	3	5	4	2	4
28/08/2020 1:30				5	8	3	5	5	9	3	7	4	2	4	3	2	4
28/08/2020 1:45	3.3	N	D	3	6	2	3	5	8	2	7	4	2	5	7	3	4
28/08/2020 2:00				3	5	0	3	3	6	2	4	3	0	3	2	1	3
28/08/2020 2:15	3.5	NNW	D	4	6	2	5	3	5	3	5	6	1	4	3	1	3
28/08/2020 2:30				5	7	3	6	4	5	3	5	8	4	5	6	5	5
28/08/2020 2:45	3.5	NNW	D	4	6	3	5	3	5	2	4	3	-2	4	4	4	4
28/08/2020 3:00				4	7	3	5	3	5	3	4	9	1	4	2	4	3
28/08/2020 3:15	2.6	NW	E	5	8	3	6	3	5	2	4	2	-2	5	3	4	4
28/08/2020 3:30				7	10	4	8	4	5	4	7	6	3	5	6	3	3
28/08/2020 3:45	3.0	WSW	D	4	7	2	5	2	3	3	5	6	2	4	3	4	3
28/08/2020 4:00				5	9	0	7	-2	1	-3	1	4	-1	2	-2	1	1
28/08/2020 4:15	2.3	SSW	D	4	7	0	5	1	5	-1	5	3	0	4	-1	1	2
28/08/2020 4:30				2	2	0	2	2	5	1	6	6	3	1	0	2	4
28/08/2020 4:45	3.0	SW	D	0	0	-4	-1	1	2	1	7	5	2	1	1	3	4
28/08/2020 5:00				2	5	-3	2	1	4	1	6	7	2	2	1	3	3
28/08/2020 5:15	3.0	SSW	D	0	2	-3	0	1	4	1	5	6	3	1	0	3	2
28/08/2020 5:30				-1	-1	-4	-2	1	3	2	5	7	3	1	1	4	3
28/08/2020 5:45	5.3	SW	D	-1	-1	-2	-2	2	2	3	5	9	4	2	0	6	5
28/08/2020 6:00				0	0	2	-1	7	2	4	4	9	5	-2	0	6	5

27 August – 28 August 2020 – Ships in Port

Vessel Type	Berth	Side To	Funnel Facing
Container Vessel	BD6	S	E
Container Vessel	BD7	S	E
Container Vessel	BD9	P	W
Container Vessel	BD10	P	E
Container Vessel	HD1	S	S
Bulk Liquids	BLB1	P	N

28 August – 29 August 2020 – High Perceived Noise Night

Date & Time	Wind Speed m/s	Wind Direction	Stability Class	Location & Direction from Port													
				L1a Woonah Inside SE		L1b Woonah Outside SE		L2 Wassell St E		L3 Anthony St NE		L4 Wilson St NW		P1 Foreshore NW		P2 Botany Rd E	
				L_{A10}	L_{ALF}	L_{A10}	L_{ALF}	L_{A10}	L_{ALF}	L_{A10}	L_{ALF}	L_{A10}	L_{ALF}	L_{A10}	L_{ALF}	L_{A10}	L_{ALF}
29/08/2020 0:15	2.6	NW	F	4	7	4	4	7	7	5	7	5	3	9	5	5	4
29/08/2020 0:30				6	9	4	7	6	7	5	8	7	3	8	4	5	4
29/08/2020 0:45	2.3	NNW	D	4	8	3	5	6	7	5	9	6	4	10	4	2	3
29/08/2020 1:00				3	5	4	3	8	8	4	7	5	3	7	5	5	5
29/08/2020 1:15	1.6	WNW	D	4	6	3	3	7	6	6	11	5	2	4	2	5	5
29/08/2020 1:30				4	5	4	3	6	6	4	9	5	0	1	2	4	4
29/08/2020 1:45	2.3	NW	D	4	6	4	3	6	7	5	8	3	0	3	3	3	4
29/08/2020 2:00				3	5	2	3	5	6	6	9	3	-2	1	1	4	6
29/08/2020 2:15	2.6	W	D	3	4	2	2	5	6	6	8	3	-1	-1	1	5	5
29/08/2020 2:30				3	5	2	3	6	7	6	8	5	1	1	3	6	6
29/08/2020 2:45	1.9	WNW	D	3	4	2	2	6	7	7	9	7	1	1	1	4	4
29/08/2020 3:00				3	4	2	2	6	6	8	9	4	2	1	2	6	7
29/08/2020 3:15	1.9	NW	D	3	4	2	3	6	6	7	9	4	3	2	2	6	6
29/08/2020 3:30				3	4	2	2	7	7	8	12	5	5	2	1	5	6
29/08/2020 3:45	2.3	NW	D	3	3	3	2	7	9	8	11	6	6	4	2	5	7
29/08/2020 4:00				1	1	-2	-1	1	3	1	7	3	3	-1	-2	2	4
29/08/2020 4:15	2.3	NW	D	0	1	-3	-1	1	3	1	7	1	1	0	-3	1	3
29/08/2020 4:30				1	1	-3	0	0	2	2	8	2	0	3	-1	0	3
29/08/2020 4:45	2.3	NW	D	1	2	-2	0	2	4	3	9	2	-1	3	-1	1	4
29/08/2020 5:00				1	1	-2	0	1	2	3	9	3	0	3	-1	2	4
29/08/2020 5:15	3.0	NW	D	1	2	-2	0	1	3	2	5	3	0	3	-1	1	3
29/08/2020 5:30				2	3	0	1	3	6	2	6	5	1	4	-1	1	3
29/08/2020 5:45	3.0	NW	D	2	3	1	1	3	5	3	6	6	1	5	0	1	3
29/08/2020 6:00				2	2	3	1	6	5	4	6	6	1	1	-1	1	3

