DONALDSONCOAL

Part of the Yancoal Australia Group

ABN: 87 073 088 945

YANCOAL

兖煤澳大利亚有限公司

Annual Review

Abel Underground Coal Mine

1 January 2019 – 31 December 2019

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DONALDSON COAL

PTY LTD

ABN: 87 073 088 945

Annual Review

for the

Abel Underground Coal Mine

1 January 2019 – 31 December 2019

Compiled for:

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Ref No. 737/23b

March 2020

DONALDSONCOAL
Part of the Yancoal Australia Group

TITLE BLOCK

Name of Operation	Abel Underground Coal Mine
Name of Operator	Donaldson Coal Pty Ltd
Development consent / project approval #	05_0136
Name of holder of development consent / project approval	Donaldson Coal Pty Ltd
Mining Lease #	ML1618 and ML 1653
Name of holder of mining lease	Donaldson Coal Pty Ltd
Water licence #	20WA218986 and WAL41525
Name of holder of water licence	Donaldson Coal Pty Ltd
MOP/RMP start date	02/05/2016
MOP/RMP end date	01/05/2021
Annual Review start date	01/01/2019
Annual Review end date	31/12/2019

I, Phillip Brown, certify that to the best of my knowledge this report is a true and accurate record of the compliance status of the Abel Underground Coal Mine for the period 1 January 2019 to 31 December 2019 and that I am authorised to make this statement of behalf of Donaldson Coal Pty Ltd.

Note.

a) The Annual Review is an 'environmental audit' for the purposes of section 122B(2) of the Environmental Planning and Assessment Act 1979. Section 122E provides that a person must not include false or misleading information (or provide information for inclusion in) an audit report produced to the Minister in connection with an environmental audit if the person knows that the information is false or misleading in a material respect. The maximum penalty is, in the case of a corporation, $1 million and for an individual, $250,000.

b) The Crimes Act 1900 contains other offences relating to false and misleading information: Section 192G (Intention to defraud by false or misleading statement – maximum penalty 5 years imprisonment); Section 307A, 307B and 307C (false or misleading application/information/documents – maximum penalty 2 years imprisonment or $22,000, or both).

Name of authorised reporting officer	Phillip Brown
Title of authorised reporting officer	Environment and Community Relations Superintendent
Signature of authorised reporting officer	Phil Brown
Date	31 March 2020

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TABLES

1. STATEMENT OF COMPLIANCE

The compliance status of relevant approvals was reviewed for the reporting period and is summarised in **Table 1.1**. It was determined that there was one administrative non-compliance during the reporting period. The non-compliance recorded during the reporting period has been ranked according to the risk matrix included in **Table 1.2**.

Table 1.1
Statement of Compliance

Were all conditions of the relevant approval(s) complied with?	Yes / No
Project Approval 05_0136	No
Mining Lease 1618	Yes
Mining Lease 1653	Yes
Water Supply Works Approval 20WA218986 and Water Access Licence 41525	Not Determined[1]
1. Updated licence with conditions not yet received.	

Table 1.2
Non-compliances

Relevant Approval	Cond #	Condition Description (summary)	Compliance Status	Comment	Where Addressed in Annual Review
PA 05_0136	2/11a	Ensure that all new buildings and structures, and any alterations or additions are constructed in accordance with the relevant requirements of the BCA.	Non-compliant	Construction Certificates have been received for buildings within the surface infrastructure area but not Occupation Certificates. Certifying body inspected once and requested changes. Changes have been made and the Certifying body requested to reinspect. Certificates yet to be issued.	Section 11

Compliance Status Key

Risk level	*Colour code*	*Description*
High	*Non-compliant*	*Non-compliance with potential for significant environmental consequences, regardless of the likelihood of occurrence.*
Medium	*Non-compliant*	*Non-compliance with:* • *potential for serious environmental consequences, but is unlikely to occur; or* • *potential for moderate environmental consequences, but is likely to occur.*
Low	*Non-compliant*	*Non-compliance with:* • *potential for moderate environmental consequences, but is unlikely to occur; or* • *potential for low environmental consequences, but is likely to occur.*
Administrative non-compliance	*Non-compliant*	*Only to be applied where the non-compliance does not result in any risk of environmental harm (e.g. submitting a report to government later than required under approval conditions).*

2. INTRODUCTION

2.1 OVERVIEW OF OPERATIONS

The Abel Underground Coal Mine (the "mine") is located approximately 23km northwest of Newcastle, New South Wales (see **Figure 2.1**). Following the grant of Project Approval 05_0136 in June 2007, the Company undertook construction and mining activities until the mine was placed in care and maintenance from 2 May 2016. Activities undertaken to date include the following.

i) Construction of surface infrastructure and facilities, including the administration offices, amenities, service and storage facilities and car parking area, within the surface infrastructure area.

ii) Initial mine construction involving the formation of three mining portals and underground roadways and construction of the ventilation, conveying and coal stockpiling systems.

iii) Coal recovery using bord and pillar methods including first and second workings.

iv) Processing of recovered coal at the Bloomfield Colliery CHPP and transportation via the Bloomfield Rail Loop and Spur and subsequently via the Main Northern Railway.

Several of the earlier activities relating to the mine, involving the formation of the box cut within which the surface facilities and ROM stockpiles are located, were undertaken as part of the approved Donaldson Open Cut Coal Mine.

2.2 SCOPE AND FORMAT

This Annual Review for the Abel Underground Coal Mine has been compiled by R.W. Corkery & Co. Pty. Limited on behalf of Donaldson Coal Pty Ltd (the "Company"). Donaldson Coal Pty Ltd became part of Yancoal Australia Limited in July 2012.

This is the fourth Annual Review submitted for the mine, following eight Annual Environmental Management Reports, and is applicable for the period 1 January to 31 December 2019 ("the reporting period"). The information presented within this Annual Review has been compiled based on information and advice provided by the Company.

This Annual Review generally follows the format and content requirements identified in the Department of Planning and Environment's (DPE) *Annual Review Guideline* dated October 2015 and meets the requirements of Condition 4, Schedule 6 of PA 05_0136.

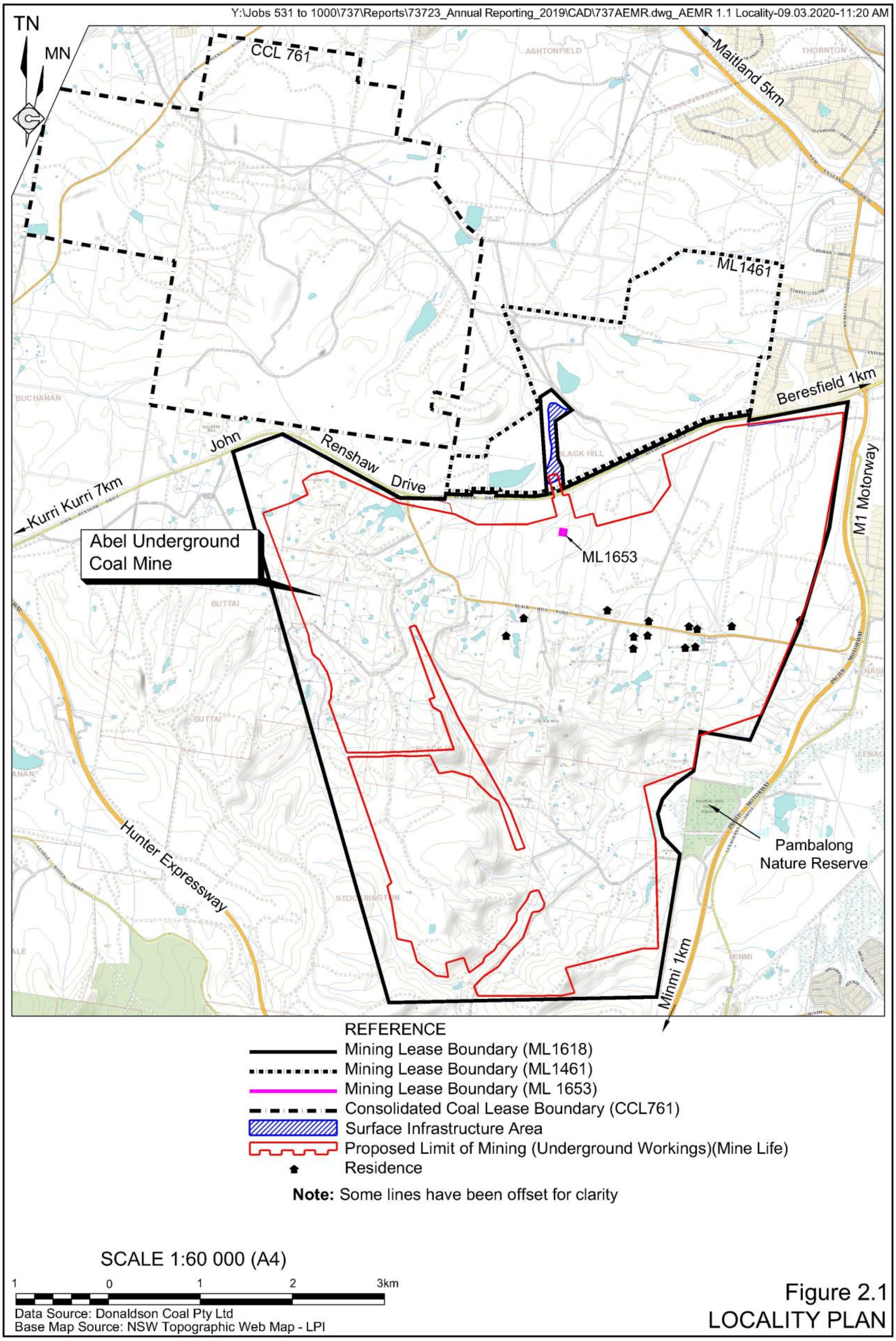


Figure 2.1
LOCALITY PLAN

2.3 KEY PERSONNEL CONTACT DETAILS

The Manager, Mining Engineering, Mr William Farnworth is the primary mine contact (Tel: 02 4015 1100). Mr Farnworth is currently the Manager Mining Engineering for legislative purposes and as such, is responsible for the environmental management of the mine and ensuring compliance with all relevant legislative obligations. Mr Phillip Brown (Tel: 0439 909 952) is the nominated Environment & Community Relations Superintendent and is also responsible for the environmental management of the mine. The contact details for the mine office are as follows.

Postal Address:	Donaldson Coal Pty Ltd	Tel: 02 4015 1100
	PO Box 2216 GREENHILLS NSW 2323	Fax: 02 4015 1159
Email:	donaldson@doncoal.com.au	
Physical Address:	Abel Underground Coal Mine	
	1132 John Renshaw Drive BLACKHILL NSW 2322	

A 24-hour Environmental Hotline (Tel: 1800 111 271) is maintained by the Company. Details of calls taken on this number are forwarded to the Environment & Community Relations Superintendent for further actioning, if required.

3. APPROVALS

The Company has operated the approved activities at the mine under the approvals listed in **Table 3.1**.

Table 3.1
Abel Underground Coal Mine – Consents, Leases and Licences

Consent/Lease/Licence	Issue Date	Expiry Date	Details / Comments
Project Approval 05_0136	7 June 2007	31 December 2030	Granted by the (then) Minister for Planning and last modified on 04 December 2013.
Mining Lease ML 1618*	15 May 2008	15 May 2029	Granted by the Minister for Primary Industries. Incorporates 2755ha of surface area.
Mining Lease ML 1653*	21 January 2011	21 January 2032	Granted by the Minister for Primary Industries. Incorporates 0.25ha of surface area. Issued construction of ventilation shaft.
Environment Protection Licence No. 12856	9 July 2008 (licence version date 21 December 2011)	Not applicable	Issued by the (then) Department of Environment and Climate Change (EPA).
Water Supply Works Approval 20WA218986	01/07/2016	30/06/2029	Bore Licence 20BL171935 was issued for the interception and inflow of groundwater due to the underground mining operations. Following commencement of the *Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources 2016* in July 2016 20BL171935 was converted to a water supply works approval and water access licence with an allocation of 500ML/year.
Water Access Licence (WAL) 41525	01/07/2016	Continuing	
* See **Figure 2.1**			

It is noted that this Annual Review has been prepared to fulfil the annual reporting requirements of Project Approval 05_0136, ML 1618, ML 1653, and WAL 41525. A separate Annual Return has continued to be submitted to the NSW EPA in accordance with the requirements of Environment Protection Licence (EPL) 12856. It is noted that an application to consolidate and rationalise EPL 12856, for the Abel Mine, and EPL 11080, for the Donaldson Open Cut Coal Mine, is currently being processed by the EPA and is expected to be finalised during the next reporting period.

The Company also holds Exploration Licence 5497 (see **Figure 2.1**) which was granted on 22 July 1998, with a current expiry date of 21 July 2019. An application for renewal of EL 5497 has been submitted and is awaiting determination.

4. OPERATIONS SUMMARY

4.1 MINING OPERATIONS

Coal mining activities ceased on 2 May 2016 when the site was placed into care and maintenance. No coal mining is planned during the next reporting period. **Table 4.1** presents a summary of the production statistics.

Table 4.1
Production Summary

Material	Approved limit (specify source)	Previous reporting period (actual)	This reporting period (actual)	Next reporting period (forecast)
Waste Rock / Overburden (m^3)	None specified	0	0	0
ROM Coal / Ore (t)	6 100 000 (PA 05_0136 Cond 2/6)	0	0	0
Coarse Reject (t)	None specified	0	0	0
Fine Reject (Tailings) (t)	None specified	0	0	0
Saleable Product (t)	None specified	0	0	0

4.2 OTHER OPERATIONS DURING THE REPORTING PERIOD

No exploration, land preparation, construction or processing activities were undertaken during the reporting period.

Environmental monitoring activities continued throughout the reporting period including surface water, groundwater, flora and fauna and subsidence monitoring. Results of this monitoring is summarised in Sections 6 and 7.

The following management plans were updated during the reporting period to reflect more appropriate environmental monitoring programs during the care and maintenance period and to reflect comments raised as part of the 2018 Independent Environmental Audit. These management plans were approved by DPIE on 4 June 2019.

- Water Management Plan – Care and Maintenance (Version 4 – 3 June 2019).
- Rehabilitation Management Plan – Care and Maintenance (Version 2 – 3 June 2019).
- Noise Management Plan – Care and Maintenance (Version 5 – 3 June 2019).
- Air Quality and Greenhouse gas Management plan – Care and Maintenance (Version 3 – 3 June 2019).
- Abel Underground Mine: Aboriginal Heritage Management Plan (Revision 2.1 – June 2019).
- Rehabilitation Management Plan – Care and Maintenance (Version 2 – 3 June 2019).

The Pollution Incident Response Management Plan (Version 4 – 5 July 2019) was also updated during the reporting period to reflect the most appropriate content and contact details.

4.3 NEXT REPORTING PERIOD

The activities proposed for 2020 will principally involve continued monitoring and, if required, maintenance activities. The following provides a summary of the planned activities.

Exploration

The Company is considering further exploration but currently does not intend to undertake any drilling within ML 1618 or ML 1653 during the 2020 reporting period. In the event that drilling is undertaken, the appropriate approvals will be sought and the drilling reported as part of the next Annual Review and within the annual exploration report.

Mining

No mining is currently planned to be undertaken during the 2020 reporting period.

Rehabilitation

No specific rehabilitation activities are currently planned for the 2020 reporting period, however, work will continue to be undertaken to develop a closure strategy. Any rehabilitation works undertaken will relate to rehabilitation of any subsidence impacts or to ongoing maintenance, principally erosion and sediment control.

Monitoring

The following monitoring will be undertaken during the next reporting period.

- Air Quality – ongoing deposited dust (until approval of variation of EPL 12856), and PM_{10} monitoring will continue to be undertaken.
- Surface water – ongoing surface water quality at a range of routine monitoring sites located within Blue Gum Creek, Viney Creek, Buttai Creek, Four Mile Creek and a number of local water storages. This monitoring will be undertaken as part of the integrated monitoring with the Bloomfield, Donaldson and Tasman Extended Mines.
- Groundwater – ongoing groundwater quality and level monitoring will be undertaken as part of the integrated network of monitoring bores for the Bloomfield, Donaldson and Tasman Mines. Measurement of the quality and volume of inflow water to the underground workings will also continue to be undertaken.
- Noise – noise monitoring will continue but at a six monthly frequency whilst the mine remains on care and maintenance.
- Flora & Fauna – flora and fauna surveys and reporting will continue to be undertaken in accordance with approved Flora and Fauna Management Plan. It is noted that, whilst the mine is on care and maintenance, the Pambalong Nature Reserve, dam monitoring and sub-tropical rainforest monitoring will be deferred pending the recommencement of mining.

- Meteorological – the on-site meteorological station at the Abel Mine will be maintained and data collated.
- Subsidence monitoring will continue to be undertaken in accordance with the approved subsidence monitoring programs.

Community Consultation and Liaison

The community consultative committee will continue to be convened during the next reporting period. It is expected that meetings will be held six-monthly unless otherwise agreed with the committee. The 24hr environmental hotline will be maintained and a register retained of any complaints received.

Mining Operations Plan

A new or amended Mining Operations Plan (MOP) will be prepared and submitted prior to 31 August 2020 to reflect the outcomes of the closure strategy (see Section 5).

5. ACTIONS REQUIRED FROM PREVIOUS ANNUAL REVIEW

The 2018 Annual Review was forwarded to the Resources Regulator within the (then) Department of Planning and Environment (DPE) and the DPE compliance unit on 29 March 2019. Feedback was received from the DPE compliance unit dated 30 April 2019. The Annual Review was considered to generally satisfy the conditions of the approval.

Feedback was also received from the Resources Regulator dated 16 July 2019 confirming the Annual Review was considered to satisfy the requirements of the relevant conditions of the mining leases. However, the feedback noted that, during the review of the Annual Review and following a site inspection on 7 June 2019, closure planning was considered an "emerging risk". A separate Section 240(1)(c) Notice dated 11 July 2019 was issued with two directions required to be implemented by 31 August 2020. A summary of these directions (and subcomponents) is provided in **Table 5.1**

Table 5.1
Actions from the previous Annual Review / Section 240(1)(c) Notice

Action required from previous Annual Review / Notice	Requested by	Action taken by the Operator	Where discussed in Annual Review
1. Develop a Closure Strategy ("Strategy") for the management of the West and Square Pits. The Strategy is to: i. Be developed to reflect the following separate closure pathways: a. the resumption of mining within the Abel Underground Mine and development of the voids; b. the closure of the Abel Underground Mine with no resumption of mining. ii. Include Rehabilitation Objectives and Completion Criteria for both closure pathways identified in Point (i) above. iii. Include a risk assessment that identifies and assesses risks to rehabilitation that are associated with each closure pathway identified in Point (i) above. Following the risk assessment, develop control actions that are incorporated in a Trigger Action Response Plan for each closure pathway. iv. Incorporate a timeline for completion of rehabilitation works required for each closure pathway identified in Point (i) above. v. Reflect Project Approval requirements, including completion of a gap analysis that assesses whether Project Approval modifications are required for intended post mining landforms.	Resources Regulator	Preliminary planning and consideration of this matter has been undertaken. The Closure Strategy will be finalised during the next reporting period.	Section 8.3.1
2. Submit an updated Mining Operations Plan (MOP) for ML 1618 and ML 1653 - Abel Underground Mine that includes Closure Strategy that is outlined in Direction 1. The MOP is to be submitted electronically to minres.environment@planning.nsw.gov.au to the satisfaction of the Regulator, referencing "Response to NTCE0003227" in the subject heading.	Resources Regulator	Either a new or amended MOP will be submitted prior to 31 August 2020 to reflect the outcomes of the Closure Strategy.	Section 4.3 & 5

6. ENVIRONMENTAL PERFORMANCE

6.1 SUMMARY OF ENVIRONMENTAL PERFORMANCE

A summary of environmental performance for the principal environmental aspects is provided in **Table 6.1**. Further detail regarding specific environmental aspects is also provided in the following subsections. It is noted that a range of monitoring activities are integrated with the Donaldson Open Cut Coal Mine and Bloomfield Colliery, as outlined within the Integrated Environmental Monitoring Program. The following subsections present results specific to the Abel Mine with data relevant to other operations presented in their respective Annual Reviews.

Table 6.1
Environmental performance

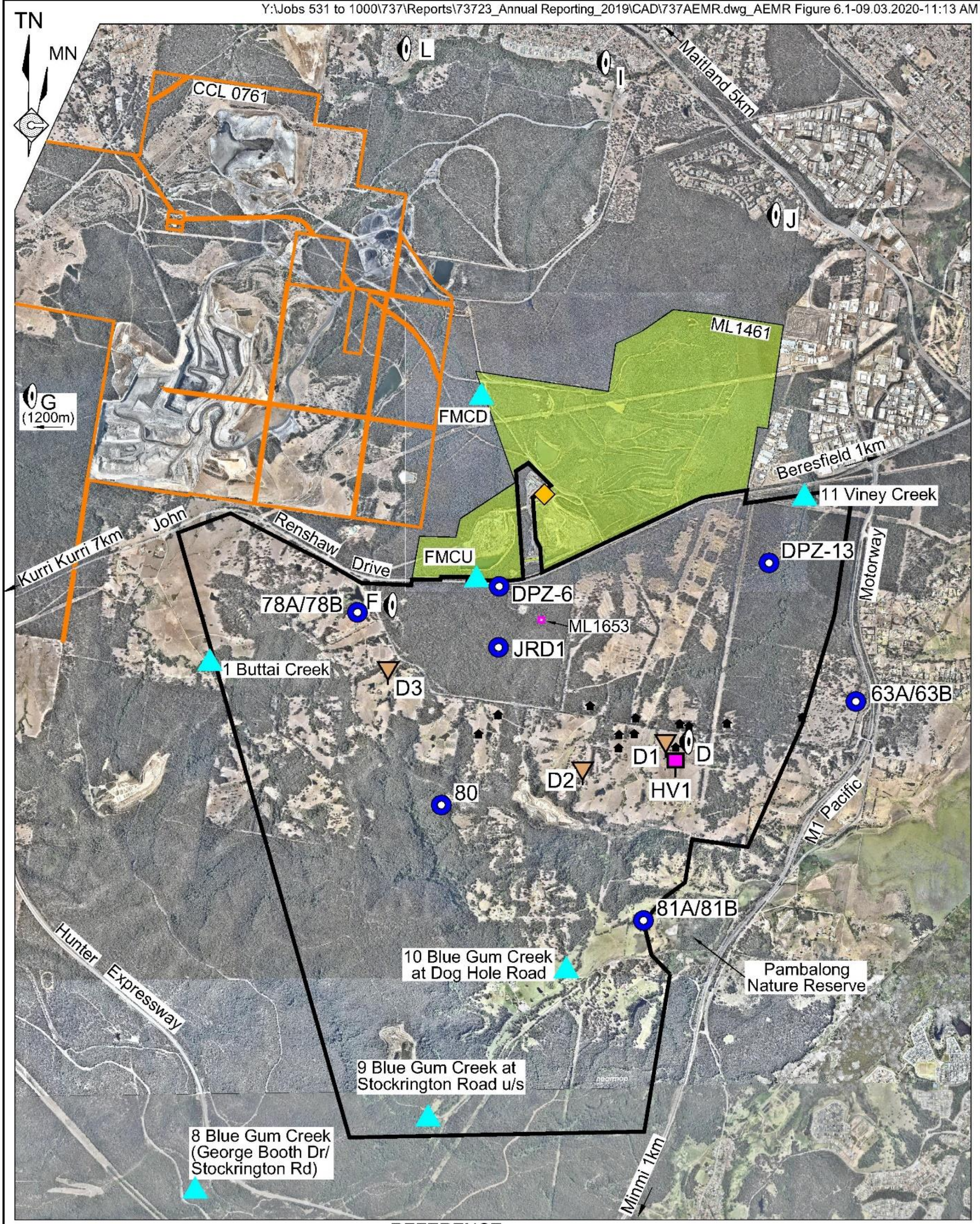
Aspect	Approval criteria / EIS prediction	Performance during the reporting period	Trend/key management implications	Implemented/proposed management actions
Noise	No exceedance of applicable noise criteria.	No exceedances and no complaints.	Implies management measures are currently adequate.	No additional management action required.
Blasting	No exceedance of applicable blast criteria.	No blasts undertaken. No complaints.	Implies management measures are currently adequate.	No additional management action required.
Air Quality	No exceedances of applicable air quality criteria.	No exceedances and no complaints.	Implies management measures are currently adequate.	No additional management action required.
Biodiversity	No significant impacts upon flora, fauna species, populations, communities or habitat.	No impacts upon flora, fauna species, populations, communities or habitat were recorded. No effect upon Pambalong Nature Reserve or Sub-tropical rainforest.	Implies current mining design and safeguards are currently adequate.	No additional management action required.
Heritage	Management in accordance with approved Aboriginal Heritage Management Plan.	No heritage items undermined during the reporting period. No subsidence impacts.	Implies no specific management actions were necessary.	No additional management action required.
Subsidence	Subsidence management in accordance with approved Subsidence management Plan / Extraction Plan.	No notifiable events occurred.	Implies management measures are currently adequate and predictions sufficiently accurate.	No additional management action required.

6.2 METEOROLOGICAL MONITORING

An automated weather station, installed for the Donaldson Mine, has been approved by the (then) Department of Planning as also meeting the requirements for the Abel Mine. The weather station records wind speed and direction, temperature, rainfall and solar radiation. This station was subsequently relocated in March 2015 to adjacent the Helipad near the Abel surface facilities (see **Figure 6.1**). A summary of the rainfall data since commencement of the Abel Mine in 2007 is presented in **Table 6.2**.

Total rainfall during the 2019 calendar year was 564.0mm, representing an annual rainfall equivalent to less than 60% of the average annual rainfall of 964.7mm.

Y:\Jobs 531 to 1000\737\Reports\73723_Annual Reporting_2019\CAD\737AEMR.dwg_AEMR Figure 6.1-09.03.2020-11:13 AM



REFERENCE

- Mining Lease Boundary (ML1618)
- Mining Lease Boundary (ML 1653)
- Mining Lease Boundary (ML1461)
- Consolidated Coal Lease Boundary (CCL0761)
- Noise Monitoring Location
- Residence
- Meteorological Station
- Deposited Dust Monitoring Location
- Surface Water Monitoring Location
- High Volume Air Sampler (HVAS) Location
- Groundwater Monitoring Location

Note: Some lines have been offset for clarity

SCALE 1:60 000 (A4)

1 0 1 2 3km

Data Source: Donaldson Coal Pty Ltd
Base Photo Source: Nearmap - Date: 20 December 2019

Figure 6.1
ENVIRONMENTAL
MONITORING LOCATIONS

Table 6.2
Monthly Rainfall Records

Period	Average Monthly Rainfall (mm)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**Total**
2007	13.4	87.6	102.4	85.6	60.0	253.0	16.5	79.6	28.3	35.0	163.8	49.5	974.7
2008	153.4	191.8	46.0	237.6	2.2	122.9	30.0	28.5	195.3	62.2	73.3	62.6	1205.8
2009	11.3	340.7	136.5	189	143.8	75.7	32.1	1.8	29.2	59.8	51.4	62.0	1133.3
2010	89.0	52.1	83.9	37.1	89.4	112.8	65.3	38.5	26.0	80.6	171.1	55.9	901.7
2011	25.6	34.5	65.6	138	98.8	152.2	128.7	48.9	103.2	100.0	171.9	75.9	1143.2
2012	96.1	207.0	137.6	114.7	11.8	172.3	53.8	26.6	18.7	5.7	47.9	47.9	944.1
2013	166.7	226.6	97.9	89.4	60.9	96.5	11.2	9.7	21.2	49.5	261.8	2.6	1094.0
2014	15.6	108.3	112.8	99.3	44.3	31.4	24.6	104.0	42.4	55.0	38.4	133.4	809.5
2015	167.0	48.0	73.3	412.0	89.4	44.6	17.9	30.6	56.8	59.0	69.8	103.8	1172.2
2016	430.8	26.0	78.0	31.8	13.4	113.0	44.2	74.2	60.0	43.8	33.2	58.6	1007.0
2017	66.9	71.7	150.4	94.5	12.7	128.5	3.2	6.0	12.6	77.7	66.8	41.6	732.6
2018	6.6	120.0	191.4	52.8	7.0	107.4	4.2	21.4	55.4	109.0	92.6	91.8	859.6
2019	**17.2**	**32.8**	**158.0**	**27.0**	**19.4**	**97.4**	**26.0**	**66.6**	**69.4**	**22.0**	**28.2**	**0.0**	**564.0**
Average	*96.9*	*119.0*	*110.3*	*123.8*	*50.2*	*116.0*	*35.2*	*41.3*	*55.3*	*58.4*	*97.7*	*60.4*	*964.7*
Note:	Results relevant to this reporting period are in bold.												

6.3 NOISE

Environmental Management

The principal noise control prior to the site entering care and maintenance was the continued use of low modulated frequency reversing alarms on mobile equipment used on the surface. Whilst mobile equipment usage during care and maintenance has been minimal this remains the principal management measure.

Environmental Performance

Quarterly noise monitoring applicable to the Abel Mine commenced in December 2008 as an extension of the monitoring survey previously undertaken for the Donaldson Open Cut Coal Mine. Quarterly attended and unattended noise monitoring continued to be undertaken throughout the reporting period at six monitoring locations relevant to the Abel Mine (see **Figure 6.1**) for quarters ending March (Q1), June (Q2), September (Q3) and December (Q4) 2019. Monitoring results are presented in **Table 6.3** and copies of the monitoring reports are presented within **Appendix 1**.

The findings of the monitoring surveys were that operations were inaudible at all monitoring locations during Q1, Q2 and Q3. Operations at the Bloomfield CHPP were audible at monitoring locations I and L during night periods during Q4 but remained well below the applicable criteria. Notably, all monitoring events were undertaken whilst the Abel Mine was under care and maintenance and therefore not audibly contributing to received noise. Further discussion regarding the Bloomfield CHPP is provided in their respective annual reporting.

Whilst PA 05_0136 provides for cumulative noise criteria, given that the Abel operations were inaudible at all times, the Donaldson Coal Mine is also on care and maintenance, and noise from the Bloomfield CHPP was either inaudible or well below the relevant criteria, no cumulative effects are considered to have occurred.

Table 6.3
Summary of Attended Noise Monitoring Results – 2019

Location	Time	Noise Criteria	Attended Monitoring[1]				Noise generated by Abel Mine
			Q1	Q2	Q3	Q4	
D Black Hill School, Black Hill	Day ($L_{A\,eq\,(15\,min)}$)	35	NA	NA	NA	NA	Operations inaudible at all times
	Evening ($L_{A\,eq\,(15\,min)}$)	35	NA	NA	NA	NA	Operations inaudible at all times
	Night ($L_{A\,eq\,(15\,min)}$)	35	NA	NA	NA	NA	Operations inaudible at all times
	Night ($L_{A1(1min)}$)	45	NA	NA	NA	NA	Operations inaudible at all times
F Black Hill Rd, Black Hill	Day ($L_{A\,eq\,(15\,min)}$)	35	NA	NA	NA	NA	Operations inaudible at all times
	Evening ($L_{A\,eq\,(15\,min)}$)	35	NA	NA	NA	NA	Operations inaudible at all times
	Night ($L_{A\,eq\,(15\,min)}$)	35	NA	NA	NA	NA	Operations inaudible at all times
	Night ($L_{A1(1min)}$)	45	NA	NA	NA	NA	Operations inaudible at all times
G Buchanan Rd, Buchanan	Day ($L_{A\,eq\,(15\,min)}$)	35	NA	NA	NA	NA	Operations inaudible at all times
	Evening ($L_{A\,eq\,(15\,min)}$)	35	NA	NA	NA	NA	Operations inaudible at all times
	Night ($L_{A\,eq\,(15\,min)}$)	35	NA	NA	NA	NA	Operations inaudible at all times
	Night ($L_{A1(1min)}$)	45	NA	NA	NA	NA	Operations inaudible at all times
I Lord Howe Drive, Ashtonfield	Day ($L_{A\,eq\,(15\,min)}$)	36	NA	NA	NA	NA	Operations inaudible at all times
	Evening ($L_{A\,eq\,(15\,min)}$)	36	NA	NA	NA	NA	Operations inaudible at all times
	Night ($L_{A\,eq\,(15\,min)}$)	36	NA	NA	NA	<25	CHPP operations barely audible during Q4
	Night ($L_{A1(1min)}$)	45	NA	NA	NA	<25	CHPP operations barely audible during Q4
J Parish Drive, Thornton	Day ($L_{A\,eq\,(15\,min)}$)	35	NA	NA	NA	NA	Operations inaudible at all times
	Evening ($L_{A\,eq\,(15\,min)}$)	35	NA	NA	NA	NA	Operations inaudible at all times
	Night ($L_{A\,eq\,(15\,min)}$)	35	NA	NA	NA	NA	Operations inaudible at all times
	Night ($L_{A1(1min)}$)	45	NA	NA	NA	NA	Operations inaudible at all times
L 7 Kilshanny Av, Ashtonfield	Day ($L_{A\,eq\,(15\,min)}$)	40	NA	NA	NA	NA	Operations inaudible at all times
	Evening ($L_{A\,eq\,(15\,min)}$)	40	NA	NA	NA	NA	Operations inaudible at all times
	Night ($L_{A\,eq\,(15\,min)}$)	40	NA	NA	NA	33	CHPP operations audible during Q4
	Night ($L_{A1(1min)}$)	47	NA	NA	NA	41	CHPP operations audible during Q4

NA – Not able to be calculated as operations inaudible at all times (dBA)
CHPP – Bloomfield Coal Handling Processing Plant
[1] Estimated Abel Contribution

Reportable Incidents

No reportable incidents were recorded during the reporting period.

Further Improvements

Other than ongoing plant maintenance and noise monitoring (both attended and unattended), no additional management measures are planned during the next reporting period. Given the results of previous noise monitoring, the placement of the Abel Mine into care and maintenance, and the approval of the Noise Management Plan – Care and Maintenance (Version 5 – 3 June 2019), it is intended that noise monitoring will occur at reduced six-monthly frequencies during the next reporting period as required by the Noise Management Plan.

6.4 BLASTING

No blasts were undertaken during the reporting period.

6.5 AIR QUALITY

Environmental Management

As the Abel Mine is on care and maintenance the principal air quality management measure during the reporting period was maintenance of mobile equipment and on-site vehicles to reduce greenhouse and particulate emissions.

Environmental Performance

Monthly deposited dust monitoring was undertaken by the Company at a total of three locations surrounding and relevant to the Abel Mine. Total Suspended Particulates (TSP) and Particulate Matter <10µm (PM_{10}) monitoring was also undertaken at the existing High Volume Air Sampling (HVAS) station located approximately 2,300m southeast of the surface infrastructure area at Blackhill (located at Site D1). Monitoring locations are shown on **Figure 6.1** and results are summarised in **Table 6.4** and **Figures 6.2**, **6.3** and **6.4**.

Deposited Dust

The highest monthly dust deposition measurement was 3.6g/m^2/month (insoluble solids) at D3 during December 2019 (see **Table 6.4**). Given that December 2019 dust deposition at D1 and D2 were also relatively high at 2.1g/m^2/month and 3.2g/m^2/month respectively, the slightly elevated results are likely to reflect regional drought conditions and bushfires during this period.

The annual average monthly deposition rates for the reporting period were between 0.9g/m^2/month and 1.5g/m^2/month which is significantly below the cumulative criteria of 4g/m^2/month and compliant with the incremental criteria of an increase of 2g/m^2/month, indicating good air quality with respect to dust deposition.

Table 6.4
Deposited Dust Monitoring Results – 2019^

	Monthly Dust Deposition Rate (g/m^2/month)					
	D1		D2		D3	
Month	Insoluble	Ash	Insoluble	Ash	Insoluble	Ash
January	1.2	1.0	1.7	1.1	1.5	1.1
February	0.7	0.6	1.6	1.1	1.3	1.0
March	1.3	0.9	1.8	1.5	2.0	1.5
April	0.3	0.3	0.8	0.7	0.9	0.9
May	0.4	0.2	0.9	0.5	0.8	0.5
June	0.5	0.3	1.7	0.8	0.7	0.5
July	0.3	0.2	0.4	0.3	0.4	0.3
August	0.4	0.2	0.5	0.4	0.7	0.4
September	0.5	0.3	0.6	0.5	0.6	0.4
October	1.0	0.6	2.9	1.3	1.5	1.1
November	1.2	0.8	1.4	0.9	1.7	1.2
December	2.1	1.8	3.2	2.4	3.6	2.8
Monthly Minimum	*0.3*	*0.2*	*0.4*	*0.3*	*0.4*	*0.3*
Monthly Maximum	*2.1*	*1.8*	*3.2*	*2.4*	*3.6*	*2.8*
Average	***0.8***	***0.6***	***1.5***	***1.0***	***1.3***	***1.0***

Source: Donaldson Coal Pty Ltd. ^ Historical data included in **Appendix 2**

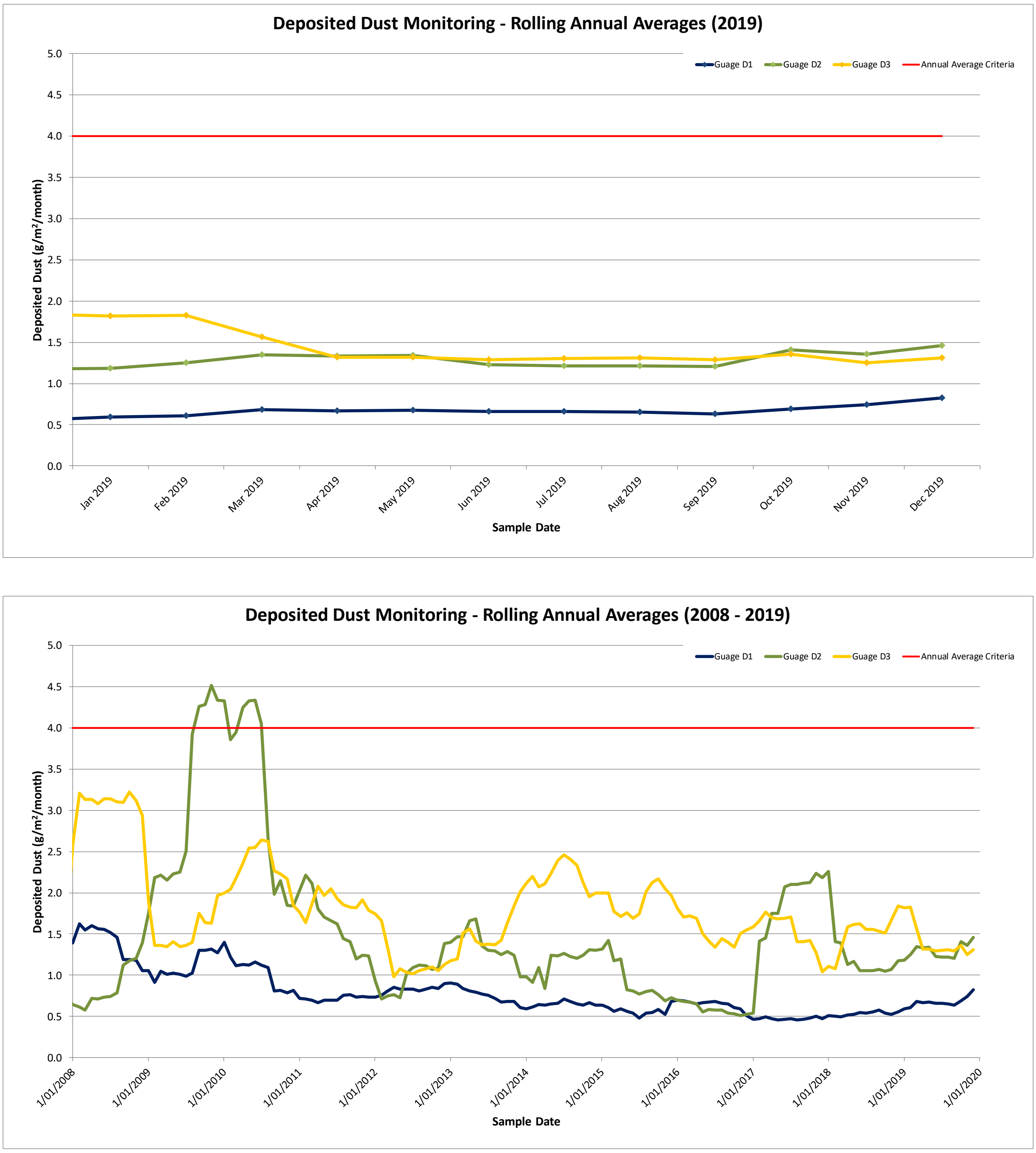


Figure 6.2 Deposited Monitoring Results

Since commencement of the Abel operations, the rolling annual average deposited dust levels have remained low although spikes are evident due to local events, particularly at sites D2 and D3. However, when accounting for such events, no specific trends are evident and deposited dust levels remain significantly below the annual average criteria.

Suspended Particulates – PM_{10} & TSP

The suspended particulate monitoring results indicate that the 50µg/m^3 24-hour *National Environment Protection Measures* (NEPM) goal was exceeded on six occasions during the reporting period, with five of the six exceedances occurring between 29 October 2019 and 10 December 2019 and the remaining exceedance occurring on 13 February 2019 (see **Figure 6.3**). The highest 24-hour average PM_{10} concentration during the reporting period, measured on 10 December 2019, was 118.0µg/m^3.

The October to December 2019 exceedances are consistent with similar or higher PM_{10} levels recorded at the DPIE monitoring stations at Wallsend, Beresfield and Newcastle due to bushfires. The February 2019 exceedance is considered to be the result of both elevated regional and local PM_{10} levels and follows dry conditions throughout January 2019. As no exploration, land preparation, construction or processing works were undertaken during the reporting period, the Abel Mine would have had minimal contribution to the recorded levels.

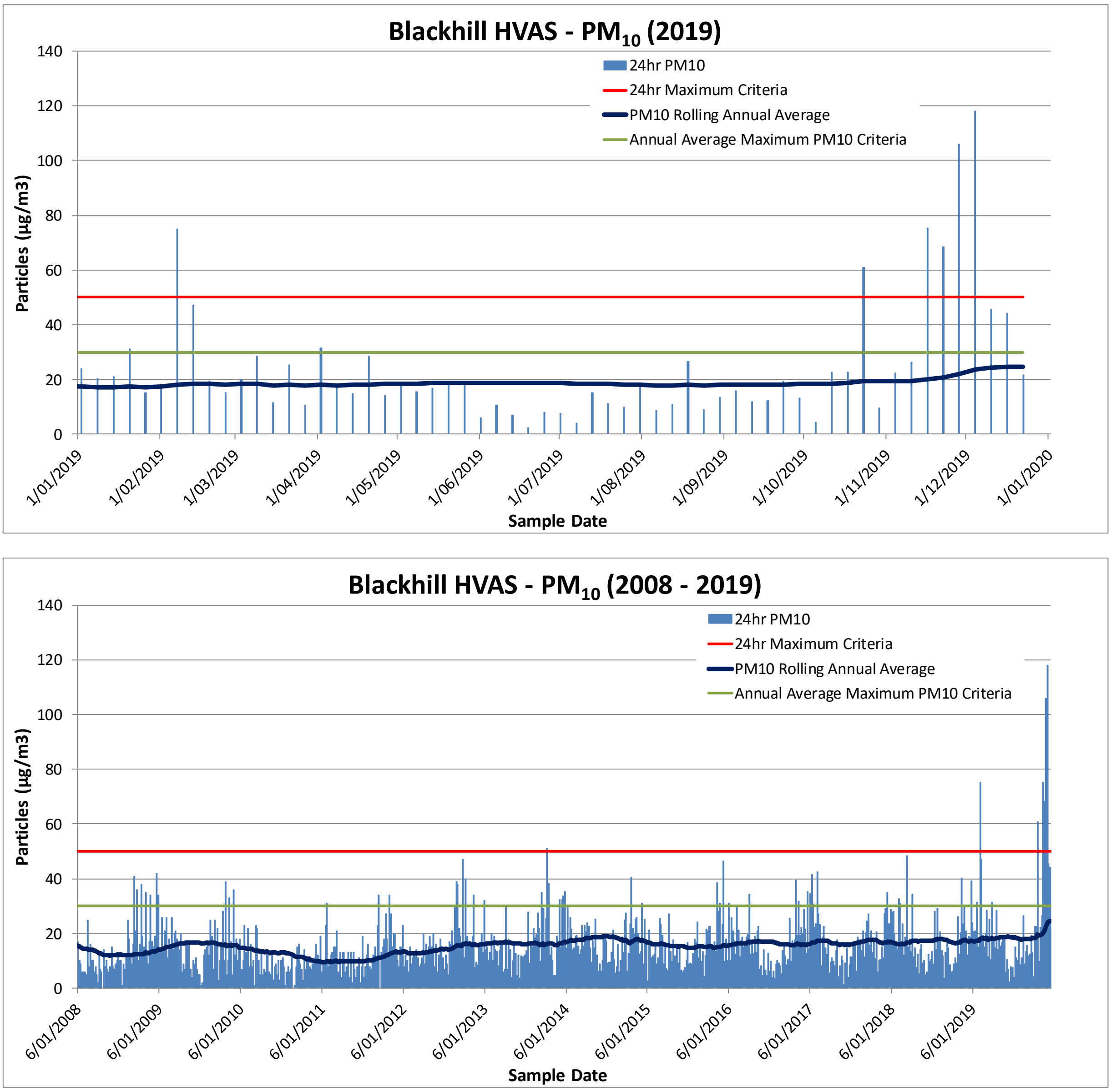


Figure 6.3 PM_{10} Monitoring Results

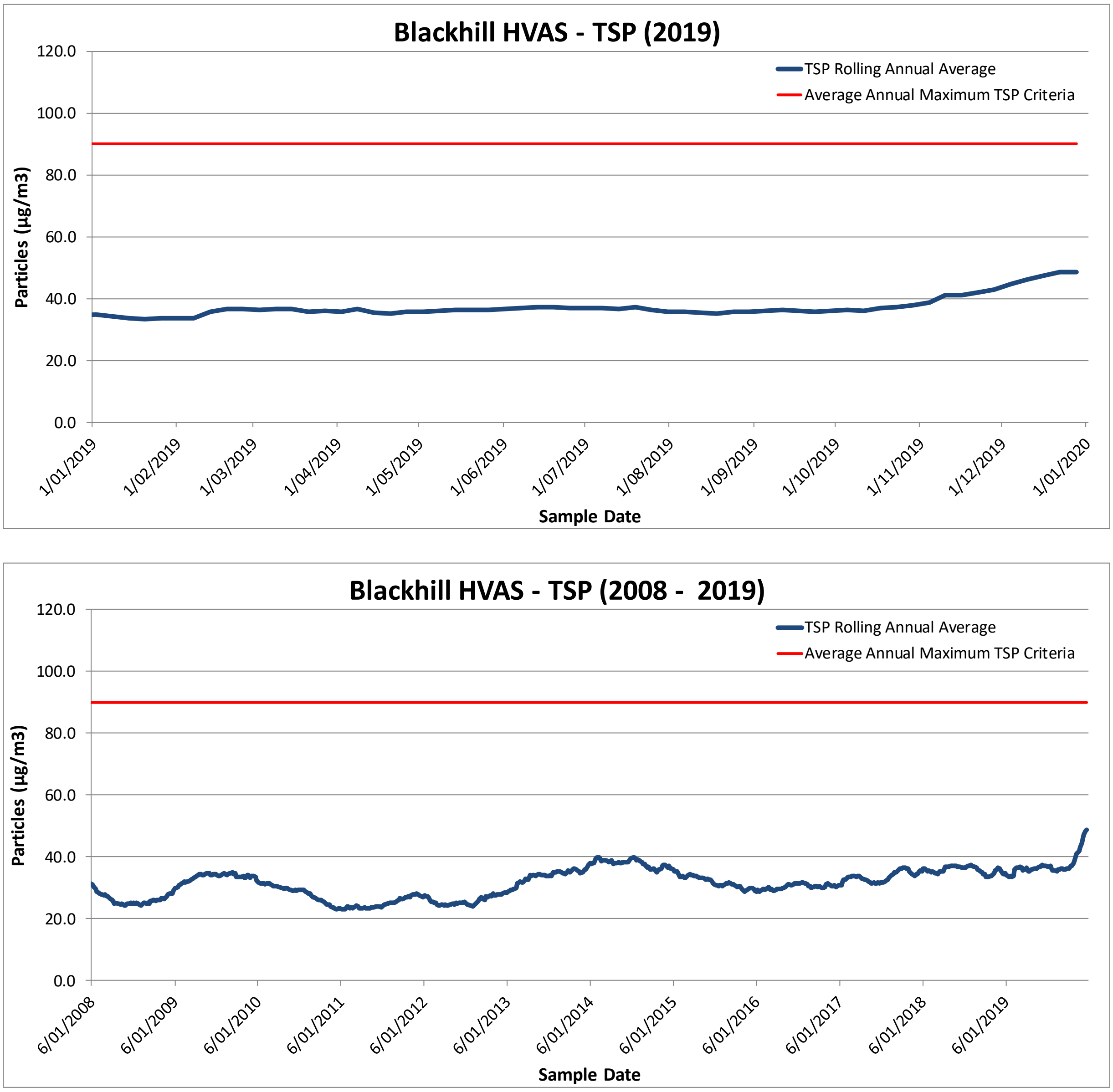


Figure 6.4 TSP Monitoring Results

The annual average PM_{10} concentration for Blackhill was 24.7µg/m^3 for the 12 months to 31 December 2019 whilst the annual average TSP concentration was 48.7µg/m^3, both below the annual average criteria of 30µg/m^3 and 90µg/m^3 respectively. Notwithstanding, these annual average values are significantly higher than the long term (from 6 January 2008) PM_{10} and TSP averages of 16.0µg/m^3 and 32.7µg/m^3 respectively. This is largely attributed to the ongoing bushfires across NSW which have resulted in regular and substantially higher than average particulate levels. This is evident in the rolling annual average PM_{10} data (see **Figure 6.3**).

Other than an annual trend of lower 24-hour average PM_{10} during the winter months and higher 24-hour averages during the summer months, no other long-term PM_{10} trends and no TSP trends are currently apparent.

Reportable Incidents

No reportable incidents relating to air pollution occurred during the reporting period.

Further Improvements

No other improvements relating to air pollution are planned or considered necessary.

6.6 BIODIVERSITY

Environmental Management

No underground mining occurred during the reporting period and no mining has previously been undertaken within areas that would lead to subsidence under or near the Pambalong Nature Reserve or under sub-tropical rainforest. Hence, no specific flora or fauna management measures have been required to date above these areas.

Environmental Performance

Ongoing survey work was completed by Kleinfelder Australia Pty Ltd during the reporting period as part of the Pambalong Nature Reserve Monitoring Plan (see **Appendix 3**). Macroinvertebrate sampling also continued to be undertaken within Blue Gum Creek upstream of the Pambalong Nature Reserve by Niche Environment and Heritage during Autumn and Spring 2019 (see **Appendix 4**).

In accordance with the updated Flora and Fauna Management Plan (Version 4 – 3 June 2019), presented as Appendix 3 of the Rehabilitation Management plan – Care and Maintenance (Version 2 – 3 June 2019), the dam monitoring and management survey and monitoring of the sub-tropical rainforest was not required during the reporting period. Monitoring of flora and fauna present in dams and sub-tropical rainforest areas will recommence following the recommencement of mining operations.

A summary of the results from surveys during the reporting period is provided as follows.

Pambalong Nature Reserve Monitoring

Whilst no mining occurred which could potentially impact upon the Pambalong Nature Reserve, monitoring was undertaken as part of the Pambalong Nature Reserve Monitoring Plan. The 2018/2019 survey represents the 11^{th} year of baseline monitoring. The monitoring plan is aimed at building a picture of what constitutes normal variation so that any impacts from mining in the future can be identified, should they occur.

A total of 109 flora species were recorded during the December 2018 survey, including 22 that were not recorded in the 2017/2018 survey. A total of 200 flora species have been identified since monitoring commenced in 2008. No significant changes to the spatial extent of vegetation communities were observed, however, the following changes in weed abundance and distribution were recorded.

- Increased coverage of *Lantana camara* recorded in the Coastal Foothills Spotted Gum – Ironbark Forest community.
- Increase in weed diversity (12 weed species compared to seven during the 2017 survey) recorded in the Freshwater Wetland Complex.
- Significant decrease in coverage (from 50-<75% during the 2017 survey to <5%) of *Atriplex prostrata* in the Paperbark Swamp Forest.

Key weed species recorded within the Pambalong Nature Reserve during the survey included:

- *Eichhornia crassipes* (Water Hyacinth);
- *Alternanthera philoxeroides* (Alligator Weed);
- *Cenchrus clandestinus* (Kikuyu);
- *Rubus fruticosus* sp. aggregate (Blackberry); and
- *Lantana camara* (Lantana).

A total of 104 fauna species were recorded during the November/December 2018 and May 2019 surveys which is marginally below the yearly average of 105 species. Species recorded included 79 bird, 17 mammal (two arboreal, three terrestrial and 12 bat), six frog and two reptile species (**Figure 6.5**). Bird numbers were slightly less than the 2017/2018 monitoring but consistent with the 2 yearly cyclical rise and fall that recorded to date. Threatened species recorded during the survey included three bat species (*Miniopterus australis*, *Pteropus poliocephalus* and *Falsistrellus tasmaniensis*) and three bird species (*Haliaeetus leucogaster*, *Botaurus poiciloptilus* and *Glossopsitta pusilla*).

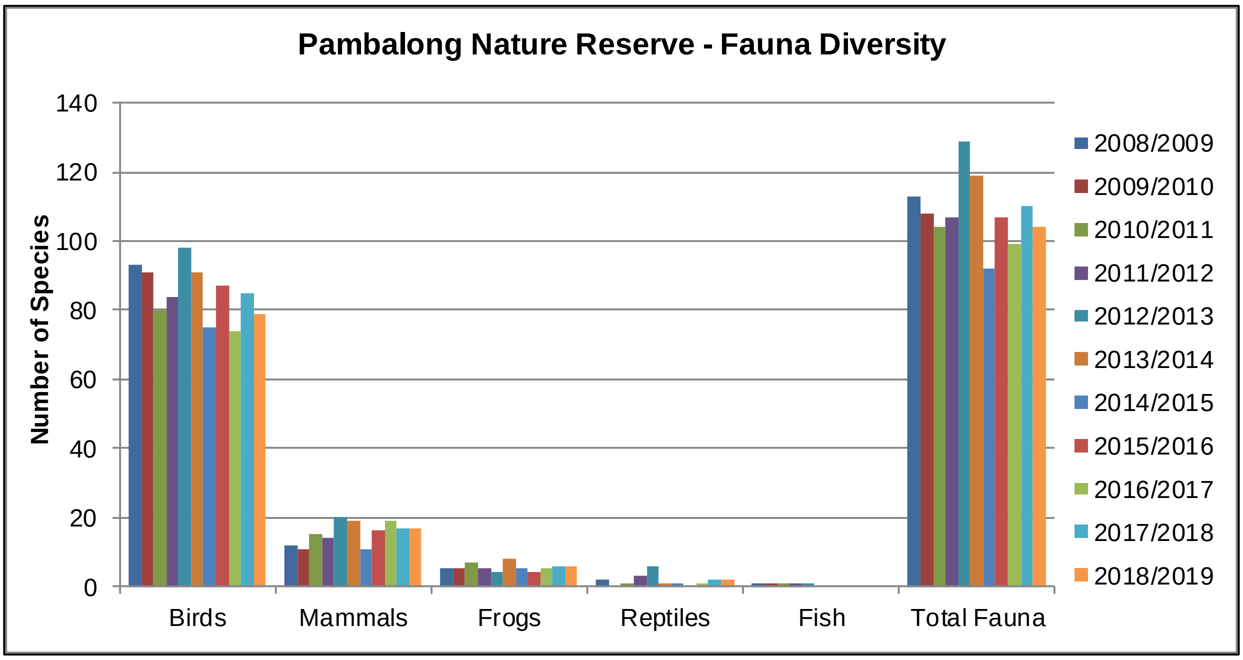


Figure 6.5 Selected Ecological Monitoring Results

Macroinvertebrate – Blue Gum Creek

Macroinvertebrate surveys have been undertaken within Blue Gum Creek at Stockrington Road and Dog Hole Road since 2009 and 2008 respectively. Monitoring during the reporting period included an assessment of the Riparian Channel Environmental (RCE) ranking and aquatic ecology diversity (utilising the SIGNAL index).

During the 2019 Autumn and Spring surveys, the RCE rankings were 38 and 40 respectively for the upstream sites. For the downstream sites, RCE rankings were 35 and 36 during the 2019 Autumn and Spring periods respectively. RCE scores above 40 reflect a stream in good condition, between 20 and 40 reflect a stream in moderate condition and below 20 indicates a stream in poor condition. The 2019 RCE rankings are consistent with previous monitoring events which range from 33 to 40, indicating that Blue Gum Creek remains in moderate condition.

Table 6.5 provides a summary of the biological characteristics recorded during monitoring undertaken to date. It is noted that the use of the SIGNAL2 index was adopted in 2015 and results in a lower score that the original SIGNAL index utilised in previous monitoring.

Table 6.5
Summary of Biological Characteristics (Macroinvertebrates)

Parameter	Date	Blue Gum Creek at Stockrington Road (upstream)	Blue Gum Creek at Dog Hole Road (downstream)
Number of Taxa	01/08/08	-	22
	20/05/09	29	25
	16/11/09	20	22
	27/04/10	-	11
	14/12/10	33	35
	01/04/11	24	20
	18/10/11	24	16
	12/04/12	-	23
	01/11/12	28	20
	21/03/13	10	12
	29/09/13	22	16
	24/03/14	9	8
	15/09/14	20	13
	12/06/15	17	16
	07/10/15	15	2
	03/03/16	15	20
	08/09/16	22	5
	May 17	13	8
	Sep 17	-	9
	08/05/18	11	16
	14/11/18	19	11
	28/05/19	19	13
	16/09/19	12	21
SIGNAL Index	01/08/08	-	5.1
	20/05/09	5.7	5.8
	16/11/09	4.6	4.6
	27/04/10	-	3.4
	14/12/10	4.7	4.7
	01/04/11	4.7	4.4
	18/10/11	5.0	5.3
	12/04/12	-	5.6
	01/11/12	4.4	5.0
	21/03/13	4.9	5.6
	29/09/13	4.8	5.3
	24/03/14	4.8	3.2
	15/09/14	5.2	4.8
SIGNAL2 (weighted) Index	12/06/15	4.45	4.1
	07/10/15	3.29	3.17
	03/03/16	3.75	3.76
	08/09/16	3.98	2.73
	May 17	3.41	2.94
	Sep 17	-	3.43
	08/05/18	3.96	3.81
	14/11/18	3.18	3.54
	28/05/19	4.28	4.44
	16/09/19	4.05	4.11

Source: Niche Environment & Heritage and Robyn Tuft Associates

The upstream and downstream weighted SIGNAL2 scores during Autumn were 4.28 and 4.44 respectively, with upstream and downstream weighted SIGNAL2 scores in Spring decreasing to 4.05 and 4.11 respectively. The higher a SIGNAL2 score the more pollution sensitive taxa are present, indicating lower pollution, whilst a lower score indicates more pollution tolerant taxa are present, indicating greater pollution. SIGNAL2 scores of 5 and above indicate dominance of pollution sensitive taxa whilst scores of 4 and below indicate dominance of pollution tolerant taxa.

Therefore, the weighted SIGNAL2 scores recorded during the reporting period indicate the sites are subject to moderate pollution, potentially the result of pollution from erosion, siltation, weeds and elevated salinity. Additionally, taxa present indicate a dominance of pollution tolerant macroinvertebrate families. Despite the weighted SIGNAL2 scores, sensitive mayfly taxa (Leptophlebiida) and caddis fly taxa (Leptoceridae) were recorded at both upstream and downstream sites.

Overall, RCE and SIGNAL scores recorded for Blue Gum Creek during the 2019 Autumn and Spring surveys are consistent with previous monitoring results which indicate that the creek is in moderate condition and is potentially subject to ongoing disturbance or pollution. This poor stream health appears unrelated to the Abel or previous Tasman mining operations and is more likely related to disturbance from roadways, agriculture, and past high flow events as well as ongoing land use management issues and low flows associated with dry conditions during the reporting period.

Given the likely significance of other disturbance sources, the ongoing Blue Gum Creek monitoring program will be reviewed to determine whether the current monitoring sites remain appropriate locations for identifying mining-related impacts.

Reportable Incidents

No reportable incidents were recorded during the reporting period.

Further Improvements

In accordance with the updated Flora and Fauna Management Plan, monitoring of dams, sub-tropical rainforest and the Pambalong Nature Reserve will now not be undertaken until the recommencement of mining activities. As recommended by Niche Environment and Heritage, consideration will also be given to the need for ongoing aquatic monitoring within Blue Gum Creek and/or whether the monitoring program is continued in its current form.

Prior to the recommencement of mining operations, relevant dams will be reassessed for frog habitat to account for changes such as eutrophication from stock, fertiliser applications or other farming practices as opposed to changes resulting from mining.

6.7 HERITAGE

In accordance with the June 2019 *Abel Underground Mine: Aboriginal Heritage Management Plan* (Donaldson Coal, 2019), annual reporting will be undertaken through the Annual Reviews with a 5 yearly report documenting the results of monitoring undertaken in accordance with the plan to be prepared and provided to either the Mindaribba or Awabakal Local Aboriginal Land Councils (LALCs) (as applicable to the area monitored), DPIE and OEH. Given that no mining was undertaken during the 2019 reporting period, no specific monitoring was completed. The first of the 5 yearly reports is planned following the recommencement of mining operations.

6.8 SUBSIDENCE

Environmental Management

To date four Subsidence Management Plan (SMP)/Extraction Plan areas have been prepared for the mine. As part of each SMP/Extraction Plan, subsidence monitoring programs have been prepared together with required environmental and public safety management plans. Copies of all relevant SMP/Extraction Plan assessment reports and management plans are available on the Company's website.