28 August – 29 August 2020 – Ships in Port

Vessel Type	Berth	Side To	Funnel Facing
Container Vessel	BD6	S	E
Container Vessel	BD7	S	E
Container Vessel	BD8	S	E
Container Vessel	BD9	P	W
Container Vessel	BD10	S	W
Bulk Liquids	BLB1	P	N
Container Vessel	HD1	S	S
Container Vessel	HD2	P	N

3 September – 4 September 2020 – High Perceived Noise Night

Date & Time	Wind Speed m/s	Wind Direction	Stability Class	Location & Direction from Port													
				L1a Woonah Inside SE		L1b Woonah Outside SE		L2 Wassell St E		L3 Anthony St NE		L4 Wilson St NW		P1 Foreshore NW		P2 Botany Rd E	
				L_{A10}	L_{ALF}	L_{A10}	L_{ALF}	L_{A10}	L_{ALF}	L_{A10}	L_{ALF}	L_{A10}	L_{ALF}	L_{A10}	L_{ALF}	L_{A10}	L_{ALF}
4/09/2020 0:15	3.0	NE	D	6	10	6	9	2	5	0	2	6	3	3	3	0	-1
4/09/2020 0:30				6	10	6	10	2	5	0	2	6	5	5	7	-2	-1
4/09/2020 0:45	2.3	NNE	D	7	11	6	10	2	4	-1	1	5	3	4	4	-3	-1
4/09/2020 1:00				7	12	6	10	1	4	0	2	4	2	3	3	-1	0
4/09/2020 1:15	1.9	N	F	7	12	6	10	2	5	-1	2	5	2	3	3	-2	0
4/09/2020 1:30				6	11	6	10	3	6	0	3	4	3	6	6	0	0
4/09/2020 1:45	2.6	N	D	5	9	4	8	3	6	0	4	2	1	5	4	1	0
4/09/2020 2:00				4	7	4	7	1	4	0	0	2	-1	3	3	0	0
4/09/2020 2:15	1.6	N	E	4	8	3	7	1	4	0	1	2	-1	3	4	0	0
4/09/2020 2:30				5	8	4	7	2	5	0	2	4	-1	5	2	1	1
4/09/2020 2:45	0.0	CALM	E	5	8	4	8	3	6	3	4	5	0	6	5	0	1
4/09/2020 3:00				4	7	3	6	3	5	2	3	4	0	6	5	0	0
4/09/2020 3:15	1.2	NNE	D	3	6	2	5	2	3	0	2	7	1	6	3	0	0
4/09/2020 3:30				4	8	2	7	2	4	1	3	11	3	7	5	1	1
4/09/2020 3:45	1.2	N	E	5	9	4	8	3	6	2	4	6	-2	7	4	1	1
4/09/2020 4:00				4	8	1	7	0	5	-3	4	2	-1	5	3	0	0
4/09/2020 4:15	2.3	S	E	3	7	0	6	0	5	-1	5	2	-1	6	3	0	0
4/09/2020 4:30				2	5	1	5	-1	4	-2	3	4	-1	6	2	0	0
4/09/2020 4:45	2.3	S	E	5	8	3	8	0	3	-2	1	4	2	5	2	0	0
4/09/2020 5:00				5	8	4	7	1	4	0	2	5	3	5	2	0	1
4/09/2020 5:15	1.6	WSW	F	5	8	4	7	1	4	2	6	6	4	6	3	2	3
4/09/2020 5:30				2	4	2	4	5	4	2	5	6	4	5	3	3	2
4/09/2020 5:45	1.2	NNW	F	3	4	4	4	7	5	3	6	8	5	6	4	2	3
4/09/2020 6:00				4	6	8	5	3	6	4	7	9	6	2	4	3	3