Environmental Performance and Further Improvements

No mining occurred during the reporting period and no further quantitative monitoring of previous undermined panels occurred. However, photographic monitoring and visual inspections continued during the reporting period. A summary of the outcomes of this monitoring and any actions taken is outlined as follows.

- No further impacts to Blackhill Road were observed and the infrastructure remained within a safe and serviceable condition.
- All subsidence impacts on the Hunter Water Corporation Waterline, Ausgrid Powerlines and TransGrid Transmission Towers were within predicted levels with no subsidence impacts or management actions required during the reporting period.
- There have been no other observed and/or reported subsidence impacts, incidents, service difficulties, community complaints during the reporting period that would require notification under the SMP/Extraction Plan approvals or plans.

A comparison of previously surveyed subsidence levels against predicted levels for all panels within which extraction has been completed to date is provided within the annual Subsidence Management Report (see **Appendix 6**). A summary of subsidence impacts against the performance measures outlined in PA 05_0136 *Schedule 3 Condition 1* is also provided in **Table 6.6**.

During the next reporting period monitoring will be continued in accordance with the approved or any new SMP/Extraction Plans.

6.9 WASTE MANAGEMENT

In accordance with *Schedule 3 Condition 25* of PA 05_0136, a summary of waste management during the reporting period is provided as follows.

Wastes generated on site during the reporting period included the following.

- Hazardous (Recycled) - lead acid batteries and oil.
- Non-Hazardous (Recycled) – paper and cardboard, confidential documents, scrap steel.
- Hazardous (Disposal) – medical and sanitary waste, oily rags.
- Non-Hazardous (Disposal) – mixed solid waste.

Table 6.6
Review of Subsidence Impact Performance Measures

Table 2: Subsidence Impact Performance Measures

Performance Measure		Status
Water Resources		
• Hexham Swamp; • Blue Gum Creek and Alluvium; and • Long Gully.	• Negligible environmental consequences, including: - *negligible* reduction in the quantity of water entering the swamp or the creeks (ie baseflow or environmental flows); - *negligible* reduction in the quality of water entering the swamp or the creeks; and - *negligible* reduction in creek bed or bank stability. • No connective cracking between the surface and the mine.	Mining to date has occurred substantially north of these features. Groundwater level monitoring has also not recorded any drawdown of surficial aquifers (see Section 7.3). Subsidence monitoring has not recorded any impacts upon other watercourses.
• All other watercourses in the mining area.	• No greater environmental consequences than predicted in the EA and EA (MOD 3).	
Land		
• Cliffs.	• Minor environmental consequences (that is, occasional rockfalls, displacement of or dislodgement of boulders or slabs, or fracturing, that in total do not impact more than 3% of the total face area of cliffs within the mining area).	Mining has not yet occurred under any major cliff areas. Subsidence monitoring has not recorded any rock falls or other impacts. No impacts upon Pambalong Nature Reserve have been recorded.
• Minor cliffs • Rock face features; and • Steep slopes.	• Minor environmental consequences (that is, occasional rockfalls, displacement or dislodgement of boulders or slabs, or fracturing, that in total do not impact more than 5% of the total face area of each such type of feature within the mining area).	
• Pambalong Nature Reserve.	• Negligible environmental consequences.	
Biodiversity		
• Threatened species; and • Endangered ecological communities (including unspecified Lowland Rainforest EEC).	• Negligible environmental consequences.	No mining related impacts have been recorded to date (see Section 6.6).
Heritage Sites		
• Aboriginal heritage sites.	• No greater subsidence impacts or environmental consequences than predicted in the EA and EA (MOD 3).	No impacts upon Aboriginal or historical heritage have been recorded to date.
• Historic heritage.	• No greater subsidence impacts or environmental consequences than predicted in the EA and EA (MOD 3).	
Mine workings		
• First workings under an approved Extraction Plan beneath any feature where performance measures in this table require negligible subsidence impacts, negligible environmental consequences.	• To remain long-term stable and non-subsiding.	Subsidence control zones and second workings have been implemented in accordance with the approved Subsidence Management Plans.
• Second workings.	• To be carried out only in accordance with an approved Extraction Plan.	

Waste oil was stored within 205L drums, 1,000L IBCs or the waste oil tank within the oil store before being removed from site, along with used oil filters and oily rags, by J R Richards & Sons. A purpose built bunded storage container is also utilised to ensure adequate bunded storage is available. Used tyres are removed from site during servicing by Marathon Tyres Pty Ltd for repair or disposal.

Paper, cardboard, steel, aluminium and any other recyclable material was stored separately in 1.5m^3 and 3.0m^3 skip bins for recycling. Paper, cardboard and general waste material continued to be collected by J R Richards & Sons on a weekly basis whilst scrap metal was also collected by J R Richards & Sons on an as-needs basis. The scrap steel/drum crusher continued to be used.

All general wastes were stored in skip bins and removed by J R Richards & Sons.

The approximate volume of each waste stream generated during the reporting period is presented in **Table 6.7** together with the proportion of waste recycled. The proportion of waste recycled decreased from 74.30% in 2018 to 12.88% in 2019, largely due to a decrease in the volume of scrap steel generated, and subsequently recycled. As is expected, the total volume of wastes has also decreased since the mine entered care and maintenance.

As part of the Company's Environmental Management Strategy, it is a requirement for contractors and employees to minimise waste generation wherever possible and to dispose of all waste in a satisfactory matter. Whilst waste volumes during care and maintenance will remain relatively low, waste volumes will continue to be monitored into the future and opportunities to minimise waste or increase recycling implemented, where appropriate.

Table 6.7
Approximate Waste Volumes 2016 to 2019

Waste Class	Waste Stream	Total Volume (kg)			
		2016	2017	2018	2019
Hazardous (Recycled)	Effluent	43,500	0	0	0
	Lead Acid Batteries	0	0	220	0
	Empty Drums	0	88	0	16
	Waste Oil & Oil Filters	6 046	2 900	800	1 100
	Recycled	20.55%	6.31%	1.11%	5.17%
Non-Hazardous (Recycled)	Paper and Cardboard	1 960	1 170	545	1 200
	Confidential Documents	0	0	420	466
	Scrap Steel	116 560	14 100	66 271	0
	Timber	4 560	0	0	0
	Recycled	51.05%	32.24%	73.19%	7.72%
Hazardous (Disposal)	Medical and Sanitary Waste	359	138	161	238
	Oily Rags	408	258	54	72
	Recycled	0.35%	0.84%	0.23%	1.44%
Non-Hazardous (Disposal)	Mixed Solid Waste	67 595	28 715	23 390	18 499
	Recycled	28.04%	60.62%	25.46%	85.68%
Total Waste		**241 077**	**47 369**	**91 861**	**21 591**
Recycled Waste		**172 633**	**18 258**	**68 256**	**2 782**
Recycled Waste (%)		**71.61%**	**38.54%**	**74.30%**	**12.88%**

7. WATER MANAGEMENT

7.1 WATER TAKE

Applicable water licencing held for the Abel Mine operations include Water Supply Works and
Applicable water licencing held for the Abel Mine operations include Water Supply Works and
Use Approval 20WA218986 and Water Access Licence (WAL) 41525, which provide for up to 500ML of water take annually. The Abel Mine is not actively dewatered in advance of mining, rather passive inflows into the mine workings are transferred to completed mine workings or to the surface.

The net groundwater inflow volume has been estimated to be 178.8ML for the current water year 01 July 2018 to 30 June 2019, well within the 500ML allocation. No take of water from the overlying alluvial aquifers has occurred to date.

No compensatory water has been required to be supplied throughout the life of the mine.

7.2 SURFACE WATER

Environmental Management

As part of the Water Management Plan, Abel Mine transfers water off site to the Big Kahuna Dam and then to Bloomfield CHPP, as required. During the reporting period, a total of 207ML was transferred from the Abel Mine to the Big Kahuna Dam (consisting of groundwater inflows to the underground working and surface flows from the Square Pit, West Pit and Surface Infrastructure Area) and a total of 311ML was transferred from the Big Kahuna Dam to the Bloomfield CHPP. Surface water monitoring sites specified for the Abel Mine are aimed at detecting indirect impacts such as from underground mining activities and activities in the surface infrastructure area. Monitoring at Sites Four Mile Creek Upstream (FMCU) and Four Mile Creek Downstream (FMCD) commenced prior to the commencement of the Abel Mine and serve to provide baseline data. Monitoring at Sites 1, 8, 10 and 11 commenced in 2006 and provide baseline data and can also be used to assess impacts attributable to the Abel Mine.

Environmental Performance

Surface water monitoring data for the reporting period is summarised in **Table 7.1** and presented graphically in **Figure 7.1** with the full graphical presentation since 2008 presented in **Figure 7.2** and data set provided in **Appendix 2**.

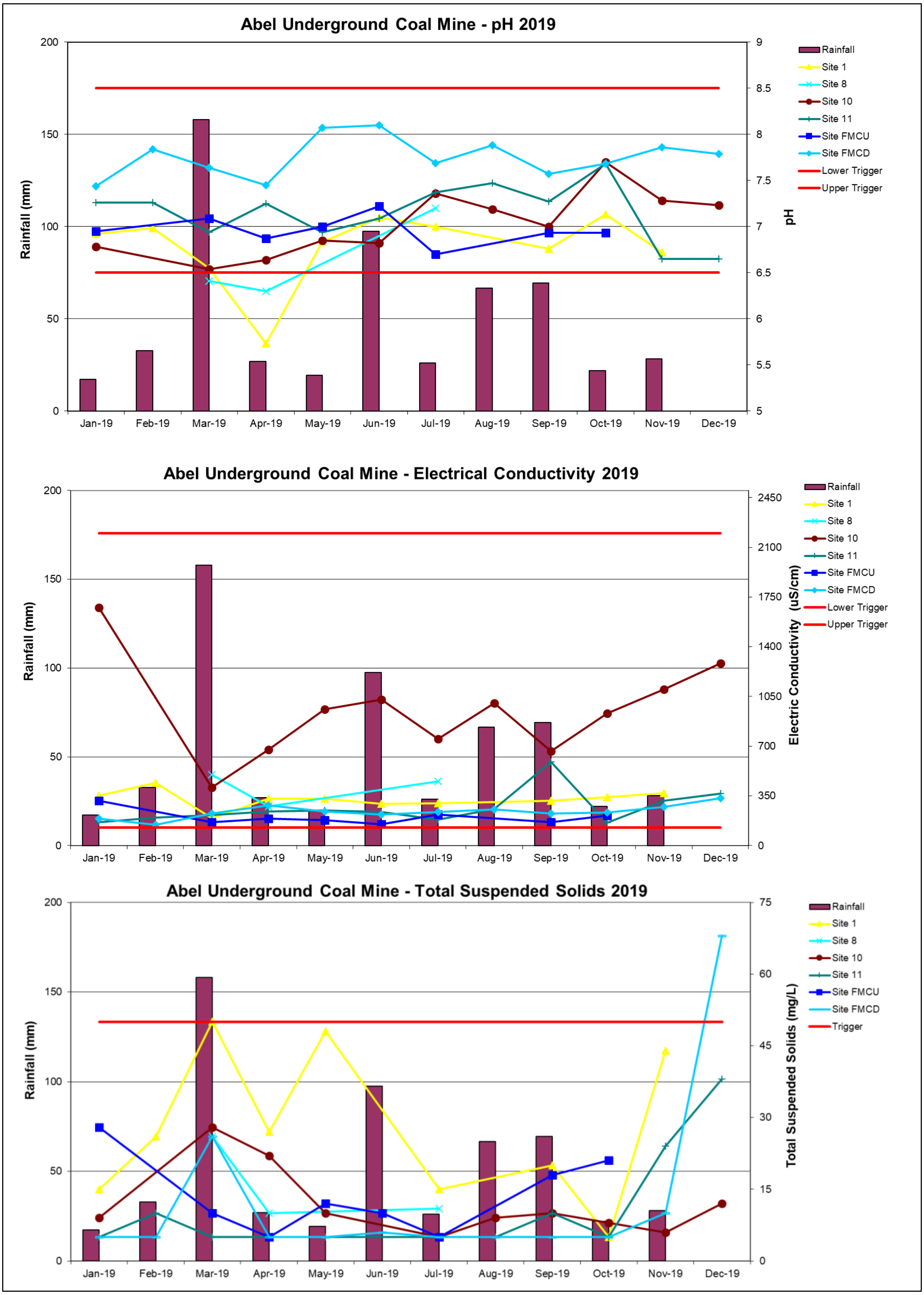


Figure 7.1 Surface Water Quality Monitoring Results – 2019

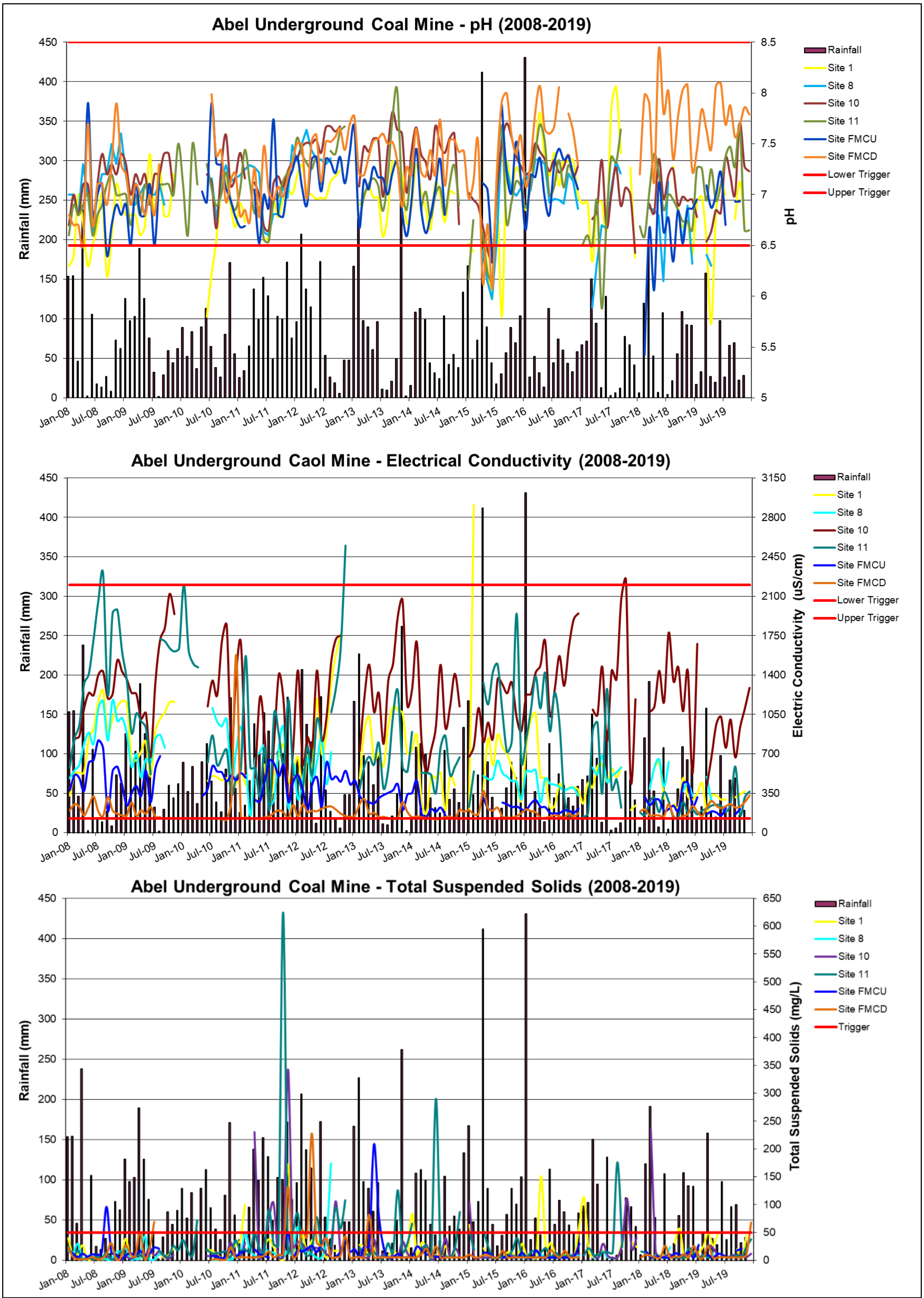


Figure 7.2 Surface Water Quality Monitoring Results – 2008 to 2019

Table 7.1
Summary of Water Quality Monitoring Results – 2019[1]

Sampling Site^	pH#	EC (µS/cm)#	Turbidity (NTU)	TSS (mg/L)
Upstream of Underground Workings				
1	**5.73** – 7.13 (6.77)	193.9 – 443.0 (326.2)	20.9 – **120.0** (48.0)	5 – 50 (28)
8	**6.30** – 7.20 (6.64)	275.2 – 498.0 (409.2)	10.9 – 31.2 (20.7)	10 – 26 (16)
10	6.54 – 7.70 (7.04)	410.0 – 1 676.0 (953.2)	**5.9** – 45.0 (22.85)	5 – 28 (12)
Downstream of Underground Workings				
11	6.65 – 7.68 (7.15)	160.3 – 588.0 (264.3)	**0.7** – 32.0 (7.12)	5 – 38 (11)
FMCU	6.70 – 7.22 (6.96)	151.8 – 314.0 (198.7)	20.0 – 48.1 (39.5)	5 – 28 (14)
FMCD	7.44 – 8.10 (7.75)	147.9 – 332.0 (238.5)	**5.3** – 16.9 (11.3)	5 – **68** (13)
Trigger Level	*6.5 – 8.5**	*125 to 2 200**	*6 – 50 (NTU)**	*50@*

1. Results cover period 01/1/2019 to 31/12/2019 ( ) = Average
^ See **Figure 6.1** @Standard Industry Criterion * ANZECC Chapter 3 – Aquatic Ecosystems – Lowland Rivers in NSW
Bold Red Text – Exceedance of Trigger Level # Field Measurement NS – Not Sampled

Analysis of the results obtained during the reporting period indicates the following.

1. Recorded pH values for two of the six monitoring sites fell below the lower pH water quality trigger value (6.5) for Lowland Rivers in NSW outlined in the *Guidelines for Fresh and Marine Water Quality* (ANZECC 2000) on one to two occasions during the reporting period (see **Figure 7.1**). Both sites, Site 1 and 8, are located upstream of the underground workings. Long-term monitoring records a history of short-term declines in pH. Previously, short term declines in pH have followed significant rainfall events (see April 2015 and January 2016 in **Figure 7.2**). Results which fall below the lower trigger value during this reporting period also appear to follow significant rainfall during March 2019.

   It is also noted that there is a divergence of the pH between the Four Mile Creek Upstream (FMCU) and Downstream (FMCD) locations. This is thought to be the result of ongoing leakage from the Stoney Pinch Reservoir above the Four Mile Creek Downstream sample point. As can be seen from the results, the lower pH originates at the upstream location and improves to neutral / slightly alkaline downstream. This is not mine related given that no operational activities or discharges occurred from either the Donaldson Open Cut Coal Mine or Abel Underground Coal Mine.

   No other long-term trends in pH are apparent (**Figure 7.2**).

2. The electrical conductivity (EC) results range between 147.9µS/cm and 1 676.0µS/cm for all sites which are within the water quality trigger values for Lowland Rivers in NSW (125 to 2 200µS/cm) (ANZECC 2000) at all sample sites.

   EC does not appear to be strongly correlated with the monthly rainfall. The average EC values upstream are significantly higher than the corresponding downstream values. No long-term trends in EC are apparent..

3. Turbidity (NTU) at upstream Site 1 and total suspended solids (TSS) levels at downstream Sites FMCD, exceeded the respective upper water quality trigger values for Lowland Rivers in NSW (6 to 50 NTU) (ANZECC, 2000) and industry standard TSS criteria (50mg/L). The lower NTU limit was also exceeded at upstream Site 10 and downstream Sites 11 and FMCD.

   Consistent with historical trends, TSS and NTU results do not appear to coincide with rainfall (**Figure 7.2**). In fact, the TSS exceedance at Site FMCD in December 2019 occurred during a month of no rainfall (**Figure 7.1**).

   Given that that each recorded exceedance did not persist across multiple survey periods, it is considered that short-term, localised conditions rather than mine activities contributed to these levels.

   No long-term trends are apparent within the monitoring data. Widely varying results with spikes in turbidity and TSS are not necessarily correlated with monthly rainfall. Baseline monitoring results for both upstream and downstream sites have previously recorded significantly elevated TSS which are considered to form part of the natural variation.

The Environmental Assessment (Donaldson Coal, 2006) predicted no significant impacts upon surface water as a result of the mine activities. The monitoring results to date support that assessment.

Reportable Incidents

No reportable incidents occurred during the reporting period.

Further Improvements

No other surface water control measures are planned or considered necessary.

7.3 GROUNDWATER

Environmental Management

Monthly monitoring of regional groundwater levels and groundwater quality was undertaken, where possible, throughout the reporting period in accordance with the Water Management Plan and Integrated Environmental Monitoring Program.

Environmental Performance

Groundwater Levels

A graphical summary of groundwater level monitoring results relevant to the Abel Underground Coal Mine is provided in **Figure 7.3** and an interpretation of these results is provided as follows.

Monitoring indicates that there is little evidence of any drawdown response in the alluvium or regolith groundwater. In particular Piezometers 81A and 81B are located adjacent the Pambalong Nature Reserve (see **Figure 6.1**). Monitoring results from 81A (single vibrating wire transducer placed within the Lower Donaldson Seam) showed a drawdown response to mining the Donaldson Seam within the Abel Mine. However, Piezometer 81B is screened within overlying shallow Permian strata with water levels remaining stable. The lack of response in the shallow piezometer may indicate minimal mining impact on the Pambalong Nature Reserve.

Piezometers 63A and 63B are located to the east of the Abel Mine adjacent to the F3 Freeway and near the Hexham Swamp (see **Figure 6.1**). It appears that the shallow Piezometer 63B has failed or the bore has collapsed and therefore this piezometer no longer provides useful data. However, Piezometer 63A is screened in the Lower Donaldson Seam and remains operational. Monitoring results from Piezometer 63A remained consistent throughout the reporting period indicating minimal impact from previous mining activities.

Similarly, monitoring results from 78A (standpipe piezometer within the Donaldson Seam) indicated minimal impact until the start of secondary extraction in Panel 23 in June 2013. Drawdown rates stabilised during 2016 and have since remained steady. As for the other nested piezometers, 78B located within the overlaying regolith indicates minimal drawdown response

Piezometer 80 is screened in the Donaldson Seam and located to the south of the mining activities completed to date. An expected drawdown commenced during secondary extraction in Panel 23 June 2013. The decline has steadied since the cessation of mining activities with a steady but modest recovery since mid-2017.

The results indicate that groundwater pressure reduction within the Lower Donaldson Seam resulting from mining has occurred as anticipated and is insulated from shallow and surficial groundwater systems in this area. This is consistent with the predictions within the Environmental Assessment.

Groundwater Inflows

As reported for 2015, between August 2013 and October 2015 inflow volumes could not be accurately estimated as a significant portion of mine water was accumulating in isolated in-mine storages. From 01 October 2015 water began reporting from the overflow of the storage areas. Based on a total in-mine storage volume of 459ML, it is calculated that average groundwater inflow ranged from 120ML/year to 240ML/year during that time.

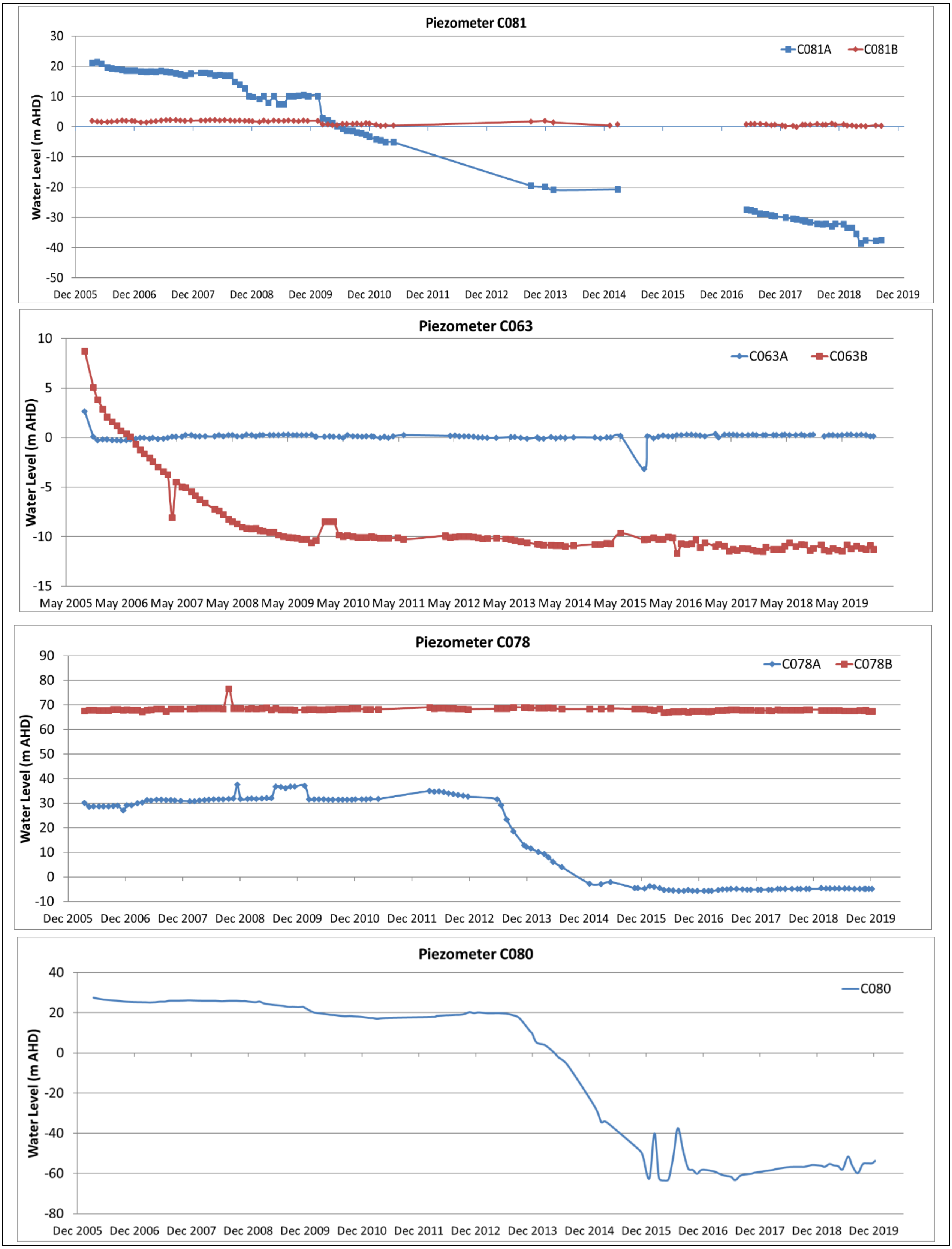


Figure 7.3 Groundwater Level Results – All Data

During the 2019 reporting period, groundwater inflows are estimated at 178.8ML. Since the mine was placed on care and maintenance, water has continued to be pumped from the underground workings, however, there have been smaller volumes of inflow and declining outflows. Groundwater model predictions for this stage of mining were for between 800ML and 1,000ML/year. Therefore, the actual inflow rates remain well below the predicted maximum rate.

Groundwater Quality

Groundwater quality monitoring results are presented in **Appendix 2**. A summary of three representative bores located within the Abel underground mine area is presented in **Table 7.2** and **Figures 7.3** with the full graphical presentation since 2008 presented in **Figure 7.4**.

Table 7.2
Summary of Groundwater Quality Monitoring Results – 2019

Sampling Site#	pH	EC (µS/cm)
DPZ – 6	6.59 – 6.96 (6.78)	1 960 – 2 420 (2 264)
DPZ – 13*	No Access	No Access
JRD2	6.27 – 7.28 (6.96)	146 – 2 550 (2 134)
Source: Donaldson Coal Pty Ltd *DPZ – 13 inaccessible during 2019	( ) = Average	# see **Figure 6.1**

These bores record pH values ranging from slightly acidic to slightly alkaline (6.27-7.28) and EC values between 146µS/cm and 2 550µS/cm.

Whilst some variations have occurred in pH, monitoring has generally recorded consistent pH values over time with all pH results within previously recorded baseline ranges

A downward trend in EC has previously been observed at bore DPZ13 (**Figure 7.5**) starting in 2010 / 2011, which may be due to enhanced recharge following drawdowns in the coal measures as a result of mining. Landholder access was unable to be obtained to enable sampling from DPZ-13 during the reporting period to confirm whether this trend had continued or plateaued. Conversely, EC has been relatively consistent within DPZ-6 and JRD2, with monitoring indicating occasional 'outliers' of significantly lower EC. This is likely due to ingress of rainwater temporarily lowering the salinity

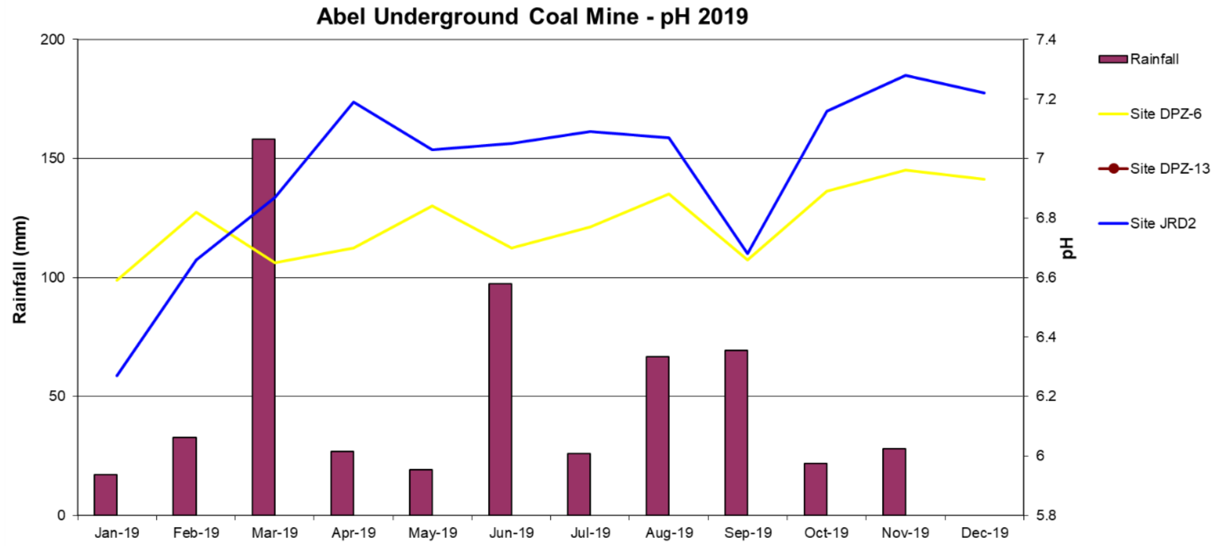
For comparison, the Environmental Assessment baseline monitoring reported that the quality of groundwater sampled within the underground mining area of the Abel Mine was variable with total dissolved solids (TDS) ranging from less than 518mg/L to 13 000mg/L, which is approximately equivalent to EC readings of between 865µS/cm and 21 700µS/cm.

Reportable Incidents

No reportable incidents occurred during the reporting period.

Further Improvements

Monitoring will continue in accordance with the current Water Management Plan (WMP).



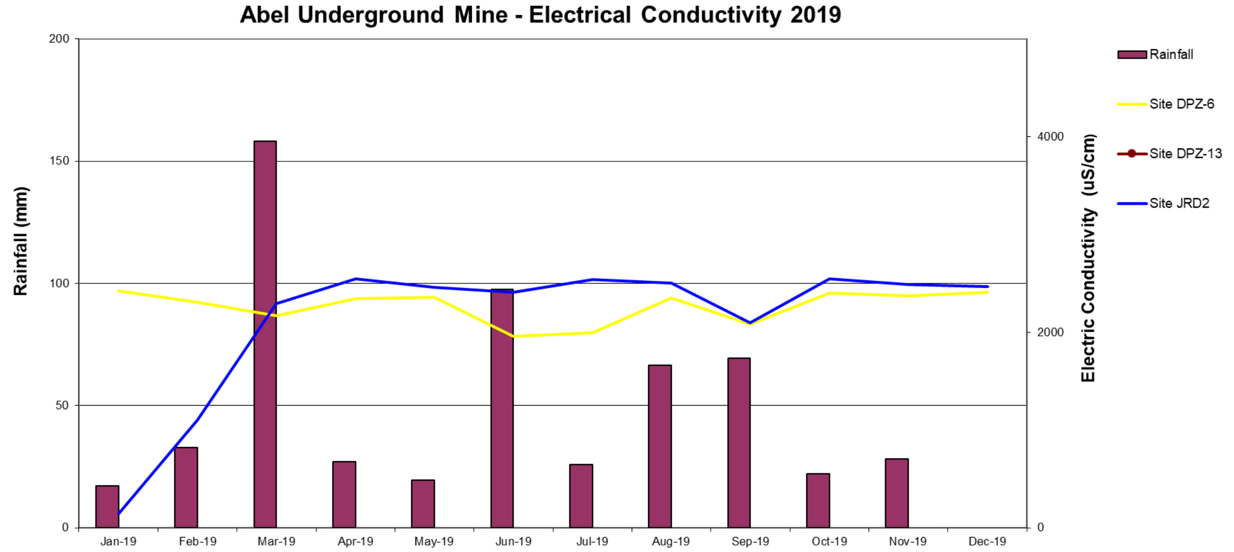
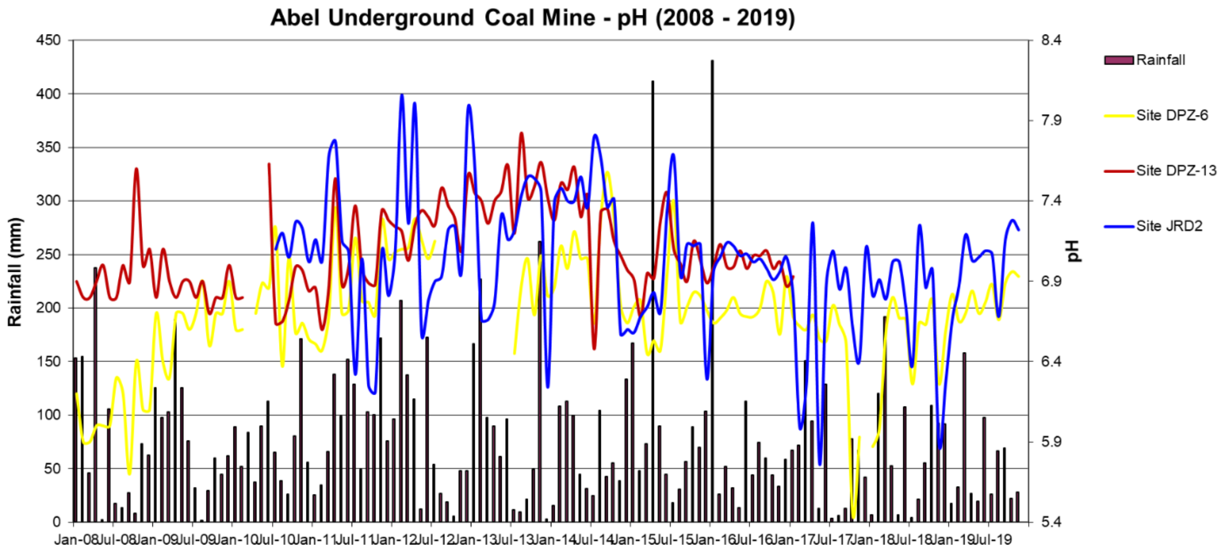


Figure 7.4 Groundwater Quality Monitoring Results – 2019



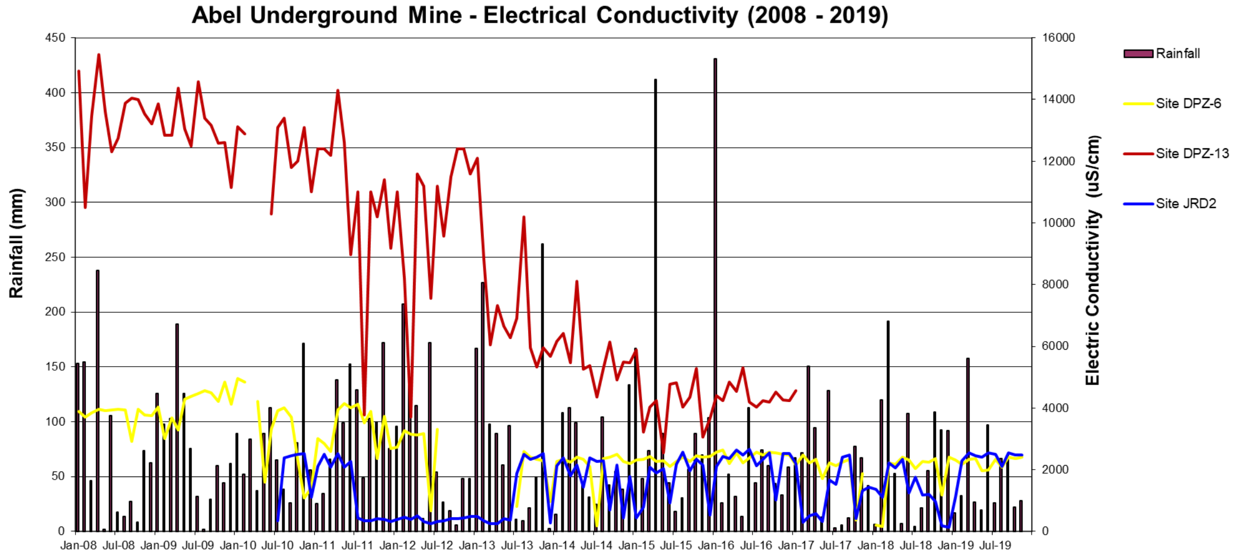


Figure 7.5 Groundwater Quality Monitoring Results – 2008 - 2019

8. REHABILITATION

8.1 REHABILITATION PERFORMANCE DURING THE REPORTING PERIOD

Figure 8.1 shows the status of rehabilitation and a summary of the areas of rehabilitation is provided in **Table 8.1**.

Table 8.1
Rehabilitation Summary

Mine Area Type	Previous Reporting Period (Actual)	This Reporting Period (Actual)	Next Reporting Period (Forecast)
	Year 10 (ha)	**Year 11 (ha)**	**Year 12 (ha)**
Total mine footprint	13.15[1]	13.15[1]	13.15[1]
Total active disturbance	13.15[2]	13.15[2]	13.15[2]
Land being prepared for rehabilitation	0	0	0
Land under active rehabilitation	0	0	
Completed rehabilitation	0	0	0

Notes:

1: Includes 0.41ha associated with the extended light vehicle car park, 0.23ha for the downcast ventilation shaft and 0.58ha relating to the upcast ventilation shaft but excludes underground mining areas. Areas that have been temporarily rehabilitated also included.

2: Whilst some areas have been temporarily rehabilitated, all areas within ML 1618 surface infrastructure area are considered to be 'active'.

A wild dog and fox baiting program was undertaken by Enright Land Management in October 2019 in consultation with surrounding landholders.

Within the surface infrastructure area, no permanent buildings were structurally altered, renovated or removed during the reporting period and, other than regular inspection and maintenance of previously temporarily rehabilitated areas (i.e. batter slopes) and retained vegetation, no specific rehabilitation activities were undertaken. Maintenance activities completed included scheduled equipment maintenance, regular security patrols of boundary fencing to prevent unauthorised access, and ongoing control of weeds (e.g. Pampas Grass) across the entire surface infrastructure area.

No rehabilitation trials or research was undertaken during the reporting period and there were no variations to the rehabilitation activities as outlined within the approved Mining Operations Plan.

There are currently no specific issues affecting the ability to successfully rehabilitate the site and therefore no specific management measures.

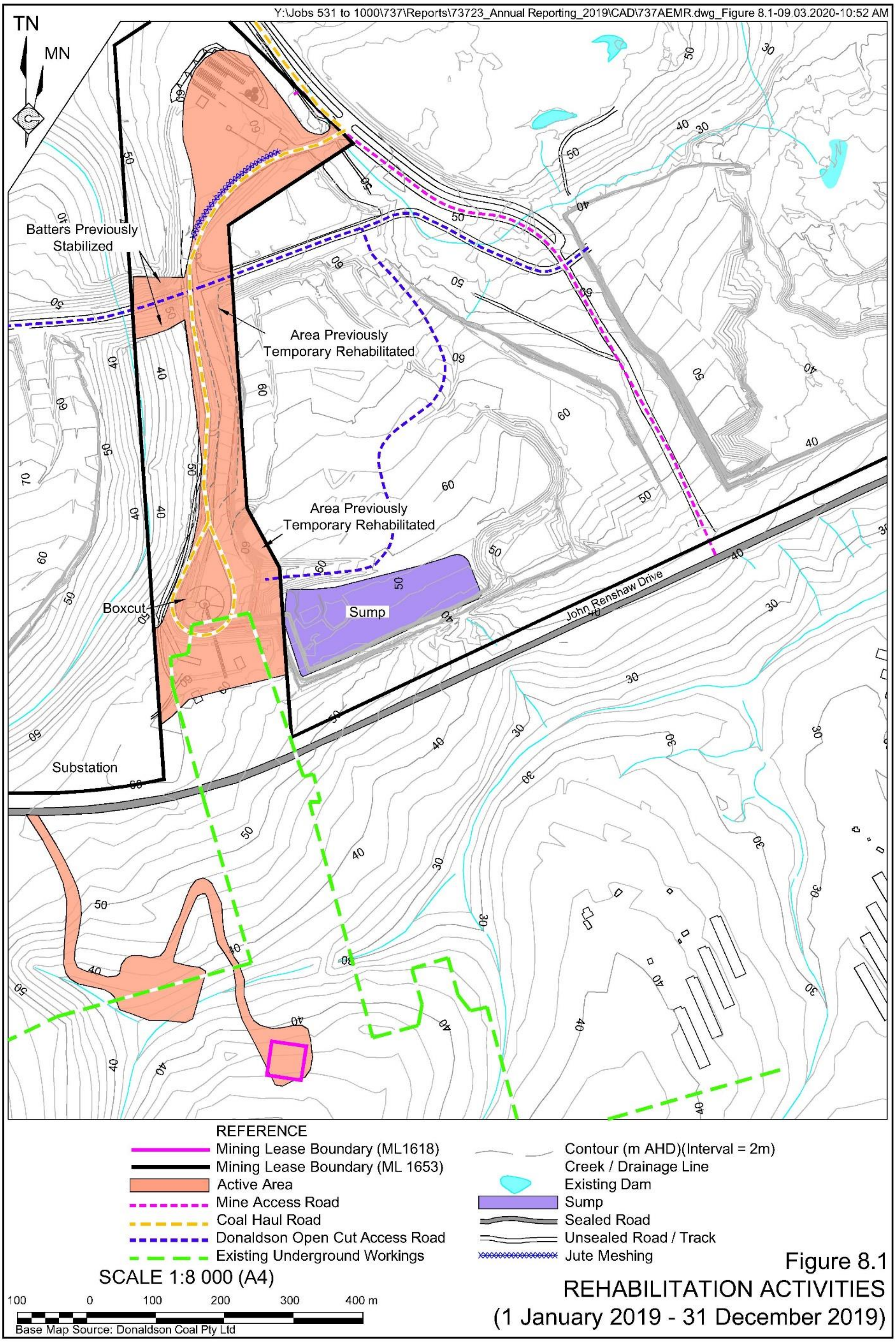


Figure 8.1
REHABILITATION ACTIVITIES
(1 January 2019 - 31 December 2019)

No rehabilitation areas became available for sign off by the Resources Regulator and no final land use objectives were met during the reporting period. As the Abel Mine is an underground operation, the only significant rehabilitation will be during mine decommissioning. As outlined within the approved 2019 Mining Operations Plan, during decommissioning the creation of the final landform will involve blasting of the western side of the Abel Box Cut (as part of final landform creation within the West Pit) followed by grading using a dozer to create a maximum slope of 18 degrees. The northern side of the Abel Box Cut will also be blasted and graded to a maximum of 10 degrees, with a permanent vehicle access and egress ramp constructed to allow access to the final void for ongoing monitoring and management.

Surface infrastructure areas located within existing forested areas, such as the substation and ventilation shafts, will be returned to native vegetation. The current post-mining land use goal for the Abel Box Cut is for use as water storage suitable for use in surrounding mining operations.

8.2 ACTIONS FOR THE NEXT REPORTING PERIOD

No specific rehabilitation works are planned during the next reporting period and no major rehabilitation work will be able to be undertaken until the decommissioning of the site. Any surface cracks that appear will be backfilled, compacted, topsoiled and seeded and ongoing repairs to any subsidence damage to public roads will be completed in accordance with the approved subsidence monitoring and management plans. Notably, any further rehabilitation works to Blackhill Road will be completed by the Subsidence Advisory NSW.

Maintenance works, such as erosion and sediment control, and ongoing control of weeds and feral pests will also be undertaken as required.

In addition to these works, a closure strategy will be developed for the West and Square Pits addressing the closure pathways should mining recommence at the Abel Underground Coal Mine or if mining does not recommence.

9. COMMUNITY

9.1 COMMUNITY COMPLAINTS

No complaints were received during the 2019 reporting period. The last complaint was received on 9 October 2017. Since commencement of the Abel Mine, a total of seven complaints have been received which are summarised in **Table 9.1** and presented on the Donaldson website. Given that no further complaints have been received and the Abel Mine is currently under care and maintenance, no specific actions are currently deemed necessary.

Table 9.1
Community Complaints Summary

Location	Date of Complaint	Comments
Blackhill	24/04/2009	Light from Donaldson Open Cut/Abel shining towards house and is very bright. Light was turned down.
EPA	22/06/2015	Complaint about noise from trucks on 5th and 18th June 2015. Advised the EPA officer that there had been no change to truck movements on site and that the recent noise monitoring in May 2015 showed compliance with Licence limits.
Browns Road, Black Hill	17/07/2015	A resident in Brown's Road Black Hill lodged a complaint with the EPA regarding truck noise on 16/07/15 at 20:30hrs. Quebe provided data that trucks were parked up at that time. Advised the EPA officer. No further action.
John Renshaw Drive	3/09/2015	Complaint received regarding sulphur smell for the last month. Complainant told the EPA that it was the mine on John Renshaw Drive that was owned by Ashton company. Advised EPA that there was no odour emanating from site.
Meredith Road Black Hill	1/10/2015	Concerned about subsidence to his property and Meredith Road. Repairs undertaken in accordance with the Property Subsidence Management Plan.
210 Meredith Road Black Hill	2/10/2015	Concerned about subsidence damage to Meredith Road/Blackhill Road. Repairs undertaken in accordance with Property Subsidence Management Plan.
Avalon Drive, Thornton	9/10/2017	Complainant has experienced a "dramatic increase" in coal dust around her property since moving there 4 years ago. Provided response to complainant indicating that this corresponded with the closure and rehabilitation of Donaldson Open Cut. Abel Underground has been placed in Care and Maintenance with no coal mined, processed or transported since mid-2016.
Source: Donaldson Coal		

9.2 COMMUNITY LIAISON

The principal formal community consultation undertaken is the Community Consultative Committee. In accordance with *Schedule 6 Condition 6* of PA 05_0136, the Company has established a Community Consultative Committee for the Abel Mine. During the reporting period, the committee consisted of:

- four representatives of the local community (Mr Alan Brown, Mr Allan Jennings, Mr Terry Lewin, Mr Brad Ure);
- a representative from Bloomfield Colliery (Mr Greg Lamb);
- four representatives from the Company (Mr Tony Sutherland, Mr William (Bill) Farnworth, Mr James Benson and Mr Phillip Brown); and
- a representative from Cessnock Council (Clr Melanie Dagg).

The committee was chaired by Mrs Margaret MacDonald-Hill, an independent chairperson appointed as the independent Chair by the Secretary, Department of Planning and Environment.

The committee held a total of two meetings during the reporting period (4 March and 9 September 2019). The meetings have continued to provide an opportunity for the Company to keep the community up to date with activities undertaken and programmed at the Abel Mine and for community members to table issues relating to the Abel Mine for the Company's consideration. It is noted that the Company provided presentations during each meeting to provide updates on the mine development / care and maintenance, environmental monitoring, subsidence management, planning, and other relevant matters.

Copies of minutes and presentations are available on the Donaldson Coal Website at www.doncoal.com.au.

10. INDEPENDENT AUDIT

The last independent environmental audit of the mine was undertaken in December 2018, in accordance with *Schedule 5 Condition 5* of PA 05_0136 for the period 20 March 2015 to 20 December 2018. The independent audit report was finalised in February 2019 and confirmed that the areas inspected were generally satisfactory and that mining has occurred generally in accordance with the approved mine plan. The audit identified a total of six (6) non-compliances against PA 05_0136 for the audit period, of which four (4) can be considered relevant to the 2018 reporting period (see Section 11). No non-compliances were recorded against ML1683.

A range of recommendations were provided within the audit and a response plan prepared. A status review of these responses is provided in **Table 10.1** and will continue to be updated as part of the Annual Review for the next reporting period.

The next independent environmental audit is due 2021.

Table 10.1
Independent Audit Action Response Plan Status

Ref	Description	Donaldson Response	Timeline	Status Update
Section 4	Annual groundwater reporting in the Abel Mine Annual Review should include graphical presentations of water level data to indicate trends. These should continue to be included in Annual Review's during care and maintenance phase for bores approved in the revised WMP	The Abel Annual Review will continue to provide graphical representation of relevant groundwater bores within the relevant section of the document.	31 March 2019	Graphical summaries were presented in the 2018 Annual Review and are presented in Section 7.3 of this Annual Review.
PA 05_0136 Compliance Recommendations				
Various	Work with relevant regulators to resolve where possible all of the non-compliances.	Accept recommendation and continue to work with regulators to resolve non-compliances.	As and when required	Compliance status update provided in Sections 1 and 11 of this Annual Review.
Sch 3 Cond 1	Blue Gum Creek and Long Gully – Water Quality Recommend for future Trigger Level EC exceedances, assessment of metals (Fe, Al and Mn) are used to assess whether change in EC is mining induced. Trigger values for metals should also be included for Site 10 in Table 3.7 of the WMP. Further consideration of this trigger level in the revised WMP should be undertaken in consultation with a relevant water specialist and relevant regulators in consideration of distance to active mining. Pambalong Nature Reserve – Groundwater Levels Recommend monthly monitoring at Piezometer C081B or in accordance with approved WMP. Further consideration of this trigger level in the revised WMP should be undertaken in consultation with a relevant groundwater specialist and relevant regulators in consideration of distance to active mining. Recommend the following updates to the WMP: • Revision of Piezometer Monitoring Sites for Pambalong Nature Reserve to ensure the piezometer relevant to the feature; and • Clarify Trigger Level 1 and 2 for Groundwater levels for the Pambalong Nature Reserve.	The Water Management Plan will be reviewed and updated in 2019. This update will include a review of trigger actions that determine if a change in water quality is mining induced. Abel Coal Mine will update the Water Management Plan in 2019 and review comments provided by the audit team. A water specialist will, where relevant, incorporate comments into the updated management plan.	30 April 2019	The Water Management Plan was reviewed and updated during the reporting period with DPIE approval received 04 June 2019.

Table 10.1 (Cont'd)
Independent Audit Action Response Plan Status

Ref	Description	Donaldson Response	Timeline	Status Update
PA 05_0136 Compliance Recommendations (Cont'd)				
Sch 4 Cond 10b)	Recommend dust gauges re-sited (if not being removed from program).	A dust gauge audit will be conducted to identify any non-complying dust gauges with corrective actions put in place to ensure compliance. An update to the Air Quality Management Plan will propose the removal of Dust Gauges.	31 March 2019 30 April 2019	The Air Quality Management Plan was reviewed and updated with DPIE approval received 04 June 2019. The updated Plan provides for the cessation of deposited dust monitoring during care and maintenance, thereby removing the need to undertake an audit of the gauges. A variation to EPL 12856 was also submitted with comments on the draft variation returned to EPA on 24 January 2020. Deposited dust monitoring will continue until the EPL variation is finalised.
Sch 4 Cond 23	Coal Transport records are consistently made publicly available on website when production recommences	All coal transport records are up to date to the end of 2018 on the Donaldson Coal Website. This will occur on an annual basis at the start of the new year.	31 January 2019	The 2018 coal transport report is available on the Donaldson Coal website. Further coal transport reports will be uploaded following recommencement of mining.
Sch 4 Cond 24c)	Audit be undertaken to confirm compliance at lighting components which will operate in next period (e.g. CHPP and rail loadout)	On recommencement of mining, including use of the Bloomfield CHPP and Rail Loadout, Abel will recommission currently disused lights for use at night time. At this point, Abel will conduct an audit against AS4282.	When mining recommences	Not yet applicable – mining has not yet recommenced.
PA 05_0136 MOD3 Continual Improvement Recommendations				
Sch 2 Cond 4	Follow up with WaterNSW to resolve Certificate of Title for WAL 41525 being incorrectly labelled to a water source.	WaterNSW will be contacted again in February 2019 to follow up on the Abel Certificate of Title for WAL 41525.	28 February 2019	Water NSW have been regularly followed up regarding resolution of this. Still awaiting correctly labelled certificate with conditions.
Sch 2 Cond 9	Include a statement in the relevant Annual Review that discusses transportation of product coal produced on the Bloomfield site via the Bloomfield Rail Loop, and Rail Spur and the Main Northern Railway.	Accept recommendation and incorporate statement into the 2018/19 Annual Review.	31 March 2019	Commentary included in Section 2.1 of this Annual Review.
Sch 2 Cond 11	Include a statement in the Annual Review that discusses alterations and additions to building and structures.	Accept recommendation and incorporate statement into the 2018/19 Annual Review.	31 March 2019	Statement included in Section 8.1 of this Annual Review.

Table 10.1 (Cont'd)
Independent Audit Action Response Plan Status

Ref	Description	Donaldson Response	Timeline	Status Update
PA 05_0136 MOD3 Continual Improvement Recommendations (Cont'd)				
Sch 3 Cond 1	• "Minor Cliff" definition be clarified on review of EP/management plans.	• Minor Cliff's will be defined in the next update to the Subsidence Monitoring Program required under the Extraction Plan.	When mining recommences	Not yet applicable – mining has not yet recommenced.
	• Whilst mining, AEMR include PA 05_0136 Table 2 and a tabulated summary of impacts and conclusions.	• The 2018/19 Abel Annual Review and future Annual reviews will include a tabulated summary of impacts and conclusions as outlined in Table 2.	31 March 2019	Tabulated summary included in Section 6.8 of this Annual Review.
	• Labelling of Water Quality Monitoring Sites 9 and 10 in AEMR are consistent with that shown in the WMP.	• Water quality labels of sites 9 and 10 will be reviewed and addressed in the 2018/19 Annual Review.	31 March 2019	The labelling on Figure 6.1 of the 2018 Annual Review (and this Annual Review) has been updated.
	• If mining recommences, a clear definition of GDEs in the Hexham Swamp be documented (impacts and monitoring).	• When mining recommences the Water Management Plan (WMP) will require an update. If mining recommences, a definition will be included in the WMP of Groundwater Dependent Ecosystems.	When mining recommences	Not yet applicable – mining has not yet recommenced.
Sch 3 Cond 4p)	Future TARPs include Trigger Levels for Groundwater Drawdown, especially at bores relevant to Pambalong Nature Reserve (excluded from Area 4 EP).	The next update to the Extraction Plan will review the trigger levels for TARPs relating to the Pambalong Nature Reserve.	When mining recommences	Not yet applicable – mining has not yet recommenced.
Sch 3 Cond 6	No written evidence was provided that first working in South Mains were designed to DRG's satisfaction. Recommend a response is sought for any future first workings in accordance with this condition prior to works being undertaken.	On the recommencement of mining, Abel Mine will seek a written response from the relevant authority confirming that first workings are designed to the satisfaction of the DRE	When mining recommences	Not yet applicable – mining has not yet recommenced.
Sch 3 Cond 11	When revising Service Boreholes Management Plan, include mitigation and management measures for visual impacts and compensation for noise, air and visual impacts.	Accept recommendation and incorporate mitigation and management measures into the next update of the Service Boreholes Management Plan.	When mining recommences	Not yet applicable – mining has not yet recommenced.
Sch 4 Cond 1	Remove Location K from PA 05_0136 Table 4 and any other strategy, plan or program.	There is no proposed modification to PA 05_0136 where Location K will be removed. This recommendation will be considered with any future modification.	Noted	No modification currently planned.
Sch 4 Cond 3	Include statement in AEMR that reports on Cumulative Noise Criteria.	Accept recommendation and incorporate into the 2018/19 Annual review.	31 March 2019	Statement included in Section 6.3 of this Annual Review.

Table 10.1 (Cont'd)
Independent Audit Action Response Plan Status

Ref	Description	Donaldson Response	Timeline	Status Update
PA 05_0136 MOD3 Continual Improvement Recommendations (Cont'd)				
Sch 4 Cond 5c)	Clarify noise mitigation process in NMP under meteorological conditions to which noise limits do not apply.	Accept recommendation and incorporate into the 2019 update of the Noise Management Plan.	30 April 2019	The Noise Management Plan was reviewed and updated during the reporting period with DPIE approval received 04 June 2019.
Sch 4 Cond 11	Energy efficiency opportunities for the Abel Underground Mine to be identified, assessed and reported through a series of five year assessment cycles in accordance with the Energy Efficiency Opportunities Act 2006 (EEO Act, 2006).	Energy Efficiencies will be identified in the updated 2019 Air Quality Management Plan. Compliance with the Energy Efficiency Opportunities Act 2006 will be managed by Yancoal Corporate who are the 'controlling corporation' as defined by the EEO Act, 2006.	30 April 2019	The Air Quality Management Plan was reviewed and updated during the reporting period with DPIE approval received 04 June 2019. It is noted that the EEO Act 2006 was repealed in 2014.
Sch 4 Cond 16	Recommend clearly labelling column on water transfer amounts on site spreadsheet e.g. "Transfer from Big Kahuna to Lake Kennerson (ML)" and including pumped volumes in Annual Review.	Accept recommendations and update site water spreadsheet and incorporate into 2018/19 Abel Annual Review.	28 February 2019 31 March 2019	The spread sheet has been updated as recommended. The volume transferred during this reporting period is reported in Section 7.2 of this Annual Review.
Sch 4 Cond 25b)	Recommend that refresher training provided to any personnel on site to ensure that waste management and waste bins handled correctly (see Plates 7, 8, 10, 14, 15 and 18).	A tool box talk will be provided to all operational personnel onsite in March 2019 to outline the correct handling of waste onsite.	31 March 2019	A waste management presentation was presented to all operational personnel in March 2019.
Sch 4 Cond 25c)	Investigate redundant tank (see Plate 19) and respond accordingly. Confirm source of which pipe below operating sewage system to confirm it is benign.	A review of the future requirements for the redundant tank will be undertaken and actions reported in the 2019/20 Annual Review. The contractor that services the sewerage treatment plant (STP) at Abel has been approached to determine the source of the pipe below the STP.	31 March 2019	Site personnel have inspected and do not believe the pipe is connected to the sewage system. Advice was received from the wastewater treatment contractor confirming that the pipe is not associated with the STP but is rather a stormwater pipe draining from the car park. No further actions required.
Sch 4 Cond 26a)	Bush Fire Response Procedure Section be added to site induction presentation at next review.	The Abel Site Familiarisation Induction currently covers the Emergency Muster Area and what to do in the event of an emergency. It also covers fire equipment onsite.	Noted	No further action required.

Table 10.1 (Cont'd)
Independent Audit Action Response Plan Status

Ref	Description	Donaldson Response	Timeline	Status Update
PA 05_0136 MOD3 Continual Improvement Recommendations (Cont'd)				
Sch 4 Cond 29e)	Complete mine closure plan at least 5 years prior to closure or consent expiry date.	Accept recommendation and complete Mine Closure Plan 5 years prior to closure.	Noted	Currently no further action. Mine is currently in care and maintenance. Consent does not expire until 2030.
Sch 6 Cond 1f)	Recommend adding links to EMS attached documents or including as appendix to EMS.	Accept recommendation and on next update of the EMS, provide a link to the 'Abel Management Plans' page on the Donaldson Coal website.	Next update of the EMS	The Environmental Management Strategy (dated August 2018) has yet to be updated but will be reviewed during the next reporting period.
Sch 6 Cond 2	Condition list made into a table and included in each revised management plan during care and maintenance and demonstrate where each is addressed.	Accept comments and incorporate into future updates of Management Plans.	30 April 2019	The review and update of various management plans was completed and the plans approved 4 June 2019. The updated plans include a summary of relevant requirements and where each is addressed in the plan.
SOCs	Recommended that at next project approval modification (if mining recommences), a full review of the SOCs are undertaken and any commitments which are duplicative of development consent conditions are sought to be removed with a relevant justification.	Accept comment and action in the next modification of Abel Coal.	When mining recommences	Not yet applicable – mining has not yet recommenced.
Management Plans	Most plans required update for care and maintenance status. Detail in table A and B should be considered during this review. The plans would all benefit from clarification of what responsibilities are Bloomfield's (CHPP and rail loadout) and which are care and maintenance activities and as such the responsibility of Abel Mine. Some of the changes will be inconsistent with the SOCs which include significant detail which is more suited to inclusion in the management plans. An appendix should include evidence of consultation with relevant regulators for each plan. Address recommended changes to each plan as listed in Table A of Appendix D. The RMP should include confirmation of where topsoil is stored and confirmation that adequate volumes exist to achieve the nominated final land use.	Abel Coal Mine will update relevant management plans in 2019 and review comments provided by the audit team and where relevant, incorporate comments into the updated management plans. Updated plans will be specific for Care and Maintenance and include a clarification of the responsibility boundaries between Abel and Bloomfield. A summary of management plan status will be included in the Abel 2019/20 Annual Review.	30 April 2019 31 March 2020	The review and update of various management plans was completed with agency comments addressed and final approval sought from DPIE 4 June 2019. A summary of the management plans is provided in Section 4.2 of this Annual Review.

Table 10.1 (Cont'd)
Independent Audit Action Response Plan Status

Ref	Description	Donaldson Response	Timeline	Status Update
EPL12856				
A1	Recommend that consideration be given to a variation to reduce the 'coal works' scale as mine in care and maintenance status. This assumes that CHPP and rail loadout facilitates are included in Bloomfield's EPL.	Abel will review this recommendation and determine the benefits of a license variation. A variation will be applied for if it is determined there is a benefit in reducing the scale of coal works on the sites license.	Noted	Comments on draft EPL variation returned to EPA 24 January 2020. Awaiting final issue of varied EPL.
P1	Recommend updating this condition when management plans updated. Consideration should be given to seek reduction or removal of depositional dust gauges from program.	A variation to the locations of monitoring sites was submitted to the EPA in 2018. The variation is currently being assessed by the EPA. Further review of locations within site management plans may trigger another variation if required.	Noted	Comments on draft EPL variation returned to EPA 24 January 2020. Awaiting final issue of varied EPL.
L2	Recommend updating noise monitoring locations and meteorological condition limit wording to make consistent with those shown in PA 05_0136 whilst operational.	A review of the noise monitoring locations and meteorological condition limit wording will be conducted with the update to the Noise Management Plan.	30 April 2019	The Noise Management has been updated and removes location K from the active monitoring locations. Whilst noise limits are specified within EPL 12856 for additional locations it does not specify that noise must be monitored at every (or any) location. Therefore, there is no inconsistency with the updated Noise Management Plan. Notwithstanding, noise monitoring has been requested to be removed from the EPL. Awaiting final issue of varied EPL
O4	Seek removal/amendment to condition O4.2 as no sprays are utilised by the septic system.	There is no plan to remove condition O4.2 from the EPL. Abel Coal may utilise sprays in future adjustments to the Sewerage Treatment Plant.	Noted	No further action required.
U1.3-1.5	Recommend requesting U1 removed at next variation as it has been completed	Accept recommendation and incorporate into the next EPL variation.	Noted	Comments on draft EPL variation returned to EPA 24 January 2020 requested removal of this condition. Awaiting final issue of varied EPL
ML1618				
11	Date of when mine entered Care and Maintenance is reported in the Annual Mining Lease Group Exploration report as being 02 May 2016, this date is not consistent with other reports e.g. the 2017 AEMR states mine entered care and maintenance on 28 April 2016. Recommend updated in next report.	Accept and incorporate into the next Annual Mining Lease Group Exploration report or Annual Review dependent on a review of the agreed date	31 March 2019	The official date the Abel Mine entered care and maintenance has been confirmed as 2 May 2016. This is reflected in the 2018 and 2019 Annual Reviews and will be reflected in future reporting.

11. INCIDENTS AND NON-COMPLIANCES DURING THE REPORTING PERIOD

During the reporting period there were no:

- reportable incidents or exceedances; or
- official cautions, warning letters, penalty notices or prosecution proceedings.

As discussed in Section 5, a Section 240(1)(c) notice was received directing the Company to undertake a range of actions. This notice is not a non-compliance or penalty notice. The status of the required actions is discussed in **Table 5.1**.

One administrative non-compliance was recorded for the reporting period. PA 05_0136 Schedule 2 Condition 11 requires that all new buildings and structures, and any alterations or additions are constructed in accordance with the relevant requirements of the BCA. Whilst Construction Certificates have been received for buildings within the surface infrastructure area, the Occupation Certificates have not yet been received. The certifying body inspected once and requested changes prior to issuing the Occupation Certificate. The requested changes have been made and the certifying body requested to reinspect. However, the certifying body has not yet issued the final certificate. This will continue to be followed up.

12. ACTIVITIES TO BE COMPLETED IN THE NEXT REPORTING PERIOD

As outlined in Section 4.3, a range of monitoring, including surface water, groundwater, flora and fauna and subsidence monitoring are planned during the next reporting period. This monitoring represents the monitoring approved through the updated management plans for care and maintenance. Notwithstanding, the need for and frequency of monitoring is to be continually reviewed together with corresponding management plans to ensure that an appropriate level of monitoring and management during care and maintenance is undertaken.

Appendices

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Appendix 1

Noise Monitoring Reports

1. Quarterly Noise Monitoring, Quarter Ending March 2019
2. Quarterly Noise Monitoring, Quarter Ending June 2019
3. Quarterly Noise Monitoring, Quarter Ending September 2019
4. Quarterly Noise Monitoring, Quarter Ending December 2019

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DONALDSON AND ABEL COAL MINES

Quarterly Noise Monitoring
Quarter Ending March 2019

Prepared for:

Donaldson Coal Pty Ltd
PO Box 675
Green Hills 2320

SLR Ref: Q73 630.01053-R01
Version No: -v1.0
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PREPARED BY

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BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Donaldson Coal Pty Ltd (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
Q73-630.01053-R1D1	24 January 2020	Jordan Murray	Martin Davenport	Martin Davenport

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1 Introduction

1.1 Background

Donaldson Coal Pty Ltd has commissioned SLR Consulting Australia Pty Ltd (SLR) to conduct quarterly noise monitoring surveys for the Donaldson Coal Mine and Abel Coal Mine during the December 2018 quarter in accordance with the Abel Mine Project Noise Monitoring Program, dated 12 August 2014.

1.2 Objectives of this Report

The objectives of the noise monitoring survey for this operating quarter were as follows:

- Measure the ambient noise levels at six focus receptor locations (potentially worst affected) surrounding Donaldson Coal Mine and Abel Coal Mine.
- Qualify all sources of noise within each of the attended surveys, including estimated contribution or maximum level of individual noise sources.
- Assess the noise emissions of Donaldson Coal Mine and Abel Coal Mine with respect to the limits contained in the Development Consent.

1.3 Acoustic Terminology

The following report uses specialist acoustic terminology. An explanation of common terms is provided in **Appendix A**.

2 Development Consent Project Approval

Development consent was obtained by Donaldson Coal Pty Ltd for the Donaldson Mine in October 1999 following a Commission of Inquiry. Development Consent number N97/00147 was issued by the Minister for Urban Affairs pursuant to Section 101 of the Environmental Planning and Assessment Act 1979 (EP&A Act).

Project Approval (Application No. 05_0136) granted by the Minister of Planning was obtained by Donaldson Coal Pty Ltd for Abel Coal Mine in 2007.

2.1 Donaldson Coal Mine Development Consent Conditions

The Development Consent nominates hours of operation and mine noise emission goals in the Sections entitled "*Operation of Development, Condition No. 3(1) and 3(2)*", and *"Noise and Vibrational Noise Limits: Condition No. 15*" as follows:

3.(1) Subject to (2) the approved hours of operation are as follows:

Works	*Period*	*Hours*
Construction, including construction of any bunds	*Monday to Friday* *Saturday*	*7 am to 6 pm* *8 am to 1 pm*
Mining operations, including mining, haulage of waste to dumps and coal processing	*Monday to Friday* *Saturday, Sunday*	*24 hours per day* *7 am to 6 pm*
Road Transportation and stockpiling of coal	*7 days per week*	*24 hours per day*
Rail loading of coal	*7 days per week*	*7 am to 10 pm*
Maintenance of mobile and fixed plant	*7 days per week*	*24 hours per day*
Blasting, not involving closure of John Renshaw Drive	*Monday to Saturday*	*7 am to 5 pm*
Blasting, involving closure of John Renshaw Drive	*Monday to Saturday*	*10 am to 2 pm*

Notes: Restrictions on Public Holidays are the same as Sundays

(2) The Applicant shall submit a report to the Director-General's satisfaction demonstrating the noise limits in Condition 15 can be met while rail loading of coal is occurring during the period from 6 pm to 10 pm. If that report does not demonstrate that the noise limits can be met to the Director-General's satisfaction, then the hours of operation for rail loading of coal shall be restricted to 7 am to 6 pm."

15. Unless subject to a negotiated agreement in accordance with Condition 23, the Applicant shall ensure that the noise emission from construction or mining operations, when measured or computed at the boundary of any dwelling not owned by the applicant (or within 30 metres of the dwelling, if the boundary is more than 30 metres from the dwelling), shall not exceed the following noise limits:

Location	$L_{A10(15minute)}$ Noise Limits (dBA)	
	Daytime	Night-time
Beresfield area (residential)	*45*	*35*
Steggles Poultry Farm	*50*	*40*
Ebenezer Park Area	*46*	*41*
Black Hill Area	*40*	*38*
Buchanan and Louth Park Area	*38*	*36*
Ashtonfield Area	*41*	*35*
Thornton Area	*48*	*40*

Note: Daytime is 7 am to 10 pm Monday-Saturday, and 8 am to 10 pm Sundays and Public Holidays. Night-time is 10 pm to 7 am Monday-Saturday, and 10 pm to 8 am Sundays and Public Holidays.

The noise limits apply for prevailing meteorological conditions (winds up to 3 m/s), except under conditions of temperature inversions."

Other Conditions of Consent relevant to noise are as follows:

18. The applicant shall survey and investigate noise reduction measures from plant and equipment and set targets for noise reduction in each Annual Environmental Management Report (AEMR), taking into consideration valid noise complaints received in the previous year. The Report shall also include remedial measures.

19. The Applicant shall revise the Noise Management Plan as necessary and provide an updated Plan five years after commencement of mining to the Director-General, the independent noise expert (Condition 48), EPA, Councils and the Community Consultative Committee.

2.2 Abel Coal Mine – Project Approval

Approved Operations

The following operations are approved under the Abel Coal Mine Project Approval:

- Extraction of up to 6.1 Mtpa of Run of Mine (ROM) coal from the Abel Underground Coal Mine.
- Transport coal to the existing Bloomfield Coal Handling and Preparation Plant by private haul roads, or by coal conveyor, or by a combination of both methods.
- Operate the Bloomfield Coal Handling Processing Plant (CHPP) to process coal extracted from the Abel Coal Mine and the Bloomfield and Donaldson Coal Mines.
- Transportation of product coal from the Bloomfield site by rail via the Bloomfield rail loading facility.

The Project Approval was modified in June 2010 (05_0136 MOD 1) allowing construction and operation of a downcast ventilation fan. In May 2011 the Project Approval was modified again (05_0136 MOD 2) to allow the construction and operation of an upcast ventilation fan (and associated facilities). In December 2013 the Project Approval was further modified (05_0136 MOD3) to account for the increase in coal extracted including the upgrade of the Bloomfield CHPP.

Consent Conditions

The relevant conditions relating to noise from the Abel Coal Mine approval are reproduced below.

Schedule 4

NOISE

Operational Noise Criteria

1. *The Proponent shall ensure that the noise generated by the Project does not exceed the criteria in Table 4 at any residence on privately-owned land.*

Table 4: Operational Noise Criteria dB(A)

Location	Receiver Area	Day	Evening	Night	
		LAeq(15minute)	LAeq(15minute)	LAeq(15minute)	LA1(1minute)
Location I	Lord Howe Drive, Ashtonfield	*36*	*36*	*36*	*45*
Location K	Catholic Diocese Land	*37*	*37*	*37*	*45*
Location L	Kilshanny Avenue Ashtonfield	*40*	*40*	*40*	*47*
All other Locations	All other privately owned Residences	*35*	*35*	*35*	*45*

Notes:

- *To interpret the locations referred to in Table 4, see plan in Appendix 3 (Appendix A).*
- *Noise generated by the project is to be measured in accordance with the relevant requirements, and exemptions (including certain meteorological conditions), of the NSW Industrial Noise Policy.*

These noise criteria do not apply if the Proponent has an Agreement with the relevant landowner to generate higher noise levels, and the proponent has advised the Department in writing of the terms of this agreement.

Construction Noise Criteria

1. *The proponent shall ensure that the noise generated during the construction of the downcast ventilation shaft as described in EA (MOD3) does not exceed the criteria in Table 5.*

Table 5: Construction Noise Criteria dB(A)

Location	Receiver	Day
		LAeq(15minute)
Location R	*281 Lings Road, Buttai*	*50*
Location S	*189 Lings Road, Buttai*	*43*

Notes:

- *The criteria in Table 5 apply only whilst the downcast ventilation shaft is being constructed, and for a maximum of 12 weeks from the commencement of construction.*
- *To interpret the locations referred to in Table 5, see plan in Appendix 3* (attached to this report as **Appendix A**).
- *Noise generated by the project is to be measured in accordance with the relevant requirements, and exemptions (including certain meteorological conditions), of the NSW Industrial Noise Policy.*

However, these noise criteria do not apply if the Proponent has an Agreement with the relevant landowner to generate higher noise levels, and the proponent has advised the Department in writing of the terms of this agreement.

Rail Noise Criteria

1. *The proponent shall ensure that the noise from rail movements on the Bloomfield Rail Spur does not exceed the limits in Table 6 at any residence on privately owned land.*

Table 6: Rail Spur noise criteria dB (A)

Location	*Day*	*Evening*	*Night*
	LAeq(period)		
All privately-owned land	*55*	*45*	*40*

Cumulative Noise Criteria

1. *The proponent shall implement all reasonable and feasible measures to ensure that the noise generated by the project combined with noise generated by other mines does not exceed the criteria in Table 7 at any residence on privately-owned land.*

Table 7: Cumulative noise criteria dB (A)

Location	*Day*	*Evening*	*Night*
	LAeq(period)		
All privately-owned land	*55*	*45*	*40*

Notes: Cumulative noise is to be measured in accordance with the relevant requirements, and exemptions (including meteorological conditions), of the NSW Industrial Noise Policy. Appendix 4 sets out the metrological conditions under which these criteria apply and the requirements for evaluating compliance with these criteria.

Operating Conditions

1. *The proponent shall:*
   a. *Implement best management practise to minimise the construction, operational, road and rail noise of the project;*
   b. *Operate an on-site noise management system to ensure compliance with the relevant conditions of this approval;*
   c. *Minimise the noise impacts of the project during meteorological conditions under which the noise limits in this consent do not apply (see Appendix 4);*
   d. *Only receive and/or dispatch locomotives and rolling stock either on or from the site that are approved to operate on the NSW rail network in accordance with the noise limits in ARTC's EPL (No. 3142);*
   e. *Carry out regular monitoring to determine whether the project is complying with the noise criteria and other relevant conditions of approval, to the satisfaction of the Director-General.*

Noise Management Plan

2. *The proponent shall prepare and implement a Noise Management Plan for the project to the satisfaction of the Director-General. This plan must:*
   a. *Be prepared in consultation with the EPA, and be submitted to the Director-General for approval within 6 months of the date of approval of MOD 3;*
   b. *Describe the measures that would be implemented to ensure compliance with the noise criteria and operating conditions in this approval; Describe the proposed noise management system in detail; and*
   c. *Include a monitoring program that:*
      - *Uses attended monitoring to evaluate the compliance of the project against the noise criteria in this approval;*
      - *Evaluates and reports on:*
        - *The effectiveness of the on-site noise management system; and*
        - *Compliance against the noise operating conditions; and*

Defines what constitutes a noise incident, and includes protocol for identifying and notifying the Department and relevant stakeholders of any noise incidents. Appendix 4

Noise Compliance Assessment

Applicable Meteorological Conditions

1. *The noise criteria in Tables 4 and 7 are to apply under all metrological conditions except the following:*
   a. *During periods of rain or hail.*
   b. *Average wind speed at microphone height exceeds 5 m/s;*
   c. *Wind speeds greater than 3 m/s measured at 10m above ground level; or*
   d. *Temperature inversion conditions greater than $3^{o}C/100m$.*

Determination of metrological conditions

2. *Except for wind speed at microphone height, the data to be used for determining metrological conditions shall be that recorded by the meteorological station located on the site.*

Compliance monitoring

3. *Attended monitoring is to be used to evaluate compliance with the relevant conditions of this approval.*
4. *Unless otherwise agreed with the director-general, this monitoring is to be carried out in accordance with the relevant requirements for reviewing performance set out in the NSW Industrial Noise Policy (as amended from time to time), in particular the requirements relating to:*
    a. *Monitoring locations for the collection of representative noise data;*
    b. *Metrological conditions during which collection of noise data is not appropriate;*
    c. *Equipment used to collect noise data, and conformity with Australian Standards relevant to such equipment; and*
    d. *Modification to noise data collected, including for the exclusion of extraneous noise and/or penalties for modifying factors apart from adjustments for duration.*

Appendix 5

Statement of Commitments

3. Noise

3.1 Construction Activities

The following noise control measures will be implemented prior to commencement of construction of the Abel Underground Mine or the upgrade of the Bloomfield CHPP.

1. *Maintain all machinery and equipment in working order;*
    a. *No construction activities at the Abel pit top will take place on Sundays or Public Holidays;*
    b. *Where possible locate noisy site equipment behind structures that act as barriers or at the greatest distance from noise sensitive areas; and*
    c. *Orientate equipment so that noise emissions are directed away from noise sensitive areas.*

3.2 Noise Control Measures

a. *The following noise control measures will be implemented prior to the mining of coal from the Abel underground Mine:*
    i. *Orientation of the ventilation fans away from residential receivers and angle the output parallel to the ground.*
    ii. *The sound power level of the front end loader to be used near the portal should not exceed 113 dBA and will be fitted with a noise sensitive reversing alarm.*
b. *The following noise control measures will be implemented prior to the Bloomfield CHPP receiving any ROM coal from Able Underground Mine;*

i. Noise mitigation works including partial enclosure and noise screening of drives and conveyors of the Bloomfield CHPP to screen residences to the north of the site.

3.2 Monitoring

The Company will implement a Noise Monitoring Program for the Abel Underground Mine and the Bloomfield CHPP, to the satisfaction of the Director-General. The Noise Monitoring Program shall include a combination of real-time and supplementary attended monitoring measures, and a noise monitoring protocol for evaluating compliance with the noise environmental assessment. This plan will be integrated with the monitoring plans for the Tasman, Donaldson and Bloomfield Mines to provide a single integrated Noise Monitoring Program for all 4 mines.

3.4 Continuous Improvement

The Company shall:

a. Report on these investigations and implementation of any new noise mitigation measures on site in the AEMR, to the satisfaction of the Director General.

The operator of the Bloomfield CHPP shall:

b. Investigate ways to reduce the noise generated by the Bloomfield CHPP, including maximum noise levels which may result in sleep disturbance;

c. Implement all reasonable and feasible best practice noise mitigation measures on the site; and

d. Report on these investigations and the implementation of any new noise mitigation measures on site in the AEMR, to the satisfaction of the Director-General.

3 Noise Monitoring Methodology

3.1 General Requirements

The operational noise monitoring program was conducted with reference to Development Consent N97/00147 (Donaldson Coal Mine), Project Approval 05_0136 (Abel Coal Mine), and in accordance with SLR's Report 630.01053.01300-R1 dated 12 August 2014 (*Noise Management Plan Abel Underground Mine)* and AS 1055-1997 *Acoustics - Description and Measurement of Environmental Noise*.

All acoustic instrumentation employed throughout the monitoring program has been designed to comply with the requirements of AS IEC 61672.1 – 2004 *Electroacoustics—Sound level meters – Specifications*, AS IEC 61672.2-2004, AS IEC 61672.3-2004 and carried current NATA or manufacturer calibration certificates. Certificates for acoustic instrumentation used during the March 2019 quarter is provided in **Appendix B**.

Instrument calibration was conducted before and after each measurement, with the variation in calibrated levels not exceeding ±0.5 dBA.

3.2 Monitoring Locations

Baseline and preceding operational quarterly surveys have been conducted at 11 locations surrounding the Donaldson Mine and Abel Coal Mine sites. With the experience of these previous surveys, it was decided to concentrate noise monitoring at six focus locations that represent the potentially most noise affected areas from Donaldson Mine and Abel Coal Mine. The details of the monitoring locations are contained within **Table 1**.

It is relevant to note that Donaldson Open Cut Mine has ceased production and all major earthworks on the site have been finalised. Therefore, compliance noise monitoring for the Donaldson Open Cut Mine is no longer required.

Furthermore, Abel mine was placed in Care & Maintenance on 28th April 2016 and there was no operations onsite during the December 2018 noise monitoring period.

Table 1 Monitoring Locations

Noise Monitoring Location	Description
D	Black Hill School, Black Hill
F	Lot 684 Black Hill Road, Black Hill
G	156 Buchannan Road, Buchannan
I	Magnetic Drive, Ashtonfield
J	Parish Drive, Thornton
L	Kilshanny Ave, Ashtonfield

A map giving the approximate location of the noise monitoring sites is contained within **Appendix C**.

3.3 Unattended Continuous Noise Monitoring

An environmental noise logger was deployed for a minimum of seven days between Wednesday 13 March 2019 and Thursday 21 March 2019 at each of the nominated locations given in **Table 1**.

All unattended monitoring equipment was programmed to continuously record statistical noise level indices in 15 minute intervals including the L_{Amax}, L_{A1}, L_{A10}, L_{A90}, L_{A99}, L_{Amin} and L_{Aeq}. The statistical noise exceedance levels (L_{AN}) are the levels exceeded for N% of the 15 minute interval. The L_{A90} represents the level exceeded for 90% of the interval period and is referred to as the average minimum or background noise level. The L_{A10} is the level exceeded for 10% of the time and is usually referred to as the average maximum noise level. The L_{Aeq} is the equivalent continuous sound pressure level and represents the steady sound level which is equal in energy to the fluctuating level over the interval period. The L_{Amax} is the maximum noise level recorded over the interval.

3.4 Operator Attended Noise Monitoring

Operator attended surveys were conducted at each of the six monitoring locations during the daytime, evening and night-time periods, to verify the unattended logging results and to determine the character and contribution of ambient noise sources.

4 Operator Attended Noise Monitoring

4.1 Results of Operator Attended Noise Monitoring

Operator attended noise measurements were conducted during the evening and night-time period on Tuesday 26 March 2019 and Wednesday 27 March 2019. Operator attended noise measurements were conducted during the daytime period on Wednesday 13 March 2019 and Thursday 21 March 2019. All operator attended noise surveys were conducted using a Brüel & Kjær 2250L integrating sound level meter (s/n: 3003389).

Results of the operator attended noise measurements are given in **Table 2** to **Table 7**.

Ambient noise levels given in the tables include all noise sources such as traffic, insects, birds, and mine operations as well as any other industrial operations.

The tables provide the following information:

- Monitoring location.
- Date and start time.
- Wind velocity (m/s) and Temperature (ºC) at the measurement location.
- Typical maximum (L_{Amax}) and contributed noise levels.

Mine contributions listed in the tables are from the Abel Coal Mine and are stated only when a contribution could be quantified.

Table 2 Location D, Black Hill School, Black Hill

Period	Date/ Start time/ Weather	Primary Noise Descriptor (dBA re 20 µPa)					Description of Noise Emission, Typical Maximum Noise Levels (L_{Amax} – dBA)
		L_{Amax}	L_{A1}	L_{A10}	L_{A90}	L_{Aeq}	
Day	13/03/2019 13:00 26°C 2 m/s SE	78	68	56	44	56	Road traffic 50-78 Birdsong 45-60 **Abel Mine Inaudible**
		Estimated Abel Mine Noise Contribution Inaudible					
Evening	26/03/2019 18:14 23°C 1.5 m/s SE	72	63	57	40	53	Road traffic 41-72 Birdsong 51-62 School air-conditioner 39 **Abel Mine Inaudible**
		Estimated Abel Mine Noise Contribution Inaudible					
Night	26/03/2019 22:00 18°C 1 m/s S	79	58	43	39	57	Insects 38 Traffic 40-79 **Abel Mine Inaudible**
		Estimated Abel Mine Noise Contribution Inaudible					

Table 3 Location F, Lot 684 Black Hill Road, Black Hill

Period	Date/ Start time/ Weather	Primary Noise Descriptor (dBA re 20 µPa)					Description of Noise Emission, Typical Maximum Noise Levels (L_{Amax} – dBA)
		L_{Amax}	L_{A1}	L_{A10}	L_{A90}	L_{Aeq}	
Day	13/03/2019 13:30 26°C 1 m/s SSE	83	66	56	45	55	Road Traffic 49-83 Birdsong 45-66 **Abel Mine Inaudible**
		Estimated Abel Mine Noise Contribution Inaudible					
Evening	26/03/2019 18:39 22°C 1 m/s SE	74	67	58	38	55	Road Traffic 51-74 Insects 47 **Abel Mine Inaudible**
		Estimated Abel Mine Noise Contribution Inaudible					
Night	26/03/2019 22:22 18°C 1 m/s S	68	64	55	33	52	Road traffic 42-68 Insects 39-41 **Abel Mine Inaudible**
		Estimated Abel Mine Noise Contribution Inaudible					

Table 4 Location G, 156 Buchannan Road, Buchannan

Period	Date/ Start time/ Weather	Primary Noise Descriptor (dBA re 20 µPa)					Description of Noise Emission, Typical Maximum Noise Levels (L_{Amax} – dBA)
		L_{Amax}	L_{A1}	L_{A10}	L_{A90}	L_{Aeq}	
Day	13/03/2019 16:10 27°C 2 m/s SE	67	58	54	46	51	Wind related noise 60-67 Road traffic 45-60 **Abel Mine Inaudible**
		Estimated Abel Mine Noise Contribution Inaudible					
Evening	26/03/2019 19:54 20°C 1 m/s SE	71	66	62	37	57	Road traffic 38-71 Insects 38 **Abel Mine Inaudible**
		Estimated Abel Mine Noise Contribution Inaudible					
Night	27/03/2019 00:26 17°C 1 m/s SE	89	77	49	36	63	Road traffic 50-89 Insects 34 **Abel Mine Inaudible**
		Estimated Abel Mine Noise Contribution Inaudible					

Table 5 Location I, Magnetic Drive, Ashtonfield

Period	Date/ Start time/ Weather	Primary Noise Descriptor (dBA re 20 µPa)					Description of Noise Emission, Typical Maximum Noise Levels (LAmax – dBA)
		LAmax	LA1	LA10	LA90	LAeq	
Day	21/03/2019 11:15 25°C Calm	75	69	62	47	68	Road traffic 53-75 Birdsong 62-69 **Abel Mine Inaudible**
		Estimated Abel Mine Noise Contribution Inaudible					
Evening	26/03/2019 20:51 19°C 1 m/s SE	68	53	45	41	45	Road traffic 42-68 Insects 39 Domestic noise 46-51 **Abel Mine Inaudible**
		Estimated Abel Mine Noise Contribution Inaudible					
Night	27/03/2019 01:18 18°C 1 m/s S	70	58	50	36	47	Road traffic 40-48 Insects 36-38 Dog barking 68-70 **Abel Mine Inaudible**
		Estimated Abel Mine Noise Contribution Inaudible					

Table 6 Location J, Parish Drive, Thornton

Period	Date/ Start time/ Weather	Primary Noise Descriptor (dBA re 20 µPa)					Description of Noise Emission, Typical Maximum Noise Levels (LAmax – dBA)
		LAmax	LA1	LA10	LA90	LAeq	
Day	21/03/2019 11:54 27°C 1 m/s SW	56	44	37	32	39	Electric fence 31-33 Birdsong 37-56 **Abel Mine Inaudible**
		Estimated Abel Mine Noise Contribution Inaudible					
Evening	26/03/2019 20:51 19°C 1 m/s SE	59	44	40	37	39	Road traffic 37-41 Insects 35 Animal 59 **Abel Mine Inaudible**
		Estimated Abel Mine Noise Contribution Inaudible					
Night	27/03/2019 01:45 18°C 1 m/s S	50	44	41	34	38	Road traffic 43-46 Insects 38-42 Animal 50 **Abel Mine Inaudible**
		Estimated Abel Mine Noise Contribution Inaudible					

Table 7 Location L, Kilshanny Ave, Ashtonfield

Period	Date/ Start time/ Period/ Weather	Primary Noise Descriptor (dBA re 20 µPa)					Description of Noise Emission, Typical Maximum Noise Levels (LAmax – dBA)
		LAmax	LA1	LA10	LA90	LAeq	
Day	13/03/2019 16:5624°C 2 m/s SE	74	61	56	42	52	Road traffic 40-74 Birdsong 53-61 **Abel Mine Inaudible**
		Estimated Abel Mine Noise Contribution Inaudible					
Evening	26/03/2019 20:26 19°C 1 m/s SE	80	65	47	41	59	Road traffic 41-80 Insects 42 **Abel Mine Inaudible**
		Estimated Abel Mine Noise Contribution Inaudible					
Night	27/03/2019 00:54 17°C 1 m/s SE	58	48	46	46	44	Road traffic 32-40 Insects 40-44 Dog barking 58 **Abel Mine Inaudible**
		Estimated Abel Mine Noise Contribution Inaudible					

4.2 Operator Attended Noise Monitoring Summary

4.2.1 Donaldson Mine

Donaldson Open Cut Mine has ceased production and all major earthworks on the site have been finalised. Therefore, compliance noise monitoring for the Donaldson Open Cut Mine is no longer required.

4.2.2 Abel Coal Mine

Abel mine was placed in Care & Maintenance on 28th April 2016 and there was no operations onsite, excluding that from the Bloomfield CHPP which operates under the Abel Coal Mine project consent conditions.

The Bloomfield CHPP stockpile area was not audible during all operator attended noise surveys. Noise generated by local and distant traffic was a significant contributor to ambient noise levels at all monitored locations as well as 'natural' noises such as birds, insects.

4.3 Compliance Assessment and Discussion of Results

4.3.1 Operations

Results of the operational compliance assessment are given in **Table 8**.

Table 8 Compliance Noise Assessment – Operations

Location	Estimated Abel $L_{Aeq(15minute)}$ Contribution dBA			Consent Conditions			Compliance		
	Day	Eve	Night	Day	Eve	Night	Day	Eve	Night
D – Black Hill School, Black Hill	Inaudible	Inaudible	Inaudible	35	35	35	Yes	Yes	Yes
F – Black Hill Road, Black Hill	Inaudible	Inaudible	Inaudible	35	35	35	Yes	Yes	Yes
G – Buchanan Road, Buchanan	Inaudible	Inaudible	Inaudible	35	35	35	Yes	Yes	Yes
I – Magnetic Drive, Ashtonfield	Inaudible	Inaudible	Inaudible	36	36	36	Yes	Yes	Yes
J – Parish Drive, Thornton	Inaudible	Inaudible	Inaudible	35	35	35	Yes	Yes	Yes
L – Kilshanny Ave, Ashtonfield	Inaudible	Inaudible	Inaudible	40	40	40	Yes	Yes	Yes

Results presented in **Table 8** indicate that compliance with the relevant consent conditions was achieved at all noise monitoring locations during all periods.

4.3.2 Sleep Disturbance

Results of the sleep disturbance compliance assessment are given in **Table 9**.

Table 9 Compliance Noise Assessment – Sleep Disturbance

Location	Estimated Bloomfield $L_{A1(1minute)}$ Contribution dBA	Consent Conditions $L_{A1(1minute)}$ dBA	Compliance
D – Black Hill School, Black Hill	Inaudible	45	Yes
F – Black Hill Road, Black Hill	Inaudible	45	Yes
G – Buchanan Road, Buchanan	Inaudible	45	Yes
I – Lord Howe Drive, Ashtonfield	Inaudible	45	Yes
J – Parish Drive, Thornton	Inaudible	45	Yes
L – Kilshanny Ave, Ashtonfield	Inaudible	47	Yes

Results presented in **Table 9** indicate that compliance with the sleep disturbance consent conditions was achieved at all noise monitoring locations during the night-time noise surveys.

5 Unattended Continuous Noise Monitoring

5.1 Results of Unattended Continuous Noise Monitoring

Unattended continuous noise monitoring was conducted between 13 March 2019 and Monday 21 March 2019 at each of the six monitoring locations given in **Table 10**.

Table 10 Noise Logger and Noise Monitoring Locations

Location	Noise Logger Serial Number	Date of Logging
D – Black Hill School, Black Hill	ARL EL-316 16-207-050	13 March 2019 - 21 March 2019
F – Black Hill Road, Black Hill	ARL EL-316 16-203-505	13 March 2019 - 21 March 2019
G – Buchanan Road, Buchanan	ARL EL-316 16-203-508	13 March 2019 - 21 March 2019
I – Magnetic Drive, Ashtonfield	ARL EL-316 16-203-525	13 March 2019 - 21 March 2019
L – Kilshanny Ave, Kilshanny	ARL EL-316 16-103-494	13 March 2019 - 21 March 2019
J – Parish Drive, Thornton	SVAN 957 27522	13 March 2019 - 21 March 2019

The unattended ambient noise logger data from each monitoring location are presented graphically on a daily basis and are attached as **Appendix C**. A summary of the results of the unattended continuous noise monitoring is given in **Table 11.**

The ambient noise level data quantifies the overall noise level at a given location independent of its source or character.

The measured ambient noise levels were divided into three periods representing day, evening and night as designated in the NSW Noise Policy for Industry (NPfI).

Precautions were taken to minimise influences from extraneous noise sources (eg optimum placement of the loggers away from creeks, trees, houses, etc), however, not all these sources or their effects can be eliminated. This is particularly the case during the warmer times of year when noise from insects, frogs, birds and other animals can become quite prevalent.

Weather data for the subject area during the noise monitoring period was provided by Bloomfield Colliery. Noise data during periods of any rainfall and/or wind speeds in excess of 5 m/s were discarded in accordance with NPfI weather affected data exclusion methodology.

Table 11 Unattended Continuous Noise Monitoring Ambient Noise Levels (dBA)

Location	Period	Primary Noise Descriptor (dBA re 20 µPA)			
		LA1	LA10	LA90	LAeq
D Black Hill School, Black Hill	Day	68	58	41	58
	Evening	62	52	41	54
	Night	55	50	40	52
F Lot 684 Black Hill Road, Black Hill	Day	71	57	43	59
	Evening	63	53	35	54
	Night	59	52	33	52
G 156 Buchanan Road, Buchanan	Day	51	48	38	49
	Evening	48	45	36	45
	Night	45	41	32	44
I 49 Magnetic Drive, Ashtonfield	Day	71	63	44	67
	Evening	61	47	39	57
	Night	52	48	38	50
L 17 Kilshanny Ave, Ashtonfield	Day	33	53	33	52
	Evening	3	50	33	53
	Night	43	61	43	59
J 220 Parish Drive, Thornton[1]	Day	-	-	-	-
	Evening	-	-	-	-
	Night	-	-	-	-

1. Due to a technical error, no unattended monitoring data was available for Location J.

5.2 Long term Unattended Continuous Monitoring Summary for Donaldson Mine and Abel Coal Mine

5.2.1 Ambient LA90 Noise Levels

The long term ambient L_{A90} noise levels collected from each monitoring location are presented graphically in **Figure 1**, **Figure 2** and **Figure 3** for the daytime, evening and night-time periods respectively.

Figure 1 Long term Daytime LA90 Noise Levels

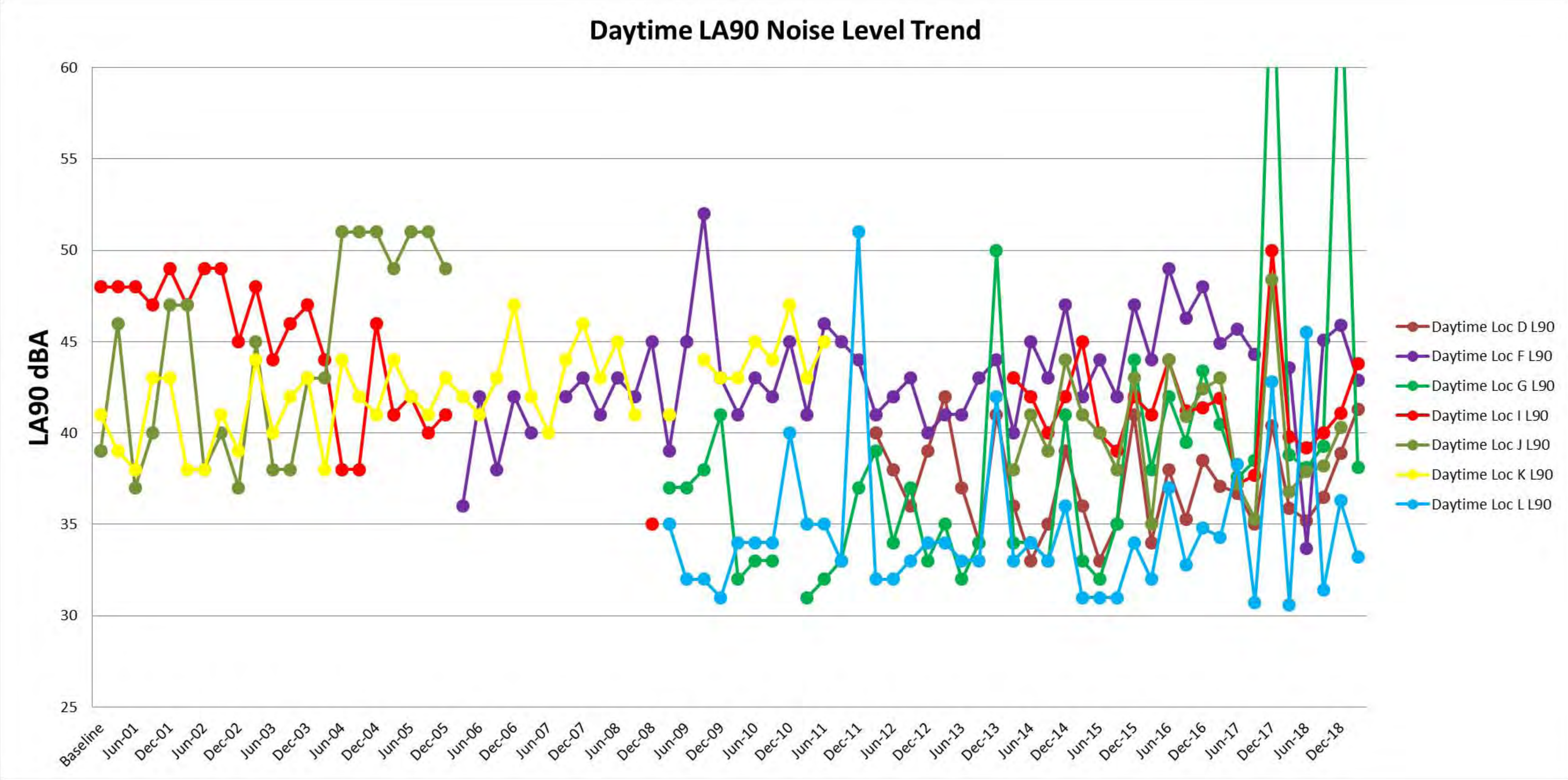


Figure 2 Long term Evening LA90 Noise Levels

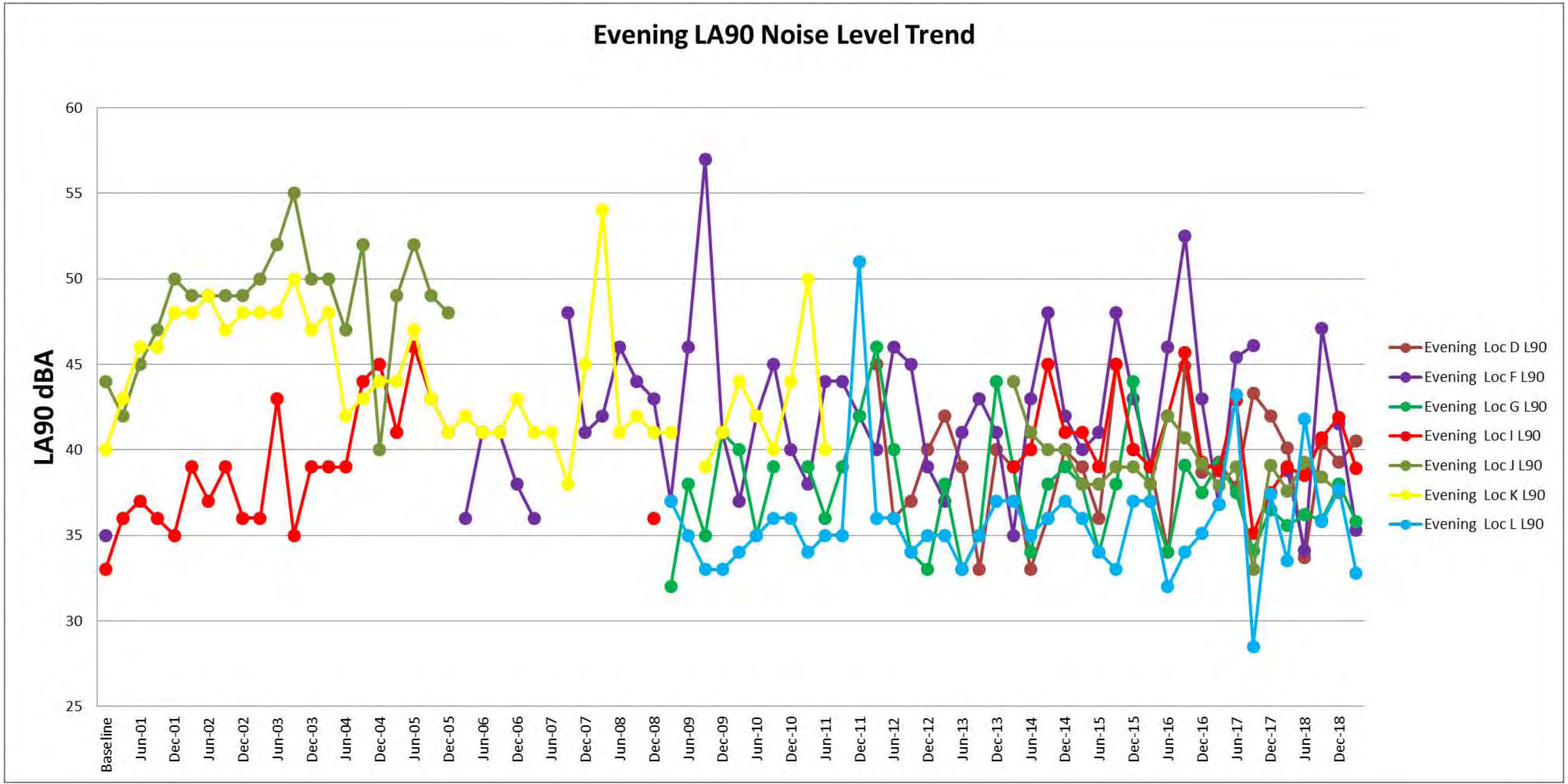
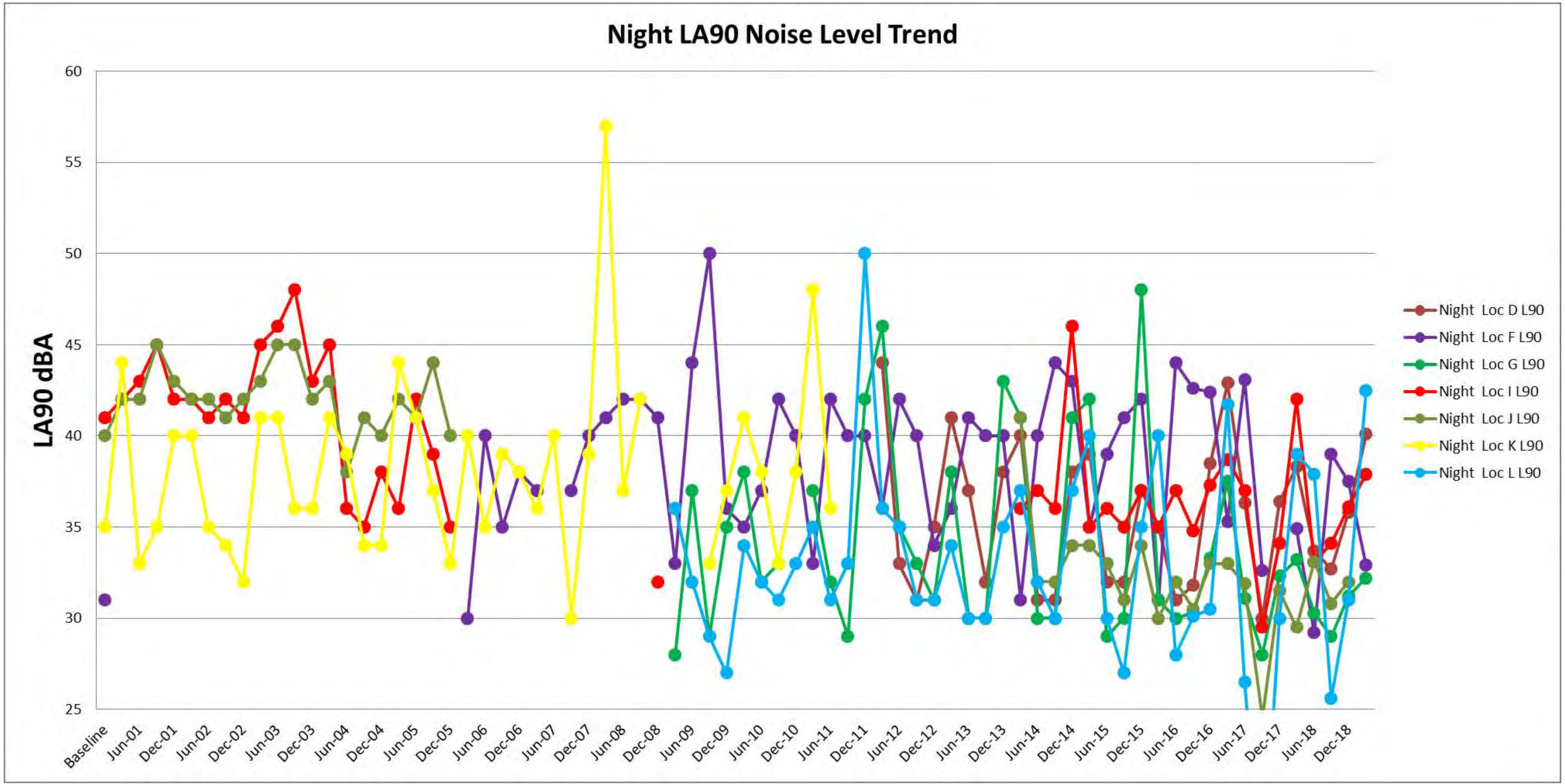


Figure 3 Long term Night-time L_{A90} Noise Levels



5.2.1.1 Baseline

The summary of results in **Table 12** shows the ambient LA90 noise levels recorded for the current monitoring period compared to the levels recorded during the baseline monitoring process (ie. prior to commencement of mining operation at Donaldson).

Table 12 LA90 Results Comparison – Baseline

Monitoring Location	Period[1]	Long term Night-time LA90 Noise Levels		Difference dB[3]
		Baseline	March 2019	
D Black Hill School, Black Hill	Day	N/A[2]	41	N/A
	Evening	N/A[2]	41	N/A
	Night	N/A[2]	40	N/A
F Lot 684 Black Hill Road, Black Hill	Day	39	43	4
	Evening	35	35	0
	Night	31	33	2
G 156 Buchanan Road, Buchanan	Day	N/A[2]	38	N/A
	Evening	N/A[2]	36	N/A
	Night	N/A[2]	32	N/A
I 49 Magnetic Drive, Ashtonfield	Day	48	44	-4
	Evening	33	39	6
	Night	41	38	-3
L 17 Kilshanny Ave, Ashtonfield	Day	N/A[2]	33	N/A
	Evening	N/A[2]	33	N/A
	Night	N/A[2]	43	N/A
J 220 Parish Drive, Thornton	Day	39	-	-
	Evening	44	-	-
	Night	40	-	-

Note 1: Periods are as detailed the NPfI and are Daytime - 7.00 am to 6.00 pm Monday to Saturday, 8.00 am to 6.00 pm Sunday; Evening - 6.00 pm 10.00 pm; Night - 10.00 pm to 7.00 am pm Monday to Saturday, 10.00 pm to 8.00 am Sunday.

Note 2: No data was available during baseline measurements, no comparisons can be made.

Note 3: Rounded to the nearest whole dB.

5.2.1.2 Previous Quarter

Table 13 presents the ambient LA90 noise levels recorded for the current monitoring period compared to those measured in the previous monitoring period.

Table 13 LA90 Results Comparison – Previous Quarter

Monitoring Location	Period[1]	Long term Night-time LA90 Noise Levels		Difference dB[2]
		December 2018	March 2019	
D Black Hill School, Black Hill	Day	39	41	2
	Evening	39	41	2
	Night	36	40	4
F Lot 684 Black Hill Road, Black Hill	Day	46	43	-3
	Evening	42	35	-7
	Night	38	33	-5
G 156 Buchanan Road, Buchanan	Day	66	38	-28
	Evening	38	36	-2
	Night	31	32	1
I 49 Magnetic Drive, Ashtonfield	Day	41	44	3
	Evening	42	39	-3
	Night	36	38	2
L 17 Kilshanny Ave, Ashtonfield	Day	36	33	-3
	Evening	38	33	-5
	Night	31	43	12
J 220 Parish Drive, Thornton	Day	40	-	-
	Evening	38	-	-
	Night	32	-	-

Note 1: 1. Periods are as detailed in the Industrial Noise Policy (INP) and are Daytime - 7.00 am to 6.00 pm Monday to Saturday, 8.00 am to 6.00 pm Sunday; Evening - 6.00 pm 10.00 pm; Night - 10.00 pm to 7.00 am pm Monday to Saturday, 10.00 pm to 8.00 am Sunday.

Note 2: Rounded to the nearest whole dB.

5.2.1.3 Coinciding Period Last Year

Table 14 presents the ambient LA90 noise levels recorded for the current monitoring period compared to those measured during the coinciding monitoring period last year.

Table 14 LA90 Results Comparison – Coinciding Period Last Year

Monitoring Location	Period[1]	Long term Night-time LA90 Noise Levels		Difference dB[2]
		March 2018	March 2019	
D Black Hill School, Black Hill	Day	36	41	5
	Evening	40	41	1
	Night	38	40	2
F Lot 684 Black Hill Road, Black Hill	Day	44	43	-1
	Evening	39	35	-4
	Night	35	33	-2
G 156 Buchanan Road, Buchanan	Day	39	38	-1
	Evening	36	36	0
	Night	33	32	-1
I 49 Magnetic Drive, Ashtonfield	Day	40	44	4
	Evening	39	39	0
	Night	42	38	-4
L 17 Kilshanny Ave, Ashtonfield	Day	31	33	2
	Evening	34	33	-1
	Night	39	43	4
J[3] 220 Parish Drive, Thornton	Day	37	-	-
	Evening	38	-	-
	Night	30	-	-

Note 1: Periods are as detailed in the Industrial Noise Policy (INP) and are Daytime - 7.00 am to 6.00 pm Monday to Saturday, 8.00 am to 6.00 pm Sunday; Evening - 6.00 pm 10.00 pm; Night - 10.00 pm to 7.00 am pm Monday to Saturday, 10.00 pm to 8.00 am Sunday.

Note 2: Rounded to the nearest whole dB.

Note 3: Due to a logger error no results are available at location J for the March 2019 quarter, as such a comparison cannot be made.

5.2.2 Ambient LA10 Noise Comparison

The long term ambient LA10 noise levels collected from each monitoring location are presented graphically in **Figure 4**, **Figure 5** and **Figure 6** for the daytime, evening and night-time respectively.

Figure 4 Long term Daytime LA10 Noise Levels

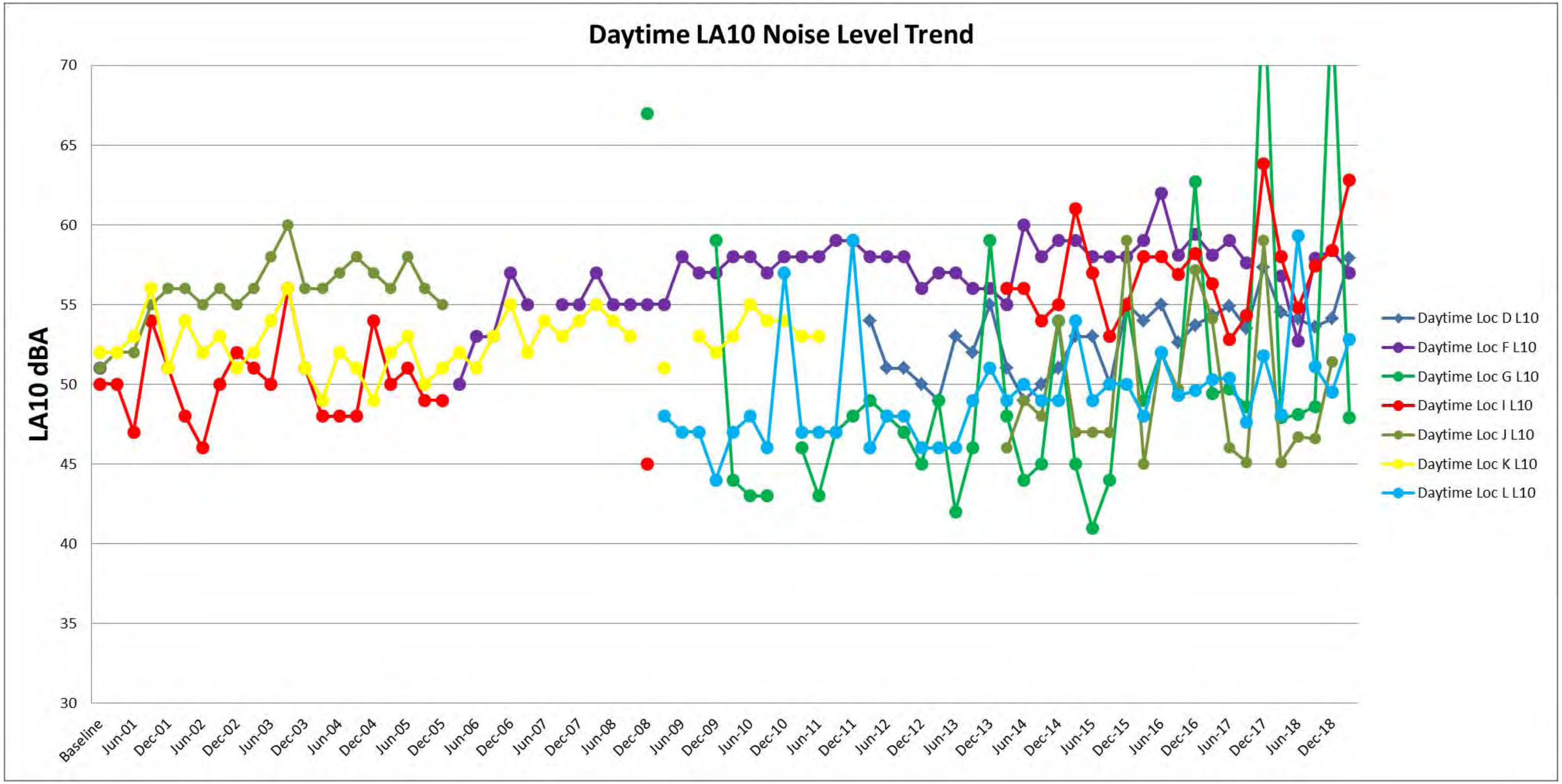


Figure 5 Long term Evening LA10 Noise Levels

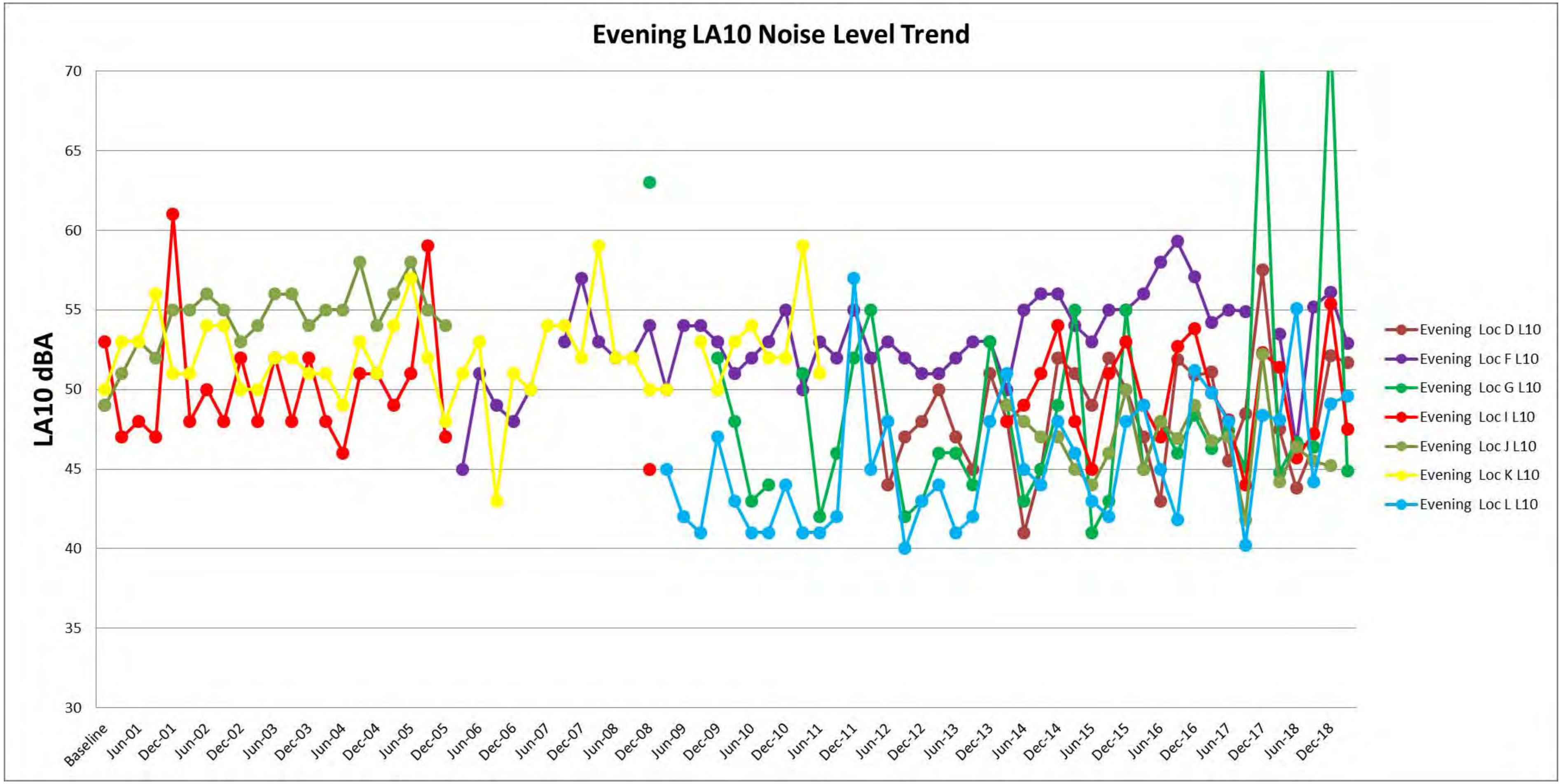
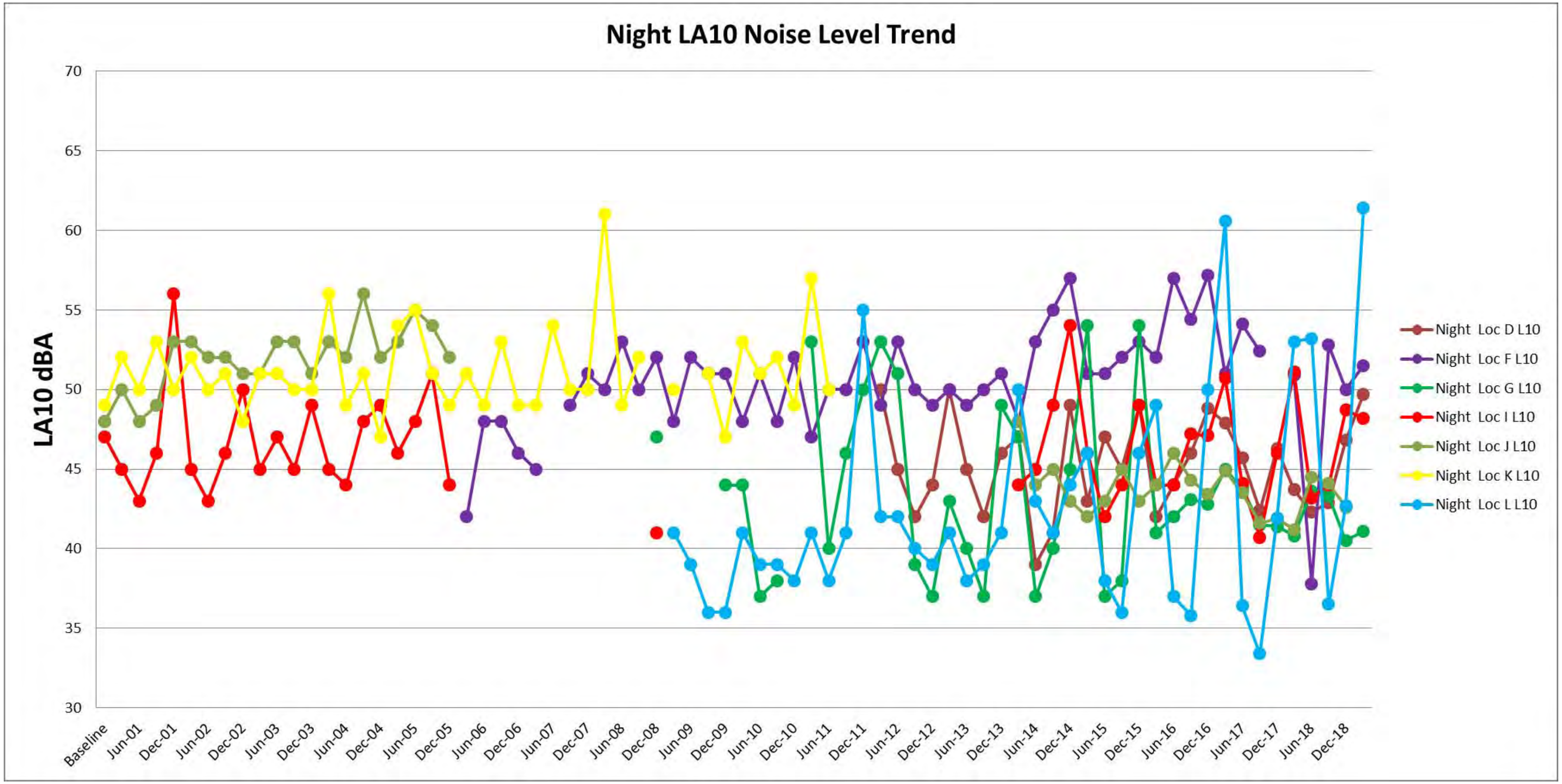


Figure 6 Long term Night-time LA10 Noise Levels



5.2.2.1 Baseline

Table 15 presents the ambient LA10 noise levels recorded for the current monitoring period compared to the levels recorded during the baseline monitoring period.