3 September – 4 September 2020 – Ships in Port

Vessel Type	Berth	Side To	Funnel Facing
Container Vessel	BD6	S	E
Container Vessel	BD7	S	E
Container Vessel	BD8	S	E
Container Vessel	BD9	S	E
Container Vessel	BD10	P	E
Container Vessel	BD11	P	E
Bulk Liquids	BLB2	P	N
Container Vessel	HD2	S	S

4 September – 5 September 2020 – High Perceived Noise Night

Date & Time	Wind Speed m/s	Wind Direction	Stability Class	Location & Direction from Port													
				L1a Woonah Inside SE		L1b Woonah Outside SE		L2 Wassell St E		L3 Anthony St NE		L4 Wilson St NW		P1 Foreshore NW		P2 Botany Rd E	
				L_{A10}	L_{ALF}	L_{A10}	L_{ALF}	L_{A10}	L_{ALF}	L_{A10}	L_{ALF}	L_{A10}	L_{ALF}	L_{A10}	L_{ALF}	L_{A10}	L_{ALF}
5/09/2020 0:15	1.9	WNW	E	3	6	2	4	0	1	2	-1	7	-1	3	3	-1	-1
5/09/2020 0:30				4	8	4	6	2	4	1	0	5	-2	3	4	-2	0
5/09/2020 0:45	2.3	W	D	2	6	2	4	3	5	3	6	5	-1	4	5	-1	1
5/09/2020 1:00				5	9	4	8	4	7	3	4	3	-1	3	4	-1	2
5/09/2020 1:15	3.3	WSW	D	7	12	6	10	6	9	5	10	5	0	3	3	0	2
5/09/2020 1:30				5	9	4	8	4	7	3	8	4	1	3	4	2	2
5/09/2020 1:45	1.9	W	D	7	11	6	10	5	10	4	10	6	1	2	2	1	1
5/09/2020 2:00				6	10	5	9	5	9	7	11	1	-2	-3	-2	0	3
5/09/2020 2:15	0.0	CALM	F	12	11	4	8	8	12	8	11	8	0	1	0	2	3
5/09/2020 2:30				5	9	3	8	6	11	6	9	0	-4	-1	-3	1	4
5/09/2020 2:45	1.2	W	F	4	7	2	6	6	10	6	10	2	-4	1	0	1	4
5/09/2020 3:00				4	7	3	6	6	10	5	9	2	-2	4	5	3	6
5/09/2020 3:15	1.6	NNW	F	4	7	3	6	6	9	5	7	3	-3	3	4	1	3
5/09/2020 3:30				3	6	2	6	4	8	5	8	3	-3	4	4	0	2
5/09/2020 3:45	1.6	NW	F	2	5	1	5	4	8	6	9	3	-2	4	2	0	2
5/09/2020 4:00				3	7	-2	7	-1	5	0	7	-2	-4	1	-2	-2	-1
5/09/2020 4:15	1.6	WNW	F	3	7	-1	7	2	8	2	9	-2	-4	2	-1	-1	2
5/09/2020 4:30				5	8	1	8	2	8	3	9	-3	-3	4	0	-2	0
5/09/2020 4:45	1.6	N	F	5	9	2	9	3	8	4	11	0	-2	5	0	-2	1
5/09/2020 5:00				5	9	2	9	5	11	3	9	1	-2	4	0	-1	1
5/09/2020 5:15	1.6	W	D	5	9	3	9	2	8	3	9	0	-3	3	-2	-2	0
5/09/2020 5:30				1	4	3	4	3	3	2	5	5	2	4	1	-2	-1
5/09/2020 5:45	1.6	WNW	D	4	-2	12	-2	7	7	3	7	6	1	4	0	0	-1
5/09/2020 6:00				2	5	3	3	2	6	4	6	7	2	2	1	1	1