Table 15 LA10 Results Comparison – Baseline

Monitoring Location	Period[1]	Long term Night-time LA10 Noise Levels		Difference dB[3]
		Baseline	March 2019	
D Black Hill School, Black Hill	Day	N/A[2]	58	N/A
	Evening	N/A[2]	52	N/A
	Night	N/A[2]	50	N/A
F Lot 684 Black Hill Road, Black Hill	Day	51	57	6
	Evening	49	53	4
	Night	48	52	4
G 156 Buchanan Road, Buchanan	Day	N/A[2]	48	N/A
	Evening	N/A[2]	45	N/A
	Night	N/A[2]	41	N/A
I 49 Magnetic Drive, Ashtonfield	Day	50	63	13
	Evening	53	48	-5
	Night	47	48	1
L 17 Kilshanny Ave, Ashtonfield	Day	N/A[2]	53	N/A
	Evening	N/A[2]	50	N/A
	Night	N/A[2]	61	N/A
J 220 Parish Drive, Thornton	Day	51	-	-
	Evening	49	-	-
	Night	48	-	-

Note 1: Periods are as detailed in the Industrial Noise Policy (INP) and are Daytime - 7.00 am to 6.00 pm Monday to Saturday, 8.00 am to 6.00 pm Sunday; Evening - 6.00 pm 10.00 pm; Night - 10.00 pm to 7.00 am pm Monday to Saturday, 10.00 pm to 8.00 am Sunday.

Note 2: No data was available during baseline measurements, no comparisons can be made.

Note 3: Rounded to the nearest whole dB.

5.2.2.2 Previous Quarter

Table 16 presents the ambient L_{A10} noise levels recorded for the current monitoring period compared to those measured during the previous monitoring period.

Table 16 L_{A10} Results Comparison – Previous Quarter

Monitoring Location	Period[1]	Long term Night-time L_{A10} Noise Levels		Difference dB[2]
		December 2018	March 2019	
D Black Hill School, Black Hill	Day	54	58	4
	Evening	52	52	0
	Night	47	50	3
F Lot 684 Black Hill Road, Black Hill	Day	58	57	-1
	Evening	56	53	-3
	Night	50	52	2
G 156 Buchanan Road, Buchanan	Day	74	48	-26
	Evening	73	45	-28
	Night	41	41	0
I 49 Magnetic Drive, Ashtonfield	Day	58	63	5
	Evening	55	48	-7
	Night	49	48	-1
L 17 Kilshanny Ave, Ashtonfield	Day	50	53	3
	Evening	49	50	1
	Night	43	61	18
J 220 Parish Drive, Thornton	Day	51	-	-
	Evening	45	-	-
	Night	43	-	-

Note 1: Periods are as detailed in the Industrial Noise Policy (INP) and are Daytime - 7.00 am to 6.00 pm Monday to Saturday, 8.00 am to 6.00 pm Sunday; Evening - 6.00 pm 10.00 pm; Night - 10.00 pm to 7.00 am pm Monday to Saturday, 10.00 pm to 8.00 am Sunday.

Note 2: Rounded to the nearest whole dB.

5.2.2.3 Coinciding Period Last Year

Table 17 presents the ambient L_{A10} noise levels recorded for the current monitoring period compared to those measured during the coinciding monitoring period last year.

Table 17 L_{A10} Result Comparison – Coinciding Period Last Year

Monitoring Location	Period[1]	Long term Night-time L_{A10} Noise Levels		Difference dB[2]
		March 2018	March 2019	
D Black Hill School, Black Hill	Day	55	58	3
	Evening	48	52	4
	Night	44	50	6
F Lot 684 Black Hill Road, Black Hill	Day	57	57	0
	Evening	54	53	-1
	Night	51	52	1
G 156 Buchanan Road, Buchanan	Day	48	48	0
	Evening	45	45	0
	Night	41	41	0
I 49 Magnetic Drive, Ashtonfield	Day	58	63	5
	Evening	51	48	-3
	Night	51	48	-3
L 17 Kilshanny Ave, Ashtonfield	Day	48	53	5
	Evening	48	50	2
	Night	53	61	8
J[3] 220 Parish Drive, Thornton	Day	45	-	-
	Evening	44	-	-
	Night	41	-	-

Note 1: Periods are as detailed in the Industrial Noise Policy (INP) and are Daytime - 7.00 am to 6.00 pm Monday to Saturday, 8.00 am to 6.00 pm Sunday; Evening - 6.00 pm 10.00 pm; Night - 10.00 pm to 7.00 am pm Monday to Saturday, 10.00 pm to 8.00 am Sunday.

Note 2: Rounded to the nearest whole dB.

Note 3: Due to a logger error no results are available at location J for the March 2019 quarter, as such a comparison can not be made.

5.3 Rail Noise Monitoring

Due to a logger error at Location J no unattended monitoring data was available for the March 2019 monitoring period. The train loading times during the noise monitoring period are presented in **Table 18**.

Table 18 Coal Train Loading Operations Log

Date	Coal Train Loading Time	Period
13/03/19	12:45-16:15	Day
14/03/19	11:45-14:55	Day

Given the results of previous quarterly monitoring periods and that only one train movement occurred during each daytime period, it is considered likely that rail traffic noise was compliant during the March 2019 monitoring period.

6 Conclusion

SLR was engaged by Donaldson Coal Pty Ltd to conduct quarterly noise monitoring surveys for Donaldson Coal Mine and Abel Coal Mine in accordance with the Abel Coal Mine Noise Monitoring Program, dated 12 August 2014.

Donaldson Open Cut Mine has ceased production and all major earthworks on the site have been finalised. Therefore, compliance noise monitoring for the Donaldson Open Cut Mine is no longer required.

Abel mine was placed in Care & Maintenance on 28th April 2016 and there was no operations onsite, excluding that from the Bloomfield CHPP which operates under the Abel Coal Mine project consent conditions.

Operator-attended and unattended noise measurements were conducted for the March 2019 quarter at six focus locations surrounding the mine.

Abel portal operations were not observed to be audible at any locations during the monitoring period. Contributed noise levels from Abel Mine did not exceed noise emission goals (including night-time sleep arousal criteria) and compliance with the Abel Mine *Project Approval* was indicated at all locations.

A comparison of ambient L_{A10} and L_{A90} noise levels recorded during the current monitoring period (March 2019), the baseline monitoring period, the last monitoring period (December 2018), and the coinciding monitoring period from last year (March 2018) has been conducted.

Given the results of previous quarterly monitoring periods, rail noise levels from the Bloomfield Rail Spur were considered to be in compliance with the Abel Mine Project Approval during the noise monitoring period.

APPENDIX A

Acoustic Terminology

1. Sound Level or Noise Level

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

Sound (or noise) consists of minute fluctuations in atmospheric pressure. The human ear responds to changes in sound pressure over a very wide range with the loudest sound pressure to which the human ear can respond being ten million times greater than the softest. The decibel (abbreviated as dB) scale reduces this ratio to a more manageable size by the use of logarithms.

The symbols SPL, L or LP are commonly used to represent Sound Pressure Level. The symbol LA represents A-weighted Sound Pressure Level. The standard reference unit for Sound Pressure Levels expressed in decibels is 2 x 10^{-5} Pa.

2. 'A' Weighted Sound Pressure Level

The overall level of a sound is usually expressed in terms of dBA, which is measured using a sound level meter with an 'A-weighting' filter. This is an electronic filter having a frequency response corresponding approximately to that of human hearing.

People's hearing is most sensitive to sounds at mid frequencies (500 Hz to 4,000 Hz), and less sensitive at lower and higher frequencies. Different sources having the same dBA level generally sound about equally loud.

A change of 1 dB or 2 dB in the level of a sound is difficult for most people to detect, whilst a 3 dB to 5 dB change corresponds to a small but noticeable change in loudness. A 10 dB change corresponds to an approximate doubling or halving in loudness. The table below lists examples of typical noise levels.

Sound Pressure Level (dBA)	Typical Source	Subjective Evaluation
130	Threshold of pain	Intolerable
120	Heavy rock concert	Extremely noisy
110	Grinding on steel	
100	Loud car horn at 3 m	Very noisy
90	Construction site with pneumatic hammering	
80	Kerbside of busy street	Loud
70	Loud radio or television	
60	Department store	Moderate to quiet
50	General Office	
40	Inside private office	Quiet to very quiet
30	Inside bedroom	
20	Recording studio	Almost silent

Other weightings (eg B, C and D) are less commonly used than A-weighting. Sound Levels measured without any weighting are referred to as 'linear', and the units are expressed as dB(lin) or dB.

3. Sound Power Level

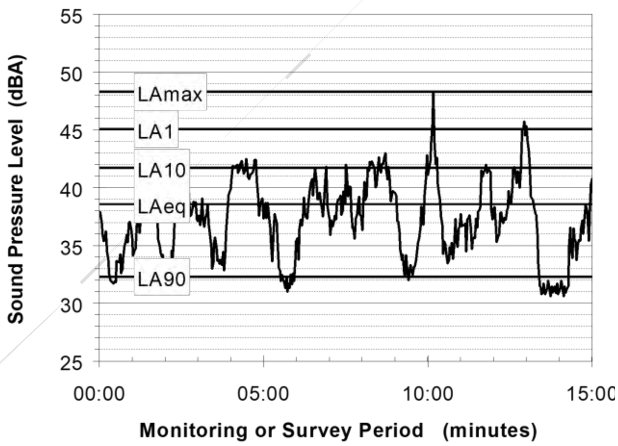
The Sound Power of a source is the rate at which it emits acoustic energy. As with Sound Pressure Levels, Sound Power Levels are expressed in decibel units (dB or dBA), but may be identified by the symbols SWL or LW, or by the reference unit 10^{-12} W.

The relationship between Sound Power and Sound Pressure is similar to the effect of an electric radiator, which is characterised by a power rating but has an effect on the surrounding environment that can be measured in terms of a different parameter, temperature.

4. Statistical Noise Levels

Sounds that vary in level over time, such as road traffic noise and most community noise, are commonly described in terms of the statistical exceedance levels LAN, where LAN is the A-weighted sound pressure level exceeded for N% of a given measurement period. For example, the LA1 is the noise level exceeded for 1% of the time, LA10 the noise exceeded for 10% of the time, and so on.

The following figure presents a hypothetical 15 minute noise survey, illustrating various common statistical indices of interest.



Of particular relevance, are:

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

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

LA90 The noise level exceeded for 90% of the sample period. This noise level is described as the average minimum background sound level (in the absence of the source under consideration), or simply the background level.

LAeq The A-weighted equivalent noise level (basically, the average noise level). It is defined as the steady sound level that contains the same amount of acoustical energy as the corresponding time-varying sound.

5. Frequency Analysis

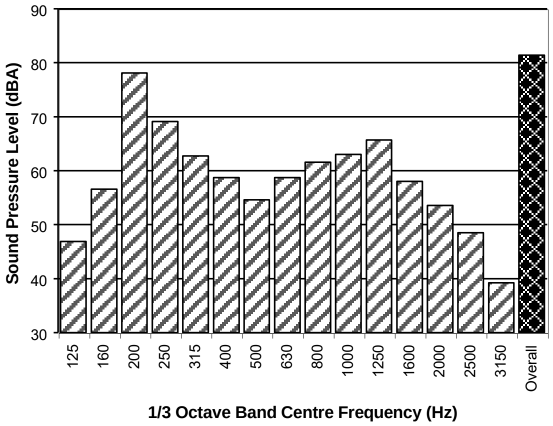
Frequency analysis is the process used to examine the tones (or frequency components) which make up the overall noise or vibration signal.

The units for frequency are Hertz (Hz), which represent the number of cycles per second.

Frequency analysis can be in:

- Octave bands (where the centre frequency and width of each band is double the previous band)
- 1/3 octave bands (three bands in each octave band)
- Narrow band (where the spectrum is divided into 400 or more bands of equal width)

The following figure shows a 1/3 octave band frequency analysis where the noise is dominated by the 200 Hz band. Note that the indicated level of each individual band is less than the overall level, which is the logarithmic sum of the bands.



6. Annoying Noise (Special Audible Characteristics)

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

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

7. Vibration

Vibration may be defined as cyclic or transient motion. This motion can be measured in terms of its displacement, velocity or acceleration. Most assessments of human response to vibration or the risk of damage to buildings use measurements of vibration velocity. These may be expressed in terms of 'peak' velocity or 'rms' velocity.

The former is the maximum instantaneous velocity, without any averaging, and is sometimes referred to as 'peak particle velocity', or PPV. The latter incorporates 'root mean squared' averaging over some defined time period.

Vibration measurements may be carried out in a single axis or alternatively as triaxial measurements (ie vertical, longitudinal and transverse).

The common units for velocity are millimetres per second (mm/s). As with noise, decibel units can also be used, in which case the reference level should always be stated. A vibration level V, expressed in mm/s can be converted to decibels by the formula 20 log (V/Vo), where Vo is the reference level (10^{-9} m/s). Care is required in this regard, as other reference levels may be used.

8. Human Perception of Vibration

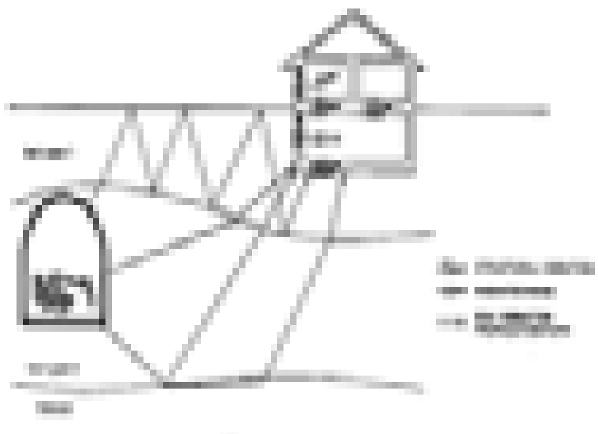
People are able to 'feel' vibration at levels lower than those required to cause even superficial damage to the most susceptible classes of building (even though they may not be disturbed by the motion). An individual's perception of motion or response to vibration depends very strongly on previous experience and expectations, and on other connotations associated with the perceived source of the vibration. For example, the vibration that a person responds to as 'normal' in a car, bus or train is considerably higher than what is perceived as 'normal' in a shop, office or dwelling.

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

Noise that propagates through a structure as vibration and is radiated by vibrating wall and floor surfaces is termed 'structure-borne noise', 'ground-borne noise' or 'regenerated noise'. This noise originates as vibration and propagates between the source and receiver through the ground and/or building structural elements, rather than through the air.

Typical sources of ground-borne or structure-borne noise include tunnelling works, underground railways, excavation plant (eg rockbreakers), and building services plant (eg fans, compressors and generators).

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



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

APPENDIX B

Calibration Certificates

CERTIFICATE OF CALIBRATION

CERTIFICATE NO.: **SLM 23293 & FILT 4792**

Equipment Description:	Sound & Vibration Analyser		
Manufacturer:	B&K		
Model No:	2250	**Serial No:**	3003389
Microphone Type:	4950	**Serial No:**	2913816
Preamplifier Type:	ZC0032	**Serial No:**	20519
Filter Type:	1/3 Octave	**Serial No:**	3003389
Comments:	All tests passed for class 1. (See over for details)		
Owner:	SLR Consulting Australia Pty Ltd Level 2, 2 Lincoln Street Lane Cove, NSW 2066		
Ambient Pressure:	990 hPa ±1.5 hPa		
Temperature:	25 °C ±2° C	**Relative Humidity:**	29% ±5%
Date of Calibration:	06/08/2018	**Issue Date:**	07/08/2018
Acu-Vib Test Procedure:	AVP10 (SLM) & AVP06 (Filters)		

CHECKED BY: JK **AUTHORISED SIGNATURE:** Jack Kielt

Accredited for compliance with ISO/IEC 17025 - Calibration
The results of the tests, calibration and/or measurements included in this document are traceable to Australian/national standards.

NATA
WORLD RECOGNISED ACCREDITATION

Accredited Lab. No. 9262
Acoustic and Vibration Measurements

ACU-VIB ELECTRONICS

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CERTIFICATE NO.: SLM 23293 & FILT 4792

The performance characteristics listed below were tested. The tests are based on the relevant clauses of IEC 61672-3:2013

Tests Performed:	*Clause*	*Result*
Absolute Calibration	10	Pass
Acoustical Frequency Weighting	12	Pass
Self Generated Noise	11.1	Entered
Electrical Noise	11.2	Entered
Long Term Stability	15	Pass
Electrical Frequency Weightings	13	Pass
Frequency and Time Weightings	14	Pass
Reference Level Linearity	16	Pass
Range Level Linearity	17	NA
Toneburst	18	Pass
Peak C Sound Level	19	Pass
Overload Indicator	20	Pass
High Level Stability	21	Pass

Statement of Compliance: The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2013, for the environmental conditions under which the tests were performed. As public evidence was available, from an independent organization responsible for approving the results of pattern evaluation tests performed in accordance with IEC 61672-2:2013, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2013, the sound level meter submitted for testing conforms to the class 1 requirements of IEC61672-1:2013.
A full technical report is available if required.

This Sound Level Meter included an Octave Filter Set. Tests were based on IEC 1260: 1995 and AS/NZS 4476 - 1997 and were conducted to test the following performance characteristics:

1. Relative attenuation clause 5.3

Date of Calibration: 06/08/2018 **Issue Date:** 07/08/2018

Checked by: ....

Accredited for compliance with ISO/IEC 17025 - Calibration
The results of the tests, calibration and/or measurements included in this document are traceable to Australian/national standards.

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www.acousticresearch.com.au

Sound Level Meter

AS 1259.1:1990 - AS 1259.2:1990

Calibration Certificate

Calibration Number C17235

Client Details	[illegible] Consulting Australia Pty Ltd
	[illegible] Lincoln Street
	Lane Cove NSW 2066

Equipment Tested/ Model Number :	ARL EL 316
Instrument Serial Number :	16-207-[illegible]50
Microphone Serial Number :	318219
Pre-amplifier Serial Number :	27911

Atmospheric Conditions

Ambient Temperature :	[illegible]
Relative Humidity :	[illegible]
Barometric Pressure :	100.0[illegible]kPa

Calibration Technician :	Vicky [illegible]swal	**Secondary Check:**	Riley Cooper
Calibration Date :	30/05/[illegible]017	**Report Issue Date :**	31/05/2017

Approval Signatory : Ken Williams

Clause and Characteristic Tested	Result	Clause and Characteristic Tested	Result
10.2.2: Absolute sensitivity	*Pass*	[illegible] Inherent system noise level	*Pass*
10.2.3: Frequency weighting	*Pass*	10.4.2: Time weighting characteristic F and S	*Pass*
10.3.[illegible]: [illegible] indications	*Pass*	10.4.3: Time weighting characteristic I	*Pass*
[illegible]: Accuracy of level range control	*Pass*	10.4.5: R.M.S. performance	*Pass*
8.9: Detector-indicator linearity	*Pass*	9.[illegible]: Time averaging	*Pass*
8.10: Differential level linearity	*Pass*	9.3.5: Overload indication	*Pass*

Least Uncertainties of Measurement -

Acoustic Tests		Environmental Conditions	
[illegible] Hz to 8kHz	*[illegible]12dB*	*Temperature*	[illegible]
12.5kHz	[illegible]	*Relative Humidity*	[illegible]
16kHz	[illegible]	*Barometric Pressure*	[illegible] Pa
Electrical Tests			
[illegible] Hz to 20kHz	*±0.12dB*		

All uncertainties are derived at the 95% confidence level with a coverage factor of 2.

The sound level meter under test has been shown to conform to the type 1 requirements for periodic testing as described in AS 1259.1:1990 and AS 1259.2:1990 for the tests stated above.

This calibration certificate is to be read in conjunction with the calibration test report.

Acoustic Research Labs Pty Ltd is NATA Accredited Laboratory Number 14172.
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The results of the tests, calibrations and/or measurements included in this document are traceable to Australian national standards.

NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration and inspection reports.

Level 7 Building 2 423 Pennant Hills Rd
Pennant Hills NSW AUSTRALIA 2120
Ph: +61 2 9484 0800 A.B.N. 65 160 399 119
www.acousticresearch.com.au

Sound Level Meter

AS 1259.1:1990 - AS 1259.2:1990

Calibration Certificate

Calibration Number C17217

Client Details	SLR Consulting Australia Pty Ltd 2 Lincoln Street Lane Cove NSW 2066
Equipment Tested/ Model Number :	ARL [illegible]
Instrument Serial Number :	16-203-[illegible]
Microphone Serial Number :	[illegible]080
Pre-amplifier Serial Number :	[illegible]089

Atmospheric Conditions

Ambient Temperature :	24.9°C
Relative Humidity :	46.4%
Barometric Pressure :	100.27kPa

Calibration Technician :	Vicky [illegible]	Secondary Check:	Riley Couper
Calibration Date :	09/06/2017	Report Issue Date :	13/06/2017

Approved Signatory : Ken Williams

Clause and Characteristic Tested	Result	Clause and Characteristic Tested	Result
10.2.[illegible]: Absolute sensitivity	Pass	10.3.[illegible]: Inherent system noise level	Pass
10.[illegible]: Frequency weighting	Pass	10.4.[illegible]: Time weighting characteristic F and S	Pass
10.[illegible]: Overload indications	Pass	10.[illegible]: Time weighting characteristic I	Pass
10.3.3: Accuracy of level range control	Pass	10.4.5: R.M.S performance	Pass
8.9: Detector-indicator linearity	Pass	9.3.2: Time averaging	Pass
8.10: Differential level linearity	Pass	9.3.5: Overload indication	Pass

Least Uncertainties of Measurement

Acoustic Tests		Environmental Conditions	
31.5 Hz to 8kHz	*±0.16dB*	*Temperature*	*±0.05°C*
12.5kHz	*±0.2dB*	*Relative Humidity*	[illegible]
16kHz	*±0.29dB*	*Barometric Pressure*	*±0.01kPa*
Electrical Tests			
31.5 Hz to [illegible]kHz	*±0.12dB*		

All uncertainties are derived at the [illegible] confidence level with a coverage factor of [illegible]

The sound level meter under test has been shown to conform to the type 1 requirements for periodic testing as described in AS 1259.1:1990 and AS 1259.2:1990 for the tests stated above.

This calibration certificate is to be read in conjunction with the calibration test report.

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Acoustic Research Labs Pty Ltd
Level 7 Building 2 [illegible] Pennant Hills Rd
Pennant Hills NSW AUSTRALIA [illegible]
Ph: [illegible] A.B.N [illegible]
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Sound Level Meter
AS 1259.1:1990 - AS 1259.2:1990
Calibration Certificate

Calibration Number C18314

Client Details SLR Consulting
Suite 2, 2 Domville Avenue
Hawthorn VIC 3122

Equipment Tested/ Model Number : ARL EL-316
Instrument Serial Number : 16-207-[illegible]
Microphone Serial Number : 319922
Pre-amplifier Serial Number : 27434

Atmospheric Conditions
Ambient Temperature : 21.7°C
Relative Humidity : 45.3%
Barometric Pressure : 99.36kPa

Calibration Technician : Lucky Jaiswal
Calibration Date : 14 Jun 2018
Secondary Check: [illegible]
Report Issue Date : 14 Jun 2018

Approved Signatory : Ken Williams

Clause and Characteristic Tested	Result	Clause and Characteristic Tested	Result
10.2.2: Absolute sensitivity	Pass	10.3.4: Inherent system noise level	Pass
10.2.3: Frequency weighting	Pass	10.4.2: Time weighting characteristic F and S	Pass
10.3.2: Overload indication	Pass	10.4.3: Time weighting characteristic I	Pass
10.3.3: Accuracy of level range control	Pass	10.4.5: R.M.S performance	Pass
8.9: Detector-indicator linearity	Pass	9.3.2: Time averaging	Pass
8.10: Differential level linearity	Pass	9.3.5: Overload indication	Pass

Least Uncertainties of Measurement

Acoustic Tests		Environmental Conditions	
31.5 Hz to 8kHz	±0.12dB	Temperature	±[illegible]
12.5kHz	±[illegible]dB	Relative Humidity	±[illegible]
16kHz	±0.29dB	Barometric Pressure	±[illegible]
Electrical Tests			
31.5 Hz to 20kHz	±0.12dB		

All uncertainties are derived at the 95% confidence level with a coverage factor of 2.

The sound level meter under test has been shown to conform to the type 1 requirements for periodic testing described in AS 1259.1:1990 and AS 1259.2:1990 for the tests stated above.

This calibration certificate is to be read in conjunction with the calibration test report.

Acoustic Research Labs Pty Ltd is NATA Accredited Laboratory Number [illegible]
Accredited for compliance with ISO/IEC 17025 - Calibration

The results of the tests, calibration and/or measurements included in this document are traceable to Australian/National Standards.

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Sound Level Meter

AS 1259.1:1990 - AS 1259.2:1990

Calibration Certificate

Calibration Number C17277

Client Details SLR Consulting
Suite 2, 2 Domville Avenue
Hawthorn VIC 3122

Equipment Tested/ Model Number : ARL EL-316
Instrument Serial Number : 16-203-505
Microphone Serial Number : 318370
Pre-amplifier Serial Number : 26962

Atmospheric Conditions
Ambient Temperature : 24.9°C
Relative Humidity : 44.3%
Barometric Pressure : 100.78kPa

Calibration Technician : Vicky Jaiswal **Secondary Check:** Riley Cooper
Calibration Date : 14/06/2017 **Report Issue Date :** 15/06/2017

Approved Signatory : Ken Williams

Clause and Characteristic Tested	Result	Clause and Characteristic Tested	Result
10.2.2: Absolute sensitivity	*Pass*	10.3.4: Inherent system noise level	*Pass*
10.2.3: Frequency weighting	*Pass*	10.4.2: Time weighting characteristic F and S	*Pass*
10.3.2: Overload indications	*Pass*	10.4.3: Time weighting characteristic I	*Pass*
10.3.3: Accuracy of level range control	*Pass*	10.4.5: R.M.S performance	*Pass*
8.9: Detector-indicator linearity	*Pass*	9.3.2: Time averaging	*Pass*
8.10: Differential level linearity	*Pass*	9.3.5: Overload indication	*Pass*

Least Uncertainties of Measurement -

Acoustic Tests		Environmental Conditions	
31.5 Hz to 8kHz	*±0.16dB*	*Temperature*	*±0.05°C*
12.5kHz	*±0.2dB*	*Relative Humidity*	*±0.46%*
16kHz	*±0.29dB*	*Barometric Pressure*	*±0.017Pa*
Electrical Tests			
31.5 Hz to 20 kHz	*±0.12dB*		

All uncertainties are derived at the 95% confidence level with a coverage factor of 2.

The sound level meter under test has been shown to conform to the type 1 requirements for periodic testing as described in AS 1259.1:1990 and AS 1259.2:1990 for the tests stated above.

NATA
WORLD RECOGNISED ACCREDITATION

This calibration certificate is to be read in conjunction with the calibration test report.

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Accredited for compliance with ISO/IEC 17025.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/National standards.

NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration and inspection reports.

Acoustic Research Labs Pty Ltd

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Sound Level Meter

AS 1259.1:1990 – AS 1259.2:1990

Calibration Certificate

Calibration Number C[illegible]

Client Details	SLR Consulting Suite 2, 2 Domville Avenue Hawthorn Vic 3122
Equipment Tested/ Model Number :	ARL EL-316
Instrument Serial Number :	16-103-294
Microphone Serial Number :	317[illegible]50
Pre-amplifier Serial Number :	280[illegible]

Atmospheric Conditions

Ambient Temperature :	[illegible] °C
Relative Humidity :	42.[illegible]%
Barometric Pressure :	99.[illegible] kPa

Calibration Technician :	Lucky Jaswal	**Secondary Check:**	Lewis [illegible]
Calibration Date :	14 Jun 2018	**Report Issue Date :**	14 Jun 2018

Approved Signatory : Ken Williams

Clause and Characteristic Tested	Result	Clause and Characteristic Tested	Result
10.2.1: Absolute sensitivity	*Pass*	[illegible]	*Pass*
10.2.1: Frequency weighting	*Pass*	10.4.5: Time weighting characteristic F and S	*Pass*
10.3.2: Overload indications	*Pass*	10.4.[illegible]: Time weighting characteristic I	*Pass*
10.3.3: Accuracy of level range control	*Pass*	[illegible]: R.M.S performance	*Pass*
8.[illegible]: Detector-indicator linearity	*Pass*	9.[illegible]: Time averaging	*Pass*
[illegible] 10: Differential level linearity	*Pass*	9.[illegible]: Overload indication	*Pass*

Least Uncertainties of Measurement -

Acoustic Tests		Environmental Conditions	
[illegible] kHz	*±0.15dB*	*Temperature*	*±[illegible]°C*
[illegible]	*±0.2[illegible]dB*	*Relative Humidity*	*±[illegible]%*
[illegible]	*±[illegible]dB*	*Barometric Pressure*	*±0.0[illegible]kPa*
Electrical Tests			
[illegible] kHz	*±0.1[illegible]dB*		

All uncertainties are derived at the 95% confidence level with a coverage factor of 2.

The sound level meter under test has been shown to conform to the class [illegible] requirements for [illegible] in AS 1259.1:1990 and AS 1259.2:1990 for the tests stated above.

CERTIFICATE OF CALIBRATION

CERTIFICATE NO.: **SLM 23294 & FILT 4793**

Equipment Description:	Sound & Vibration Analyser		
Manufacturer:	Svantek		
Model No:	Svan-957	**Serial No:**	27522
Microphone Type:	7052E	**Serial No:**	62914
Preamplifier Type:	SV12L	**Serial No:**	49862
Filter Type:	1/1 Octave	**Serial No:**	27522

Comments: All tests passed for class 1.
(See over for details)

Owner: SLR Consulting Australia Pty Ltd
Level 2, 2 Lincoln Street
Lane Cove, NSW 2066

Ambient Pressure: 996 hPa ±1.5 hPa

Temperature: 23 °C ±2° C **Relative Humidity:** 27% ±5%

Date of Calibration: 07/08/2018 **Issue Date:** 07/08/2018

Acu-Vib Test Procedure: AVP10 (SLM) & AVP06 (Filters)

CHECKED BY: IK **AUTHORISED SIGNATURE:** Jack Kielt

Accredited for compliance with ISO/IEC 17025 - Calibration
The results of the tests, calibration and/or measurements included in this document are traceable to Australian/national standards.

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Accredited Lab. No. 9262
Acoustic and Vibration Measurements

ACU-VIB
ELECTRONICS

HEAD OFFICE
Unit 14, 22 Hudson Ave. Castle Hill NSW 2154
Tel: (02) 96808133 Fax: (02)96808233
Mobile: 0413 809806
web site: www.acu-vib.com.au

CERTIFICATE NO.: SLM 23294 & FILT 4793

The performance characteristics listed below were tested. The tests are based on the relevant clauses of IEC 61672-3:2013

Tests Performed:	*Clause*	*Result*
Absolute Calibration	10	Pass
Acoustical Frequency Weighting	12	Pass
Self Generated Noise	11.1	Entered
Electrical Noise	11.2	Entered
Long Term Stability	15	Pass
Electrical Frequency Weightings	13	Pass
Frequency and Time Weightings	14	Pass
Reference Level Linearity	16	Pass
Range Level Linearity	17	Pass
Toneburst	18	Pass
Peak C Sound Level	19	Pass
Overload Indicator	20	Pass
High Level Stability	21	Pass

Statement of Compliance: The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2013, for the environmental conditions under which the tests were performed. As public evidence was available, from an independent organization responsible for approving the results of pattern evaluation tests performed in accordance with IEC 61672-2:2013, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2013, the sound level meter submitted for testing conforms to the class 1 requirements of IEC61672-1:2013.
A full technical report is available if required.

This Sound Level Meter included an Octave Filter Set. Tests were based on IEC 1260: 1995 and AS/NZS 4476 - 1997 and were conducted to test the following performance characteristics:

1. Relative attenuation clause 5.3

Date of Calibration: 07/08/2018 **Issue Date:** 07/08/2018

Checked by: ..KK..

Accredited for compliance with ISO/IEC 17025 - Calibration
The results of the tests, calibration and/or measurements included in this document are traceable to Australian/national standards.

NATA
WORLD RECOGNISED ACCREDITATION

Accredited Lab. No. 9262
Acoustic and Vibration Measurements

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ELECTRONICS
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Mobile: 0413 809806
web site: www.acu-vib.com.au

APPENDIX C

Noise Monitoring Locations

D:\Quick Jobs\Martin Davenport\Donaldson\SLR6300105301200_A8_MonitoringLocations_01.mxd

SLR
10 KINGS ROAD
NEW LAMBTON
NEW SOUTH WALES 2305
AUSTRALIA
T: 61 2 4037 3200
F: 61 2 4037 3201
www.slrconsulting.com

Project No.:	630.01053.01200
Date:	11/01/2018
Drawn by:	NT
Scale:	1:45,000
Sheet Size:	A4
Projection:	GDA 1994 MGA Zone 56