4 September – 5 September 2020 – Ships in Port

Vessel Type	Berth	Side To	Funnel Facing
Container Vessel	BD6	S	E
Container Vessel	BD7	S	E
Container Vessel	BD8	S	E
Container Vessel	BD9	S	E
Container Vessel	BD10	P	E
Container Vessel	BD11	P	E
Bulk Liquids	BLB1	P	N
Bulk Liquids	BLB2	P	N
Container Vessel	HD2	S	S

23 September – 24 September 2020 – High Perceived Noise Night

Date & Time	Wind Speed m/s	Wind Direction	Stability Class	Location & Direction from Port													
				L1a Woonah Inside SE		L1b Woonah Outside SE		L2 Wassell St E		L3 Anthony St NE		L4 Wilson St NW		P1 Foreshore NW		P2 Botany Rd E	
				L_{A10}	L_{ALF}	L_{A10}	L_{ALF}	L_{A10}	L_{ALF}	L_{A10}	L_{ALF}	L_{A10}	L_{ALF}	L_{A10}	L_{ALF}	L_{A10}	L_{ALF}
24/09/2020 0:15	1.9	NW	D	4	6	6	4	4	4	3	6	8	3	1	1	4	3
24/09/2020 0:30				3	4	4	2	3	3	3	5	1	-2	-2	-2	4	3
24/09/2020 0:45	2.6	W	D	3	4	3	2	3	4	3	7	4	1	-1	-1	3	3
24/09/2020 1:00				3	5	2	4	4	5	3	8	4	1	-1	-1	2	4
24/09/2020 1:15	3.9	W	D	3	4	3	2	3	4	2	7	3	-1	-2	-3	4	4
24/09/2020 1:30				3	4	3	3	2	3	1	5	3	-2	-2	-4	3	4
24/09/2020 1:45	3.5	WNW	D	3	4	4	3	1	3	1	6	4	-2	-2	-4	2	4
24/09/2020 2:00				2	3	3	2	0	2	2	5	5	-2	-3	-5	0	3
24/09/2020 2:15	1.9	W	D	2	2	2	1	0	1	0	2	0	-6	-5	-4	5	4
24/09/2020 2:30				2	1	2	0	0	0	0	2	2	-5	-3	-3	4	4
24/09/2020 2:45	2.6	W	D	2	2	4	1	1	1	2	5	4	-4	-2	-4	2	3
24/09/2020 3:00				2	2	2	1	1	2	2	4	6	0	-1	1	3	3
24/09/2020 3:15	2.3	WNW	D	3	4	2	3	1	2	2	4	4	-1	-1	-1	3	4
24/09/2020 3:30				8	4	3	3	1	2	2	4	3	-5	2	-1	3	4
24/09/2020 3:45	2.6	NW	D	4	6	3	4	1	1	2	3	4	-3	2	0	5	5
24/09/2020 4:00				3	4	0	3	-2	1	-4	1	4	2	0	-2	2	2
24/09/2020 4:15	3.0	WNW	E	2	3	-1	2	-1	1	-2	1	2	-2	1	-3	2	2
24/09/2020 4:30				3	5	0	3	-2	0	-3	0	2	-2	1	-3	1	2
24/09/2020 4:45	2.3	NW	D	3	4	-1	2	-1	0	-2	0	3	-2	1	-4	0	1
24/09/2020 5:00				3	4	1	3	-1	0	0	0	5	0	3	-2	0	1
24/09/2020 5:15	3.0	NW	D	4	6	4	4	6	2	0	0	6	0	2	-2	1	1
24/09/2020 5:30				5	7	6	5	1	2	3	3	7	2	3	-1	4	3
24/09/2020 5:45	2.6	NW	D	4	4	6	3	2	3	6	3	8	3	4	-1	4	3
24/09/2020 6:00				4	6	4	4	2	4	6	2	8	4	1	0	3	3

23 September – 24 September 2020 – Ships in Port

Vessel Type	Berth	Side To	Funnel Facing
Container Vessel	BD6	S	E
Container Vessel	BD10	P	E
Container Vessel	BD12	P	E
Bulk Liquids	BLB2	P	N
Container Vessel	HD2	S	S