LEGEND

Noise Monitoring Locations

N
W E
S

0 500 1,000 1,500 2,000 m

Donaldson Coal

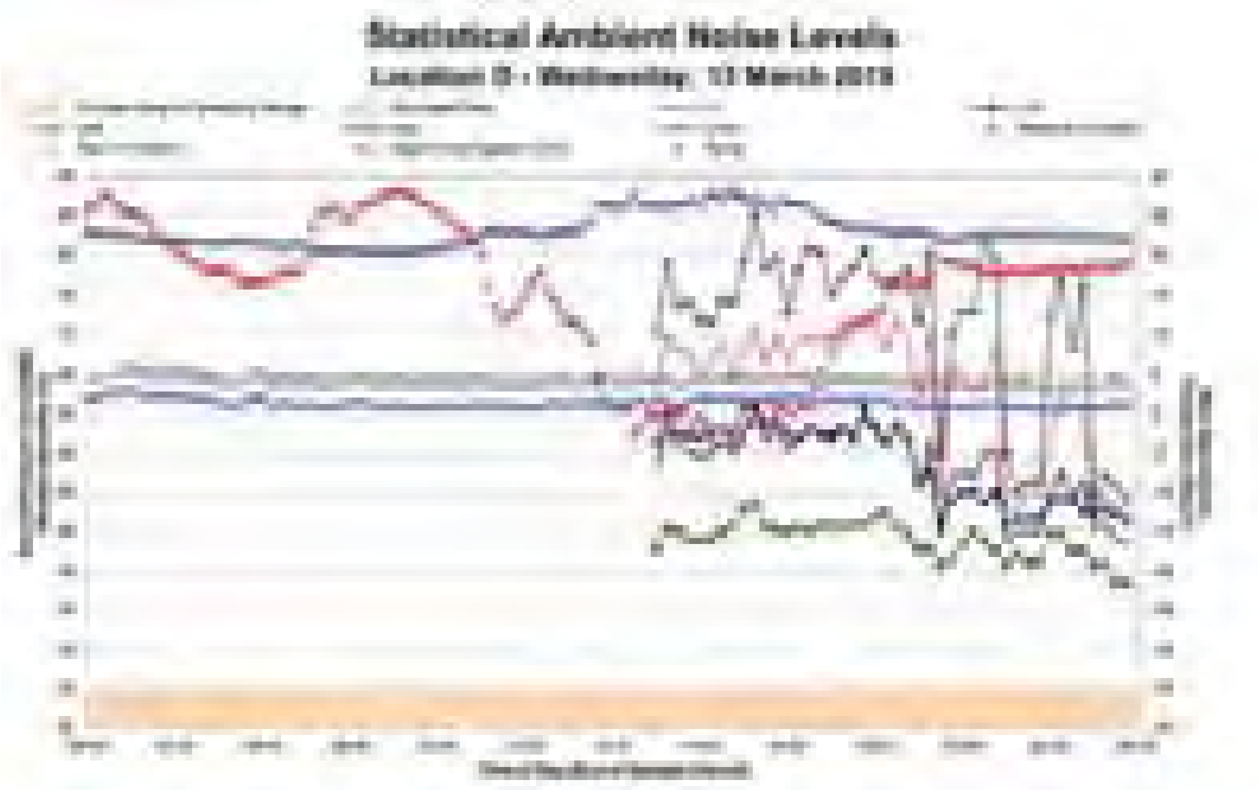
Noise Monitoring

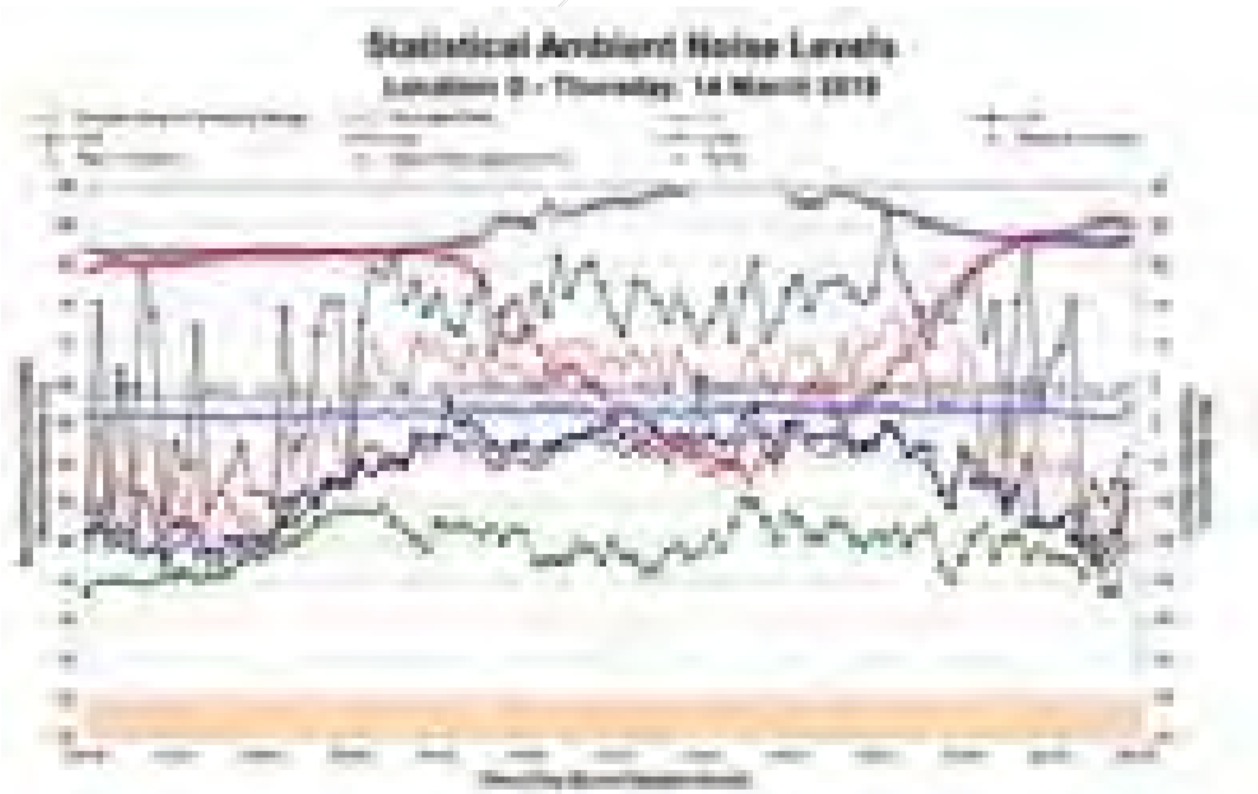
Noise Monitoring Locations

APPENDIX B

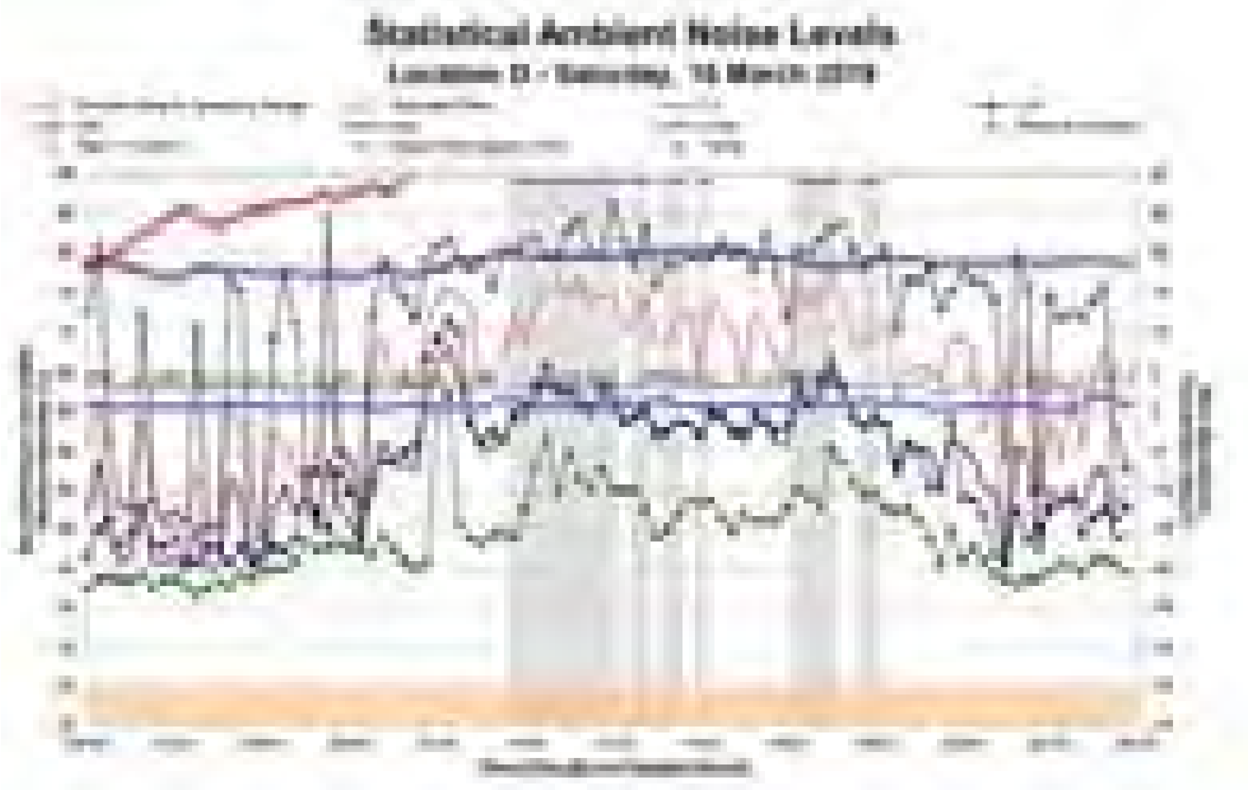
APPENDIX D

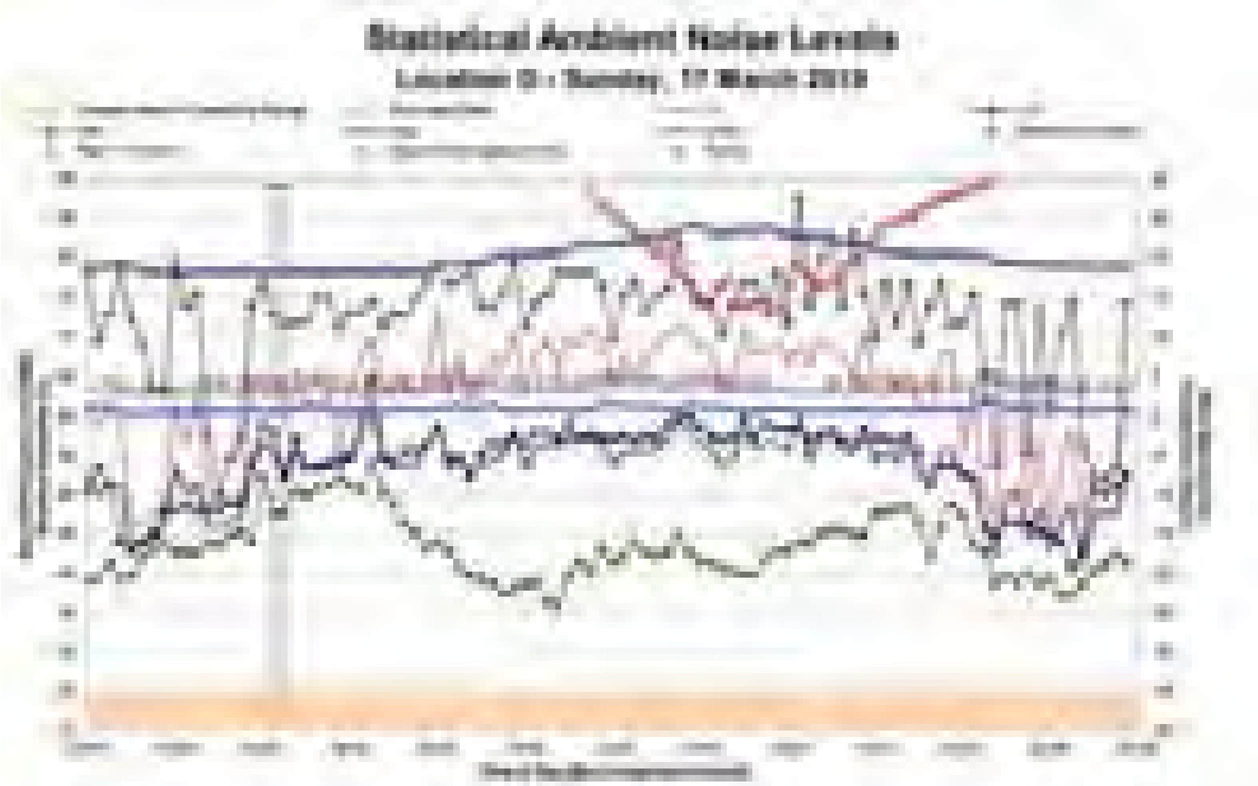
Statistical Ambient Noise Levels

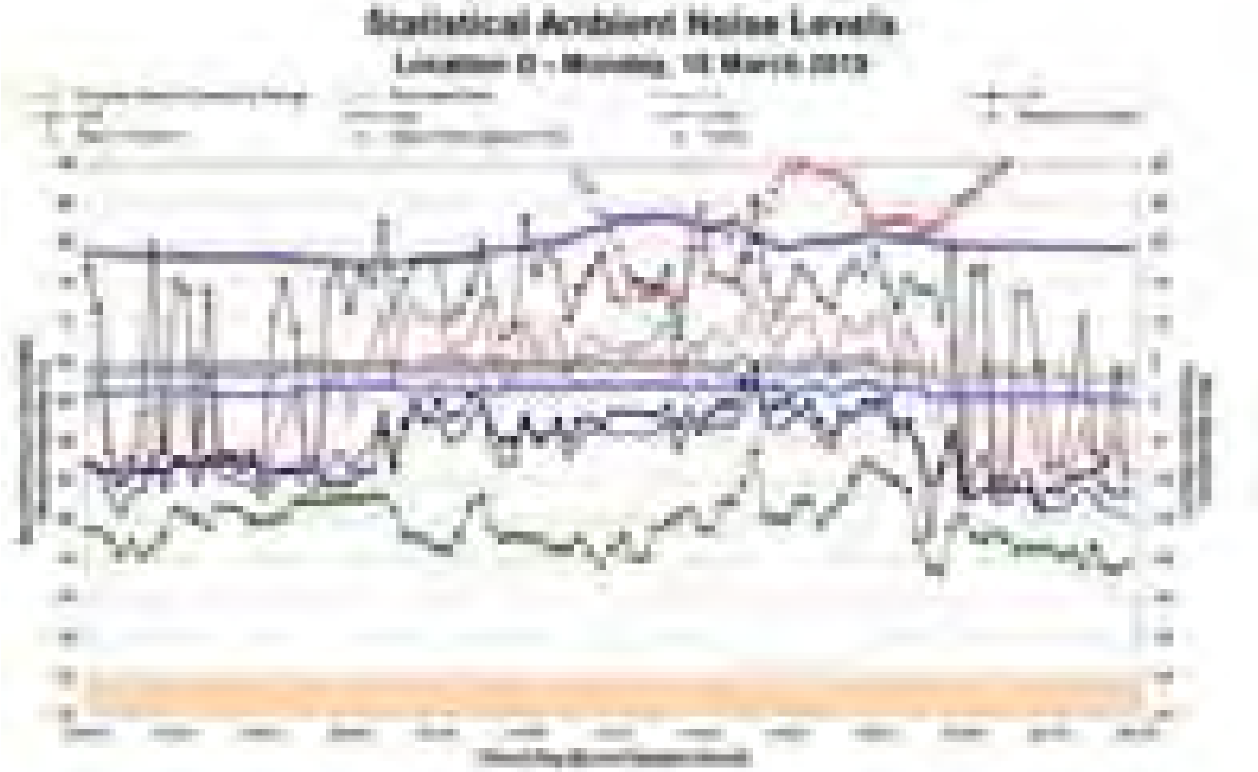


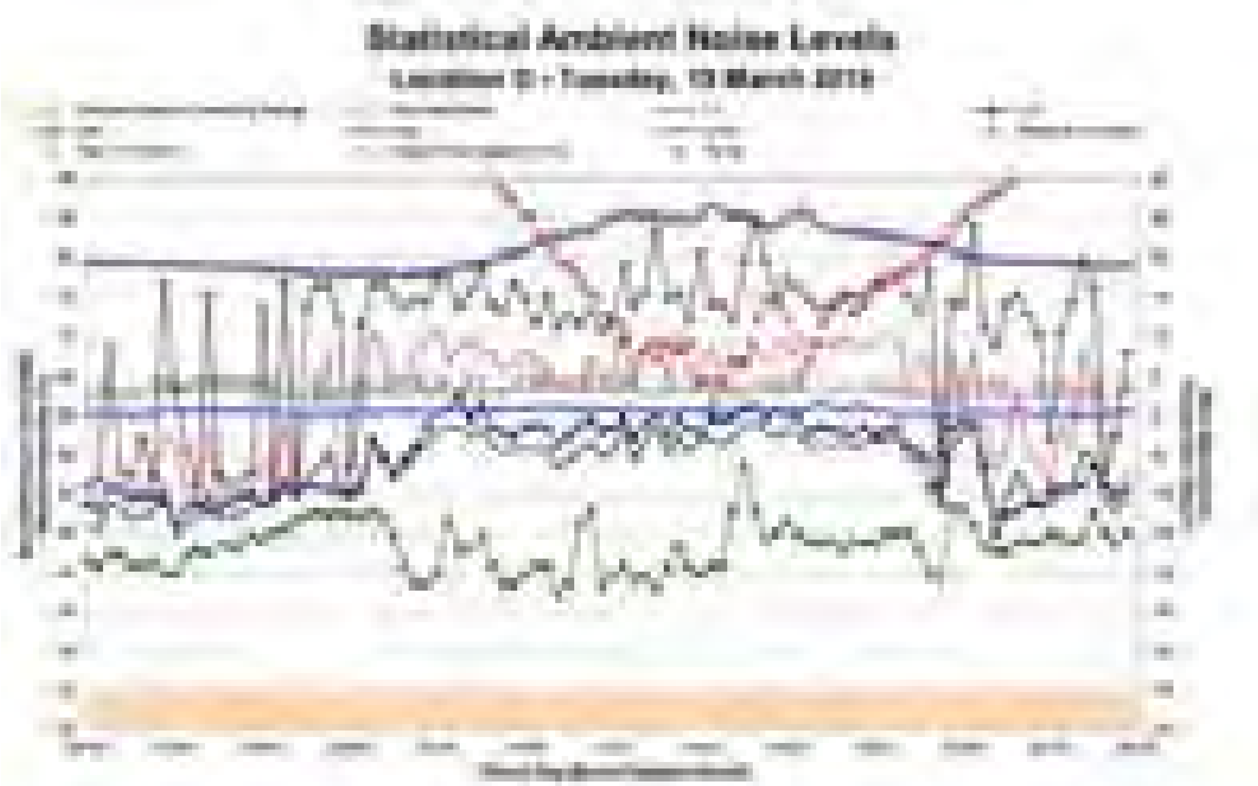


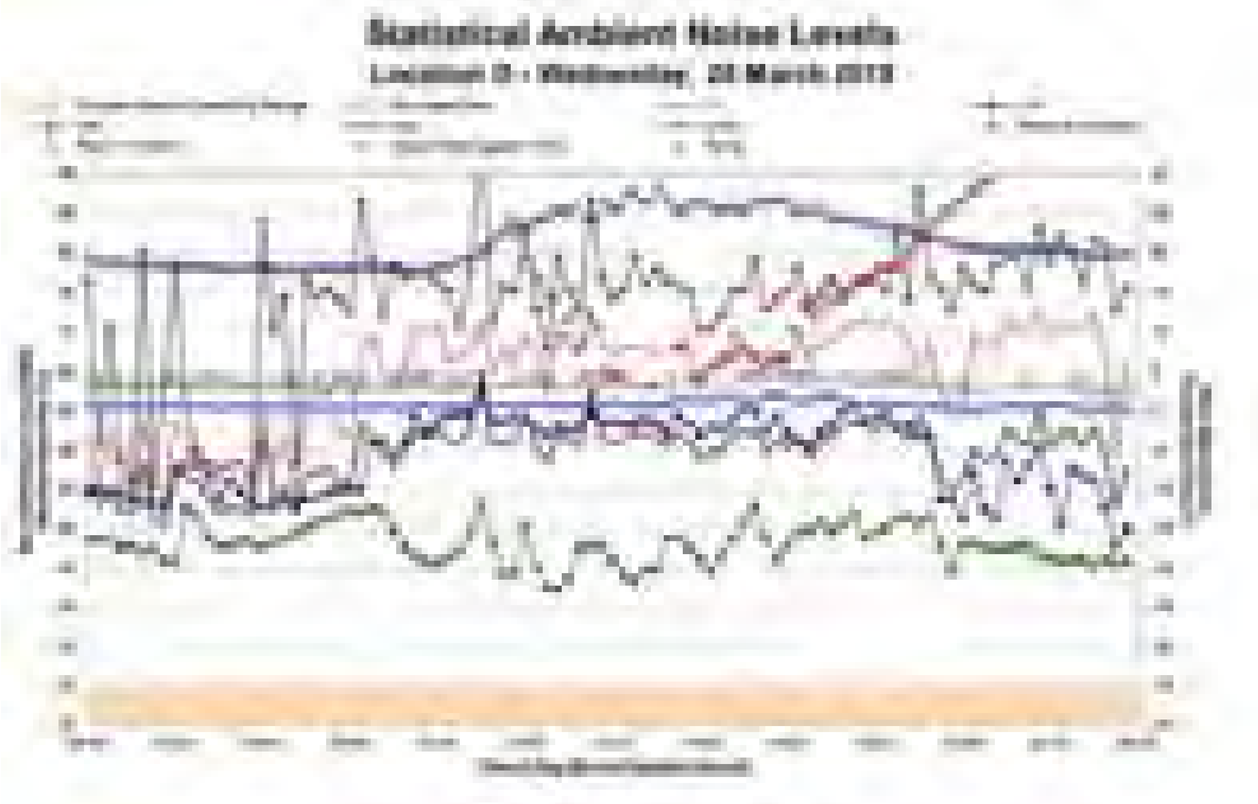

Statistical Ambient Noise Levels
Location D - Friday, 15 March 2019

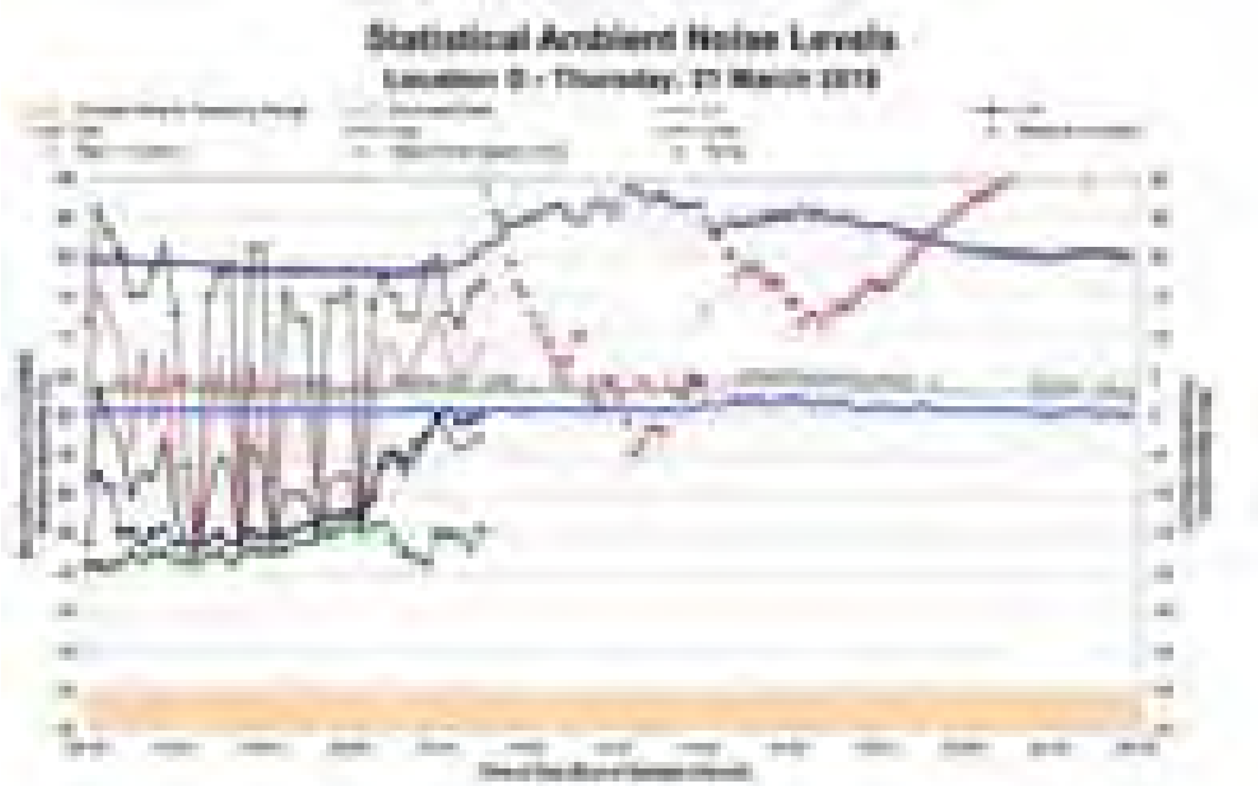

Statistical Ambient Noise Levels
Location D - Saturday, 16 March 2019

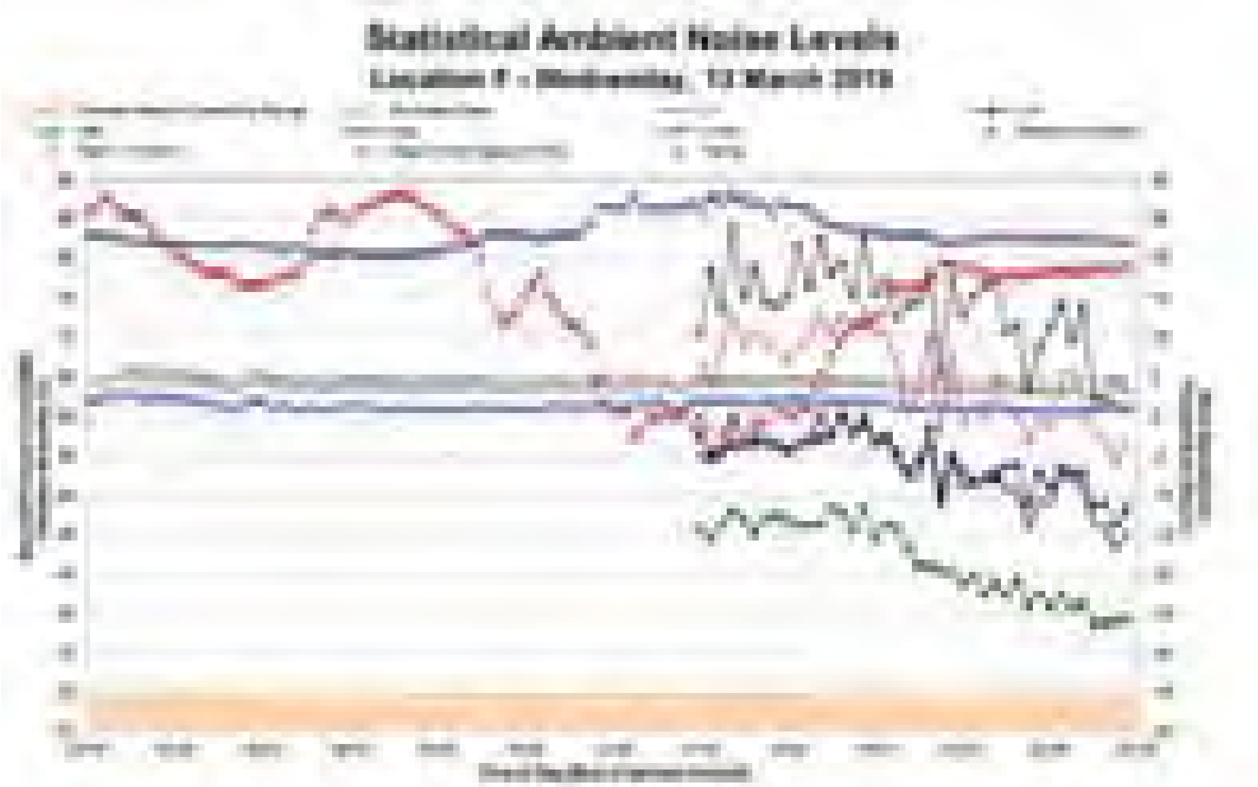

Statistical Ambient Noise Levels
Location D - Sunday, 17 March 2019

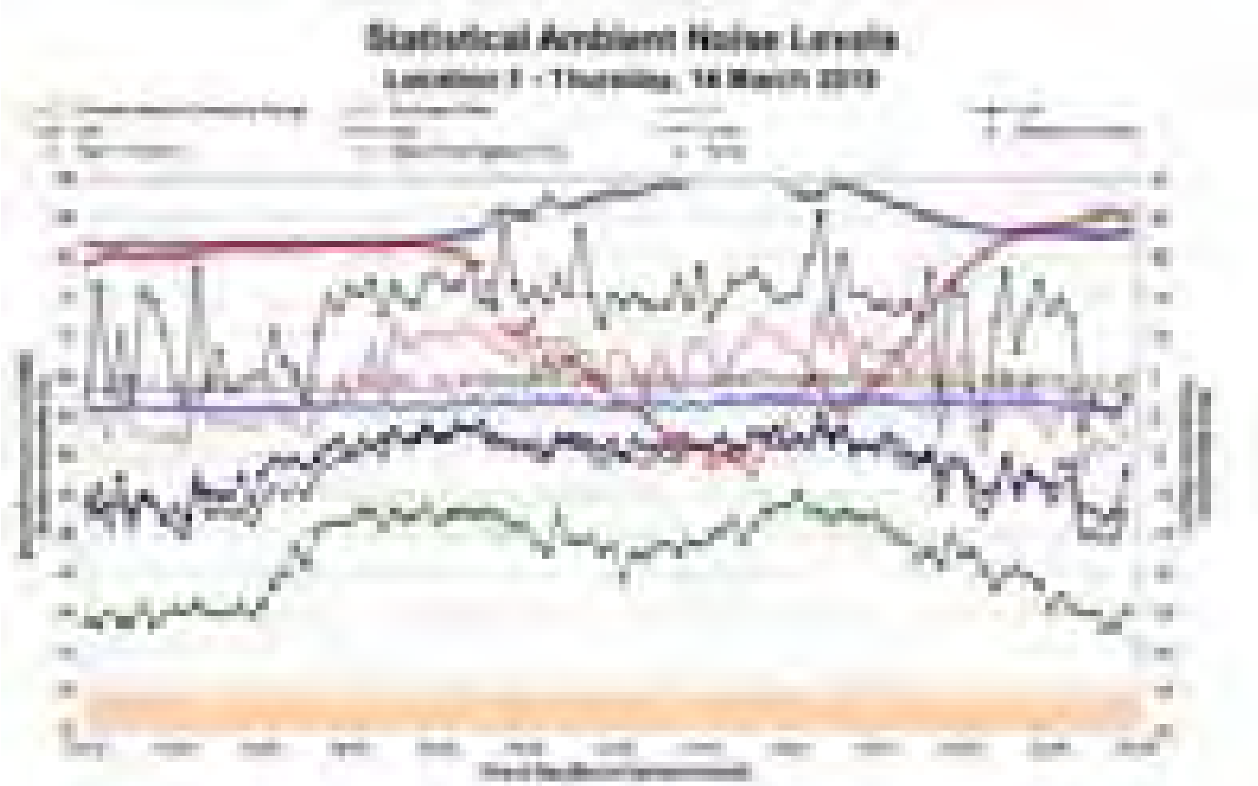

Statistical Ambient Noise Levels
Location D - Monday, 18 March 2019

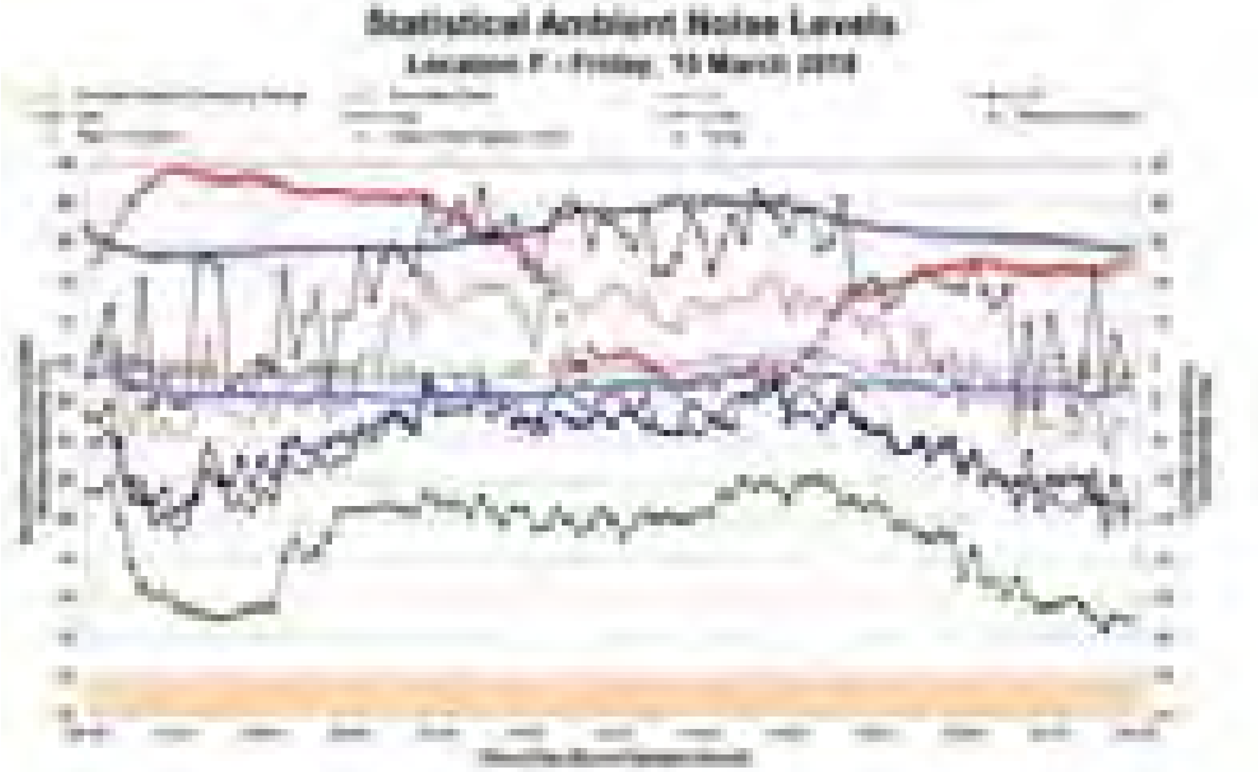

Statistical Ambient Noise Levels


Statistical Ambient Noise Levels


Statistical Ambient Noise Levels
Location D - Thursday, 21 March 2019


Statistical Ambient Noise Levels
Location F - Wednesday, 13 March 2019


Statistical Ambient Noise Levels
Location F - Thursday, 14 March 2019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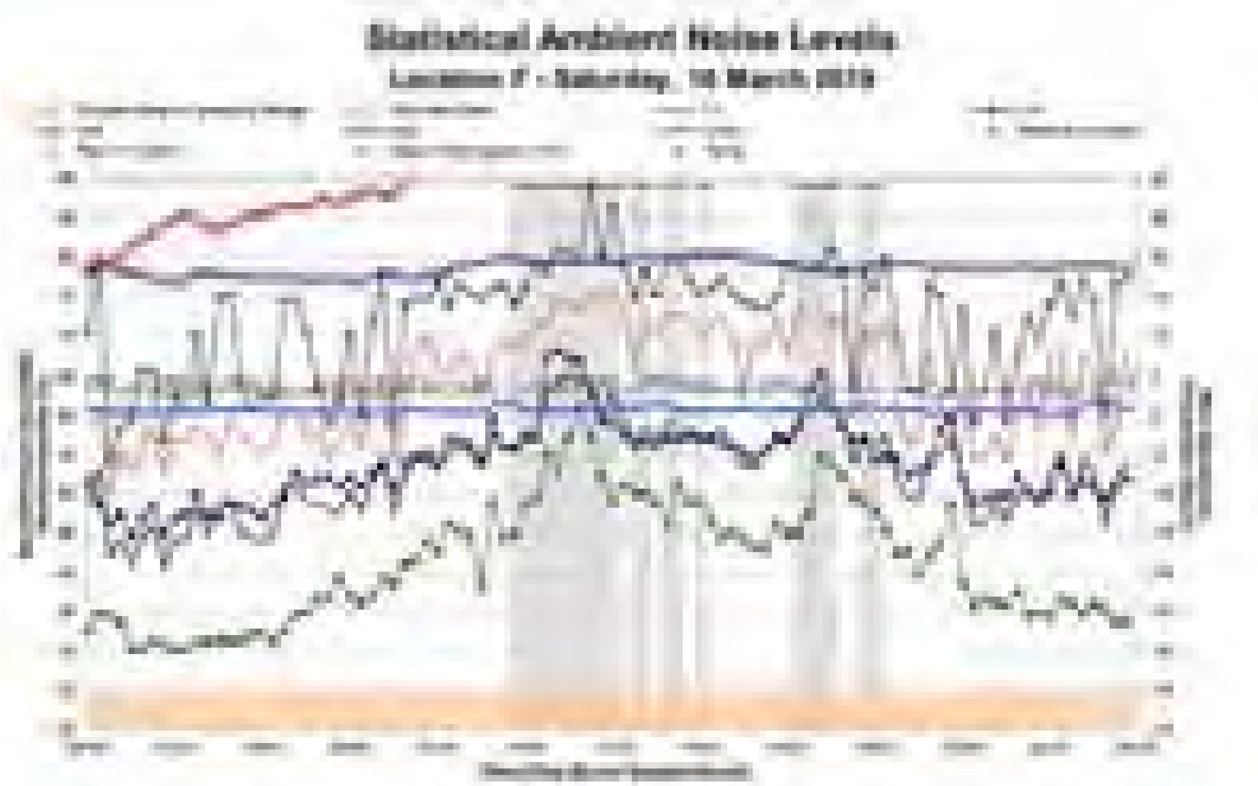
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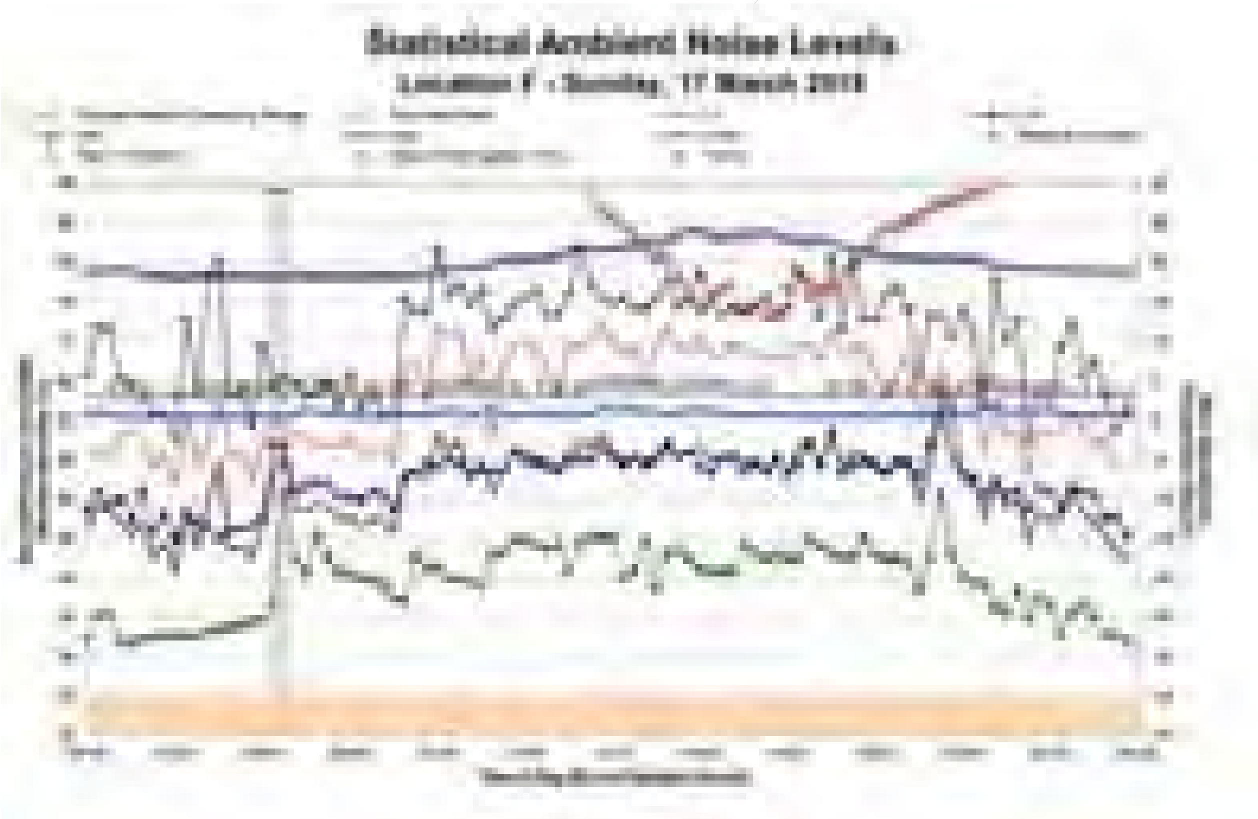
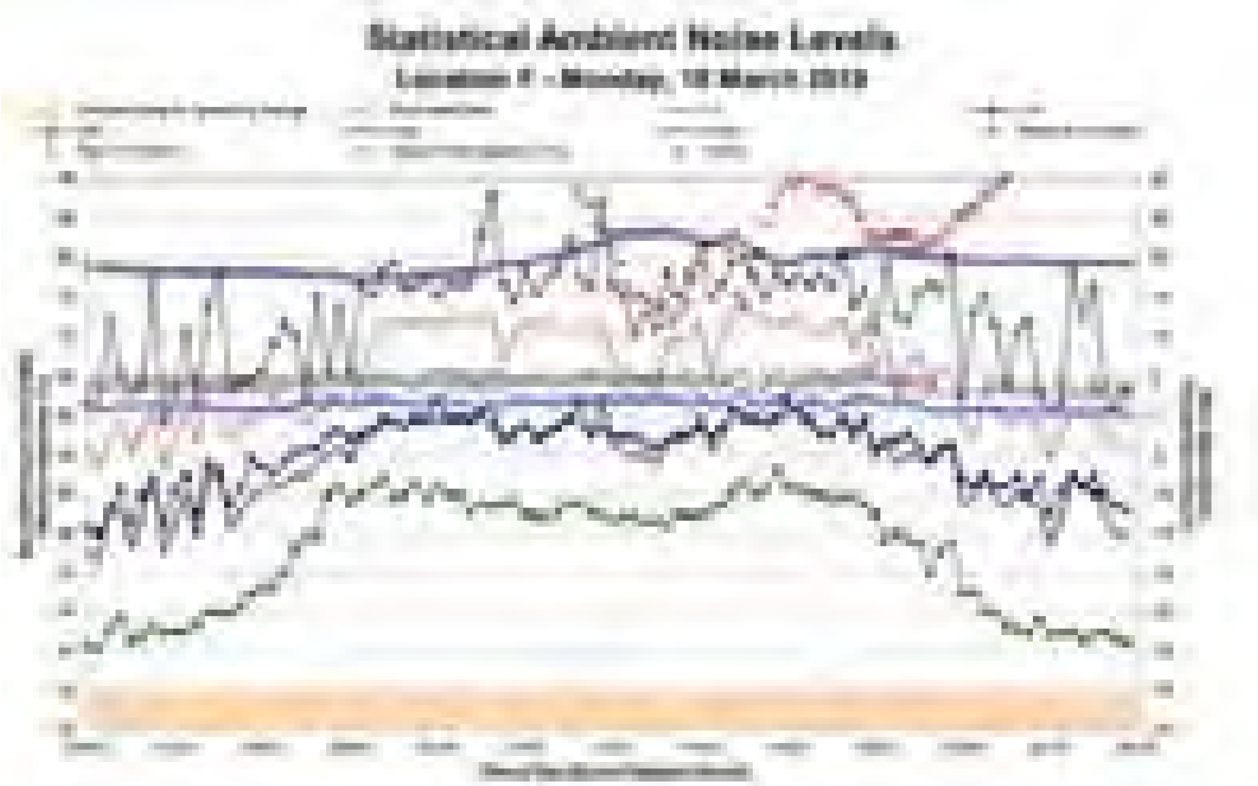
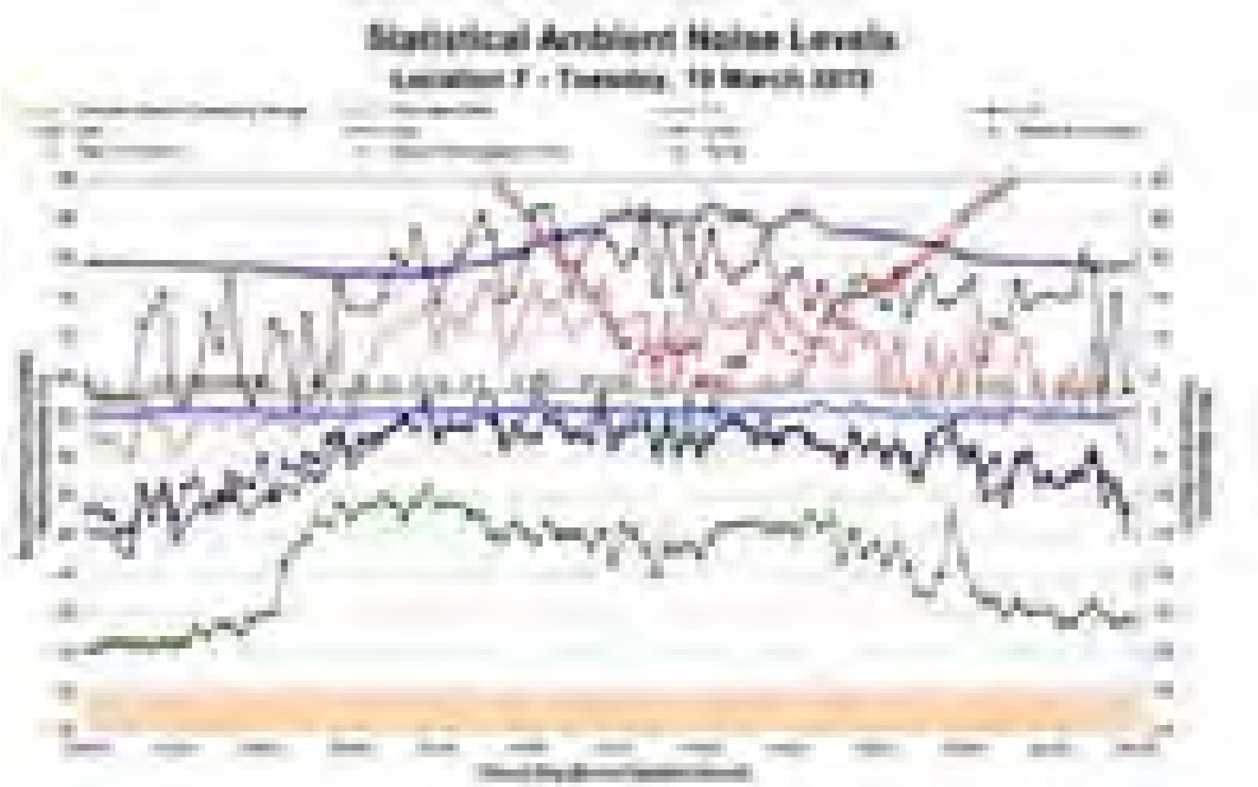
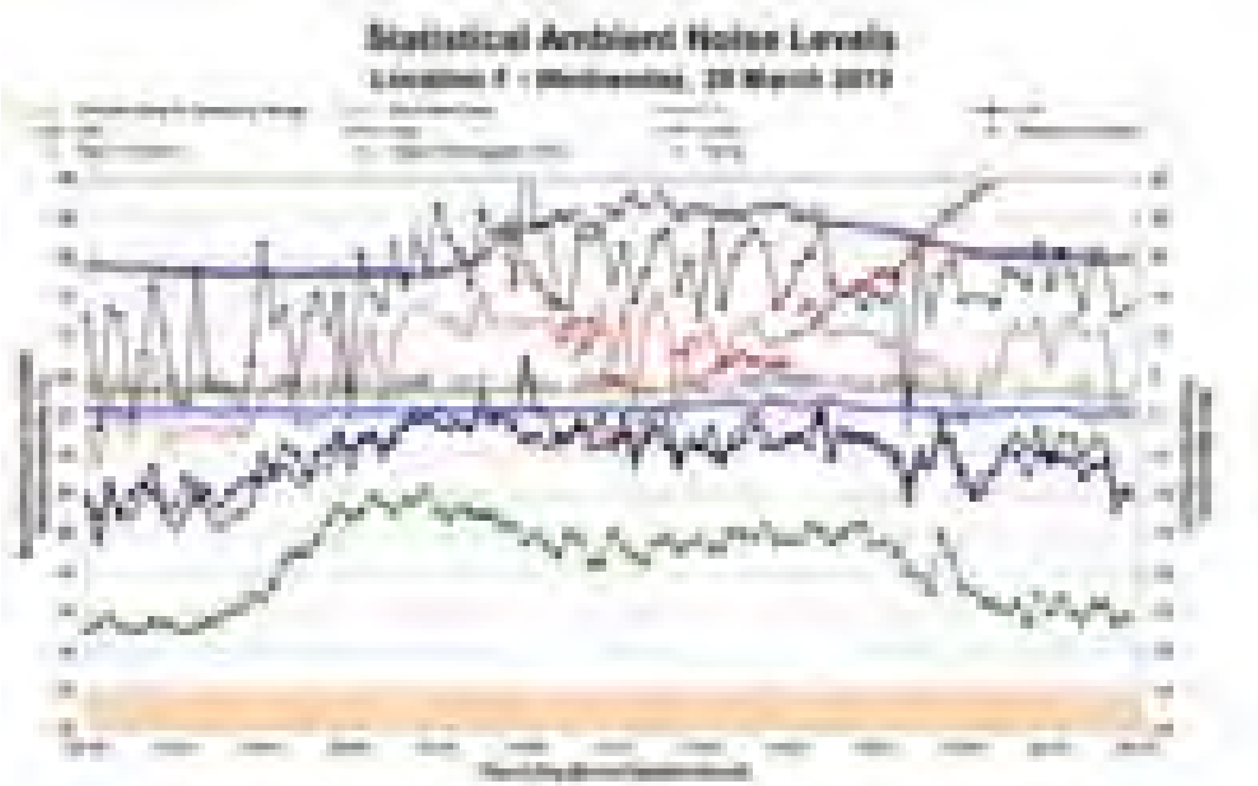
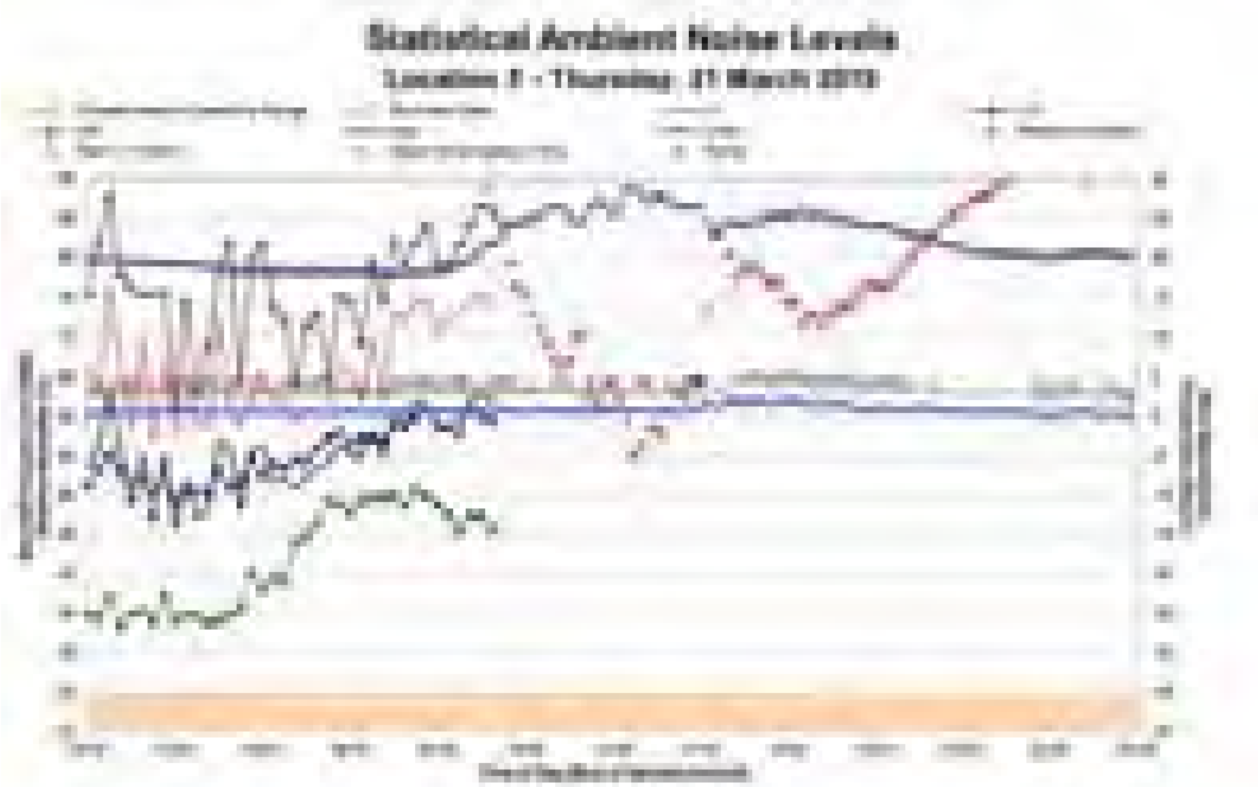
Location F - Saturday, 16 March 2019

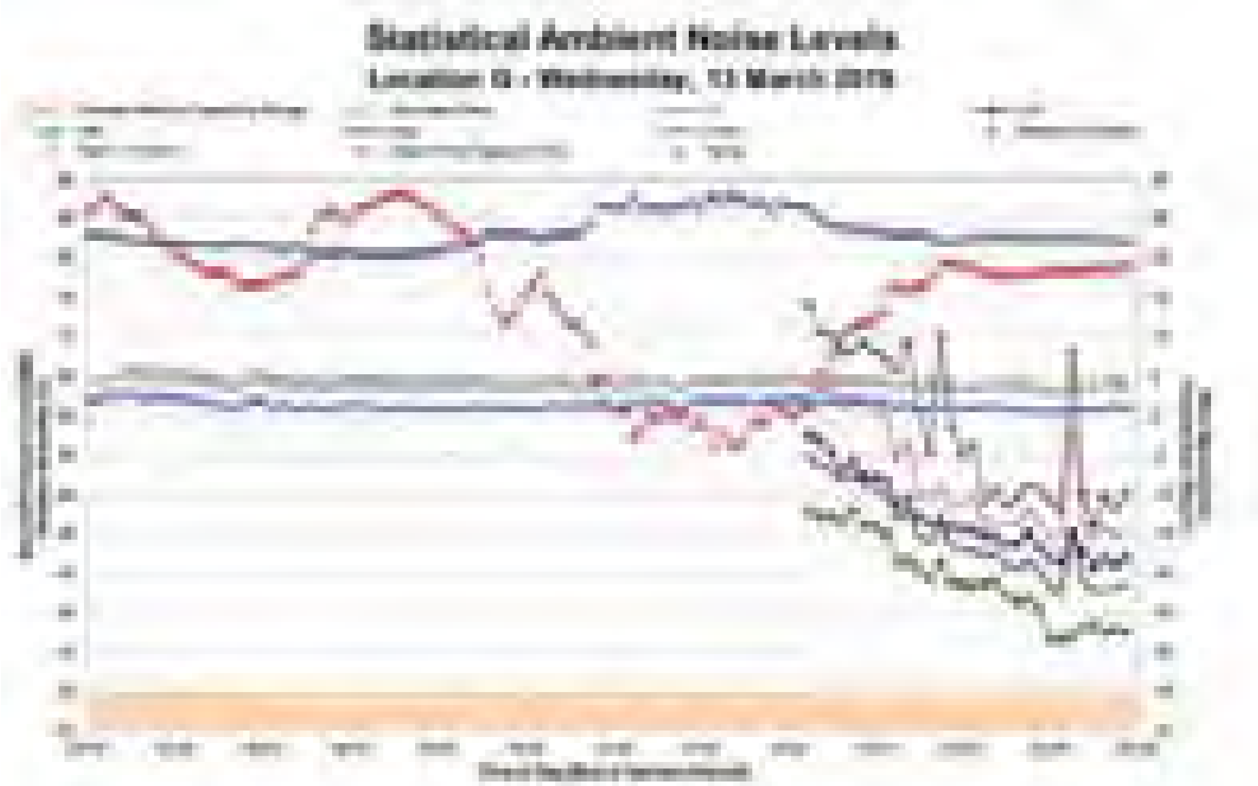

Statistical Ambient Noise Levels
Location F - Sunday, 17 March 2019

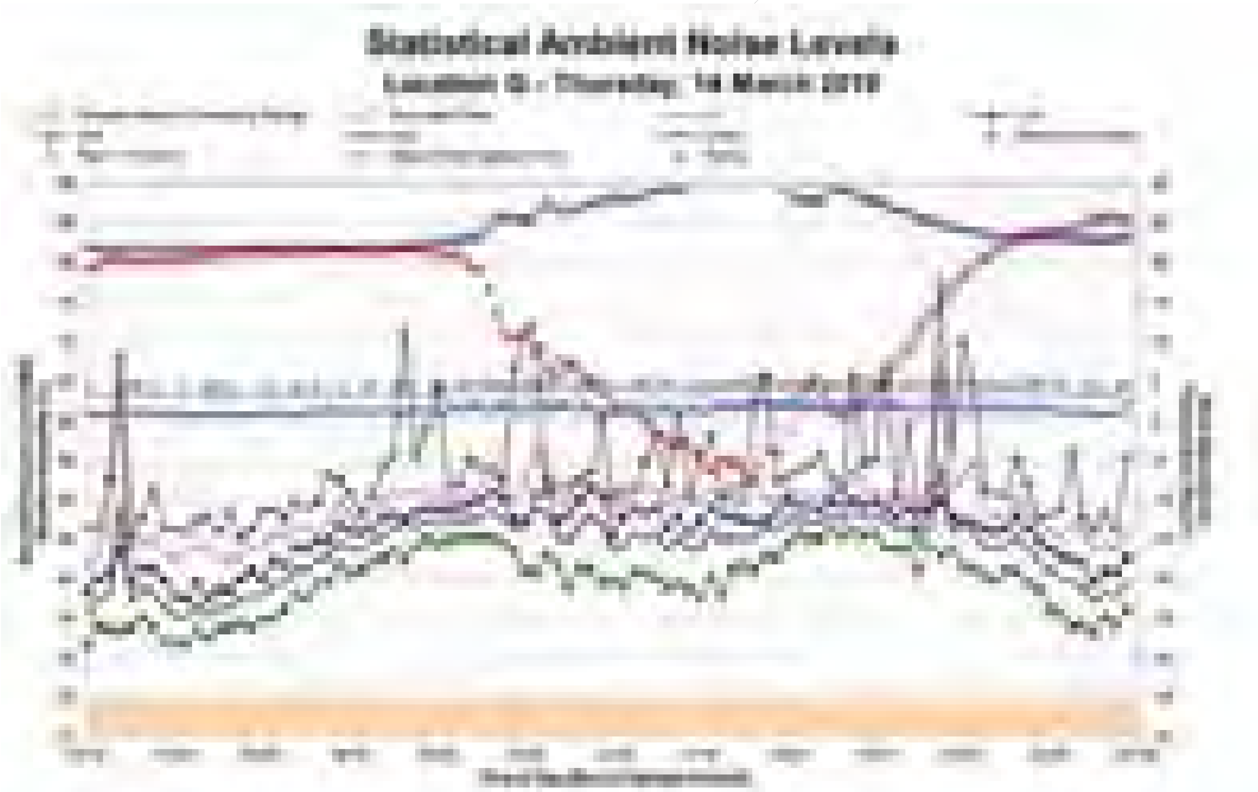

Statistical Ambient Noise Levels
Location 7 - Monday, 18 March 2019

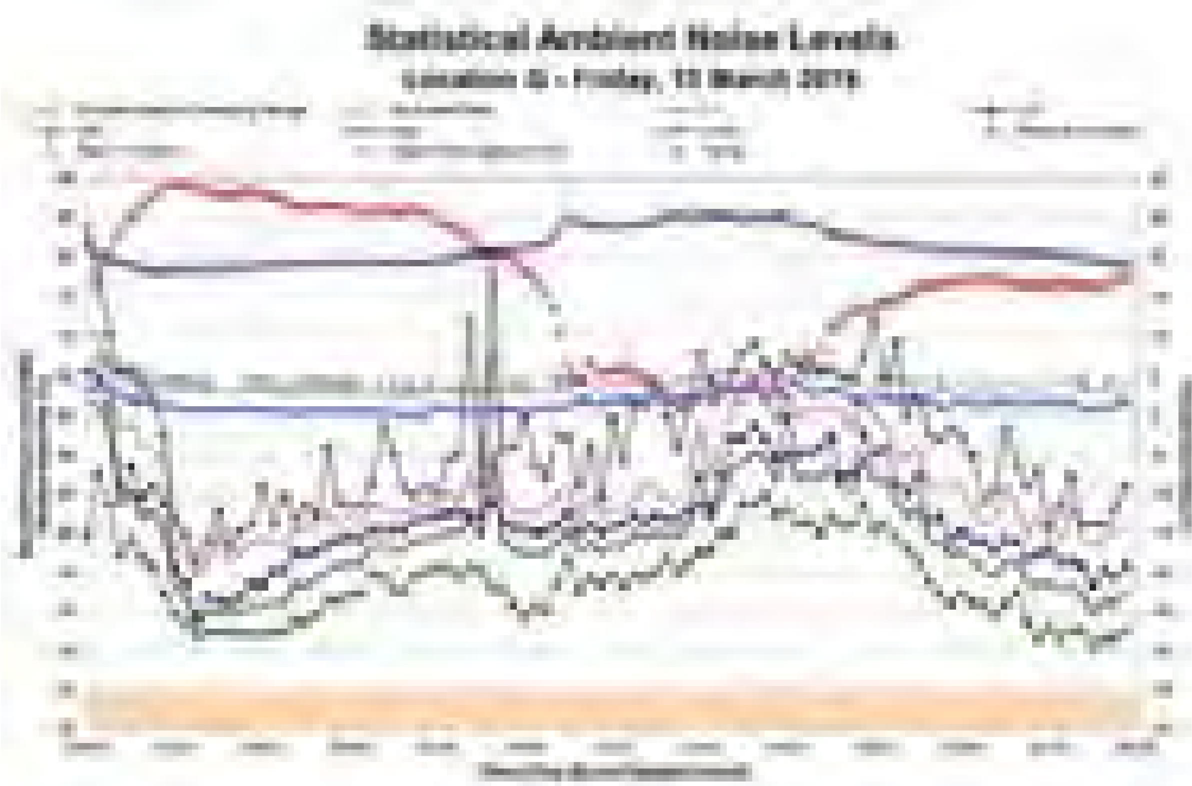

Statistical Ambient Noise Levels
Location 7 - Tuesday, 19 March 2019

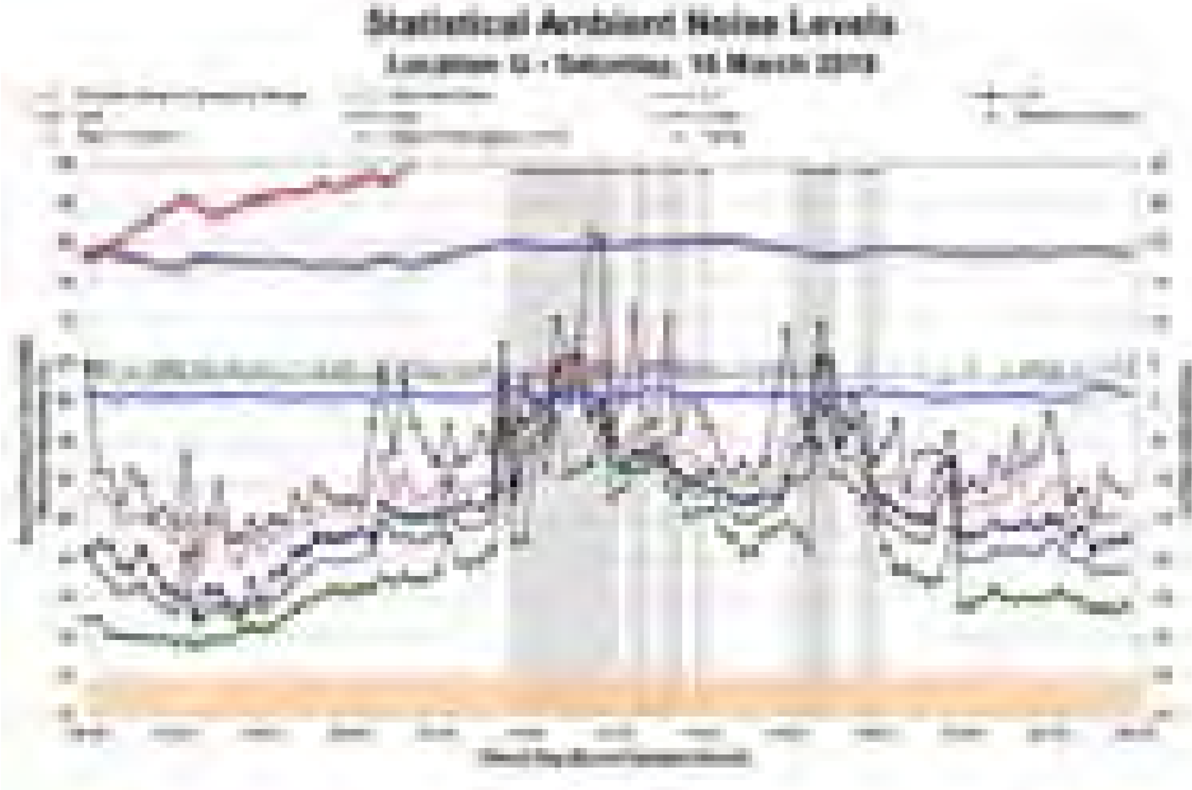

Statistical Ambient Noise Levels
Location 7 - Wednesday, 20 March 2019

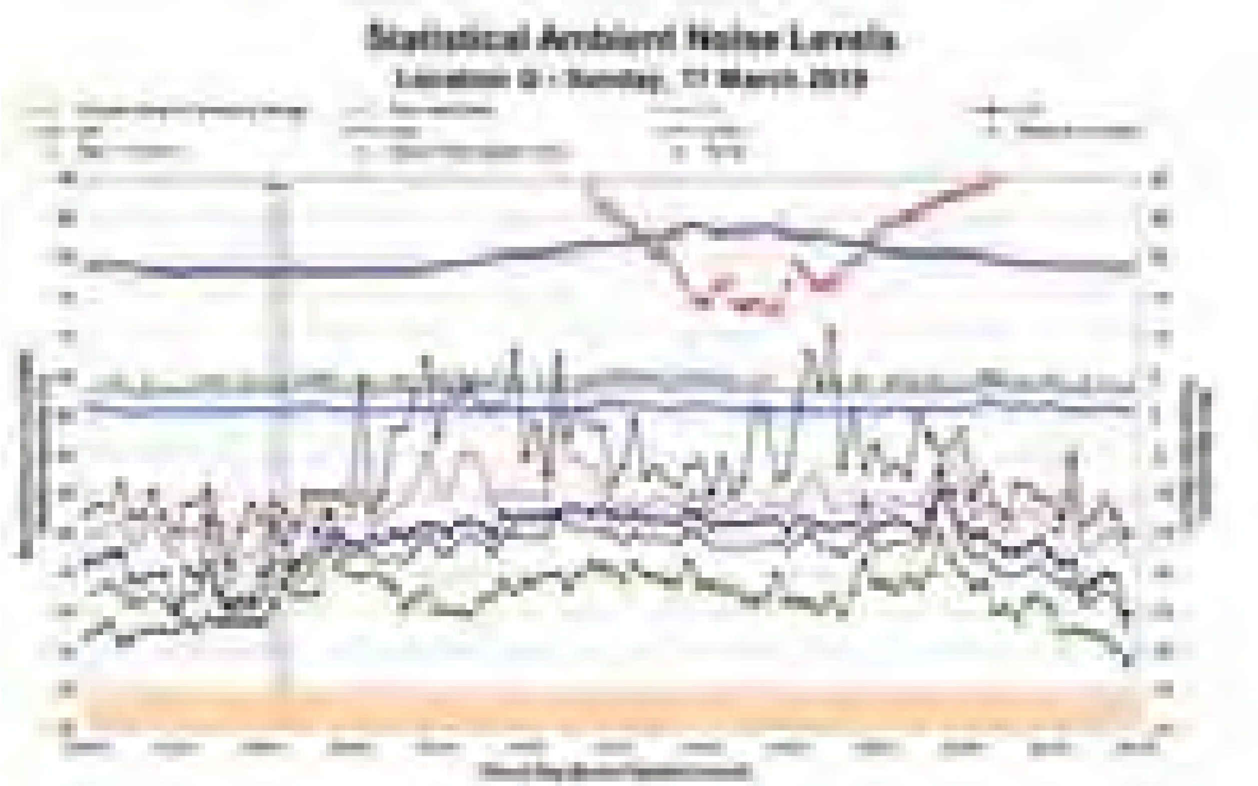

Statistical Ambient Noise Levels
Location 7 - Thursday, 21 March 2019

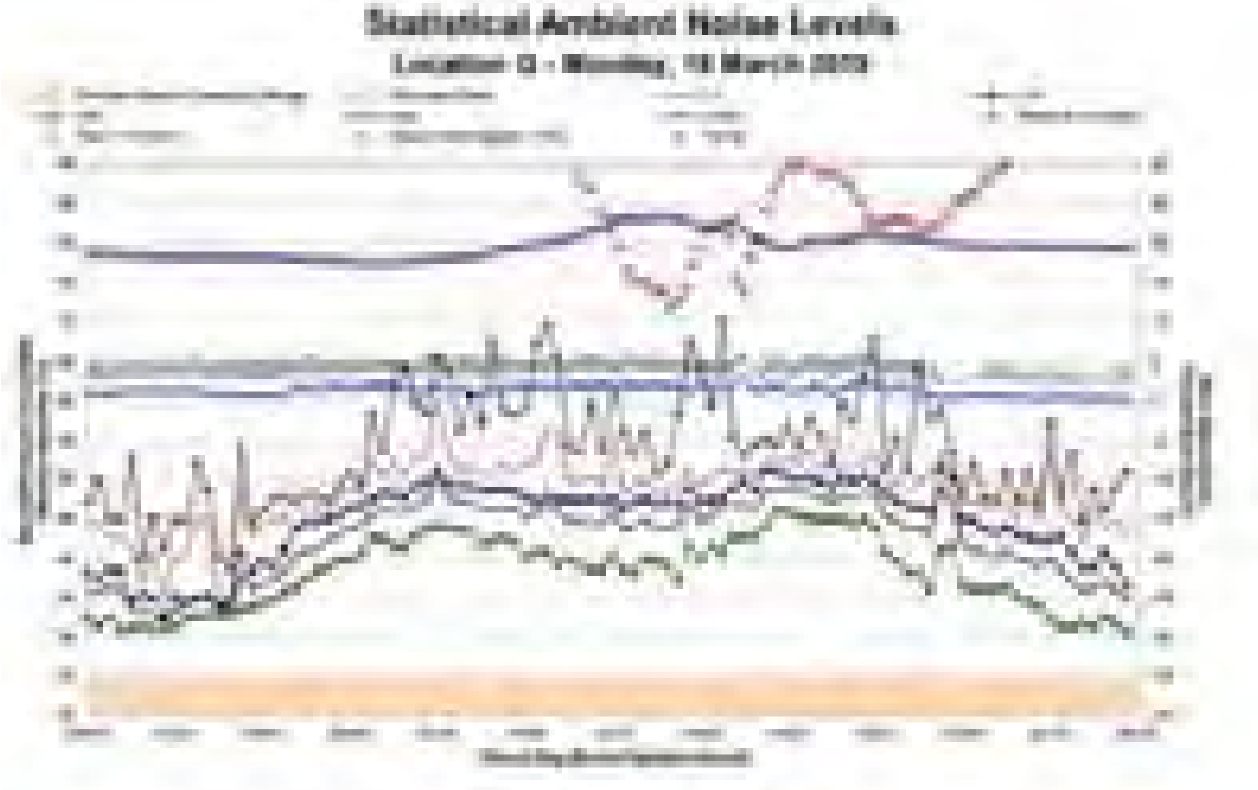

Statistical Ambient Noise Levels
Location G - Wednesday, 13 March 2019

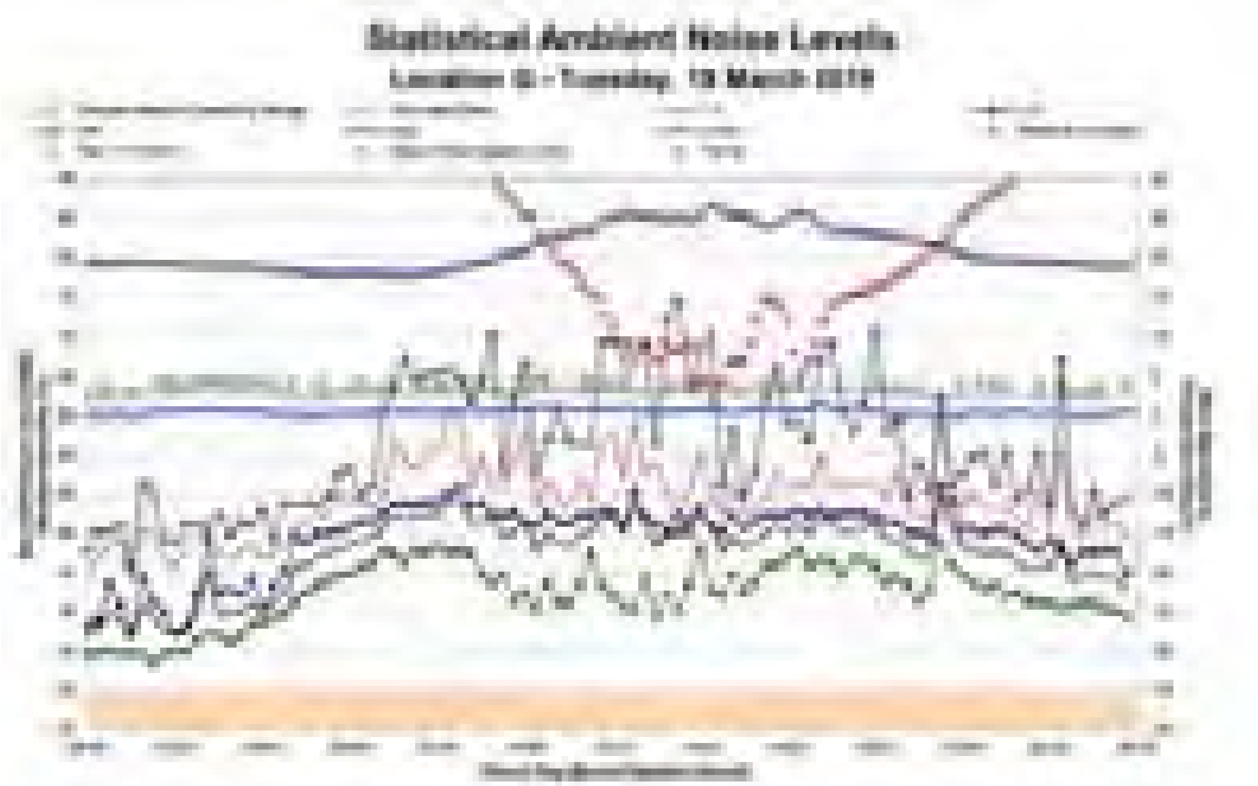

Statistical Ambient Noise Levels
Location G - Thursday, 14 March 2019

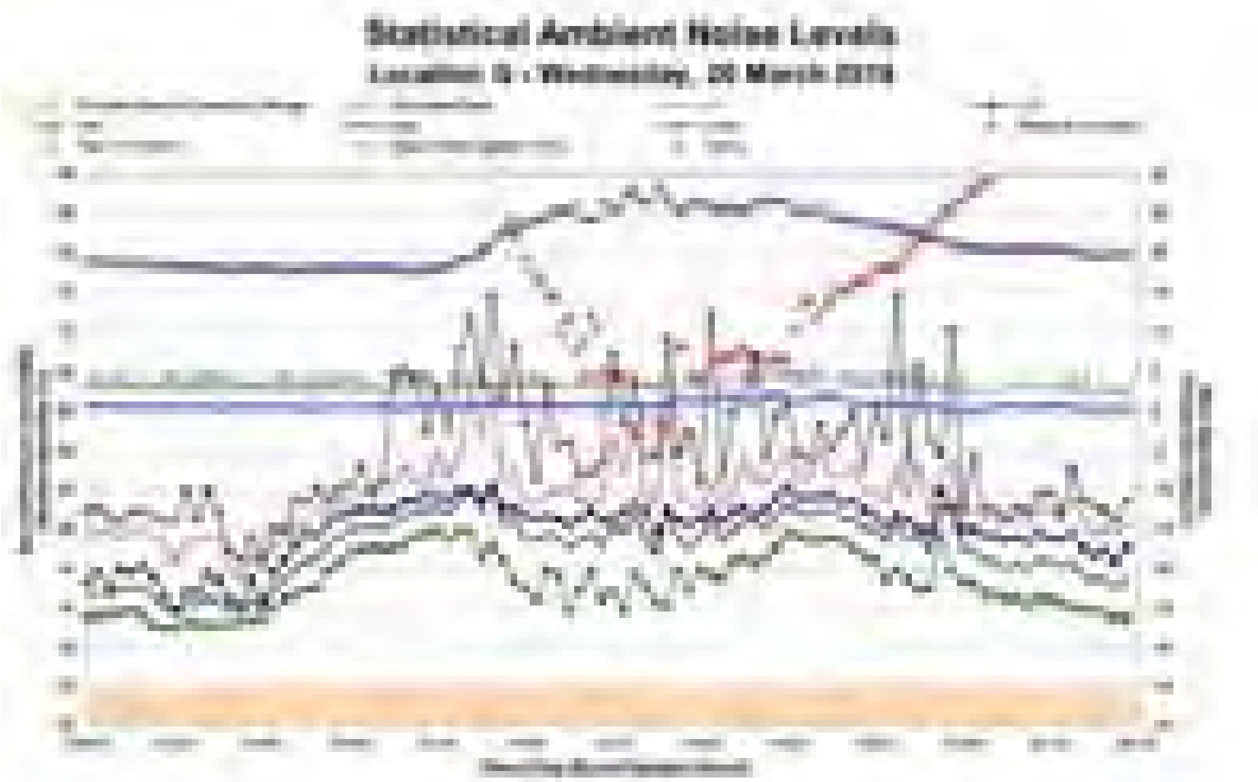

Statistical Ambient Noise Levels
Location G - Friday, 15 March 2019


Statistical Ambient Noise Levels
Location G - Saturday, 16 March 2019

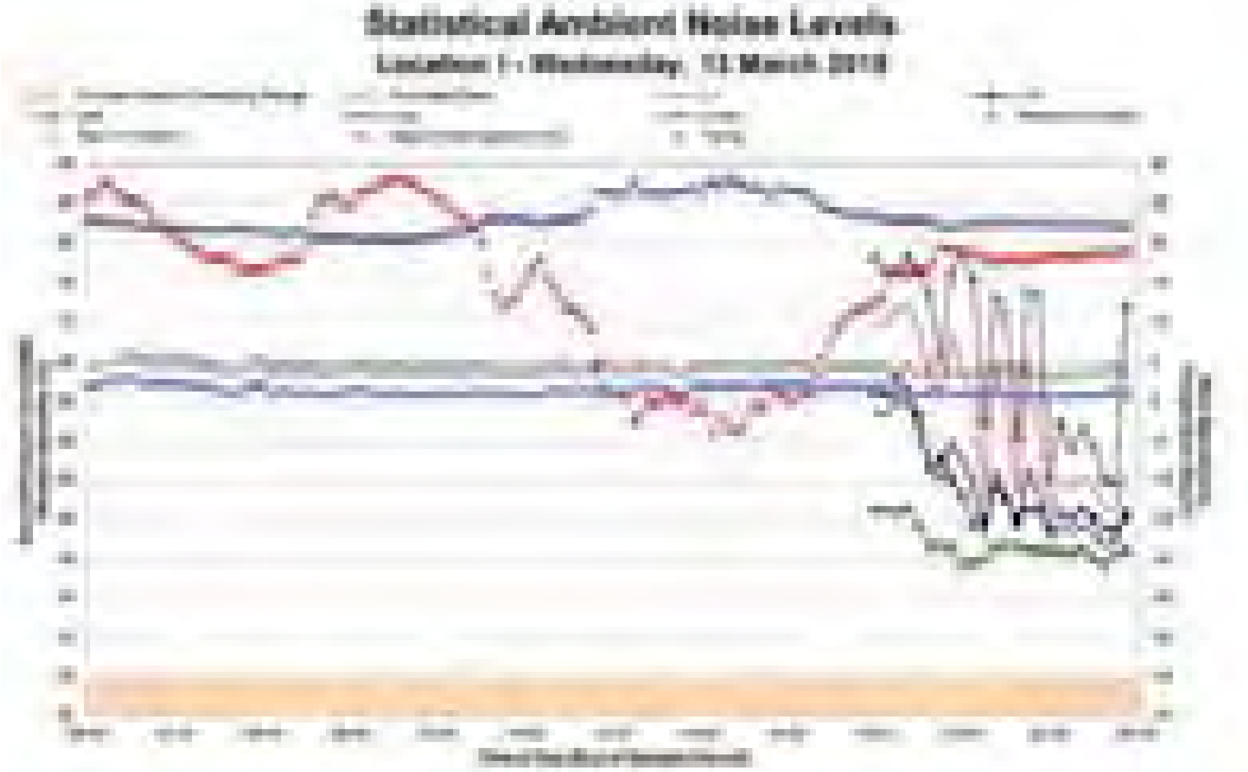

Statistical Ambient Noise Levels
Location Q - Sunday, 17 March 2019


Statistical Ambient Noise Levels
Location Q - Monday, 18 March 2019


Statistical Ambient Noise Levels
Location G - Tuesday, 19 March 2019


Statistical Ambient Noise Levels
Location G - Wednesday, 20 March 2019


Statistical Ambient Noise Levels
Location G - Thursday, 21 March 2019


Statistical Ambient Noise Levels
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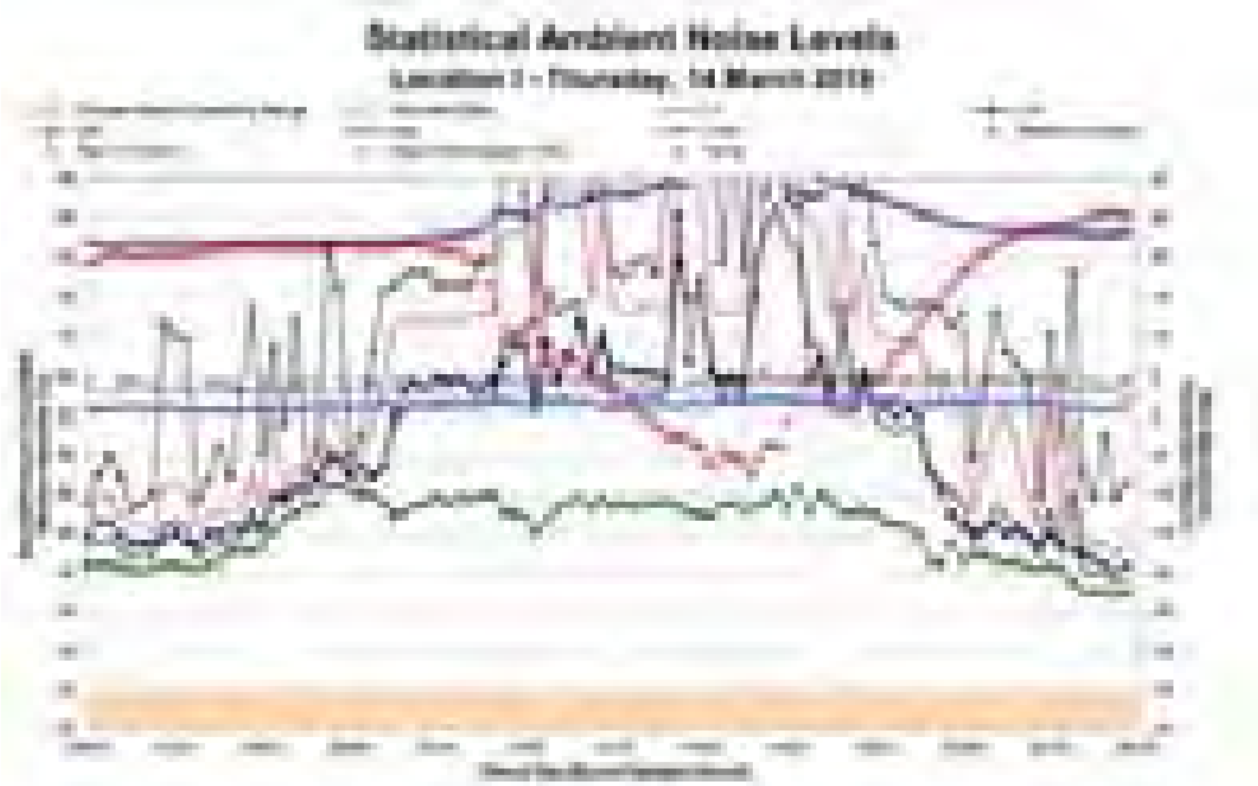
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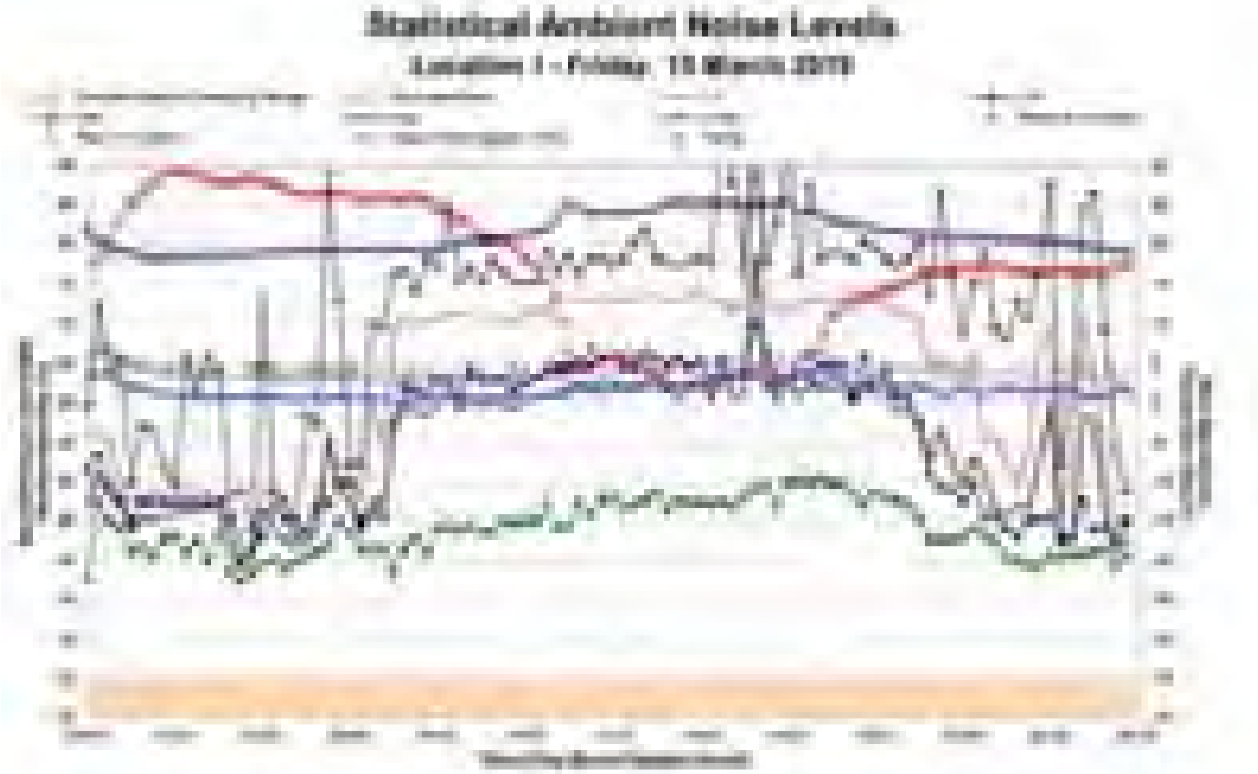
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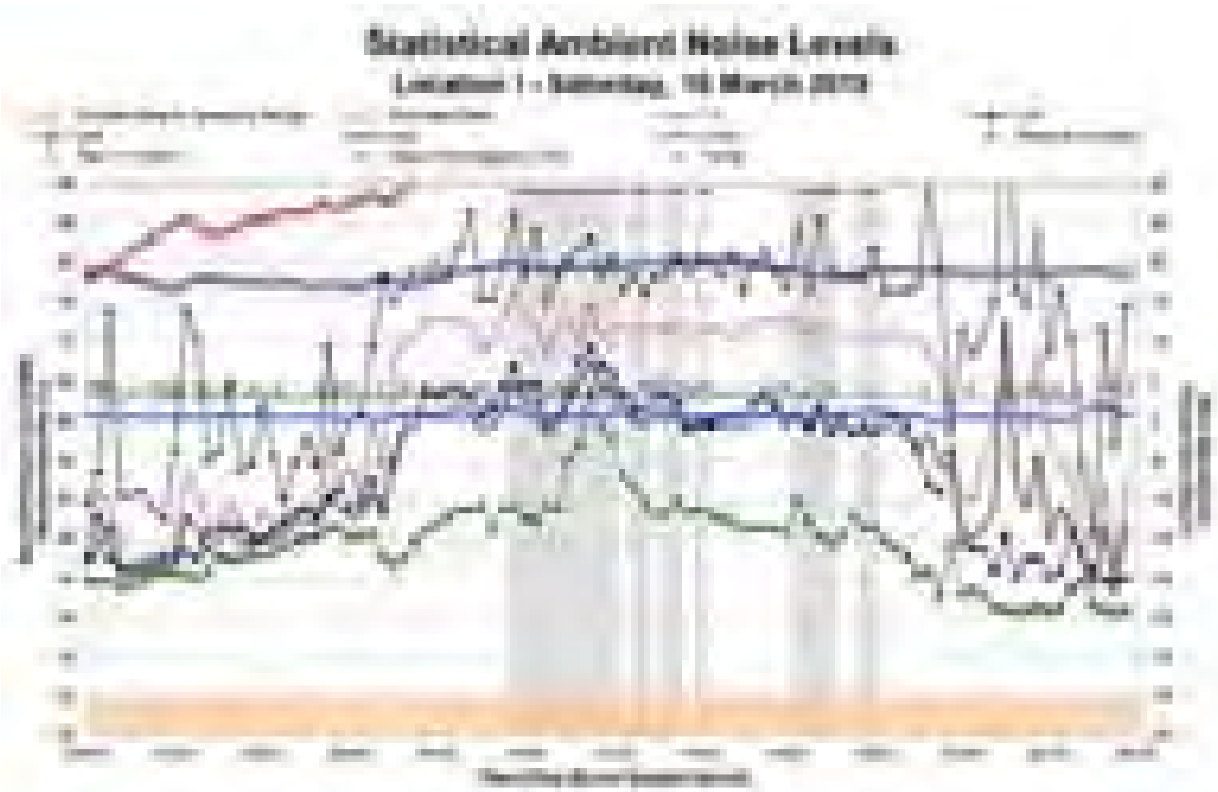
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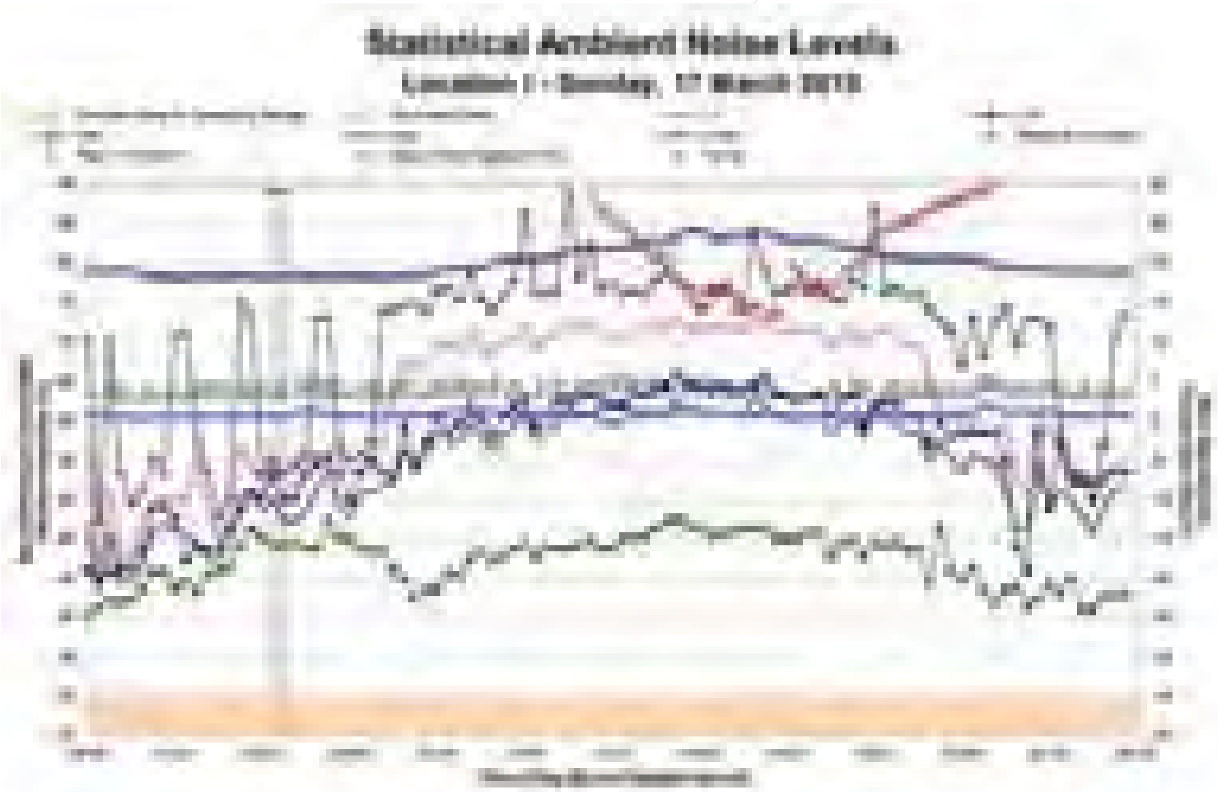
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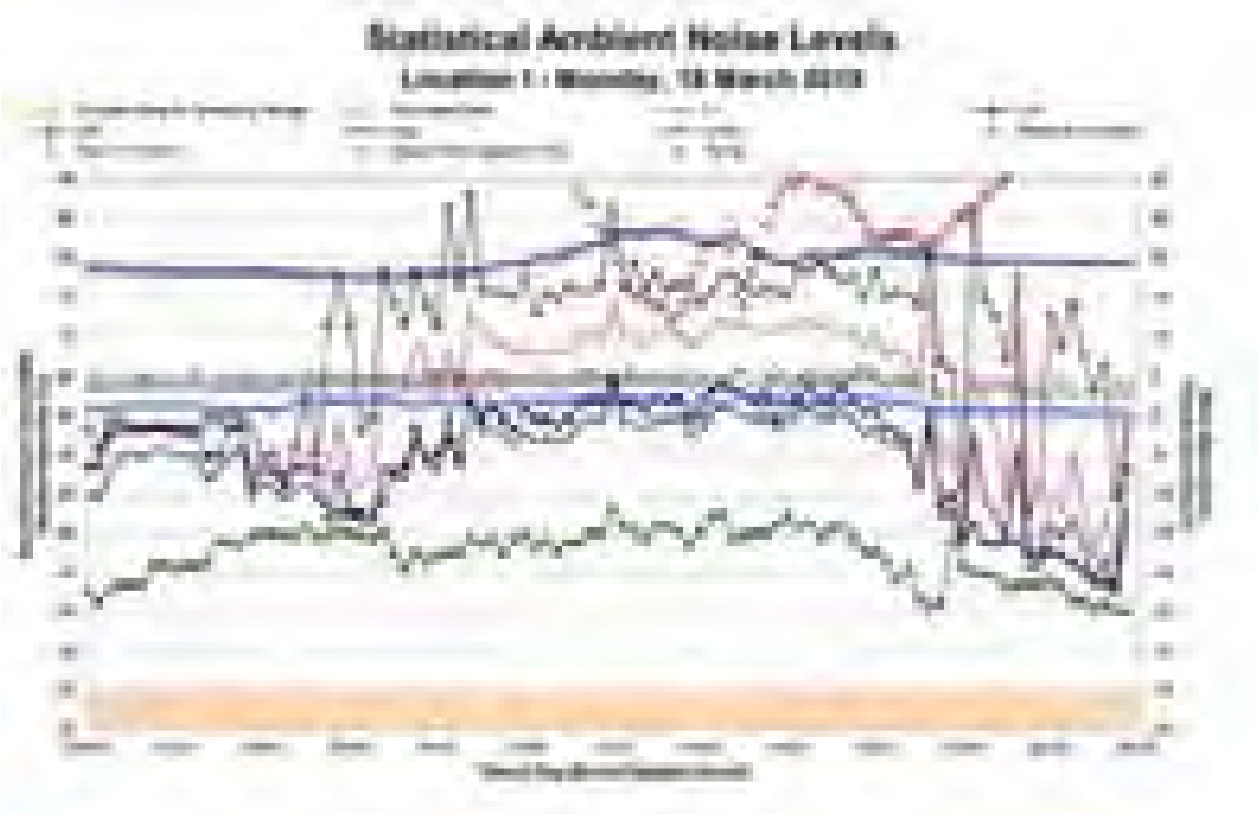
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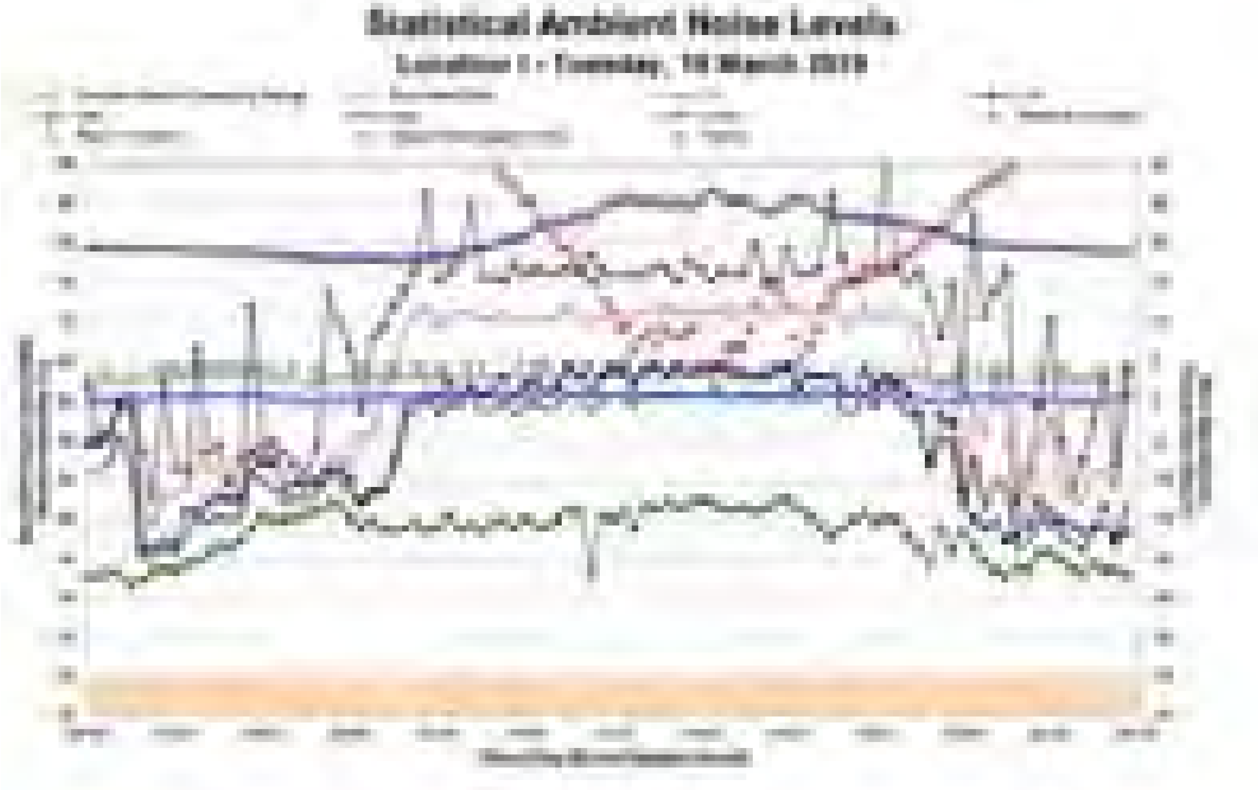
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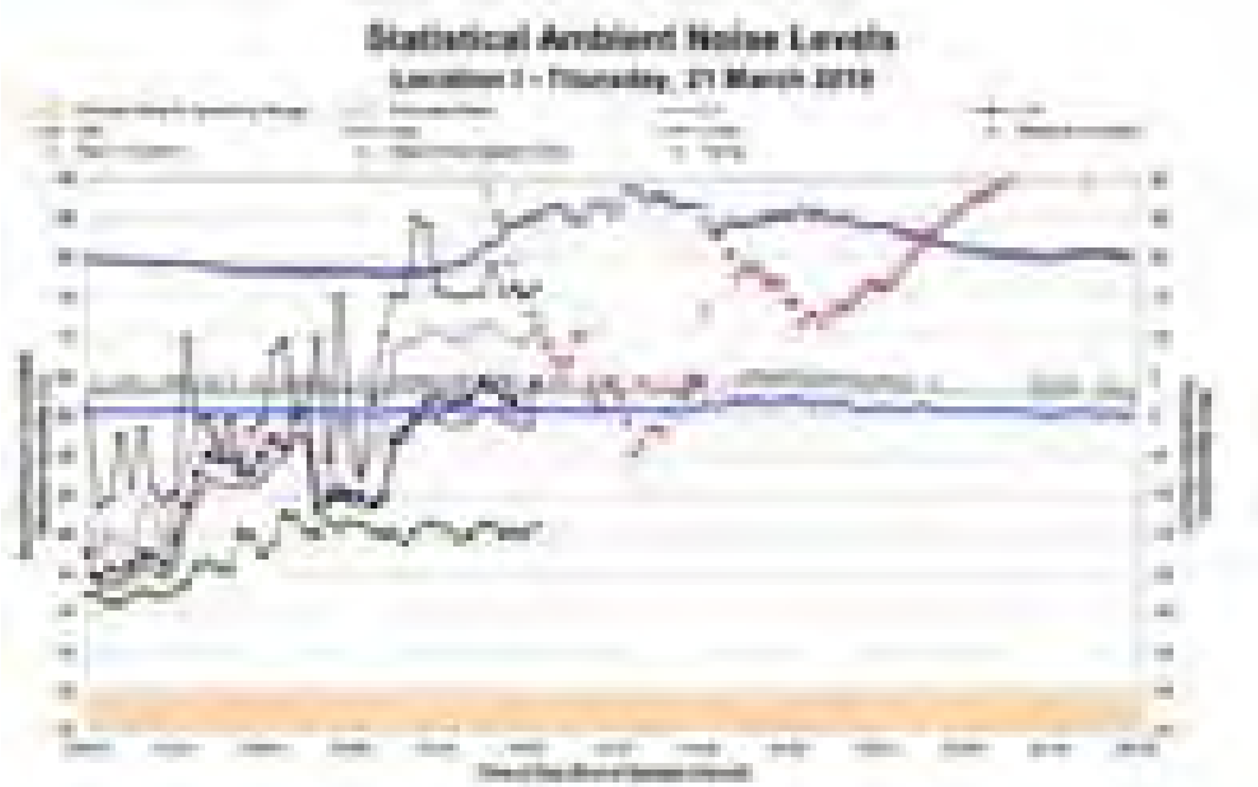
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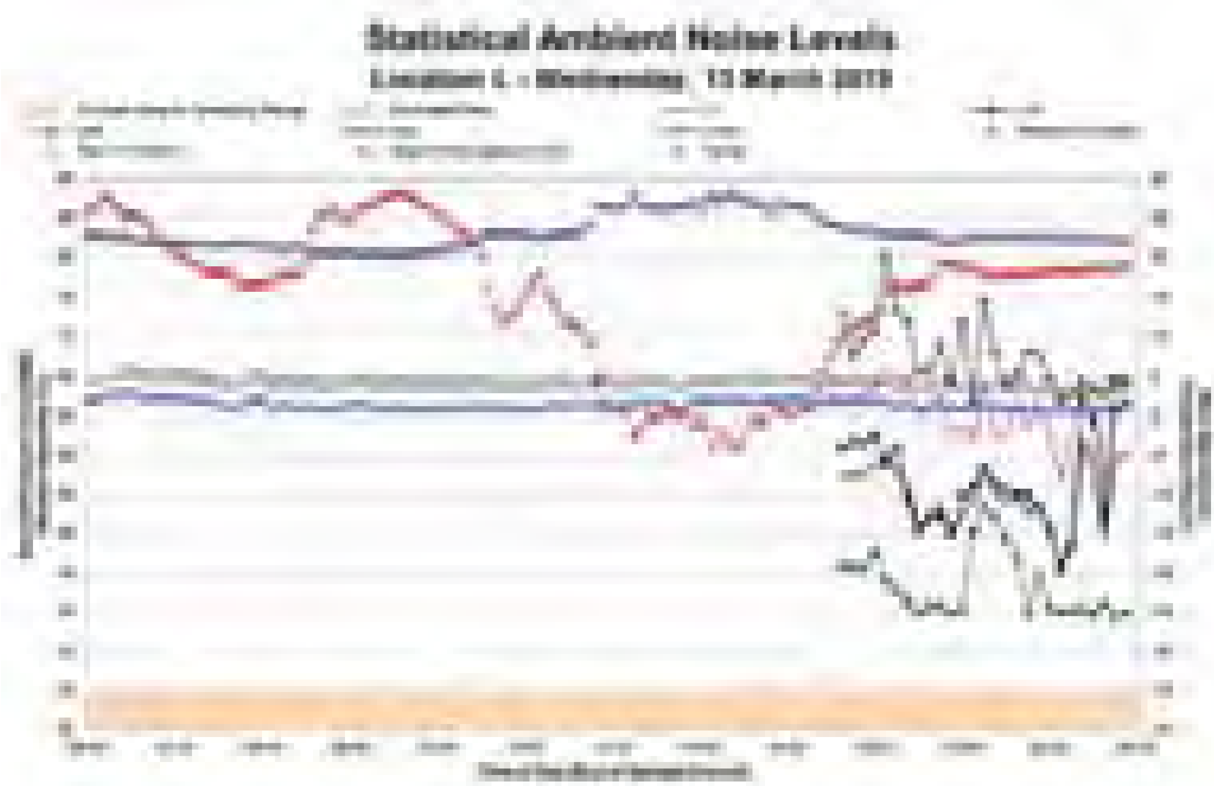
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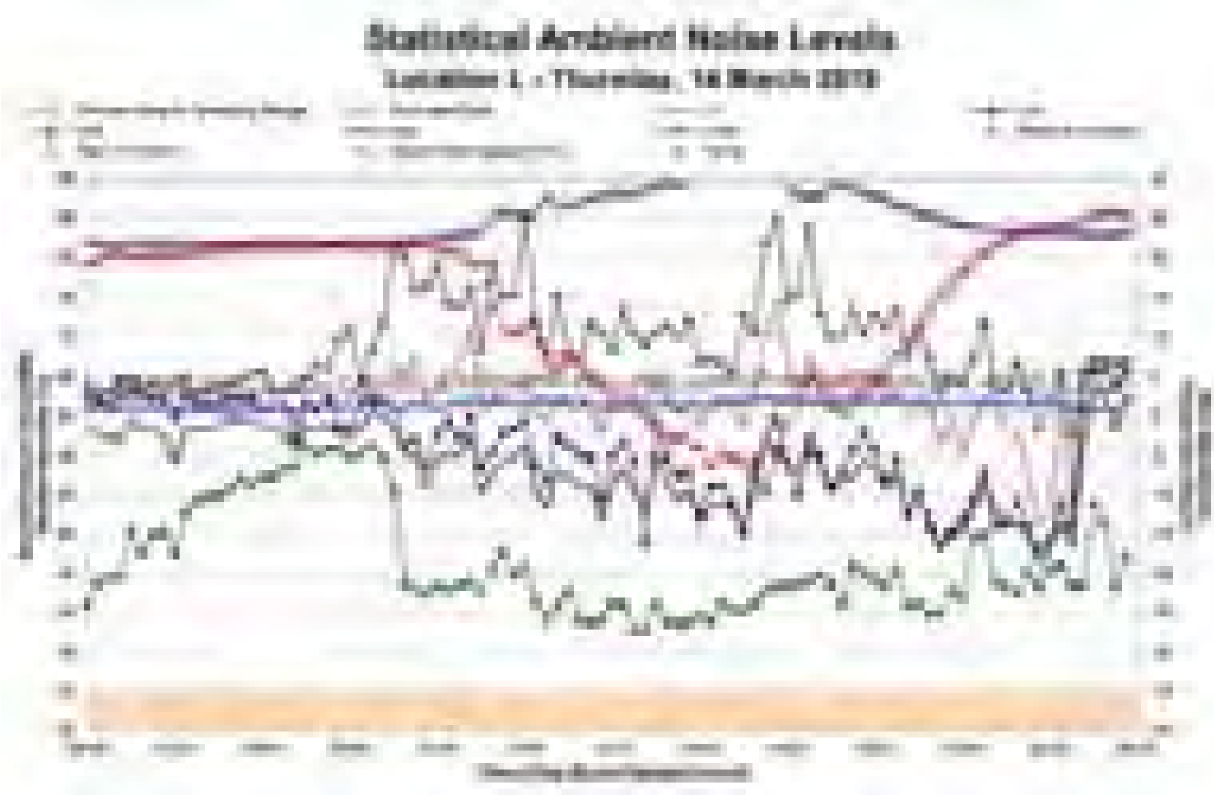
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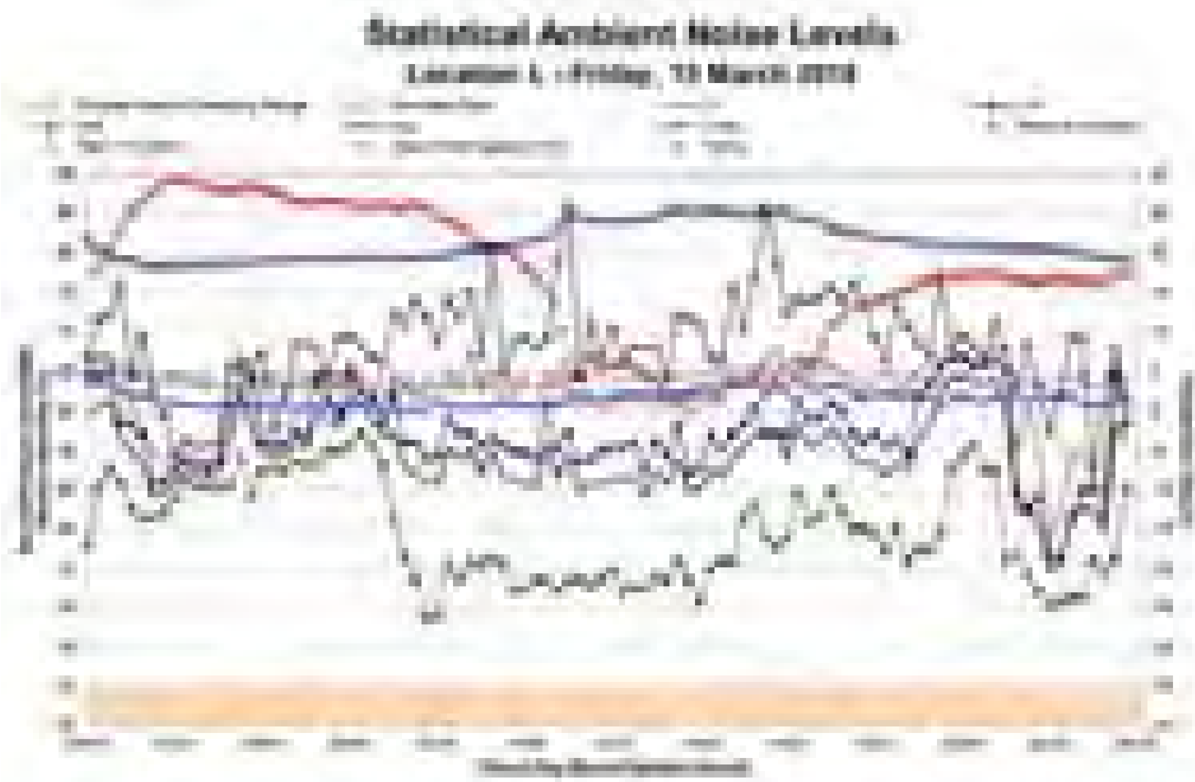
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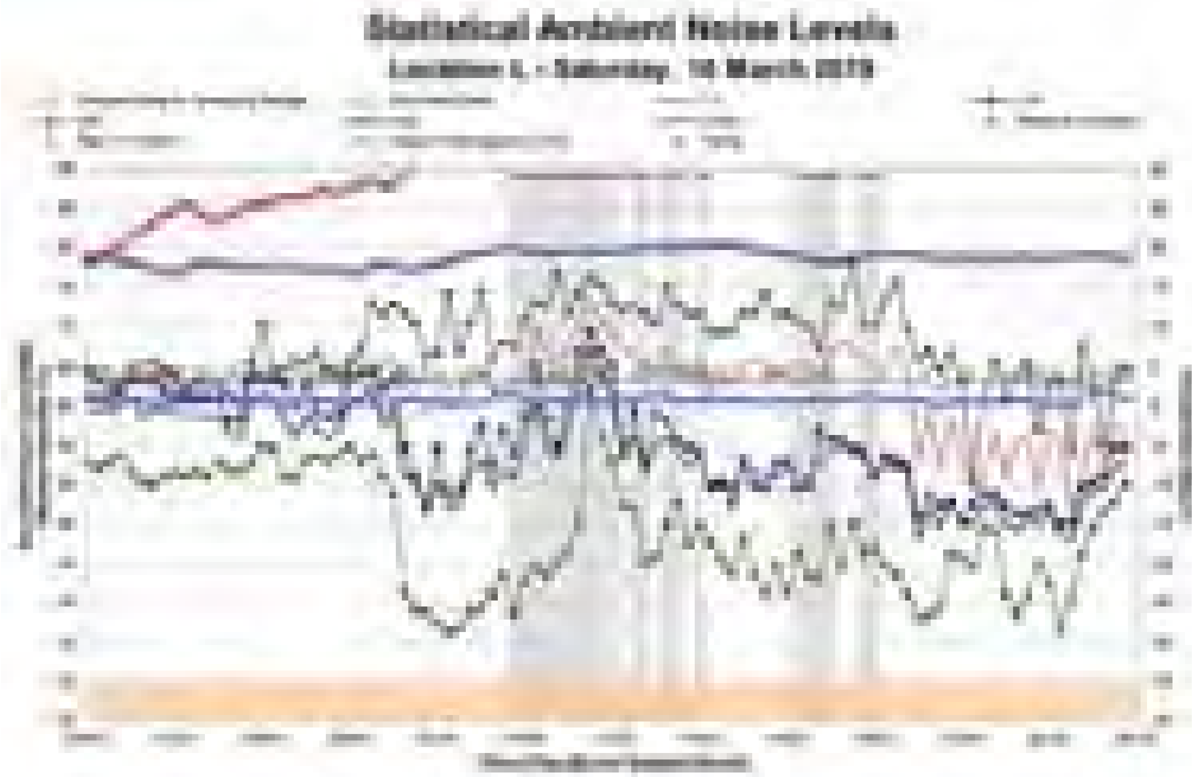
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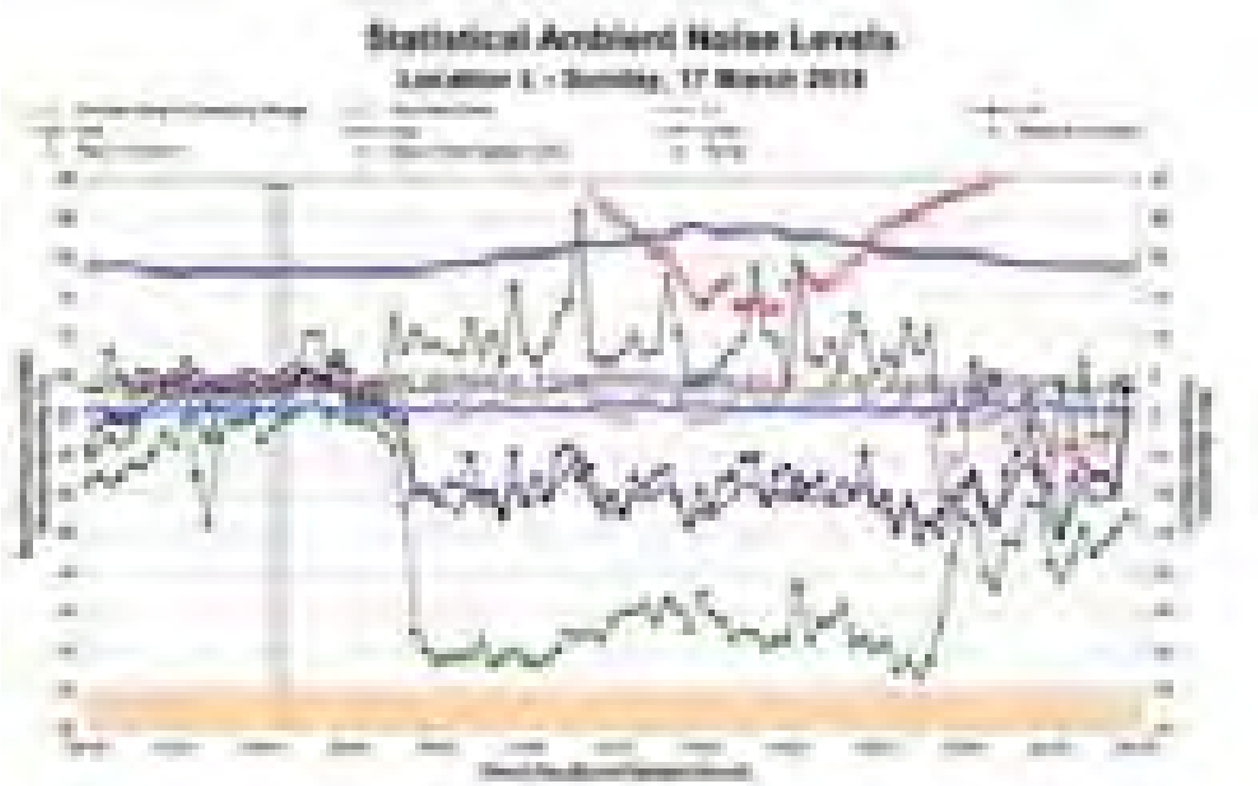

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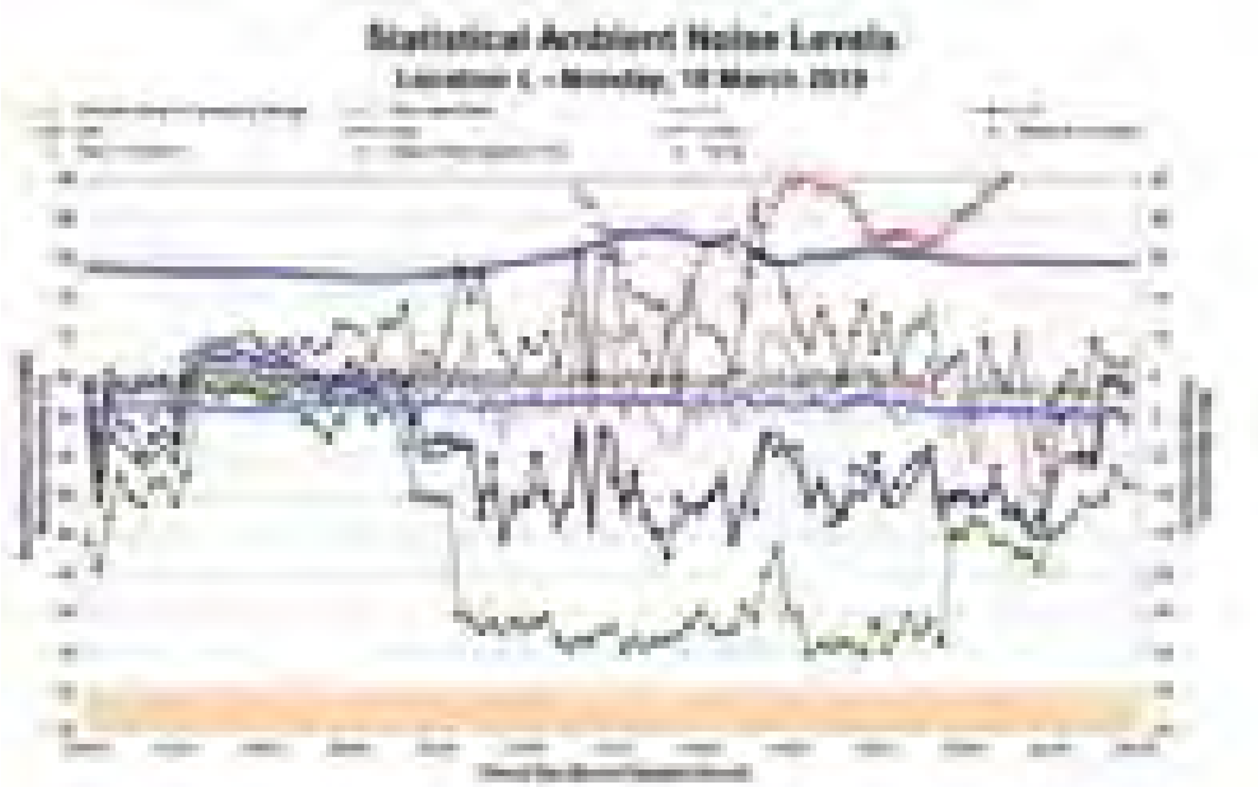

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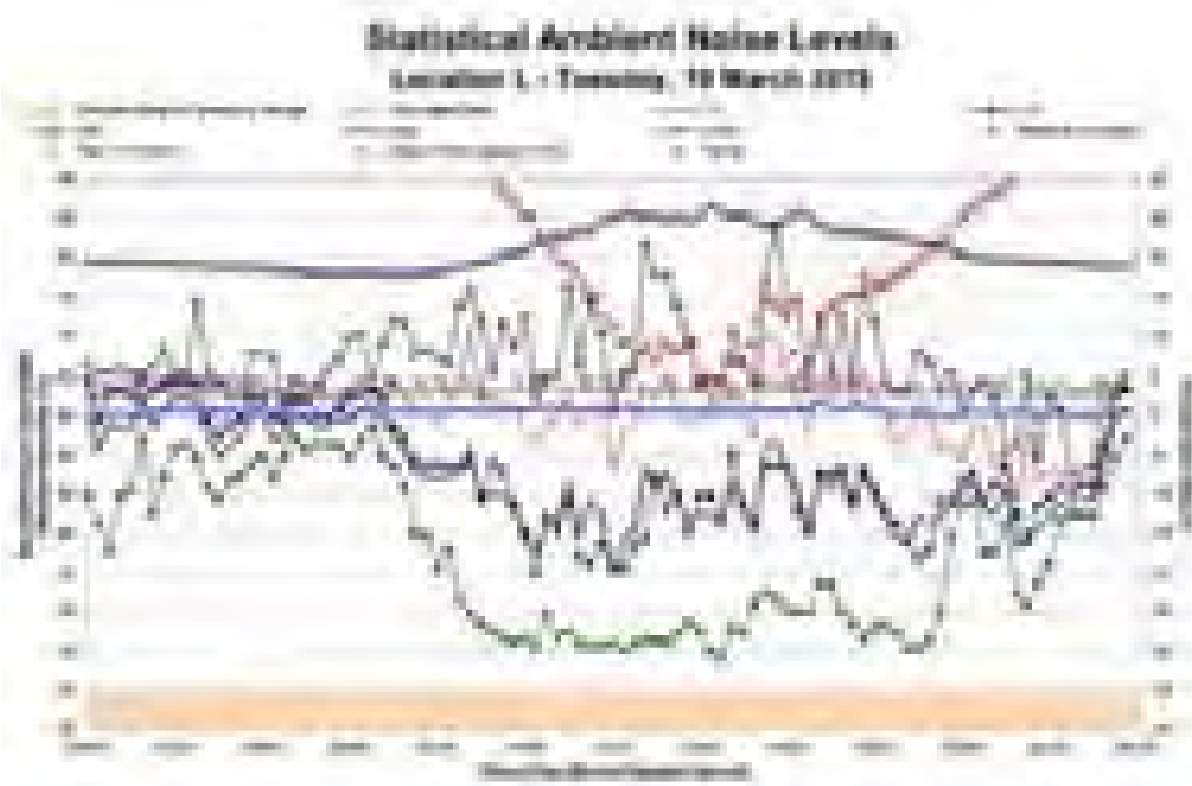
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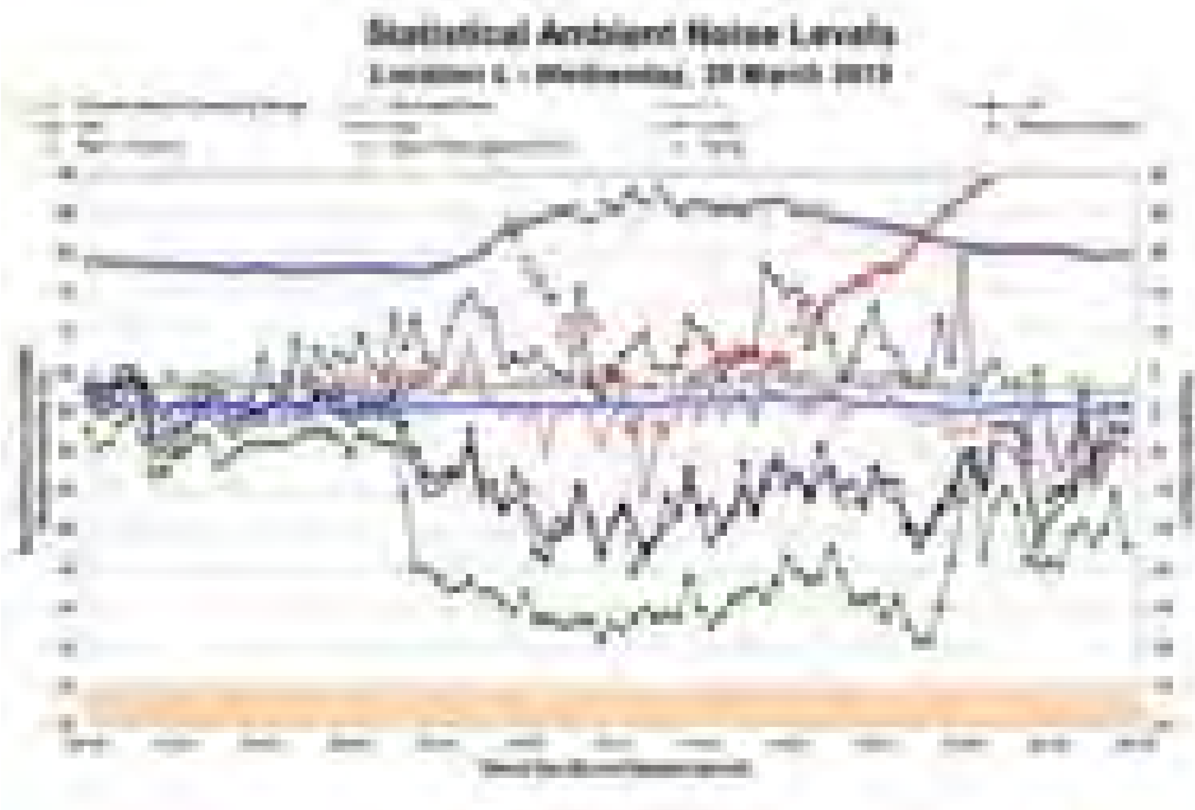
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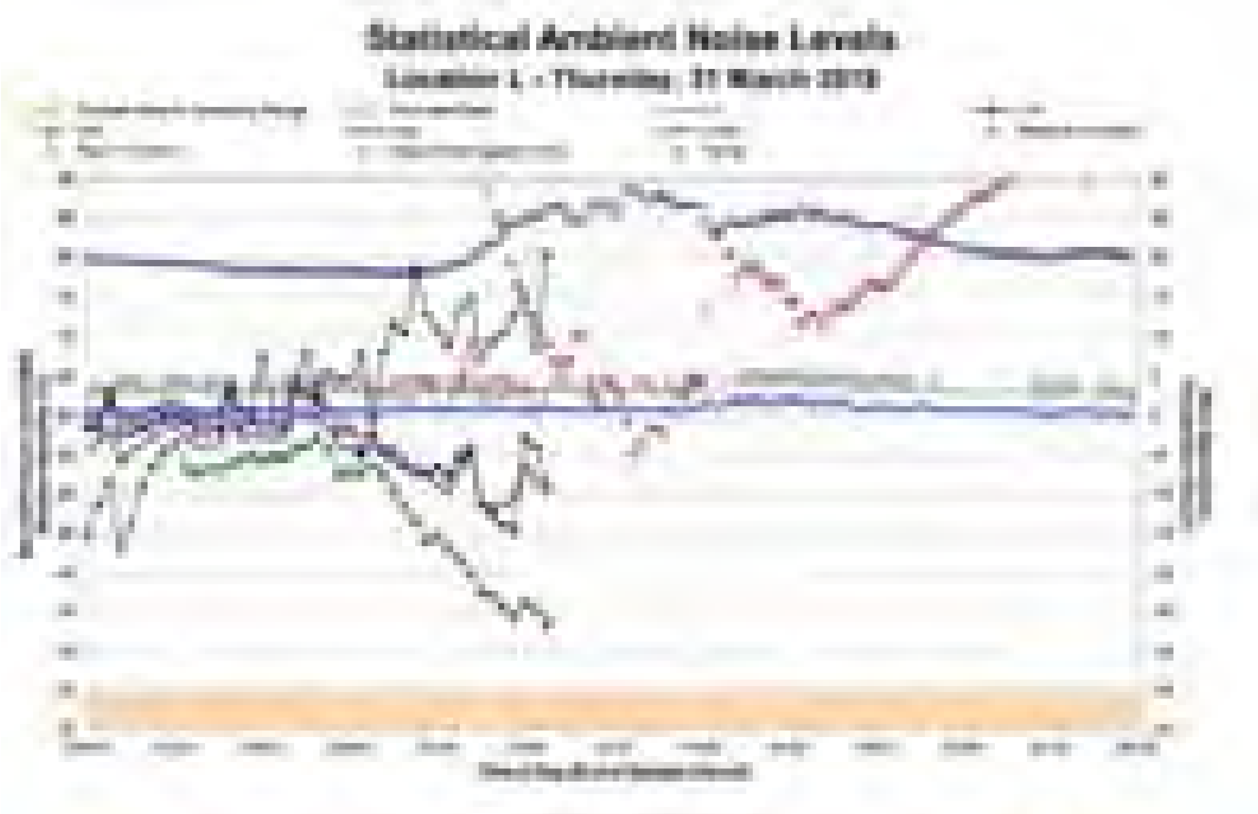
Statistical Ambient Noise Levels

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DONALDSON AND ABEL COAL MINES

Quarterly Noise Monitoring
Quarter Ending June 2019

Prepared for:

Donaldson Coal Pty Ltd
PO Box 675
Green Hills 2320

SLR Ref: Q74 630.01053-R01
Version No: -v1.0
October 2019

PREPARED BY

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BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Donaldson Coal Pty Ltd (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
Q74 630.01053-R01-v1.0	14 October 2019	Jeff Sit	Martin Davenport	Martin Davenport

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1 Introduction

1.1 Background

Donaldson Coal Pty Ltd has commissioned SLR Consulting Australia Pty Ltd (SLR) to conduct quarterly noise monitoring surveys for the Donaldson Coal Mine and Abel Coal Mine during the June 2019 quarter in accordance with the Abel Mine Project Noise Monitoring Program, dated 12 August 2014.

1.2 Objectives of this Report

The objectives of the noise monitoring survey for this operating quarter were as follows:

- Measure the ambient noise levels at six focus receptor locations (potentially worst affected) surrounding Donaldson Coal Mine and Abel Coal Mine.
- Qualify all sources of noise within each of the attended surveys, including estimated contribution or maximum level of individual noise sources.
- Assess the noise emissions of Donaldson Coal Mine and Abel Coal Mine with respect to the limits contained in the Development Consent.

1.3 Acoustic Terminology

The following report uses specialist acoustic terminology. An explanation of common terms is provided in **Appendix A**.

2 Development Consent Project Approval

Development consent was obtained by Donaldson Coal Pty Ltd for the Donaldson Mine in October 1999 following a Commission of Inquiry. Development Consent number N97/00147 was issued by the Minister for Urban Affairs pursuant to Section 101 of the Environmental Planning and Assessment Act 1979 (EP&A Act).

Project Approval (Application No. 05_0136) granted by the Minister of Planning was obtained by Donaldson Coal Pty Ltd for Abel Coal Mine in 2007.

2.1 Donaldson Coal Mine Development Consent Conditions

The Development Consent nominates hours of operation and mine noise emission goals in the Sections entitled "*Operation of Development, Condition No. 3(1) and 3(2)"*, and *"Noise and Vibrational Noise Limits: Condition No. 15*" as follows:

3.(1) Subject to (2) the approved hours of operation are as follows:

Works	*Period*	*Hours*
Construction, including construction of any bunds	*Monday to Friday* *Saturday*	*7 am to 6 pm* *8 am to 1 pm*
Mining operations, including mining, haulage of waste to dumps and coal processing	*Monday to Friday* *Saturday, Sunday*	*24 hours per day* *7 am to 6 pm*
Road Transportation and stockpiling of coal	*7 days per week*	*24 hours per day*
Rail loading of coal	*7 days per week*	*7 am to 10 pm*
Maintenance of mobile and fixed plant	*7 days per week*	*24 hours per day*
Blasting, not involving closure of John Renshaw Drive	*Monday to Saturday*	*7 am to 5 pm*
Blasting, involving closure of John Renshaw Drive	*Monday to Saturday*	*10 am to 2 pm*

Notes: Restrictions on Public Holidays are the same as Sundays

(2) The Applicant shall submit a report to the Director-General's satisfaction demonstrating the noise limits in Condition 15 can be met while rail loading of coal is occurring during the period from 6 pm to 10 pm. If that report does not demonstrate that the noise limits can be met to the Director-General's satisfaction, then the hours of operation for rail loading of coal shall be restricted to 7 am to 6 pm."

15. *Unless subject to a negotiated agreement in accordance with Condition 23, the Applicant shall ensure that the noise emission from construction or mining operations, when measured or computed at the boundary of any dwelling not owned by the applicant (or within 30 metres of the dwelling, if the boundary is more than 30 metres from the dwelling), shall not exceed the following noise limits:*

Location	$L_{A10(15minute)}$ Noise Limits (dBA)	
	Daytime	Night-time
Beresfield area (residential)	*45*	*35*
Steggles Poultry Farm	*50*	*40*
Ebenezer Park Area	*46*	*41*
Black Hill Area	*40*	*38*
Buchanan and Louth Park Area	*38*	*36*
Ashtonfield Area	*41*	*35*
Thornton Area	*48*	*40*

Note: Daytime is 7 am to 10 pm Monday-Saturday, and 8 am to 10 pm Sundays and Public Holidays. Night-time is 10 pm to 7 am Monday-Saturday, and 10 pm to 8 am Sundays and Public Holidays.

The noise limits apply for prevailing meteorological conditions (winds up to 3 m/s), except under conditions of temperature inversions."

Other Conditions of Consent relevant to noise are as follows:

18. *The applicant shall survey and investigate noise reduction measures from plant and equipment and set targets for noise reduction in each Annual Environmental Management Report (AEMR), taking into consideration valid noise complaints received in the previous year. The Report shall also include remedial measures.*

19. *The Applicant shall revise the Noise Management Plan as necessary and provide an updated Plan five years after commencement of mining to the Director-General, the independent noise expert (Condition 48), EPA, Councils and the Community Consultative Committee.*

2.2 Abel Coal Mine – Project Approval

Approved Operations

The following operations are approved under the Abel Coal Mine Project Approval:

- Extraction of up to 6.1 Mtpa of Run of Mine (ROM) coal from the Abel Underground Coal Mine.
- Transport coal to the existing Bloomfield Coal Handling and Preparation Plant by private haul roads, or by coal conveyor, or by a combination of both methods.
- Operate the Bloomfield Coal Handling Processing Plant (CHPP) to process coal extracted from the Abel Coal Mine and the Bloomfield and Donaldson Coal Mines.
- Transportation of product coal from the Bloomfield site by rail via the Bloomfield rail loading facility.

The Project Approval was modified in June 2010 (05_0136 MOD 1) allowing construction and operation of a downcast ventilation fan. In May 2011 the Project Approval was modified again (05_0136 MOD 2) to allow the construction and operation of an upcast ventilation fan (and associated facilities). In December 2013 the Project Approval was further modified (05_0136 MOD3) to account for the increase in coal extracted including the upgrade of the Bloomfield CHPP.

Consent Conditions

The relevant conditions relating to noise from the Abel Coal Mine approval are reproduced below.

Schedule 4

NOISE

Operational Noise Criteria

1. *The Proponent shall ensure that the noise generated by the Project does not exceed the criteria in Table 4 at any residence on privately-owned land.*

Table 4: Operational Noise Criteria dB(A)

Location	Receiver Area	Day	Evening	Night	
		$L_{Aeq(15minute)}$	$L_{Aeq(15minute)}$	$L_{Aeq(15minute)}$	$L_{A1(1minute)}$
Location I	Lord Howe Drive, Ashtonfield	*36*	*36*	*36*	*45*
Location K	Catholic Diocese Land	*37*	*37*	*37*	*45*
Location L	Kilshanny Avenue, Ashtonfield	*40*	*40*	*40*	*47*
All other Locations	All other privately owned Residences	*35*	*35*	*35*	*45*

Notes:

- *To interpret the locations referred to in Table 4, see plan in Appendix 3 (Appendix A).*
- *Noise generated by the project is to be measured in accordance with the relevant requirements, and exemptions (including certain meteorological conditions), of the NSW Industrial Noise Policy.*

These noise criteria do not apply if the Proponent has an Agreement with the relevant landowner to generate higher noise levels, and the proponent has advised the Department in writing of the terms of this agreement.

Construction Noise Criteria

1. *The proponent shall ensure that the noise generated during the construction of the downcast ventilation shaft as described in EA (MOD3) does not exceed the criteria in Table 5.*

Table 5: Construction Noise Criteria dB(A)

Location	Receiver	Day
		LAeq(15minute)
Location R	*281 Lings Road, Buttai*	*50*
Location S	*189 Lings Road, Buttai*	*43*

Notes:

- *The criteria in Table 5 apply only whilst the downcast ventilation shaft is being constructed, and for a maximum of 12 weeks from the commencement of construction.*
- *To interpret the locations referred to in Table 5, see plan in Appendix 3* (attached to this report as **Appendix A**).
- *Noise generated by the project is to be measured in accordance with the relevant requirements, and exemptions (including certain meteorological conditions), of the NSW Industrial Noise Policy.*

However, these noise criteria do not apply if the Proponent has an Agreement with the relevant landowner to generate higher noise levels, and the proponent has advised the Department in writing of the terms of this agreement.

Rail Noise Criteria

1. *The proponent shall ensure that the noise from rail movements on the Bloomfield Rail Spur does not exceed the limits in Table 6 at any residence on privately owned land.*

Table 6: Rail Spur noise criteria dB (A)

Location	*Day*	*Evening*	*Night*
	LAeq(period)		
All privately-owned land	*55*	*45*	*40*

Cumulative Noise Criteria

1. *The proponent shall implement all reasonable and feasible measures to ensure that the noise generated by the project combined with noise generated by other mines does not exceed the criteria in Table 7 at any residence on privately-owned land.*

Table 7: Cumulative noise criteria dB (A)

Location	*Day*	*Evening*	*Night*
	LAeq(period)		
All privately-owned land	*55*	*45*	*40*

Notes: Cumulative noise is to be measured in accordance with the relevant requirements, and exemptions (including meteorological conditions), of the NSW Industrial Noise Policy. Appendix 4 sets out the metrological conditions under which these criteria apply and the requirements for evaluating compliance with these criteria.

Operating Conditions

1. *The proponent shall:*
    a. *Implement best management practise to minimise the construction, operational, road and rail noise of the project;*
    b. *Operate an on-site noise management system to ensure compliance with the relevant conditions of this approval;*
    c. *Minimise the noise impacts of the project during meteorological conditions under which the noise limits in this consent do not apply (see Appendix 4);*
    d. *Only receive and/or dispatch locomotives and rolling stock either on or from the site that are approved to operate on the NSW rail network in accordance with the noise limits in ARTC's EPL (No. 3142);*
    e. *Carry out regular monitoring to determine whether the project is complying with the noise criteria and other relevant conditions of approval, to the satisfaction of the Director-General.*

Noise Management Plan

2. *The proponent shall prepare and implement a Noise Management Plan for the project to the satisfaction of the Director-General. This plan must:*
    a. *Be prepared in consultation with the EPA, and be submitted to the Director-General for approval within 6 months of the date of approval of MOD 3;*
    b. *Describe the measures that would be implemented to ensure compliance with the noise criteria and operating conditions in this approval; Describe the proposed noise management system in detail; and*
    c. *Include a monitoring program that:*
        - *Uses attended monitoring to evaluate the compliance of the project against the noise criteria in this approval;*
        - *Evaluates and reports on:*
            - *The effectiveness of the on-site noise management system; and*
            - *Compliance against the noise operating conditions; and*

Defines what constitutes a noise incident, and includes protocol for identifying and notifying the Department and relevant stakeholders of any noise incidents. Appendix 4

Noise Compliance Assessment

Applicable Meteorological Conditions

1. *The noise criteria in Tables 4 and 7 are to apply under all metrological conditions except the following:*
    a. *During periods of rain or hail.*
    b. *Average wind speed at microphone height exceeds 5 m/s;*
    c. *Wind speeds greater than 3 m/s measured at 10m above ground level; or*
    d. *Temperature inversion conditions greater than $3^{o}C/100m$.*

Determination of metrological conditions

2. *Except for wind speed at microphone height, the data to be used for determining metrological conditions shall be that recorded by the meteorological station located on the site.*

Compliance monitoring

3. *Attended monitoring is to be used to evaluate compliance with the relevant conditions of this approval.*
4. *Unless otherwise agreed with the director-general, this monitoring is to be carried out in accordance with the relevant requirements for reviewing performance set out in the NSW Industrial Noise Policy (as amended from time to time), in particular the requirements relating to:*
    a. *Monitoring locations for the collection of representative noise data;*
    b. *Metrological conditions during which collection of noise data is not appropriate;*
    c. *Equipment used to collect noise data, and conformity with Australian Standards relevant to such equipment; and*
    d. *Modification to noise data collected, including for the exclusion of extraneous noise and/or penalties for modifying factors apart from adjustments for duration.*

Appendix 5

Statement of Commitments

3. Noise

3.1 Construction Activities

The following noise control measures will be implemented prior to commencement of construction of the Abel Underground Mine or the upgrade of the Bloomfield CHPP.

1. *Maintain all machinery and equipment in working order;*
    a. *No construction activities at the Abel pit top will take place on Sundays or Public Holidays;*
    b. *Where possible locate noisy site equipment behind structures that act as barriers or at the greatest distance from noise sensitive areas; and*
    c. *Orientate equipment so that noise emissions are directed away from noise sensitive areas.*

3.2 Noise Control Measures

a. *The following noise control measures will be implemented prior to the mining of coal from the Abel underground Mine:*
    i. *Orientation of the ventilation fans away from residential receivers and angle the output parallel to the ground.*
    ii. *The sound power level of the front end loader to be used near the portal should not exceed 113 dBA and will be fitted with a noise sensitive reversing alarm.*
b. *The following noise control measures will be implemented prior to the Bloomfield CHPP receiving any ROM coal from Able Underground Mine;*

i. *Noise mitigation works including partial enclosure and noise screening of drives and conveyors of the Bloomfield CHPP to screen residences to the north of the site.*

3.2 Monitoring

The Company will implement a Noise Monitoring Program for the Abel Underground Mine and the Bloomfield CHPP, to the satisfaction of the Director-General. The Noise Monitoring Program shall include a combination of real-time and supplementary attended monitoring measures, and a noise monitoring protocol for evaluating compliance with the noise environmental assessment. This plan will be integrated with the monitoring plans for the Tasman, Donaldson and Bloomfield Mines to provide a single integrated Noise Monitoring Program for all 4 mines.

3.4 Continuous Improvement

The Company shall:

a. *Report on these investigations and implementation of any new noise mitigation measures on site in the AEMR, to the satisfaction of the Director General.*

The operator of the Bloomfield CHPP shall:

b. *Investigate ways to reduce the noise generated by the Bloomfield CHPP, including maximum noise levels which may result in sleep disturbance;*

c. *Implement all reasonable and feasible best practice noise mitigation measures on the site; and*

d. *Report on these investigations and the implementation of any new noise mitigation measures on site in the AEMR, to the satisfaction of the Director-General.*

3 Noise Monitoring Methodology

3.1 General Requirements

The operational noise monitoring program was conducted with reference to Development Consent N97/00147 (Donaldson Coal Mine), Project Approval 05_0136 (Abel Coal Mine), and in accordance with SLR's Report 630.01053.01300-R1 dated 12 August 2014 (*Noise Management Plan Abel Underground Mine)* and AS 1055-1997 *Acoustics - Description and Measurement of Environmental Noise*.

All acoustic instrumentation employed throughout the monitoring program has been designed to comply with the requirements of AS IEC 61672.1 – 2004 *Electroacoustics—Sound level meters – Specifications*, AS IEC 61672.2-2004, AS IEC 61672.3-2004 and carried current NATA or manufacturer calibration certificates. Certificates for acoustic instrumentation used during the June 2019 quarter is provided in **Appendix B**.

Instrument calibration was conducted before and after each measurement, with the variation in calibrated levels not exceeding ±0.5 dBA.

3.2 Monitoring Locations

Baseline and preceding operational quarterly surveys have been conducted at 11 locations surrounding the Donaldson Mine and Abel Coal Mine sites. With the experience of these previous surveys, it was decided to concentrate noise monitoring at six focus locations that represent the potentially most noise affected areas from Donaldson Mine and Abel Coal Mine. The details of the monitoring locations are contained within **Table 1**.

It is relevant to note that Donaldson Open Cut Mine has ceased production and all major earthworks on the site have been finalised. Therefore, compliance noise monitoring for the Donaldson Open Cut Mine is no longer required.

Furthermore, Abel mine was placed in Care & Maintenance on 28th April 2016 and there was no operations onsite during the June 2019 noise monitoring period.

Table 1 Monitoring Locations

Noise Monitoring Location	Description
D	Black Hill School, Black Hill
F	Lot 684 Black Hill Road, Black Hill
G	156 Buchannan Road, Buchannan
I	Magnetic Drive, Ashtonfield
J	Parish Drive, Thornton
L	65 Tipperary Dr, Ashtonfield

A map giving the approximate location of the noise monitoring sites is contained within **Appendix C**.

3.3 Unattended Continuous Noise Monitoring

An environmental noise logger was deployed for a minimum of a seven day period between Thursday 20 June 2019 and Friday 28 June 2019 at each of the six (6) nominated locations given in Table 1. Due to technical issues, the logger at location J was redeployed from 28 June 2019 to 5 July 2019.

All unattended monitoring equipment was programmed to continuously record statistical noise level indices in 15 minute intervals including the L_{Amax}, L_{A1}, L_{A10}, L_{A90}, L_{A99}, L_{Amin} and L_{Aeq}. The statistical noise exceedance levels (L_{AN}) are the levels exceeded for N% of the 15 minute interval. The L_{A90} represents the level exceeded for 90% of the interval period and is referred to as the average minimum or background noise level. The L_{A10} is the level exceeded for 10% of the time and is usually referred to as the average maximum noise level. The L_{Aeq} is the equivalent continuous sound pressure level and represents the steady sound level which is equal in energy to the fluctuating level over the interval period. The L_{Amax} is the maximum noise level recorded over the interval.

3.4 Operator Attended Noise Monitoring

Operator attended surveys were conducted at each of the six monitoring locations during the daytime, evening and night-time periods, to verify the unattended logging results and to determine the character and contribution of ambient noise sources.

4 Operator Attended Noise Monitoring

4.1 Results of Operator Attended Noise Monitoring

Operator attended noise measurements were conducted during the evening and night-time period on Thursday 20 June 2019 and Friday 21 June 2019. Operator attended noise measurements were conducted during the daytime period on Thursday 20 June 2019 and Friday 28 June 2019. Operator attended noise surveys were conducted using a Brüel & Kjær Type 2270 (serial number 2679354) and Brüel & Kjær Type 2250L integrating sound level meter (serial number 3003389).

Ambient noise levels given in the tables include all noise sources such as traffic, insects, birds, and mine operations as well as any other industrial operations.

The tables provide the following information:

- Monitoring location.
- Date and start time.
- Wind velocity (m/s) and Temperature (ºC) at the measurement location.
- Typical maximum (L_{Amax}) and contributed noise levels.

Mine contributions listed in the tables are from the Abel Coal Mine and are stated only when a contribution could be quantified.

Table 2 Location D, Black Hill Public School, Black Hill

<table>
<tr><th rowspan="2">Period</th><th rowspan="2">Date/
Start time/Weather</th><th colspan="5">Primary Noise Descriptor
(dBA re 20 µPa)</th><th rowspan="2">Description of Noise Emission, Typical Maximum Noise Levels (LAmax – dBA)</th></tr>
<tr><th>LAmax</th><th>LA1</th><th>LA10</th><th>LA90</th><th>LAeq</th></tr>
<tr><td rowspan="2">Day</td><td rowspan="2">20/06/2019
15:45
14°C
1.3 m/s SSE</td><td>72</td><td>67</td><td>55</td><td>38</td><td>54</td><td rowspan="2">Road Traffic 60-72
Birdsong 55-61
Abel Mine Inaudible</td></tr>
<tr><td colspan="5">Estimated Abel Mine Noise Contribution
Inaudible</td></tr>
<tr><td rowspan="2">Evening</td><td rowspan="2">20/06/2019
20:46
11.7°C
2.4 m/s S</td><td>59</td><td>43</td><td>40</td><td>35</td><td>38</td><td rowspan="2">Trees 38-41
Insects 42
Abel Mine Inaudible</td></tr>
<tr><td colspan="5">Estimated Abel Mine Noise Contribution
Inaudible</td></tr>
<tr><td rowspan="2">Night</td><td rowspan="2">20/06/2019
22:39
10°C
1.2 m/s SW</td><td>57</td><td>42</td><td>39</td><td>35</td><td>38</td><td rowspan="2">Road Traffic 35-42
Insects/Frogs 30-35
Operator 57
Abel Mine Inaudible</td></tr>
<tr><td colspan="5">Estimated Abel Mine Noise Contribution
Inaudible</td></tr>
</table>

Table 3 Location F, Lot 684 Black Hill Road, Black Hill

Period	Date/ Start time/Weather	Primary Noise Descriptor (dBA re 20 µPa)					Description of Noise Emission, Typical Maximum Noise Levels (LAmax – dBA)
		LAmax	LA1	LA10	LA90	LAeq	
Day	20/06/2019 16:21 13.2°C 0.5 m/s S	86	74	57	49	61	Road Traffic 75-86 Birdsong 37-45 Insects 40-47 **Abel Mine Inaudible**
		Estimated Abel Mine Noise Contribution Inaudible					
Evening	20/06/2019 20:22 11.2°C 1 m/s S	66	61	55	37	51	Road Traffic 64-66 Insects 34-36 Birdsong 48-53 **Abel Mine Inaudible**
		Estimated Abel Mine Noise Contribution Inaudible					
Night	20/06/2019 23:00 9.5°C 0.5 m/s WSW	58	55	51	35	47	Road Traffic 43-58 Insects/Frogs 30-35 **Abel Mine Inaudible**
		Estimated Abel Mine Noise Contribution Inaudible					

Table 4 Location G, Buchanan Road, Buchanan

Period	Date/ Start time/ Weather	Primary Noise Descriptor (dBA re 20 µPa)					Description of Noise Emission, Typical Maximum Noise Levels (LAmax – dBA)
		LAmax	LA1	LA10	LA90	LAeq	
Day	28/06/2019 11:48 18.3°C 1 m/s NNE	58	50	46	40	44	Bird Noise 43-58 Insect 42-45 Road traffic 56 **Abel Mine** Inaudible
		Estimated Abel Mine Noise Contribution Inaudible					
Evening	20/06/2019 19:40 11.7°C 1 m/s S	53	50	48	42	46	Road traffic 45-53 Insects 32-39 **Abel Mine** **Inaudible**
		Estimated Abel Mine Noise Contribution Inaudible					
Night	21/06/2019 00:13 10.7°C 0.5 m/s SSW	52	44	39	32	36	Road traffic 45-52 Insects 28-33 Other industry 32-39 **Abel Mine** **Inaudible**
		Estimated Abel Mine Noise Contribution Inaudible					

Table 5 Location I, Magnetic Drive, Ashtonfield

Period	Date/ Start time/Weather	Primary Noise Descriptor (dBA re 20 µPa)					Description of Noise Emission, Typical Maximum Noise Levels (LAmax – dBA)
		LAmax	LA1	LA10	LA90	LAeq	
Day	20/06/2019 13:30 15.5°C 0.5 m/s SSE	71	59	54	48	52	Road Traffic 47-71 Insects 46-48 **Abel Mine Inaudible**
		Estimated Abel Mine Noise Contribution Inaudible					
Evening	20/06/2019 21:41 10.6°C 0.5 m/s NNW	70	55	47	42	47	Road Traffic 46 70 Insects 41-43 **Abel Mine Inaudible**
		Estimated Abel Mine Noise Contribution Inaudible					
Night	20/06/2019 22:24 10°C 0.5 m/s WSW	62	51	47	38	44	Operator 62 Road Traffic 40-43 Insects 38-41 **Abel Mine Inaudible**
		Estimated Abel Mine Noise Contribution Inaudible					

Table 6 Location J, Parish Drive, Thornton

Period	Date/ Start time/Weather	Primary Noise Descriptor (dBA re 20 µPa)					Description of Noise Emission, Typical Maximum Noise Levels (LAmax – dBA)
		LAmax	LA1	LA10	LA90	LAeq	
Day	20/06/2019 13:30 15.5°C 0.5 m/s SSE	63	50	45	42	44	Road Traffic 54 Birdsong 48-63 **Abel Mine Inaudible**
		Estimated Abel Mine Noise Contribution Inaudible					
Evening	20/06/2019 21:15 11.4°C 0.5 m/s S	58	46	44	40	42	Road Traffic 45 58 Dog Barking 43 **Abel Mine Inaudible**
		Estimated Abel Mine Noise Contribution Inaudible					
Night	20/06/2019 22:08 10.2°C 0.5 m/s NNW	64	50	45	39	43	Road Traffic 43-64 **Abel Mine Inaudible**
		Estimated Abel Mine Noise Contribution Inaudible					

1 Table 7 Location L, 65 Tipperary Dr, Ashtonfield

Period	Date/ Start time/ Weather	Primary Noise Descriptor (dBA re 20 µPa)					Description of Noise Emission, Typical Maximum Noise Levels (LAmax – dBA)
		LAmax	LA1	LA10	LA90	LAeq	
Day	28/06/2019 12:26 19.4°C 1 m/s NE	76	61	44	35	50	Lawnmower 37 Road traffic 67-76 Birdsong 40-60 **Abel Mine Inaudible**
		Estimated Abel Mine Noise Contribution Inaudible					
Evening	20/06/2019 18:24 11.6°C 0.5 m/s S	70	64	50	35	50	Road Traffic 56-70 Dog Barking 37-42 **Abel Mine Inaudible**
		Estimated Abel Mine Noise Contribution Inaudible					
Night	21/06/2019 00:45 8.9°C 1 m/s SW	52	38	32	25	30	Road Traffic 33 Birdsong 49 Operator 52 **Abel Mine Inaudible**
		Estimated Abel Mine Noise Contribution Inaudible					

4.2 Operator Attended Noise Monitoring Summary

4.2.1 Donaldson Mine

Donaldson Open Cut Mine has ceased production and all major earthworks on the site have been finalised. Therefore, compliance noise monitoring for the Donaldson Open Cut Mine is no longer required.

4.2.2 Abel Coal Mine

Abel mine was placed in Care & Maintenance on 28th April 2016 and there was no operations onsite, excluding that from the Bloomfield CHPP which operates under the Abel Coal Mine project consent conditions.

The Bloomfield CHPP and stockpile area was inaudible during all operator attended noise surveys. Noise generated by local and distant traffic was a significant contributor to ambient noise levels at all monitored locations as well as ‘natural’ noises such as birds, insects.

4.3 Compliance Assessment and Discussion of Results

4.3.1 Operations

Results of the operational compliance assessment are given in **Table 8**.

Table 8 Compliance Noise Assessment – Operations

Location	Estimated Abel **LAeq(15minute)** Contribution dBA			Consent Conditions			Compliance		
	Day	**Eve**	**Night**	**Day**	**Eve**	**Night**	**Day**	**Eve**	**Night**
D – Black Hill School, Black Hill	Inaudible	Inaudible	Inaudible	35	35	35	Yes	Yes	Yes
F – Black Hill Road, Black Hill	Inaudible	Inaudible	Inaudible	35	35	35	Yes	Yes	Yes
G – Buchanan Road, Buchanan	Inaudible	Inaudible	Inaudible	35	35	35	Yes	Yes	Yes
I – Magnetic Drive, Ashtonfield	Inaudible	Inaudible	Inaudible	36	36	36	Yes	Yes	Yes
J – Parish Drive, Thornton	Inaudible	Inaudible	Inaudible	35	35	35	Yes	Yes	Yes
L – 65 Tipperary Dr, Ashtonfield	Inaudible	Inaudible	Inaudible	40	40	40	Yes	Yes	Yes

Results presented in **Table 8** indicate that compliance with the relevant consent conditions was achieved at all noise monitoring locations during all periods.

4.3.2 Sleep Disturbance

Results of the sleep disturbance compliance assessment are given in **Table 9**.

Table 9 Compliance Noise Assessment – Sleep Disturbance

Location	Estimated Bloomfield **LA1(1minute)** Contribution dBA	Consent Conditions **LA1(1minute)** dBA	Compliance
D – Black Hill School, Black Hill	Inaudible	45	Yes
F – Black Hill Road, Black Hill	Inaudible	45	Yes
G – Buchanan Road, Buchanan	Inaudible	45	Yes
I – Magnetic Drive, Ashtonfield	Inaudible	45	Yes
J – Parish Drive, Thornton	Inaudible	45	Yes
L – 65 Tipperary Dr, Ashtonfield	Inaudible	47	Yes

Results presented in **Table 9** indicate that compliance with the sleep disturbance consent conditions was achieved at all noise monitoring locations during the night-time noise surveys.

5 Unattended Continuous Noise Monitoring

5.1 Results of Unattended Continuous Noise Monitoring

Unattended continuous noise monitoring was conducted between Thursday 20 June 2019 and Friday 28 June 2019 at each of the six monitoring locations given in **Table 10**. Due to technical issues, the unattended continuous noise monitoring equipment was redeployed from Friday 28 June 2019 to Monday 8 July 2019.

Table 10 Noise Logger and Noise Monitoring Locations

Location	Noise Logger Serial Number	Date of Logging
D – Black Hill School, Black Hill	SVAN 957 23241	20 June 2019 - 28 June 2019
F – Black Hill Road, Black Hill	SVAN 957 23815	20 June 2019 - 28 June 2019
G – Buchanan Road, Buchanan	SVAN 957 27579	20 June 2019 - 28 June 2019
I – Magnetic Drive, Ashtonfield	ARL EL-316 16-103-494	20 June 2019 - 28 June 2019
L – 65 Tipperary Dr, Ashtonfield	ARL EL-316 16-203-508	20 June 2019 - 28 June 2019
J – Parish Drive, Thornton[1]	SVAN 957 21425 ARL EL-316 16-203-508	20 June 2019 - 28 June 2019 28 June 2019 – 8 July 2019

Note 1 - Due to a logger error no results are available from the SVAN 957 21425 logger at this location.

The unattended ambient noise logger data from each monitoring location are presented graphically on a daily basis and are attached as **Appendix C**. A summary of the results of the unattended continuous noise monitoring is given in **Table 11.**

The ambient noise level data quantifies the overall noise level at a given location independent of its source or character.

The measured ambient noise levels were divided into three periods representing day, evening and night as designated in the NSW Noise Policy for Industry (NPfI).

Precautions were taken to minimise influences from extraneous noise sources (eg optimum placement of the loggers away from creeks, trees, houses, etc), however, not all these sources or their effects can be eliminated. This is particularly the case during the warmer times of year when noise from insects, frogs, birds and other animals can become quite prevalent.

Weather data for the subject area during the noise monitoring period was provided by Bloomfield Colliery. Noise data during periods of any rainfall and/or wind speeds in excess of 5 m/s were discarded in accordance with NPfI weather affected data exclusion methodology.

Table 11 Unattended Continuous Noise Monitoring Ambient Noise Levels (dBA)

Location	Period	Primary Noise Descriptor (dBA re 20 µPA)			
		L_{A1}	L_{A10}	L_{A90}	L_{Aeq}
D Black Hill School, Black Hill	Day	67	54	35	64
	Evening	60	44	36	51
	Night	51	42	34	49
F Lot 684 Black Hill Road, Black Hill	Day	71	57	42	59
	Evening	64	54	39	54
	Night	59	52	38	52
G 156 Buchanan Road, Buchanan	Day	51	48	39	47
	Evening	49	46	37	45
	Night	47	43	30	43
I 49 Magnetic Drive, Ashtonfield	Day	68	58	42	58
	Evening	59	45	41	52
	Night	49	43	37	47
L 65 Tipperary Dr, Ashtonfield	Day	62	51	41	52
	Evening	59	43	32	47
	Night	45	37	29	44
J 220 Parish Drive, Thornton	Day	51	47	38	49
	Evening	49	46	40	46
	Night	48	44	33	44

5.2 Long term Unattended Continuous Monitoring Summary for Donaldson Mine and Abel Coal Mine

5.2.1 Ambient LA90 Noise Levels

The long term ambient L_{A90} noise levels collected from each monitoring location are presented graphically in **Figure 1**, **Figure 2** and **Figure 3** for the daytime, evening and night-time periods respectively.

Figure 1 Long term Daytime LA90 Noise Levels

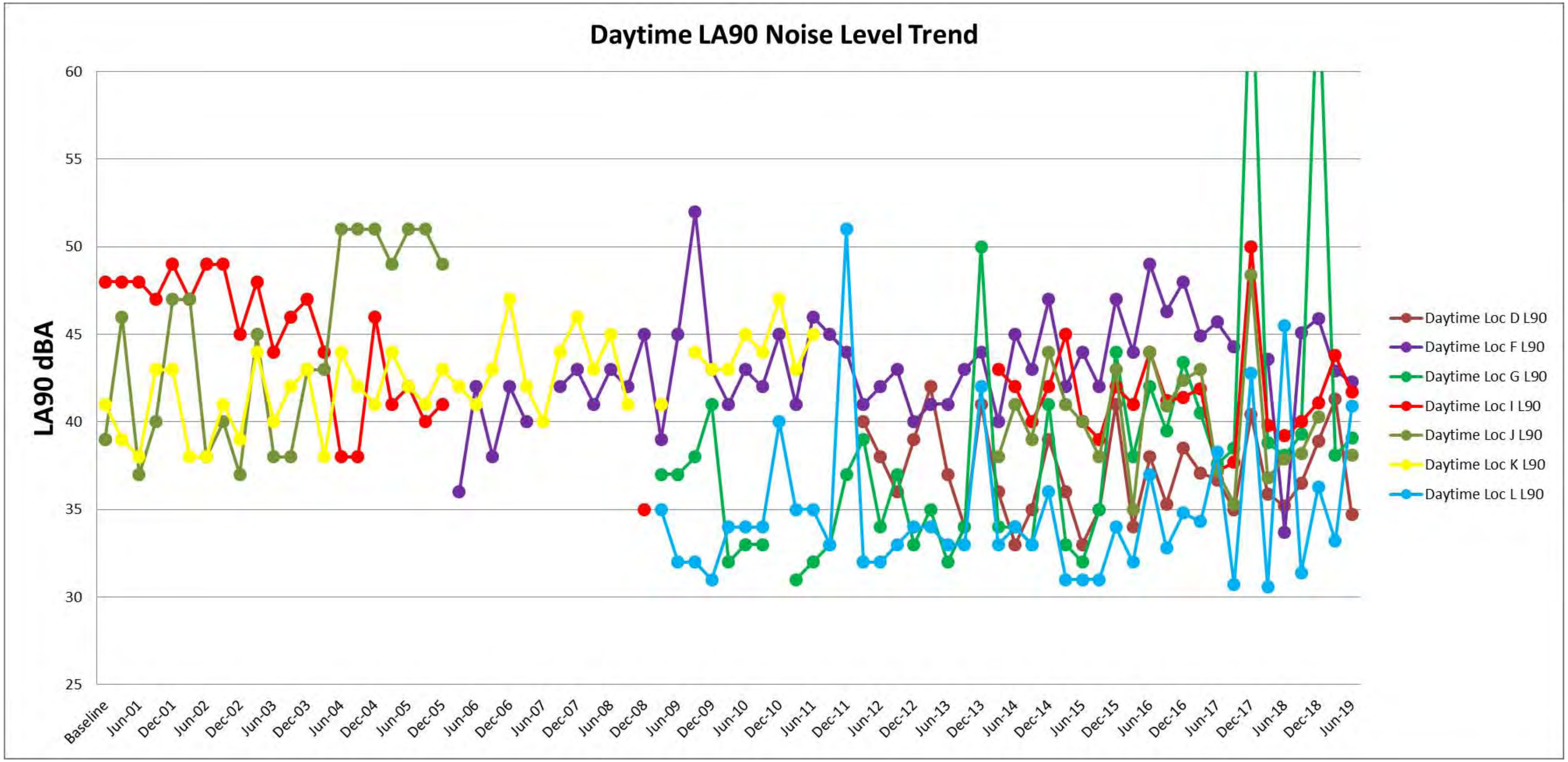


Figure 2 Long term Evening LA90 Noise Levels

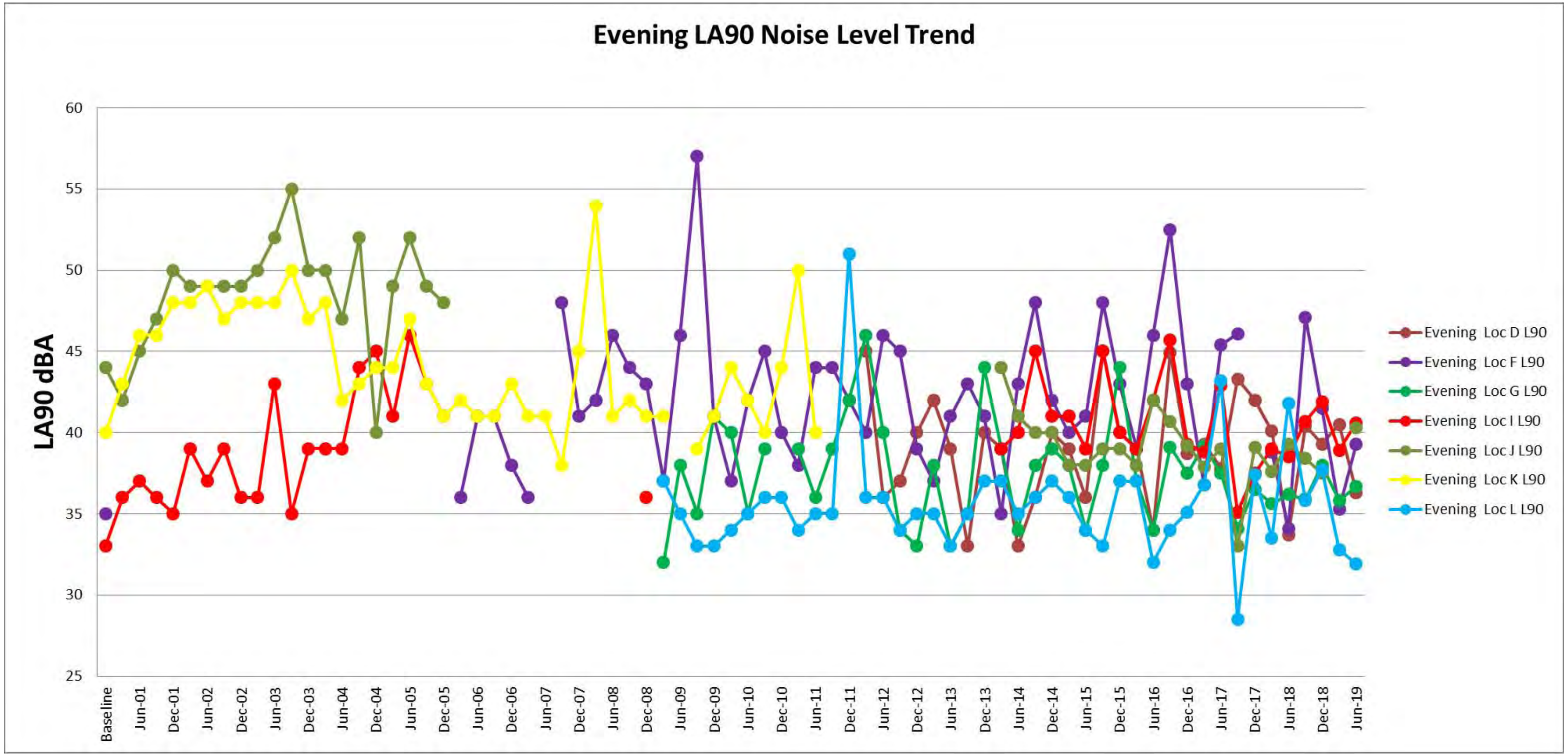
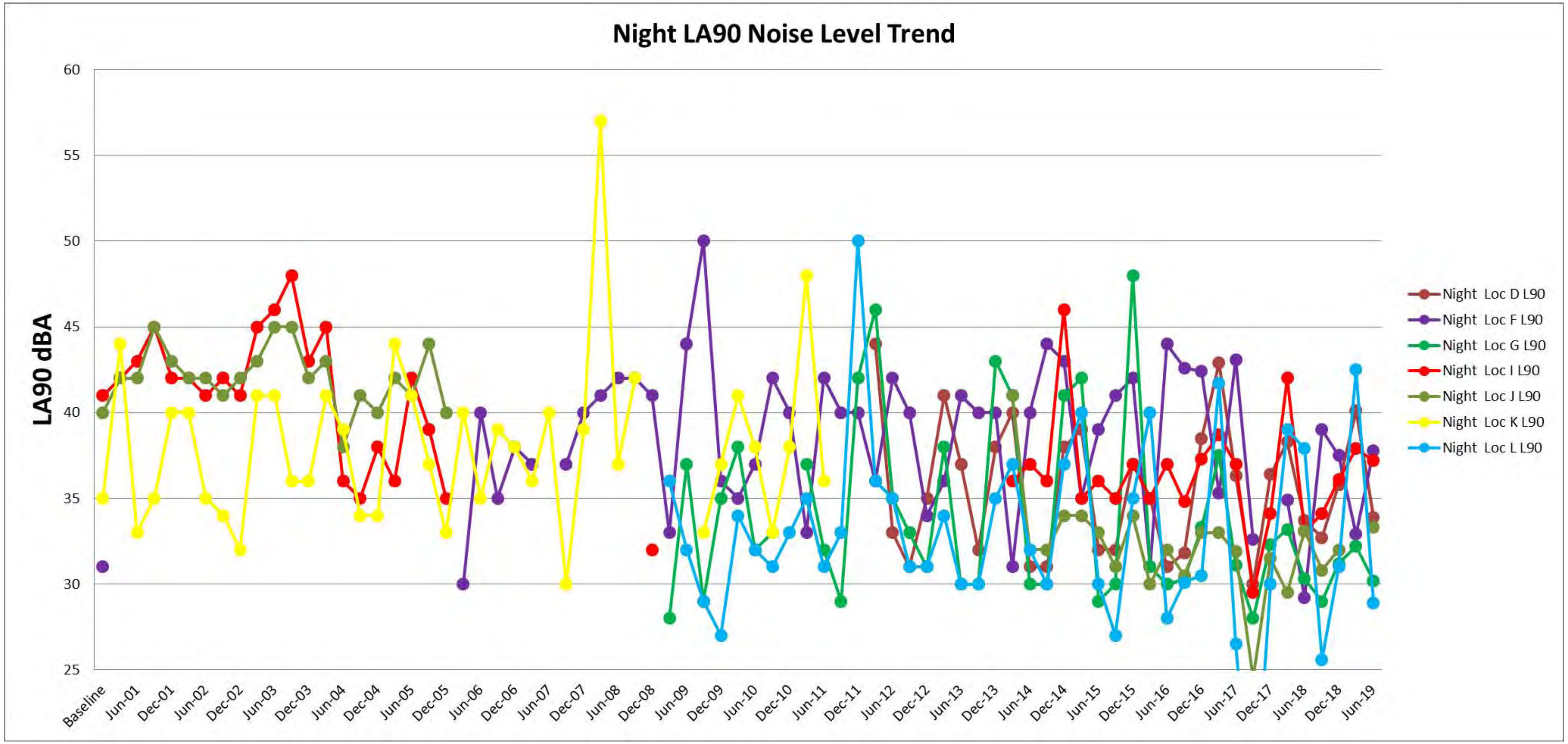


Figure 3 Long term Night-time LA90 Noise Levels



5.2.1.1 Baseline

The summary of results in **Table 12** shows the ambient LA90 noise levels recorded for the current monitoring period compared to the levels recorded during the baseline monitoring process (ie. prior to commencement of mining operation at Donaldson).

Table 12 LA90 Results Comparison – Baseline

Monitoring Location	Period[1]	Long term Night-time LA90 Noise Levels		Difference dB[3]
		Baseline	June 2019	
D Black Hill School, Black Hill	Day	N/A[2]	35	N/A[2]
	Evening	N/A[2]	36	N/A[2]
	Night	N/A[2]	34	N/A[2]
F Lot 684 Black Hill Road, Black Hill	Day	39	42	3
	Evening	35	39	4
	Night	31	38	7
G 156 Buchanan Road, Buchanan	Day	N/A[2]	39	N/A[2]
	Evening	N/A[2]	37	N/A[2]
	Night	N/A[2]	30	N/A[2]
I 49 Magnetic Drive, Ashtonfield	Day	48	42	-6
	Evening	33	41	8
	Night	41	37	-4
L 65 Tipperary Drive, Ashtonfield	Day	N/A[2]	41	N/A[2]
	Evening	N/A[2]	32	N/A[2]
	Night	N/A[2]	29	N/A[2]
J 220 Parish Drive, Thornton	Day	39	38	-1
	Evening	44	40	-4
	Night	40	33	-7

Note 1: Periods are as detailed the NPfI and are Daytime - 7.00 am to 6.00 pm Monday to Saturday, 8.00 am to 6.00 pm Sunday; Evening - 6.00 pm 10.00 pm; Night - 10.00 pm to 7.00 am pm Monday to Saturday, 10.00 pm to 8.00 am Sunday.

Note 2: No data was available during baseline measurements, no comparisons can be made.

Note 3: Rounded to the nearest whole dB.

5.2.1.2 Previous Quarter

Table 13 presents the ambient LA90 noise levels recorded for the current monitoring period compared to those measured in the previous monitoring period.

Table 13 LA90 Results Comparison – Previous Quarter

Monitoring Location	Period[1]	Long term Night-time LA90 Noise Levels		Difference dB[2]
		March 2019	June 2019	
D Black Hill School, Black Hill	Day	41	35	-5
	Evening	41	36	-4
	Night	40	34	-6
F Lot 684 Black Hill Road, Black Hill	Day	43	42	-1
	Evening	35	39	4
	Night	33	38	5
G 156 Buchanan Road, Buchanan	Day	38	39	1
	Evening	36	37	1
	Night	32	30	-2
I 49 Magnetic Drive, Ashtonfield	Day	44	42	-2
	Evening	39	41	2
	Night	38	37	-1
L 65 Tipperary Drive, Ashtonfield	Day	33	41	8
	Evening	33	32	-1
	Night	43	29	-14
J 220 Parish Drive, Thornton	Day	N/A[2]	38	N/A
	Evening	N/A[2]	40	N/A
	Night	N/A[2]	33	N/A

Note 1: 1. Periods are as detailed in the Industrial Noise Policy (INP) and are Daytime - 7.00 am to 6.00 pm Monday to Saturday, 8.00 am to 6.00 pm Sunday; Evening - 6.00 pm 10.00 pm; Night - 10.00 pm to 7.00 am pm Monday to Saturday, 10.00 pm to 8.00 am Sunday.

Note 2: No data was available during this quarter's measurements, no comparisons can be made.

Note 3: Rounded to the nearest whole dB.

5.2.1.3 Coinciding Period Last Year

Table 14 presents the ambient L_{A90} noise levels recorded for the current monitoring period compared to those measured during the coinciding monitoring period last year.

Table 14 L_{A90} Results Comparison – Coinciding Period Last Year

Monitoring Location	Period[1]	Long term Night-time L_{A90} Noise Levels		Difference dB[2]
		June 2018	June 2019	
D Black Hill School, Black Hill	Day	35	35	1
	Evening	34	36	3
	Night	34	34	0
F Lot 684 Black Hill Road, Black Hill	Day	34	42	9
	Evening	34	39	5
	Night	29	38	9
G 156 Buchanan Road, Buchanan	Day	38	39	1
	Evening	36	37	1
	Night	30	30	0
I 49 Magnetic Drive, Ashtonfield	Day	39	42	3
	Evening	39	41	2
	Night	33	37	4
L 65 Tipperary Drive, Ashtonfield	Day	46	41	-5
	Evening	42	32	-10
	Night	38	29	-9
J 220 Parish Drive, Thornton	Day	38	38	0
	Evening	39	40	1
	Night	33	33	0

Note 1: Periods are as detailed in the Industrial Noise Policy (INP) and are Daytime - 7.00 am to 6.00 pm Monday to Saturday, 8.00 am to 6.00 pm Sunday; Evening - 6.00 pm 10.00 pm; Night - 10.00 pm to 7.00 am pm Monday to Saturday, 10.00 pm to 8.00 am Sunday.

Note 2: Rounded to the nearest whole dB.

5.2.2 Ambient L_{A10} Noise Comparison

The long term ambient L_{A10} noise levels collected from each monitoring location are presented graphically in **Figure 4**, **Figure 5** and **Figure 6** for the daytime, evening and night-time respectively.

Figure 4 Long term Daytime L_{A10} Noise Levels

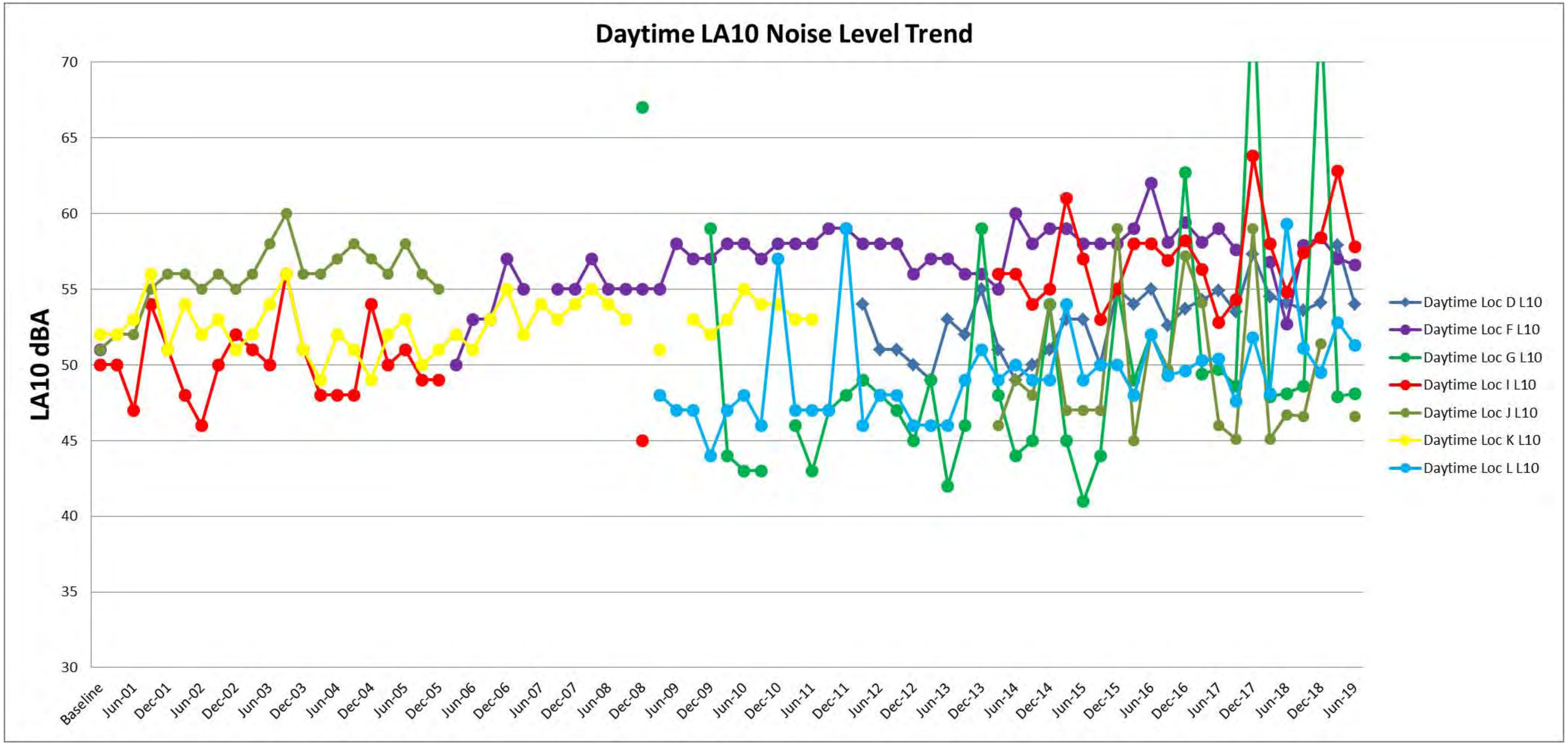


Figure 5 Long term Evening L_{A10} Noise Levels

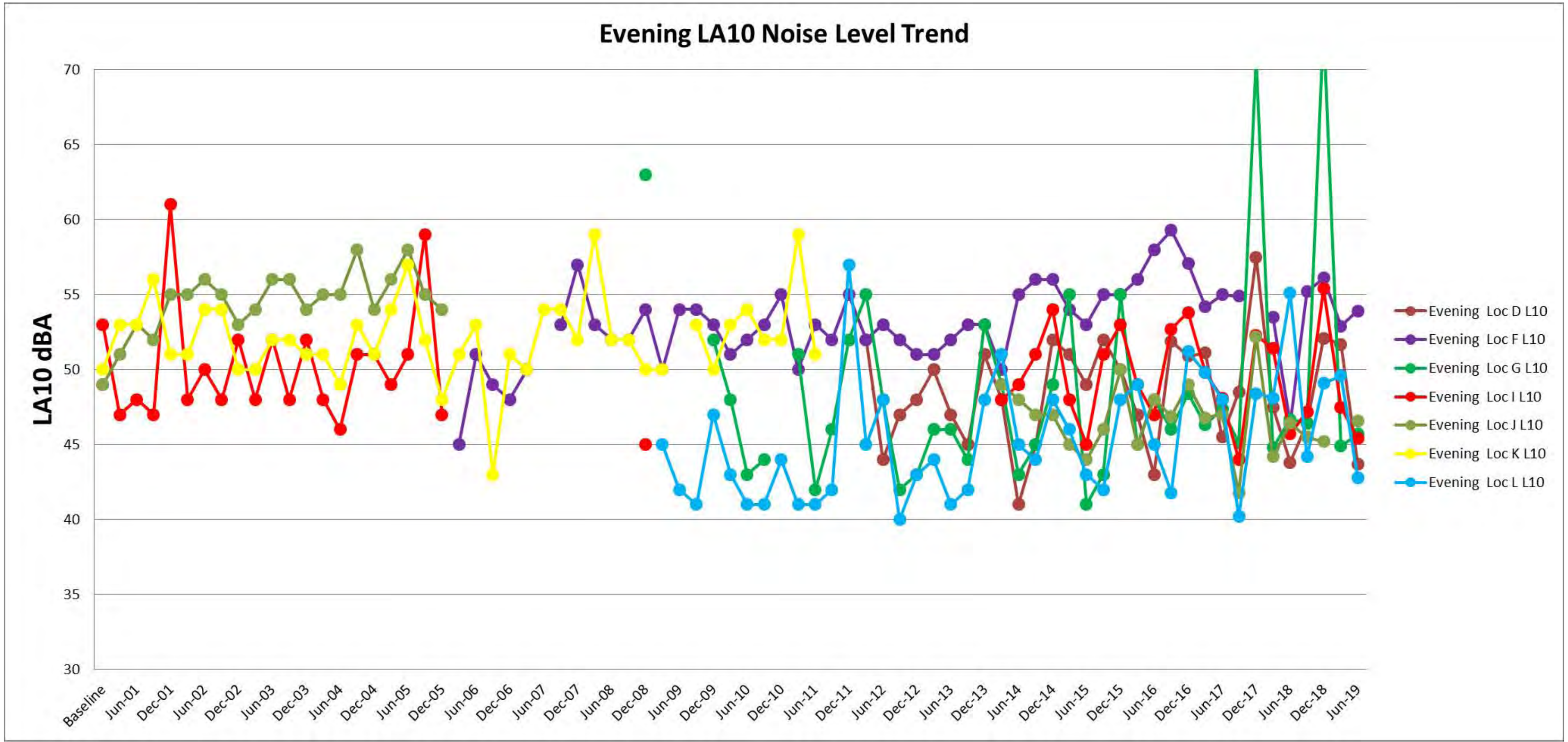


Figure 6 Long term Night L_{A10} Noise Levels

5.2.2.1 Baseline

Table 15 presents the ambient L_{A10} noise levels recorded for the current monitoring period compared to the levels recorded during the baseline monitoring period.

Table 15 L_{A10} Results Comparison – Baseline

Monitoring Location	Period[1]	Long term Night-time L_{A10} Noise Levels		Difference dB[3]
		Baseline	June 2019	
D Black Hill School, Black Hill	Day	N/A[2]	54	N/A
	Evening	N/A[2]	44	N/A
	Night	N/A[2]	42	N/A
F Lot 684 Black Hill Road, Black Hill	Day	51	57	6
	Evening	49	54	5
	Night	48	52	4
G 156 Buchanan Road, Buchanan	Day	N/A[2]	48	N/A
	Evening	N/A[2]	46	N/A
	Night	N/A[2]	43	N/A
I 49 Magnetic Drive, Ashtonfield	Day	50	58	8
	Evening	53	45	-8
	Night	47	43	-4
L 65 Tipperary Drive, Ashtonfield	Day	N/A[2]	51	N/A
	Evening	N/A[2]	43	N/A
	Night	N/A[2]	37	N/A
J 220 Parish Drive, Thornton	Day	51	47	-4
	Evening	49	46	-3
	Night	48	44	-4

Note 1: Periods are as detailed in the Industrial Noise Policy (INP) and are Daytime - 7.00 am to 6.00 pm Monday to Saturday, 8.00 am to 6.00 pm Sunday; Evening - 6.00 pm 10.00 pm; Night - 10.00 pm to 7.00 am pm Monday to Saturday, 10.00 pm to 8.00 am Sunday.

Note 2: No data was available during baseline measurements, no comparisons can be made.

Note 3: Rounded to the nearest whole dB.

5.2.2.2 Previous Quarter

Table 16 presents the ambient LA10 noise levels recorded for the current monitoring period compared to those measured during the previous monitoring period.

Table 16 LA10 Results Comparison – Previous Quarter

Monitoring Location	Period[1]	Long term Night-time LA10 Noise Levels		Difference dB[3]
		March 2019	June 2019	
D Black Hill School, Black Hill	Day	58	54	-4
	Evening	52	44	-8
	Night	50	42	-8
F Lot 684 Black Hill Road, Black Hill	Day	57	57	0
	Evening	53	54	1
	Night	52	52	1
G 156 Buchanan Road, Buchanan	Day	48	48	0
	Evening	45	46	1
	Night	41	43	2
I 49 Magnetic Drive, Ashtonfield	Day	63	58	-5
	Evening	48	45	-2
	Night	48	43	-5
L 65 Tipperary Drive, Ashtonfield	Day	53	51	-2
	Evening	50	43	-7
	Night	61	37	-24
J 220 Parish Drive, Thornton	Day	N/A[2]	47	N/A
	Evening	N/A[2]	46	N/A
	Night	N/A[2]	44	N/A

Note 1: Periods are as detailed in the Industrial Noise Policy (INP) and are Daytime - 7.00 am to 6.00 pm Monday to Saturday, 8.00 am to 6.00 pm Sunday; Evening - 6.00 pm 10.00 pm; Night - 10.00 pm to 7.00 am pm Monday to Saturday, 10.00 pm to 8.00 am Sunday.

Note 2: No data was available during baseline measurements, no comparisons can be made.

Note 3: Rounded to the nearest whole dB.

5.2.2.3 Coinciding Period Last Year

Table 17 presents the ambient L_{A10} noise levels recorded for the current monitoring period compared to those measured during the coinciding monitoring period last year.

Table 17 L_{A10} Result Comparison – Coinciding Period Last Year

Monitoring Location	Period[1]	Long term Night-time L_{A10} Noise Levels		Difference dB[2]
		June 2018	June 2019	
D Black Hill School, Black Hill	Day	54	54	0
	Evening	44	44	0
	Night	42	42	0
F Lot 684 Black Hill Road, Black Hill	Day	53	57	4
	Evening	46	54	8
	Night	38	52	14
G 156 Buchanan Road, Buchanan	Day	48	48	0
	Evening	47	46	-1
	Night	44	43	0
I 49 Magnetic Drive, Ashtonfield	Day	55	58	3
	Evening	46	45	0
	Night	43	43	0
L 65 Tipperary Dr, Ashtonfield	Day	59	51	-8
	Evening	55	43	-12
	Night	53	37	-16
J 220 Parish Drive, Thornton	Day	47	47	0
	Evening	46	46	0
	Night	45	44	0

Note 1: Periods are as detailed in the Industrial Noise Policy (INP) and are Daytime - 7.00 am to 6.00 pm Monday to Saturday, 8.00 am to 6.00 pm Sunday; Evening - 6.00 pm 10.00 pm; Night - 10.00 pm to 7.00 am pm Monday to Saturday, 10.00 pm to 8.00 am Sunday.

Note 2: Rounded to the nearest whole dB.

5.3 Rail Noise Monitoring

In order to determine compliance with the rail noise criteria, a noise logger was positioned at Location J. The train loading times during the noise monitoring period are presented in **Table 18**.

Table 18 Coal Train Loading Operations Log

Date	Coal Train Loading Time	Period
2/07/19	09:57-13:11	Day
04/07/19	13:21-16:15	Day

The measured $L_{Aeq(period)}$ noise level for each period from rail traffic at Location J are presented in **Table 19.**

Table 19 Rail Noise Impact Monitoring Results

Location	Date	Period	Measured $L_{Aeq(period)}$	Criteria $L_{Aeq(period)}$	Compliance
J	2/07/19	Day	37	55	Yes
	04/07/19	Day	34	55	Yes

Results presented in **Table 19** indicate that rail noise levels from the Bloomfield Rail Spur were in compliance with the Abel Mine Project Approval during the noise monitoring period.

6 Conclusion

SLR was engaged by Donaldson Coal Pty Ltd to conduct quarterly noise monitoring surveys for Donaldson Coal Mine and Abel Coal Mine in accordance with the Abel Coal Mine Noise Monitoring Program, dated 12 August 2014.

Donaldson Open Cut Mine has ceased production and all major earthworks on the site have been finalised. Therefore, compliance noise monitoring for the Donaldson Open Cut Mine is no longer required.

Abel mine was placed in Care & Maintenance on 28th April 2016 and there was no operations onsite, excluding that from the Bloomfield CHPP which operates under the Abel Coal Mine project consent conditions.

Operator-attended and unattended noise measurements were conducted for the June 2019 quarter at six focus locations surrounding the mine.

Abel portal operations were not observed to be audible at any locations during the monitoring period. Contributed noise levels from Abel Mine did not exceed noise emission goals (including night-time sleep arousal criteria) and compliance with the Abel Mine *Project Approval* was indicated at all locations.

A comparison of ambient L_{A10} and L_{A90} noise levels recorded during the current monitoring period (June 2019), the baseline monitoring period, the last monitoring period (March 2019), and the coinciding monitoring period from last year (June 2018) has been conducted.

Rail noise levels from the Bloomfield Rail Spur were considered to be in compliance with the Abel Mine Project Approval during the noise monitoring period.

APPENDIX A

Acoustic Terminology

1. Sound Level or Noise Level

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

Sound (or noise) consists of minute fluctuations in atmospheric pressure. The human ear responds to changes in sound pressure over a very wide range with the loudest sound pressure to which the human ear can respond being ten million times greater than the softest. The decibel (abbreviated as dB) scale reduces this ratio to a more manageable size by the use of logarithms.

The symbols SPL, L or LP are commonly used to represent Sound Pressure Level. The symbol LA represents A-weighted Sound Pressure Level. The standard reference unit for Sound Pressure Levels expressed in decibels is 2 x 10^{-5} Pa.

2. 'A' Weighted Sound Pressure Level

The overall level of a sound is usually expressed in terms of dBA, which is measured using a sound level meter with an 'A-weighting' filter. This is an electronic filter having a frequency response corresponding approximately to that of human hearing.

People's hearing is most sensitive to sounds at mid frequencies (500 Hz to 4,000 Hz), and less sensitive at lower and higher frequencies. Different sources having the same dBA level generally sound about equally loud.

A change of 1 dB or 2 dB in the level of a sound is difficult for most people to detect, whilst a 3 dB to 5 dB change corresponds to a small but noticeable change in loudness. A 10 dB change corresponds to an approximate doubling or halving in loudness. The table below lists examples of typical noise levels.

Sound Pressure Level (dBA)	Typical Source	Subjective Evaluation
130	Threshold of pain	Intolerable
120	Heavy rock concert	Extremely noisy
110	Grinding on steel	
100	Loud car horn at 3 m	Very noisy
90	Construction site with pneumatic hammering	
80	Kerbside of busy street	Loud
70	Loud radio or television	
60	Department store	Moderate to quiet
50	General Office	
40	Inside private office	Quiet to very quiet
30	Inside bedroom	
20	Recording studio	Almost silent

Other weightings (eg B, C and D) are less commonly used than A-weighting. Sound Levels measured without any weighting are referred to as 'linear', and the units are expressed as dB(lin) or dB.

3. Sound Power Level

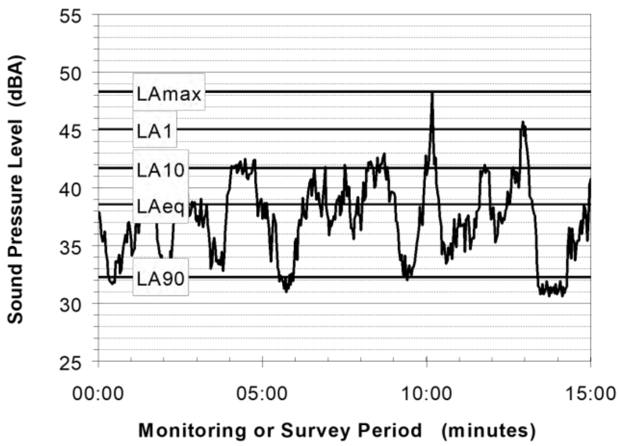
The Sound Power of a source is the rate at which it emits acoustic energy. As with Sound Pressure Levels, Sound Power Levels are expressed in decibel units (dB or dBA), but may be identified by the symbols SWL or LW, or by the reference unit 10^{-12} W.

The relationship between Sound Power and Sound Pressure is similar to the effect of an electric radiator, which is characterised by a power rating but has an effect on the surrounding environment that can be measured in terms of a different parameter, temperature.

4. Statistical Noise Levels

Sounds that vary in level over time, such as road traffic noise and most community noise, are commonly described in terms of the statistical exceedance levels LAN, where LAN is the A-weighted sound pressure level exceeded for N% of a given measurement period. For example, the LA1 is the noise level exceeded for 1% of the time, LA10 the noise exceeded for 10% of the time, and so on.

The following figure presents a hypothetical 15 minute noise survey, illustrating various common statistical indices of interest.



Of particular relevance, are:

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

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

LA90 The noise level exceeded for 90% of the sample period. This noise level is described as the average minimum background sound level (in the absence of the source under consideration), or simply the background level.

LAeq The A-weighted equivalent noise level (basically, the average noise level). It is defined as the steady sound level that contains the same amount of acoustical energy as the corresponding time-varying sound.

5. Frequency Analysis

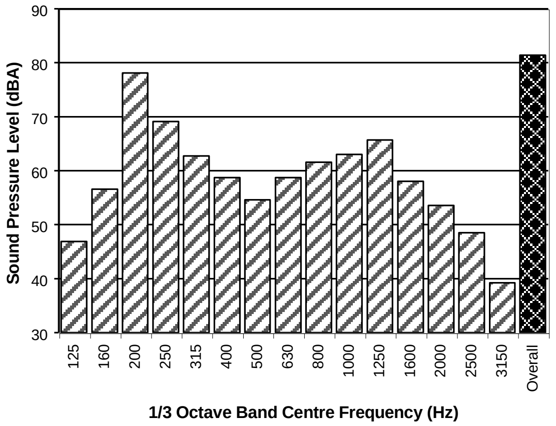
Frequency analysis is the process used to examine the tones (or frequency components) which make up the overall noise or vibration signal.

The units for frequency are Hertz (Hz), which represent the number of cycles per second.

Frequency analysis can be in:

- Octave bands (where the centre frequency and width of each band is double the previous band)
- 1/3 octave bands (three bands in each octave band)
- Narrow band (where the spectrum is divided into 400 or more bands of equal width)

The following figure shows a 1/3 octave band frequency analysis where the noise is dominated by the 200 Hz band. Note that the indicated level of each individual band is less than the overall level, which is the logarithmic sum of the bands.



6. Annoying Noise (Special Audible Characteristics)

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

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

7. Vibration

Vibration may be defined as cyclic or transient motion. This motion can be measured in terms of its displacement, velocity or acceleration. Most assessments of human response to vibration or the risk of damage to buildings use measurements of vibration velocity. These may be expressed in terms of 'peak' velocity or 'rms' velocity.

The former is the maximum instantaneous velocity, without any averaging, and is sometimes referred to as 'peak particle velocity', or PPV. The latter incorporates 'root mean squared' averaging over some defined time period.

Vibration measurements may be carried out in a single axis or alternatively as triaxial measurements (ie vertical, longitudinal and transverse).

The common units for velocity are millimetres per second (mm/s). As with noise, decibel units can also be used, in which case the reference level should always be stated. A vibration level V, expressed in mm/s can be converted to decibels by the formula 20 log (V/Vo), where Vo is the reference level (10^{-9} m/s). Care is required in this regard, as other reference levels may be used.

8. Human Perception of Vibration

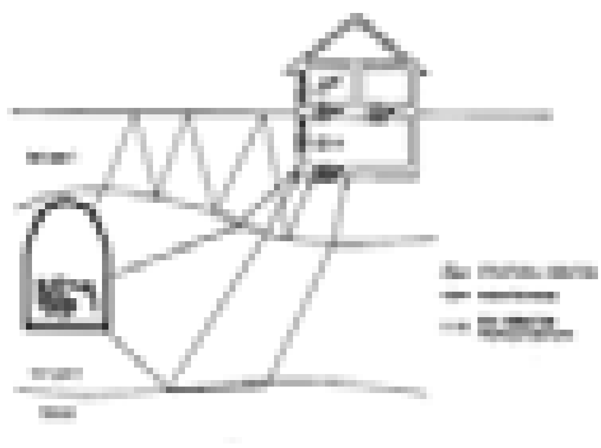
People are able to 'feel' vibration at levels lower than those required to cause even superficial damage to the most susceptible classes of building (even though they may not be disturbed by the motion). An individual's perception of motion or response to vibration depends very strongly on previous experience and expectations, and on other connotations associated with the perceived source of the vibration. For example, the vibration that a person responds to as 'normal' in a car, bus or train is considerably higher than what is perceived as 'normal' in a shop, office or dwelling.

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

Noise that propagates through a structure as vibration and is radiated by vibrating wall and floor surfaces is termed 'structure-borne noise', 'ground-borne noise' or 'regenerated noise'. This noise originates as vibration and propagates between the source and receiver through the ground and/or building structural elements, rather than through the air.

Typical sources of ground-borne or structure-borne noise include tunnelling works, underground railways, excavation plant (eg rockbreakers), and building services plant (eg fans, compressors and generators).

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



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

APPENDIX B

Noise Monitoring Locations

D:\Quick Jobs\Martin Davenport\Donaldson\SLR630010530120\0_AB_MonitoringLocations_01.mxd

SLR
10 KINGS ROAD
NEW LAMBTON
NEW SOUTH WALES 2305
AUSTRALIA
T: 61 2 4037 3200
F: 61 2 4037 3201
www.slrconsulting.com

Project No.:	630.01053.01200
Date:	11/01/2018
Drawn by:	NT
Scale:	1:45,000
Sheet Size:	A4
Projection:	GDA 1994 MGA Zone 56

LEGEND

Noise Monitoring Locations

N
W E
S

0 500 1,000 1,500 2,000 m

Donaldson Coal

Noise Monitoring

Noise Monitoring Locations

APPENDIX B

APPENDIX C

Calibration Certificates

CERTIFICATE OF CALIBRATION

CERTIFICATE NO.: SLM 23293 & FILT 4792

Equipment Description:	Sound & Vibration Analyser		
Manufacturer:	B&K		
Model No:	2250	**Serial No:**	3003389
Microphone Type:	4950	**Serial No:**	2913816
Preamplifier Type:	ZC0032	**Serial No:**	20519
Filter Type:	1/3 Octave	**Serial No:**	3003389

Comments: All tests passed for class 1.
(See over for details)

Owner: SLR Consulting Australia Pty Ltd
Level 2, 2 Lincoln Street
Lane Cove, NSW 2066

Ambient Pressure: 990 hPa ±1.5 hPa

Temperature: 25 °C ±2° C **Relative Humidity:** 29% ±5%

Date of Calibration: 06/08/2018 **Issue Date:** 07/08/2018

Acu-Vib Test Procedure: AVP10 (SLM) & AVP06 (Filters)

CHECKED BY: ...JK..... **AUTHORISED SIGNATURE:** ....
Jack Kielt

Accredited for compliance with ISO/IEC 17025 - Calibration
The results of the tests, calibration and/or measurements included in this document are traceable to Australian/national standards.

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Accredited Lab. No. 9262
Acoustic and Vibration Measurements

ACU-VIB
ELECTRONICS

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Mobile: 0413 809806
web site: www.acu-vib.com.au

CERTIFICATE NO.: SLM 23293 & FILT 4792

The performance characteristics listed below were tested. The tests are based on the relevant clauses of IEC 61672-3:2013

Tests Performed:	*Clause*	*Result*
Absolute Calibration	10	Pass
Acoustical Frequency Weighting	12	Pass
Self Generated Noise	11.1	Entered
Electrical Noise	11.2	Entered
Long Term Stability	15	Pass
Electrical Frequency Weightings	13	Pass
Frequency and Time Weightings	14	Pass
Reference Level Linearity	16	Pass
Range Level Linearity	17	NA
Toneburst	18	Pass
Peak C Sound Level	19	Pass
Overload Indicator	20	Pass
High Level Stability	21	Pass

Statement of Compliance: The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2013, for the environmental conditions under which the tests were performed. As public evidence was available, from an independent organization responsible for approving the results of pattern evaluation tests performed in accordance with IEC 61672-2:2013, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2013, the sound level meter submitted for testing conforms to the class 1 requirements of IEC61672-1:2013.
A full technical report is available if required.

This Sound Level Meter included an Octave Filter Set. Tests were based on IEC 1260: 1995 and AS/NZS 4476 - 1997 and were conducted to test the following performance characteristics:

1. Relative attenuation clause 5.3

Date of Calibration: 06/08/2018 **Issue Date:** 07/08/2018

Checked by: KL

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Brüel & Kjær

The Calibration Laboratory
Skodsborgvej 307, DK-2850 Nærum, Denmark

CERTIFICATE OF TRACEABLE CALIBRATION

No.: CDK1706457

CALIBRATION OF:

Manufacturer:	Brüel & Kjær		
Hand-held Analyzer Type:	Type: 2270	Serial No.:	2679354
Application:	Type: BZ-7233	Version No.:	4.6.3
Intensity Probe Type:	Type: 3654	Serial No.:	2783762
Customer identification:	-		

CUSTOMER:

SLR Consulting Australia Pty Ltd
PO Box 176
2066 Lane Cove
New South Wales
Australia

CALIBRATION CONDITIONS:

Preconditioning:	4 hours at 23° C ± 3° C	
Environment conditions:	Air Temperature:	23 °C ± 3 °C
	Air Pressure:	101,3 kPa ± 5 kPa
	Relative Humidity:	50% RH ± 25% RH

PROCEDURE:

The pressure residual intensity index for the complete system is then calibrated in accordance with the demands in IEC 1043 class 1 using the Brüel & Kjær calibration procedure P_3654_A05.

RESULTS:

Calibration after repair or adjustment

The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k = 2, which for a normal distribution corresponds to a coverage probability of approximately 95%. The standard uncertainty of measurement has been determined in accordance with EA-4/02

Date of Calibration: 2017-09-01 Certificate Issued: 2017-09-01

N Eriksen

Nicki Eriksen
Calibration Technician

RESULTS:

List of performed (sub)tests with status:

"OK" Means the result of the test is within tolerances.
"-" Means the result of the test is outside these tolerances.

Visual inspection:

	Result accepted?
Visual inspection	OK

Status of System Elements:

	Calibration Date	Result accepted?
Calibration of microphones	2017-09-01	OK[2]

[1] **Accredited calibration**, Environmental conditions 23°C ± 3°C, 1013 hPa ± 5 hPa

[2] **Factory calibration**, Environmental conditions 23°C ± 2°C, > 960 hPa

Sound Pressure Calibration:

Measured Value Channel A [dB re 1V/Pa]	Measured Value Channel B [dB re 1V/Pa]	Deviation [dB]	Maximum Deviation [±dB]	Calibration Uncertainty [dB]
-38,75	-38,39	0,35	1,00	0,24

3654 Gain Diviation	Open-circuit Sensitivity [dB re 1V/Pa]	Measured Value [dB re 1V/Pa]	Deviation [dB]	Calibration Uncertainty [dB]
Mic. Part 1	-38,40	-38,75	-0,35	0,24
Mic. Part 2	-38,20	-38,39	-0,19	0,24

Measurement of the P-I index for the system:

Minimum levels are in accordance with IEC 1043 class 1 limits, with a 12 spacer

Frequency [Hz]	Min. Level [dB]	Direction	Measured P-I index [dB]	Calibration Uncertainty [dB]
50	9		23,6	< 1
63	10		25,1	< 1
80	11		25,6	< 1
100	12		27,2	< 1
125	13		29,6	< 1
160	14		33,2	< 1
200	15		37,7	< 1
250	16		40,7	< 1
315	16	-	36,8	< 1
400	16	-	45,6	< 1
500	16		40,5	< 1
630	16		27,7	< 1
800	16	-	27,2	< 1
1000	16	-	27,1	< 1
1250	16	-	35,9	< 1
1600	16	-	26,8	< 1
2000	16	-	33,5	< 1
2500	16		34,6	< 1
3150	16		32,6	< 1
4000	16		29,1	< 1
5000	16		27,8	< 1

System configuration:

Part 1 to channel: A

Part 2 to channel: B

Notes:

CALIBRATION EQUIPMENT:

Description	Type	Serial No.
Pistonphone	4228	1908475
Intensity Coupler	UA-0914	1913431
Sound Source	ZI-0055	-
Vaisala Barometer	PTB100A	U2450020
Vaisala Thermometer	HMT331	C1750032

Acoustic Research Labs Pty Ltd

Level 7 Building 2 423 Pennant Hills Rd
Pennant Hills NSW AUSTRALIA 2120
Ph: +61 [illegible]
www.acousticresearch.com.au

Sound Level Meter

AS 1259.1:1990 - AS 1259.2:1990

Calibration Certificate

Calibration Number C[illegible]

Client Details	SLR Consulting Suite 2, 2 Domville Avenue Hawthorn Vic 3122
Equipment Tested/ Model Number :	ARL Ngara [illegible]
Instrument Serial Number :	16-103-[illegible]
Microphone Serial Number :	317[illegible]
Pre-amplifier Serial Number :	28012

Atmospheric Conditions

Ambient Temperature :	[illegible] °C
Relative Humidity :	42 %
Barometric Pressure :	99.[illegible] kPa

Calibration Technician :	Lucky Jaswal	**Secondary Check:**	Lewis Hamman
Calibration Date :	14 Jun 2019	**Report Issue Date :**	14 Jun 2018

Approved Signatory : Ken Williams

Clause and Characteristic Tested	Result	Clause and Characteristic Tested	Result
10.2.1: Absolute sensitivity	Pass	10.3.4: Inherent system noise level	Pass
10.2.2: Frequency weighting	Pass	10.4.2: Time weighting characteristic F and S	Pass
10.3.2: Overload indication	Pass	10.4.3: Time weighting characteristic I	Pass
10.3.3: Accuracy of level range control	Pass	10.4.4: R.M.S performance	Pass
8.[illegible]: Detector-indicator linearity	Pass	9.3.2: Time averaging	Pass
[illegible] 10: Differential level linearity	Pass	9.3.3: Overload indication	Pass

Least Uncertainties of Measurement -

Acoustic Tests		Environmental Conditions	
[illegible] kHz	*±0.15dB*	*Temperature*	*±[illegible]°C*
Frequency	*±[illegible]dB*	*Relative Humidity*	*±[illegible]%*
[illegible]	*±[illegible]dB*	*Barometric Pressure*	*±0.0[illegible]kPa*
Electrical Tests			
[illegible] - 20 kHz	*±0.1[illegible]dB*		

All uncertainties are derived at the 95% confidence level with a coverage factor of 2.

The sound level meter under test has been shown to conform to the type 1 requirements for periodic intra-verification in AS 1259.1:1990 and AS 1259.2:1990 for the tests stated above.

Acoustic Research Labs Pty Ltd

Level 7 Building 2 423 Pennant Hills Rd
Pennant Hills NSW AUSTRALIA 2120
Ph: [illegible] A.B.N [illegible]
www.acousticresearch.com.au

Sound Level Meter

AS 1259.1:1990 - AS 1259.2:1990

Calibration Certificate

Calibration Number C18314

Client Details SLR Consulting
Suite 2, 2 [illegible] Avenue
Hawthorn VIC [illegible]

Equipment Tested/ Model Number : ARL EL-316
Instrument Serial Number : 16-207-[illegible]
Microphone Serial Number : 319[illegible]
Pre-amplifier Serial Number : [illegible]

Atmospheric Conditions
Ambient Temperature : 21.7°C
Relative Humidity : 43.3%
Barometric Pressure : 99.36kPa

Calibration Technician : Lucky Jaiswal | **Secondary Check:** [illegible]
Calibration Date : 14 Jun 2018 | **Report Issue Date :** 14 Jun 2018

Approved Signatory : Ken Williams

Clause and Characteristic Tested	Result	Clause and Characteristic Tested	Result
10.2.2: Absolute sensitivity	Pass	10.3.4: Inherent system noise level	Pass
10.2.3: Frequency weighting	Pass	10.4.2: Time weighting characteristic F and S	Pass
10.3.2: Overload indication	Pass	10.4.3: Time weighting characteristic I	Pass
10.3.3: Accuracy of level range control	Pass	10.4.5: R.M.S performance	Pass
8.9: Detector-indicator linearity	Pass	9.3.2: Time averaging	Pass
8.10: Differential level linearity	Pass	9.3.5: Overload indication	Pass

Least Uncertainties of Measurement -

Acoustic Tests		Environmental Conditions	
31.5 Hz to 8kHz	±0.[illegible]dB	Temperature	[illegible]
12.5kHz	±[illegible]dB	Relative Humidity	[illegible]
16kHz	±0.29dB	Barometric Pressure	[illegible]
Electrical Tests			
31.5 Hz to 20kHz	±0.12dB		

All uncertainties are derived at the 95% confidence level with a coverage factor of 2.

The sound level meter under test has been shown to conform to the type 1 requirements for periodic testing described in AS 1259.1:1990 and AS 1259.2:1990 for the tests stated above.

This calibration certificate is to be read in conjunction with the calibration test report.

Acoustic Research Labs Pty Ltd is NATA Accredited Laboratory Number [illegible]
Accredited for compliance with ISO/IEC 17025 - Calibration

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NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration and inspection reports.

CERTIFICATE OF CALIBRATION

CERTIFICATE NO.: **SLM 24613 & FILT 5164**

Equipment Description:	Sound & Vibration Analyser		
Manufacturer:	Svantek		
Model No:	Svan-957	**Serial No:**	23241
Microphone Type:	7052H	**Serial No:**	43035
Preamplifier Type:	SV12L	**Serial No:**	29858
Filter Type:	1/3 Octave	**Serial No:**	23241

Comments: All tests passed for class 1.
(See over for details)

Owner: SLR Consulting Australia Pty Ltd
Level 2, 2 Lincoln Street
Lane Cove, NSW 2066

Ambient Pressure: 1003 hPa ±1.5 hPa

Temperature: 23 °C ±2° C **Relative Humidity:** 65% ±5%

Date of Calibration: 03/05/2019 **Issue Date:** 09/05/2019

Acu-Vib Test Procedure: AVP10 (SLM) & AVP06 (Filters)

CHECKED BY: [illegible] **AUTHORISED SIGNATURE:** ....
Jack Kielt

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Acoustic and Vibration
Measurements

CERTIFICATE NO.: SLM 24613 & FILT 5164

The performance characteristics listed below were tested. The tests are based on the relevant clauses of IEC 61672-3:2013

Tests Performed:	*Clause*	*Result*
Absolute Calibration	10	Pass
Acoustical Frequency Weighting	12	Pass
Self Generated Noise	11.1	Entered
Electrical Noise	11.2	Entered
Long Term Stability	15	Pass
Electrical Frequency Weightings	13	Pass
Frequency and Time Weightings	14	Pass
Reference Level Linearity	16	Pass
Range Level Linearity	17	Pass
Toneburst	18	Pass
Peak C Sound Level	19	Pass
Overload Indicator	20	Pass
High Level Stability	21	Pass

Statement of Compliance: The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2013, for the environmental conditions under which the tests were performed. As public evidence was available, from an independent organization responsible for approving the results of pattern evaluation tests performed in accordance with IEC 61672-2:2013, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2013, the sound level meter submitted for testing conforms to the class 1 requirements of IEC61672-1:2013.
A full technical report is available if required.

This Sound Level Meter included an Octave Filter Set. Tests were based on IEC 1260: 1995 and AS/NZS 4476 - 1997 and were conducted to test the following performance characteristics:

1. Relative attenuation clause 5.3

Date of Calibration: 03/05/2019 **Issue Date:** 09/05/2019

Checked by:

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CERTIFICATE OF CALIBRATION

CERTIFICATE NO.: SLM 21303 & FILT 4154

Equipment Description:	Sound & Vibration Analyzer		
Manufacturer:	Svantek		
Model No:	Svan-957	**Serial No:**	23815
Microphone Type:	7052E	**Serial No:**	47873
Filter Type:	1/3 Octave	**Serial No:**	23815
Comments:	All tests passed for class 1. (See over for details)		
Owner:	SLR Consulting Australia Pty Ltd Level 2, 2 Lincoln Street Lane Cove, NSW 2066		
Ambient Pressure:	1004 hPa ±1.5 hPa		
Temperature:	24 °C ±2° C	**Relative Humidity:**	34% ±5%
Date of Calibration:	24/08/2017	**Issue Date:**	25/08/2017
Acu-Vib Test Procedure:	AVP10 (SLM) & AVP06 (Filters)		

CHECKED BY: ...JK... **AUTHORISED SIGNATURE:** ....

Jack Kielt

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CERTIFICATE OF CALIBRATION

CERTIFICATE NO.: SLM 23295 & FILT 4794

Equipment Description:	Sound & Vibration Analyser		
Manufacturer:	Svantek		
Model No:	Svan-957	**Serial No:**	27579
Microphone Type:	7052E	**Serial No:**	50613
Preamplifier Type:	SV12L	**Serial No:**	58524
Filter Type:	1/3 Octave	**Serial No:**	27579
Comments:	All tests passed for class 1. (See over for details)		
Owner:	SLR Consulting Australia Pty Ltd Level 2, 2 Lincoln Street Lane Cove, NSW 2066		
Ambient Pressure:	997 hPa ±1.5 hPa		
Temperature:	25 °C ±2° C	**Relative Humidity:**	25% ±5%
Date of Calibration:	07/08/2018	**Issue Date:**	07/08/2018
Acu-Vib Test Procedure:	AVP10 (SLM) & AVP06 (Filters)		

CHECKED BY: .... **AUTHORISED SIGNATURE:** ....

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CERTIFICATE NO.: SLM 23295 & FILT 4794

The performance characteristics listed below were tested. The tests are based on the relevant clauses of IEC 61672-3:2013

Tests Performed:	*Clause*	*Result*
Absolute Calibration	10	Pass
Acoustical Frequency Weighting	12	Pass
Self Generated Noise	11.1	Entered
Electrical Noise	11.2	Entered
Long Term Stability	15	Pass
Electrical Frequency Weightings	13	Pass
Frequency and Time Weightings	14	Pass
Reference Level Linearity	16	Pass
Range Level Linearity	17	Pass
Toneburst	18	Pass
Peak C Sound Level	19	Pass
Overload Indicator	20	Pass
High Level Stability	21	Pass

Statement of Compliance: The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2013, for the environmental conditions under which the tests were performed. As public evidence was available, from an independent organization responsible for approving the results of pattern evaluation tests performed in accordance with IEC 61672-2:2013, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2013, the sound level meter submitted for testing conforms to the class 1 requirements of IEC61672-1:2013.
A full technical report is available if required.

This Sound Level Meter included an Octave Filter Set. Tests were based on IEC 1260: 1995 and AS/NZS 4476 - 1997 and were conducted to test the following performance characteristics:

1. Relative attenuation clause 5.3

Date of Calibration: 07/08/2018 **Issue Date:** 07/08/2018

Checked by:

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Mobile: 0413 809806
web site: www.acu-vib.com.au

CERTIFICATE OF CALIBRATION

CERTIFICATE NO: 23450

EQUIPMENT TESTED: Sound Level Calibrator

Manufacturer: Svantek
Type No: SV-30A **Serial No:** 39482
Owner: SLR Consulting Australia Pty Ltd
Level 2, 2 Lincoln Street
Lane Cove, NSW 2066

Tests Performed: Measured output pressure level was found to be:

Parameter	Pre-Adj	Adj Y/N	Output: (db re 20 µPa)	Frequency: (Hz)	THD&N (%)
Level 1:	NA	N	94.02	1000.21	2.00
Level 2:	NA	N	114.01	1000.06	0.40
Uncertainty:			±0.11 dB	±0.05%	±0.20 %
Uncertainty (at 95% c.l.) k=2					

CONDITION OF TEST:
Ambient Pressure: 1015 hPa ±1.5 hPa **Relative Humidity:** 41% ±5%
Temperature: 23 °C ±2° C
Date of Calibration: 04/09/2018 **Issue Date:** 04/09/2018
Acu-Vib Test Procedure: AVP02 (Calibrators)
Test Method: AS IEC 60942 - 2004
CHECKED BY: .... **AUTHORISED SIGNATURE:** ....
Jack Kielt

.Accredited for compliance with ISO/IEC 17025 - Calibration
The results of the tests, calibration and/or measurements included in this document are traceable to Australian/national standards.
The uncertainties quoted are calculated in accordance with the methods of the ISO Guide to the Uncertainty of Measurement and quoted at a coverage factor of 2 with a confidence interval of approximately 95%.

NATA
WORLD RECOGNISED ACCREDITATION
Accredited Lab. 9262
Acoustic and Vibration Measurements

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ELECTRONICS

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Mobile: 0413 809806
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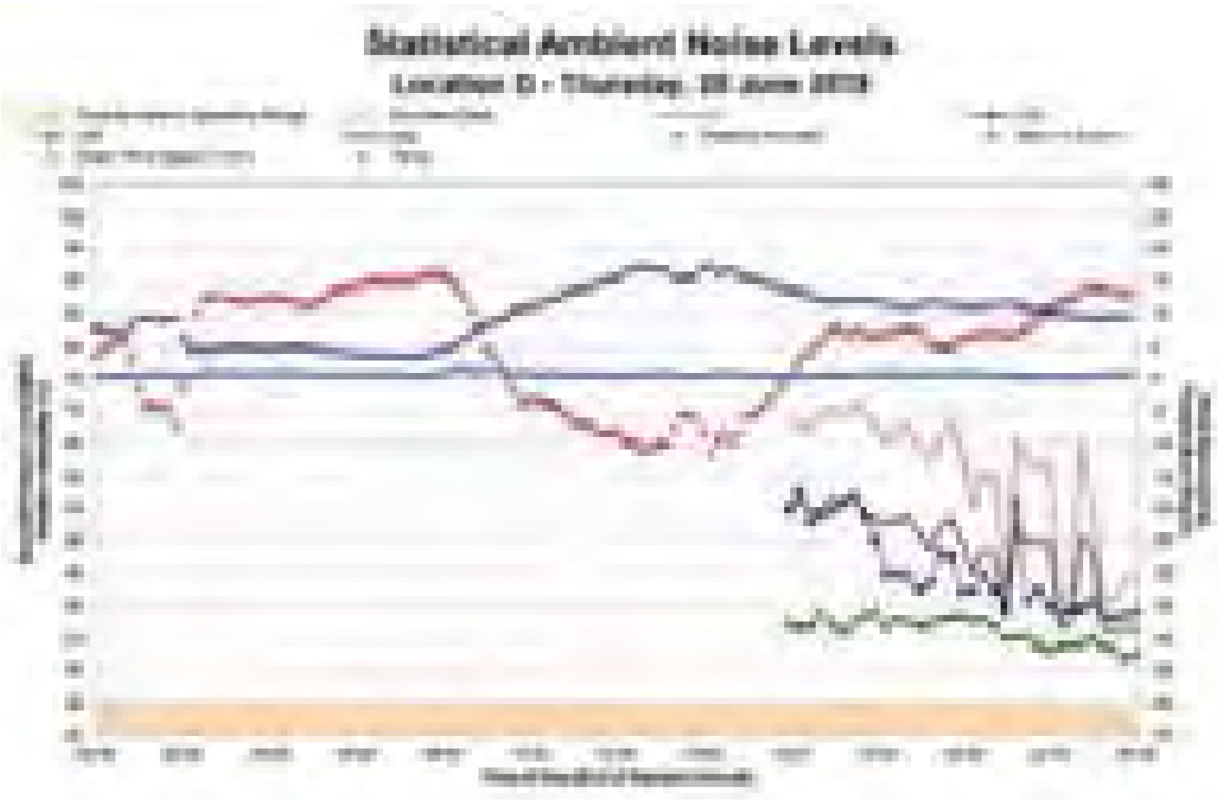
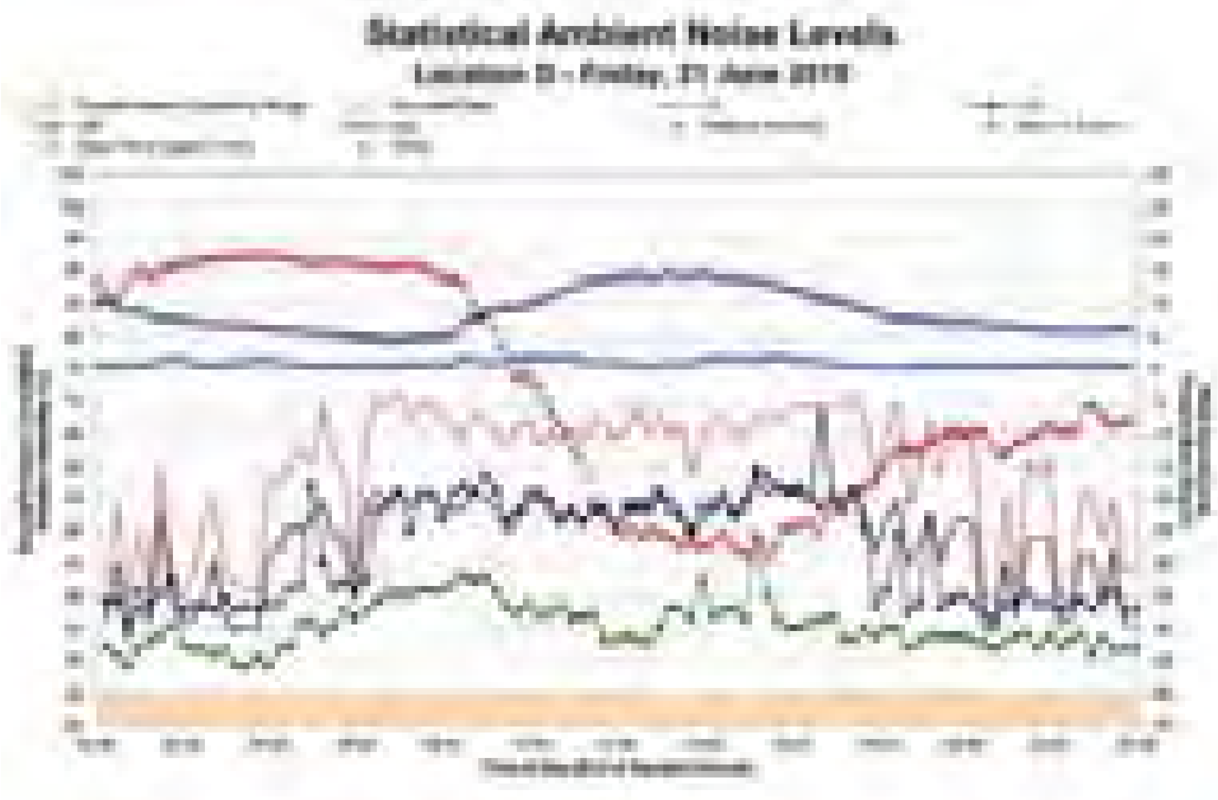
APPENDIX D

Statistical Ambient Noise Levels


Statistical Ambient Noise Levels
Location D - Thursday, 20 June 2019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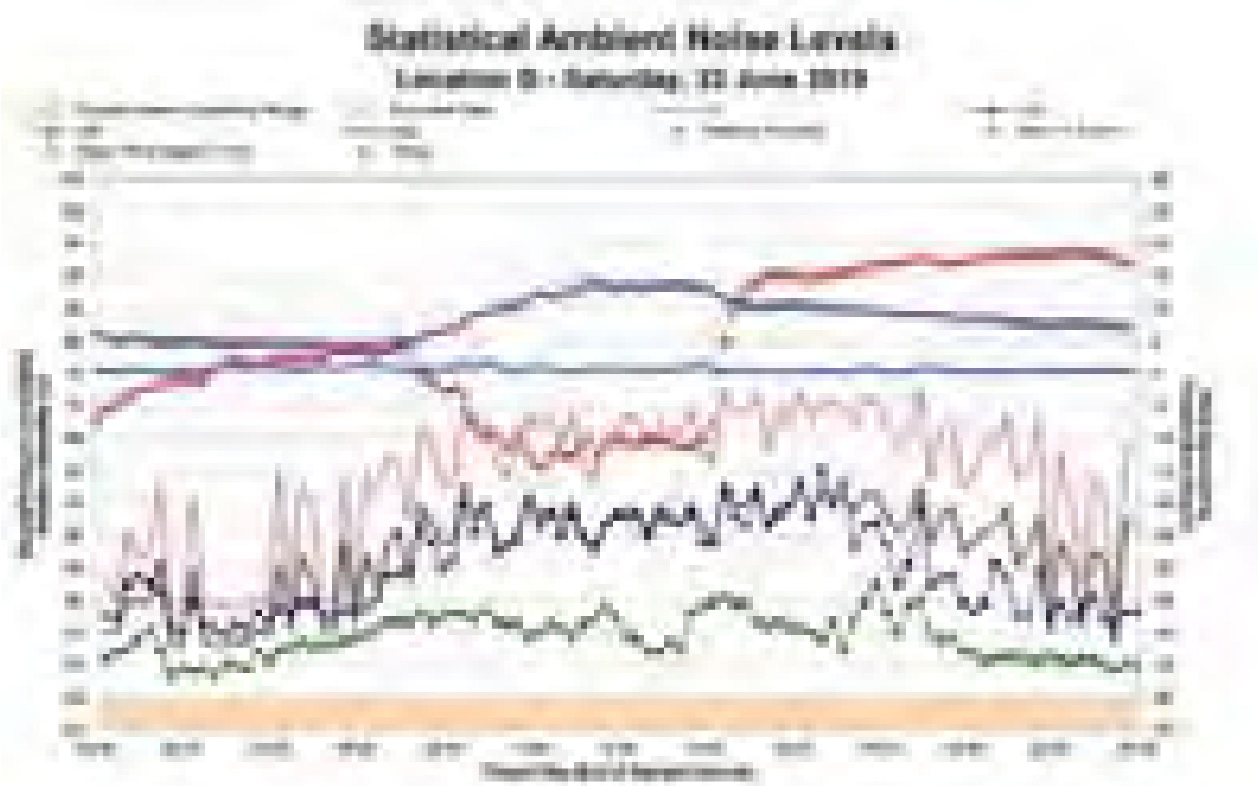
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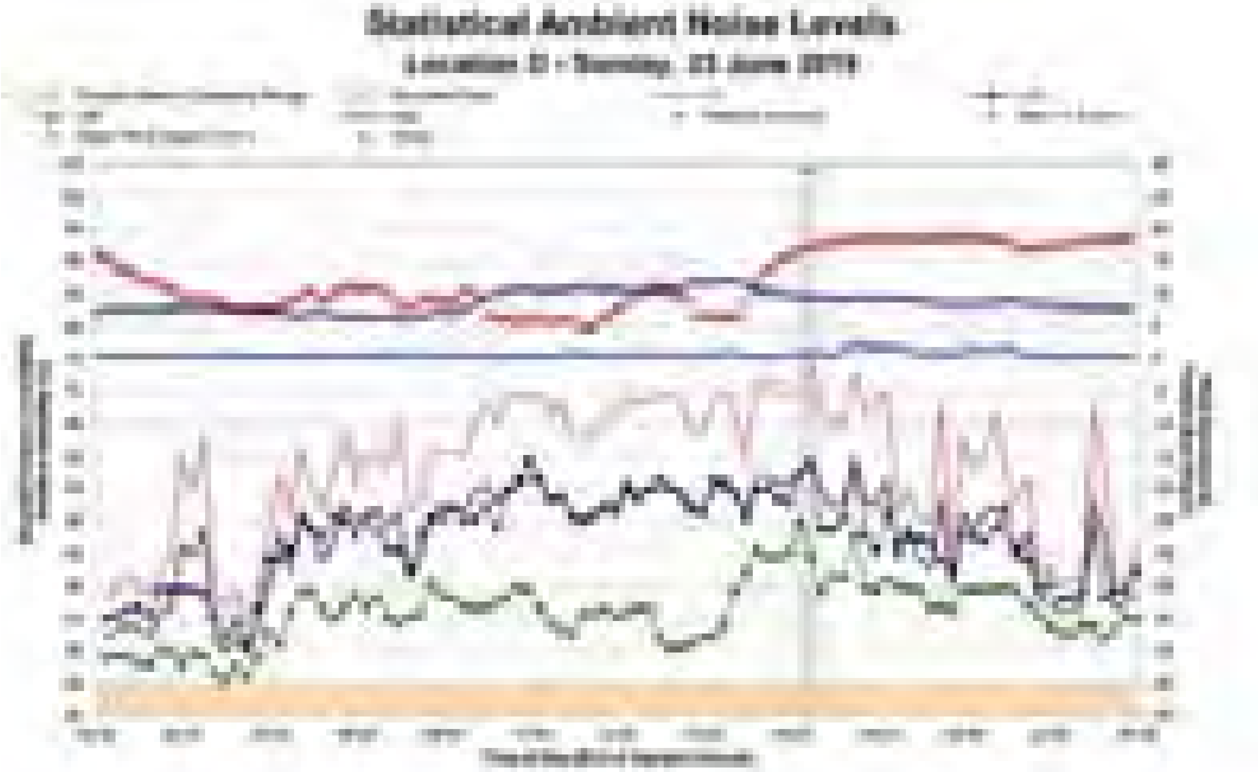
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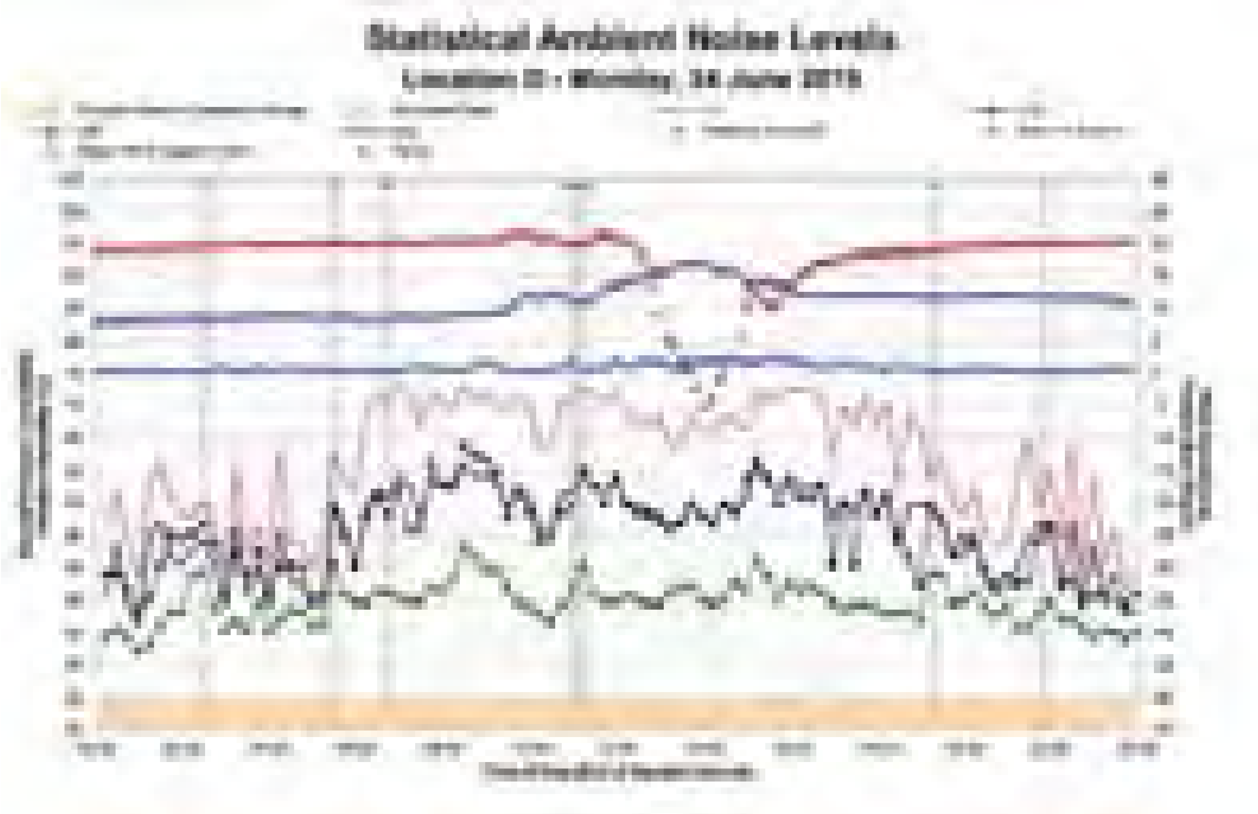
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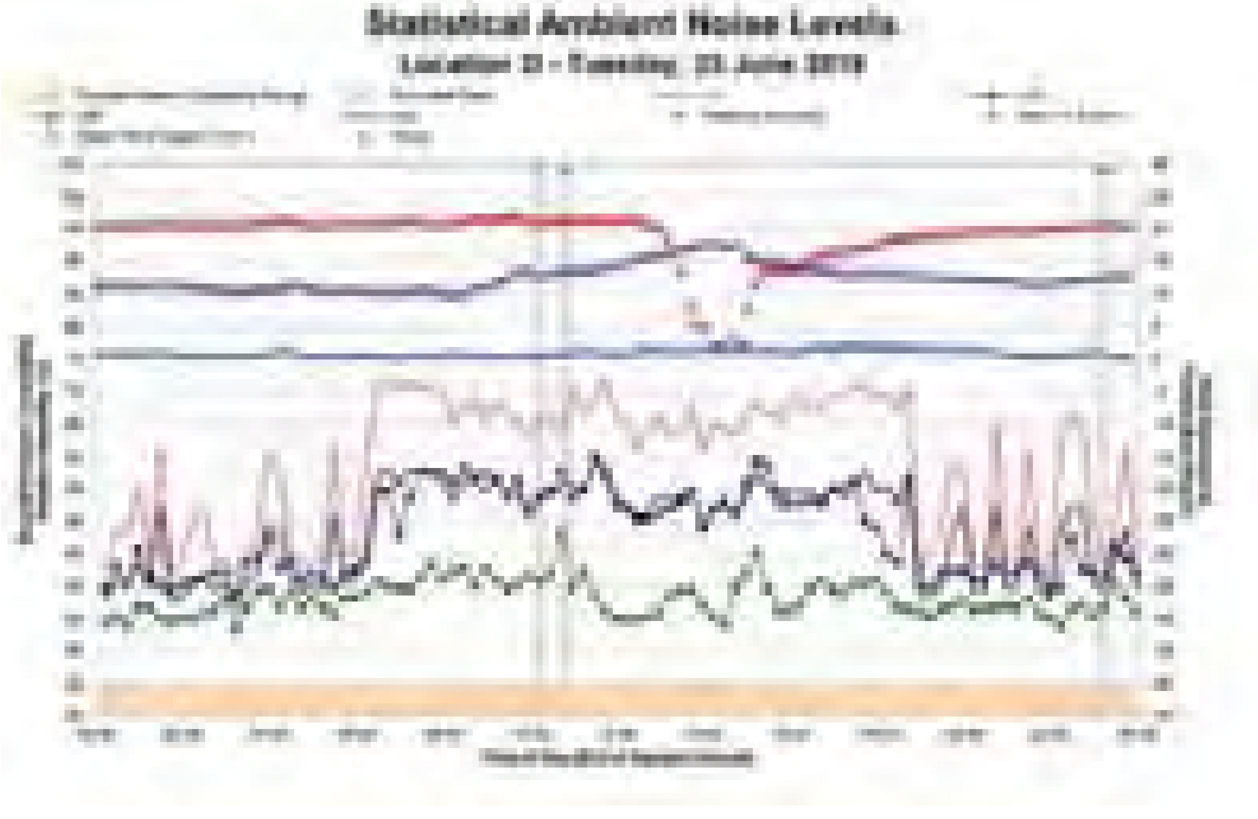
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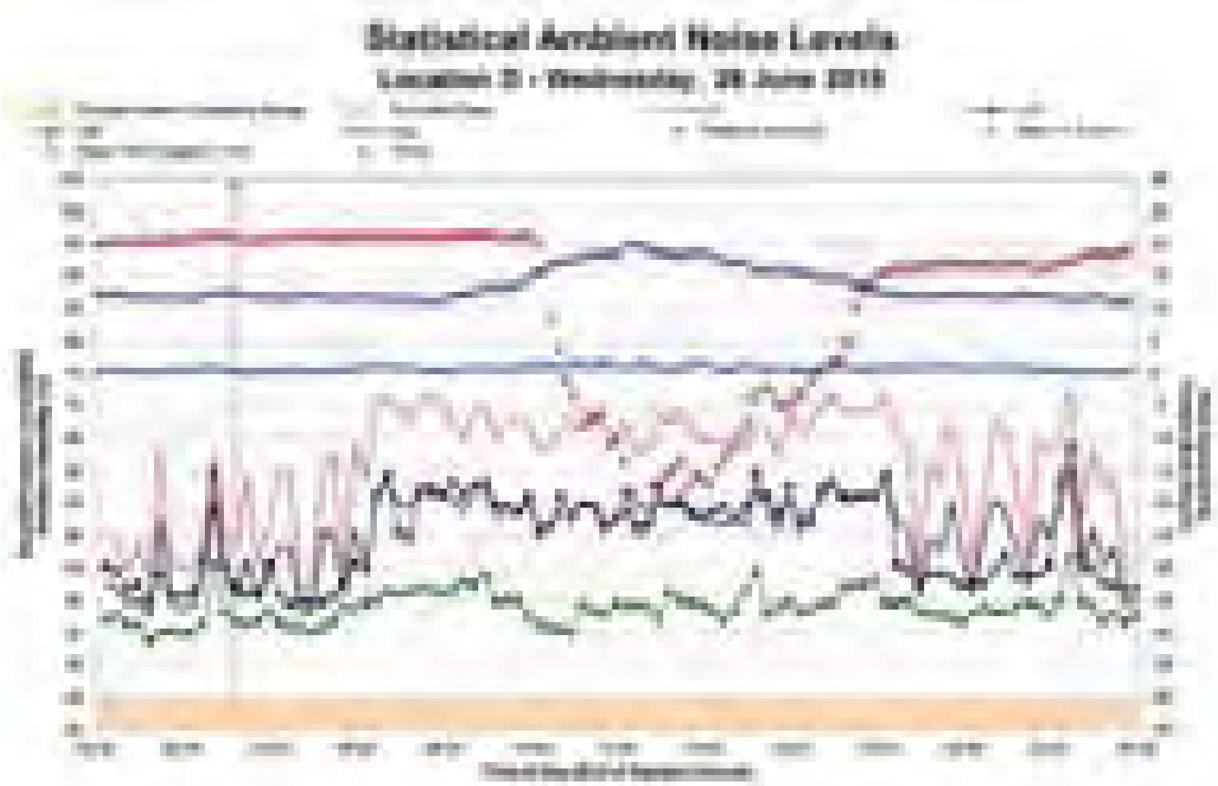
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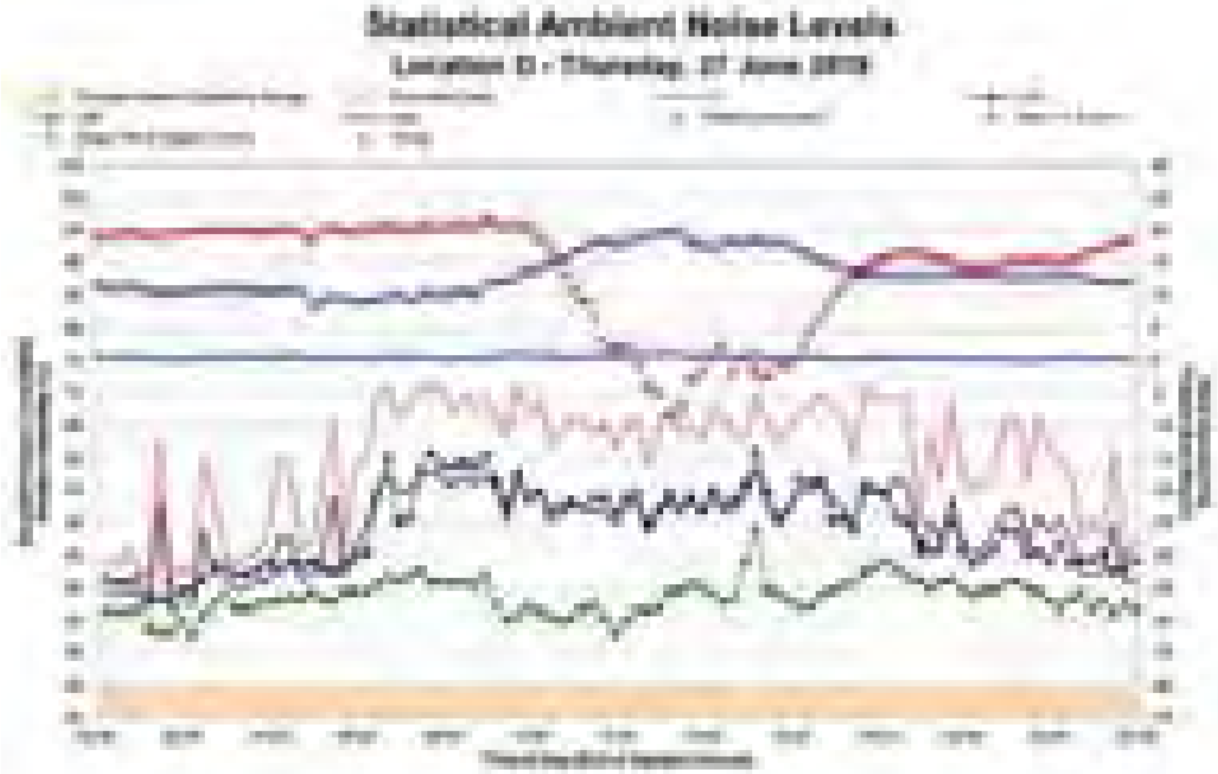
Statistical Ambient Noise Levels


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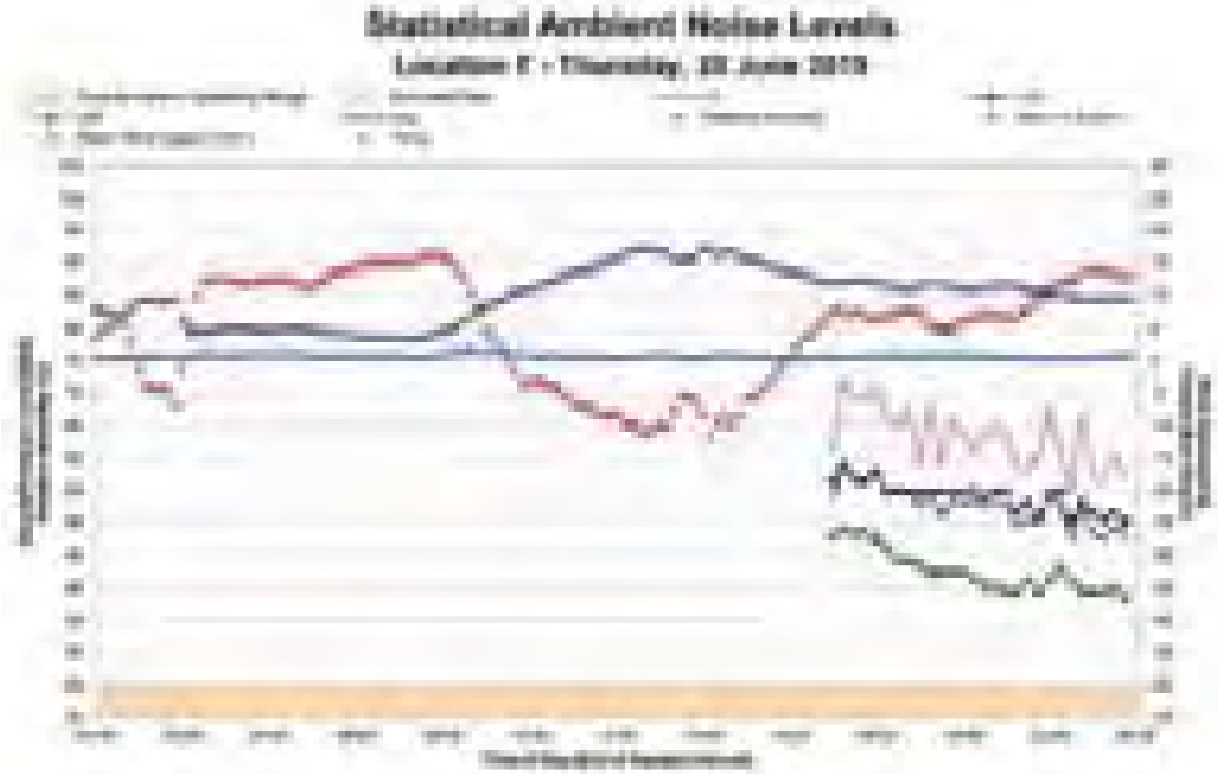
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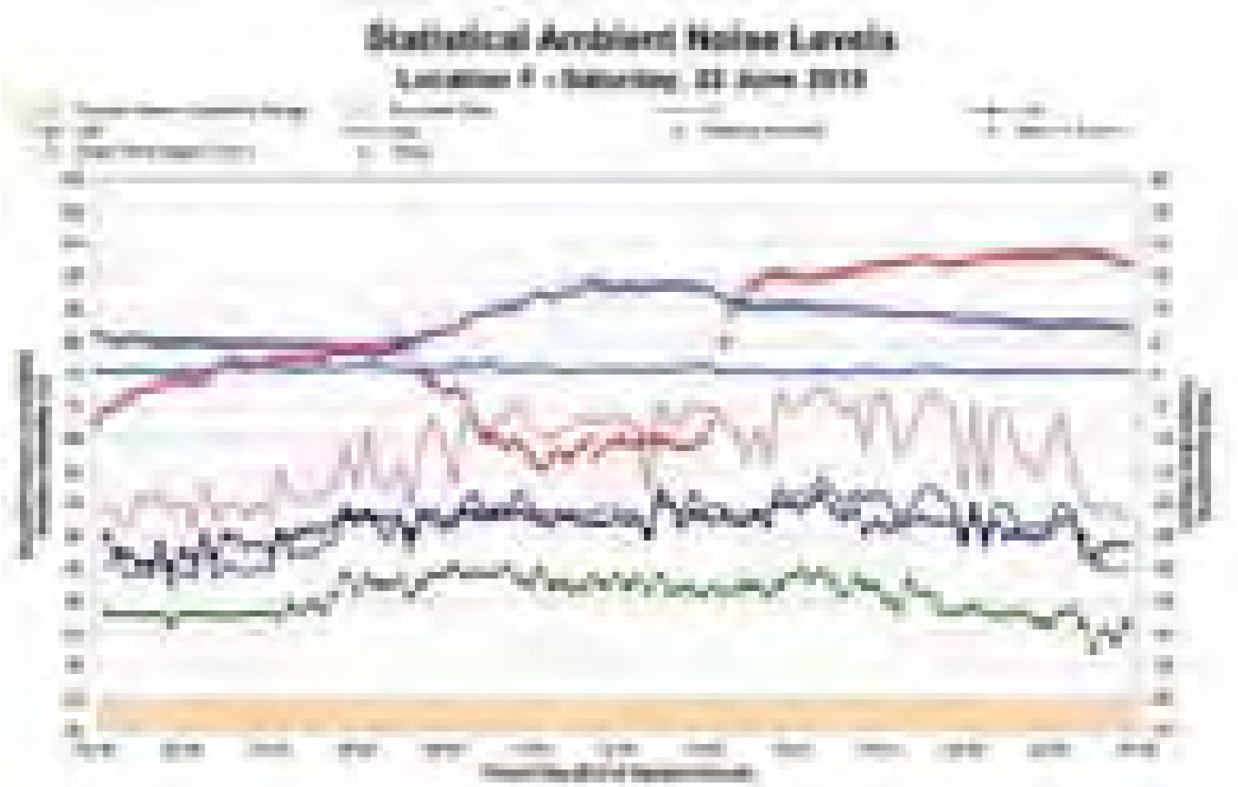
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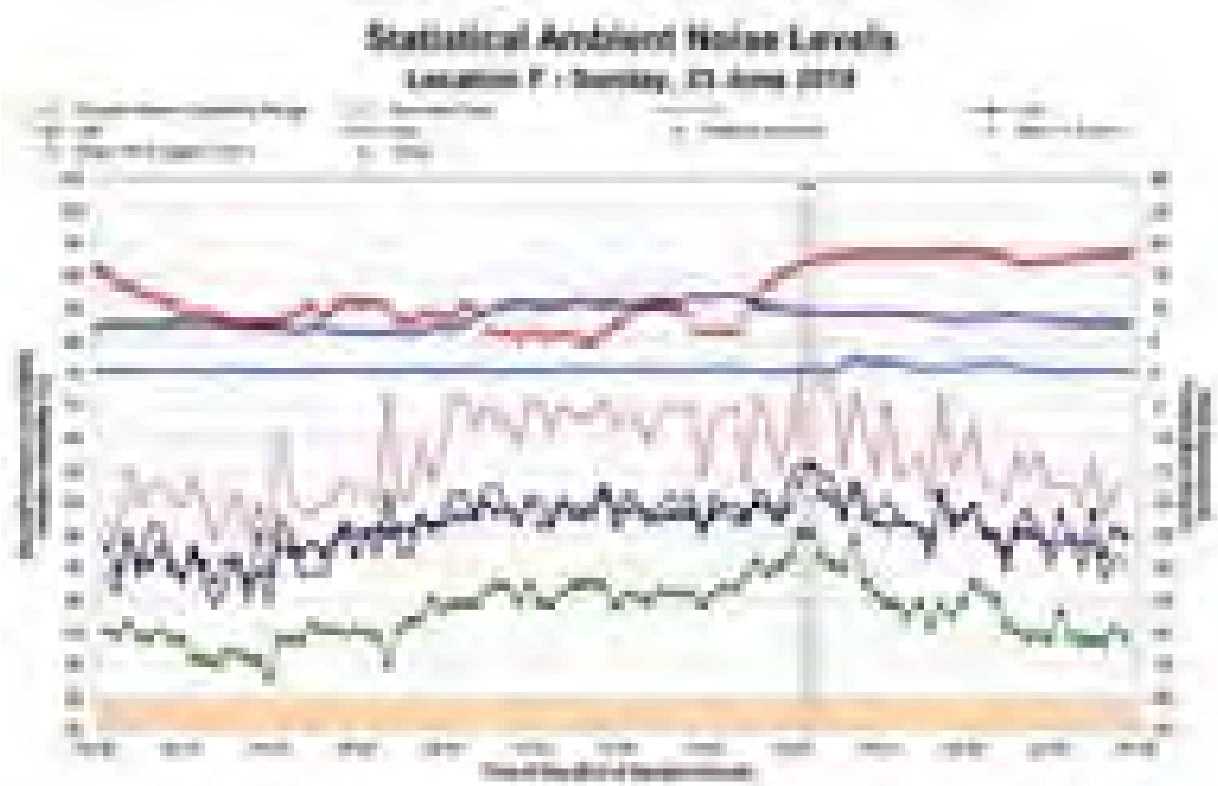
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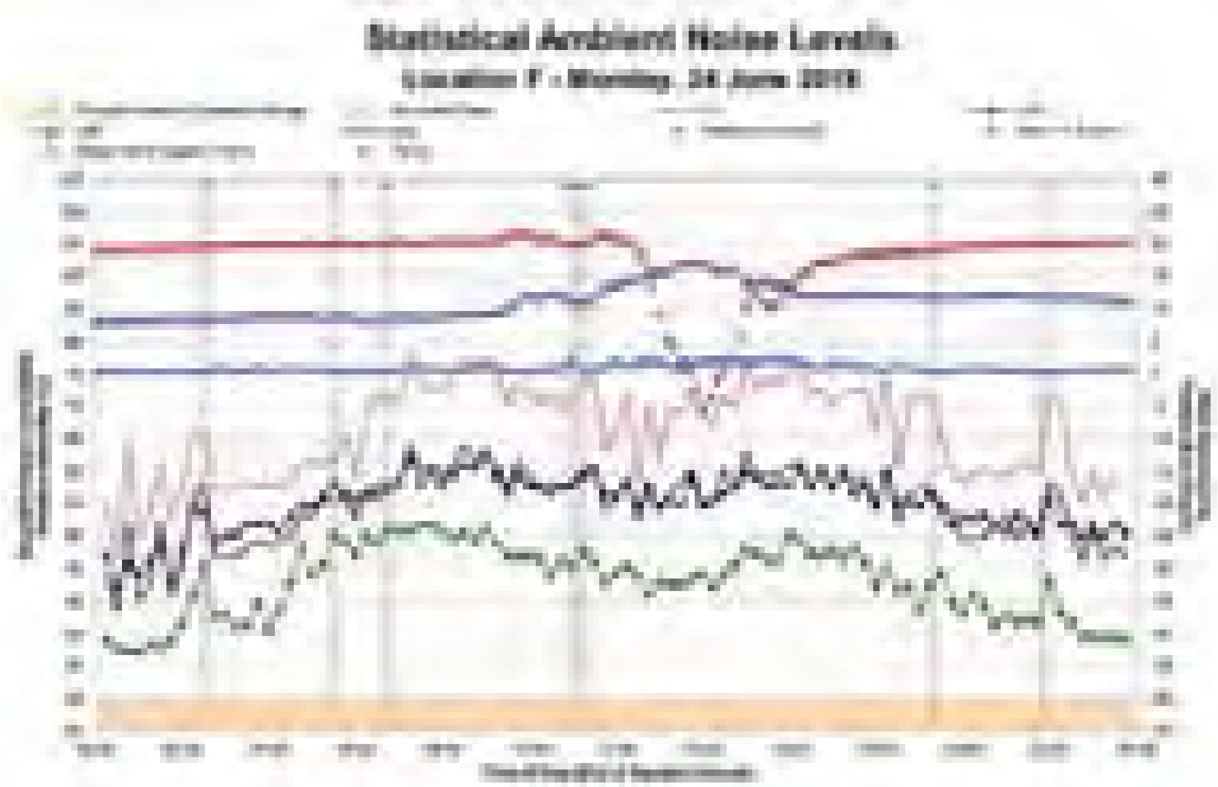
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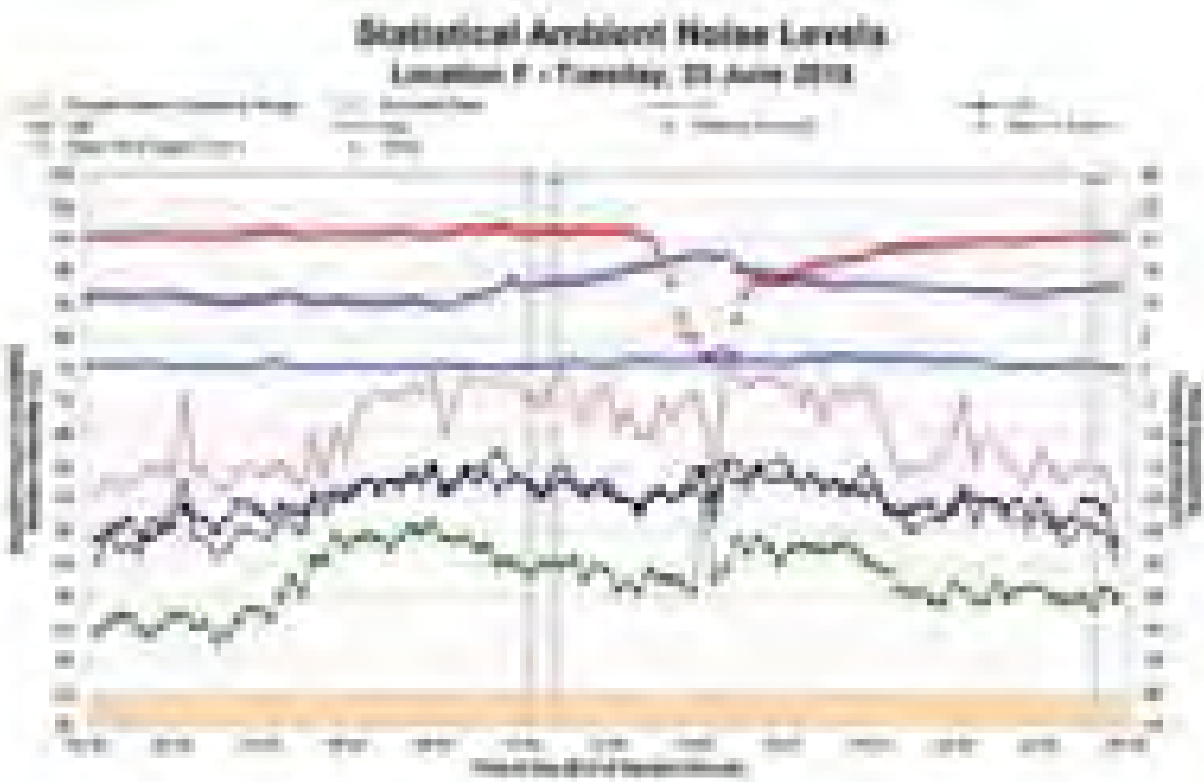
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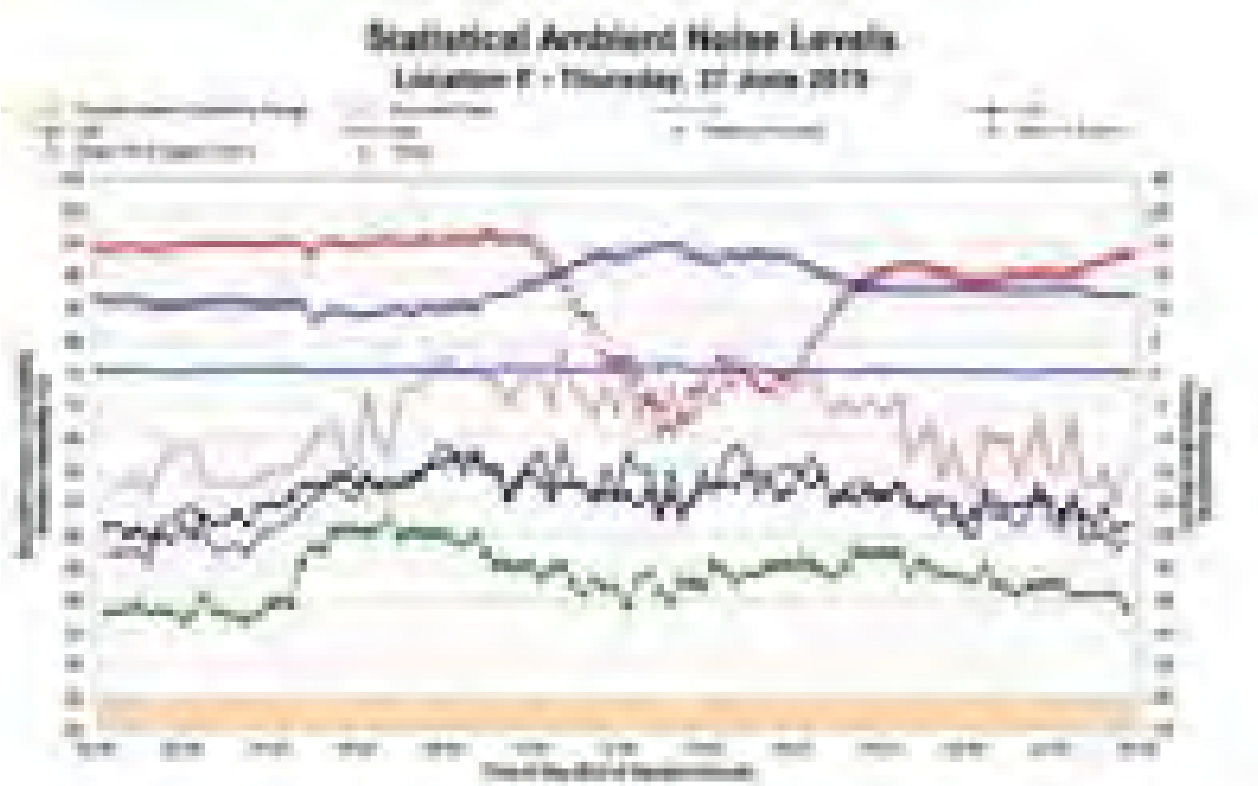
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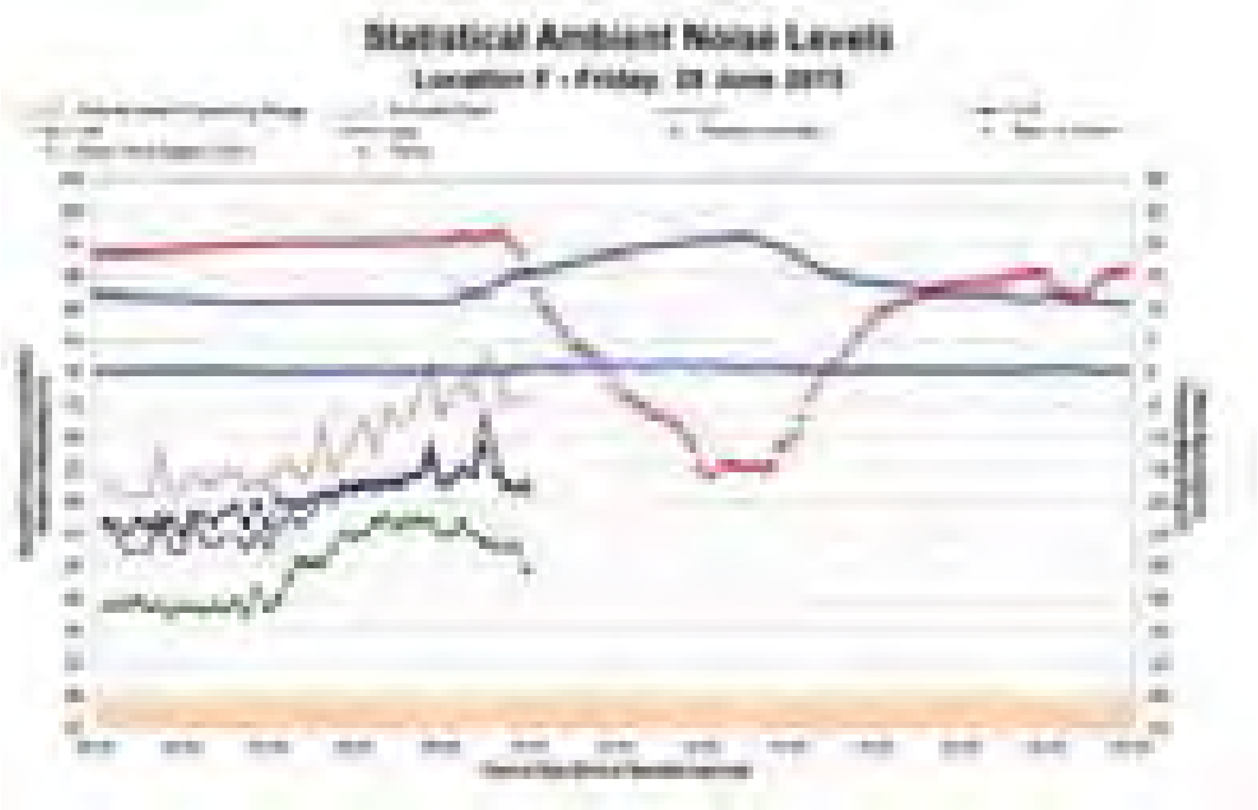
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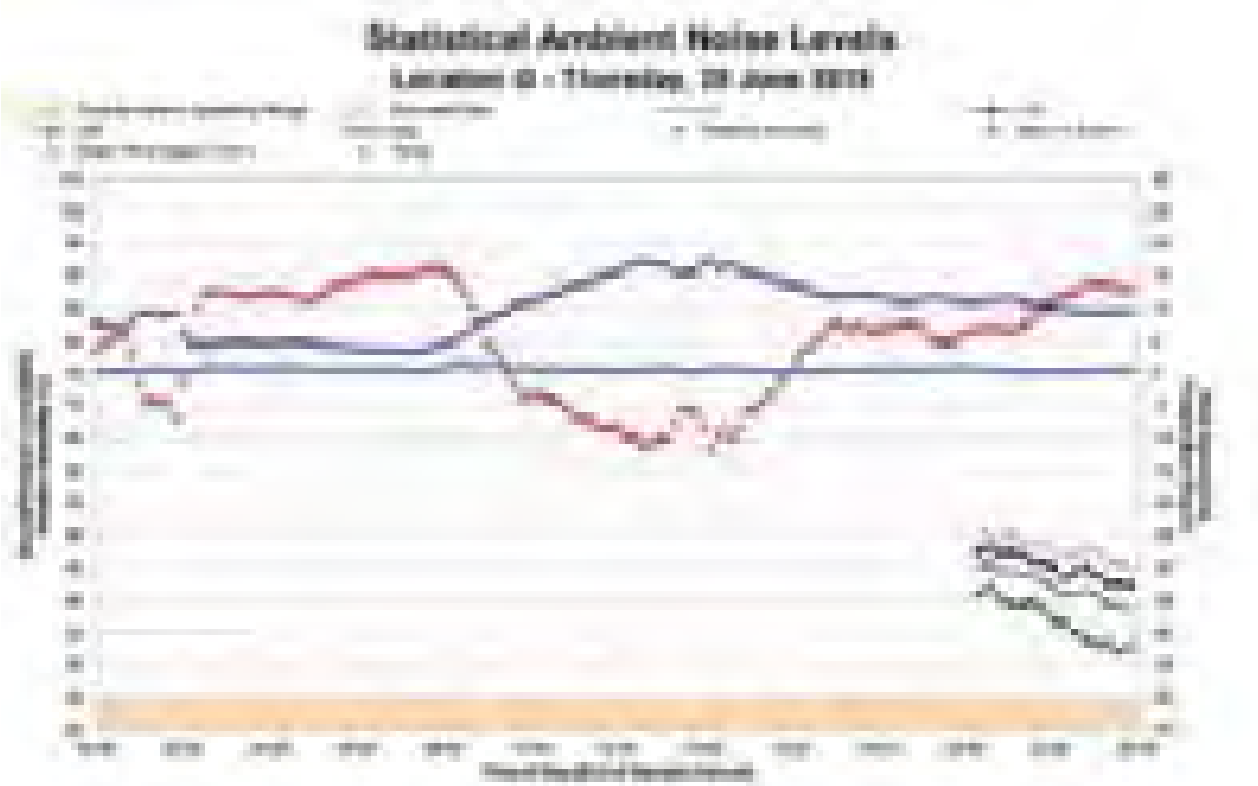
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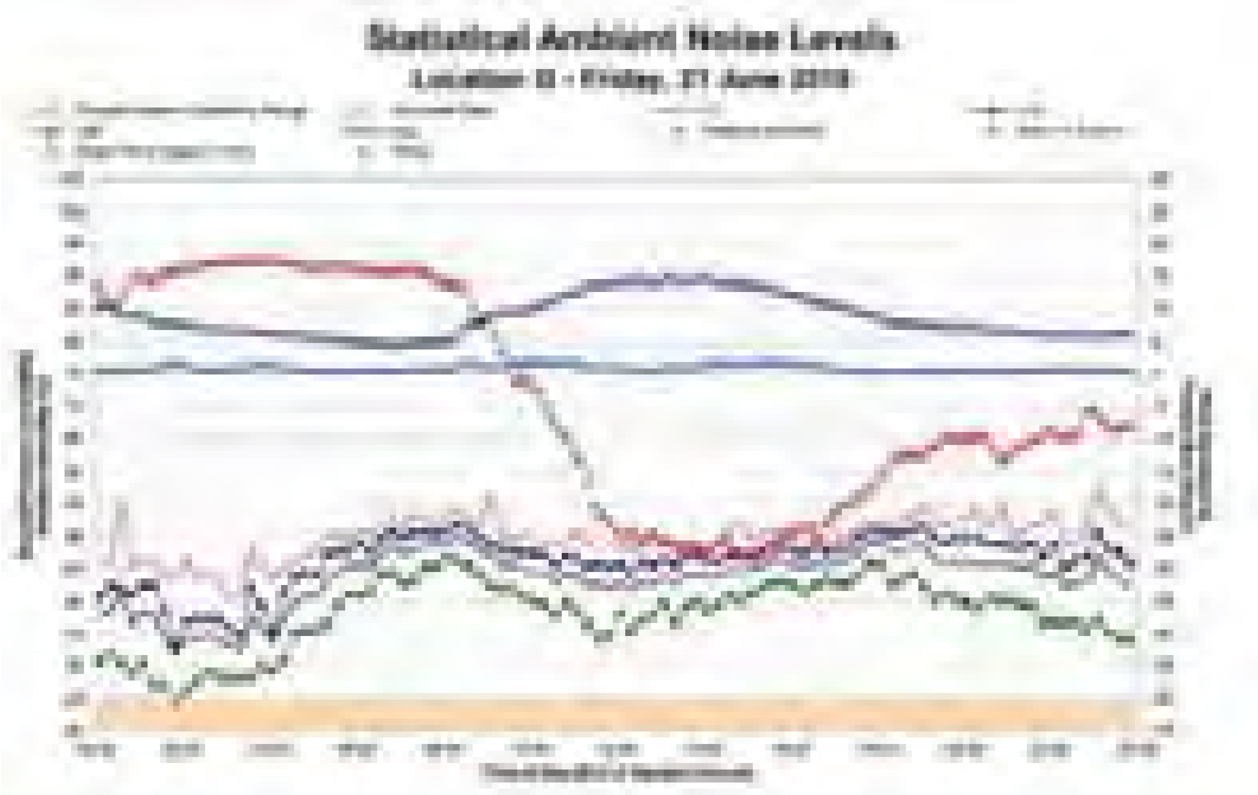
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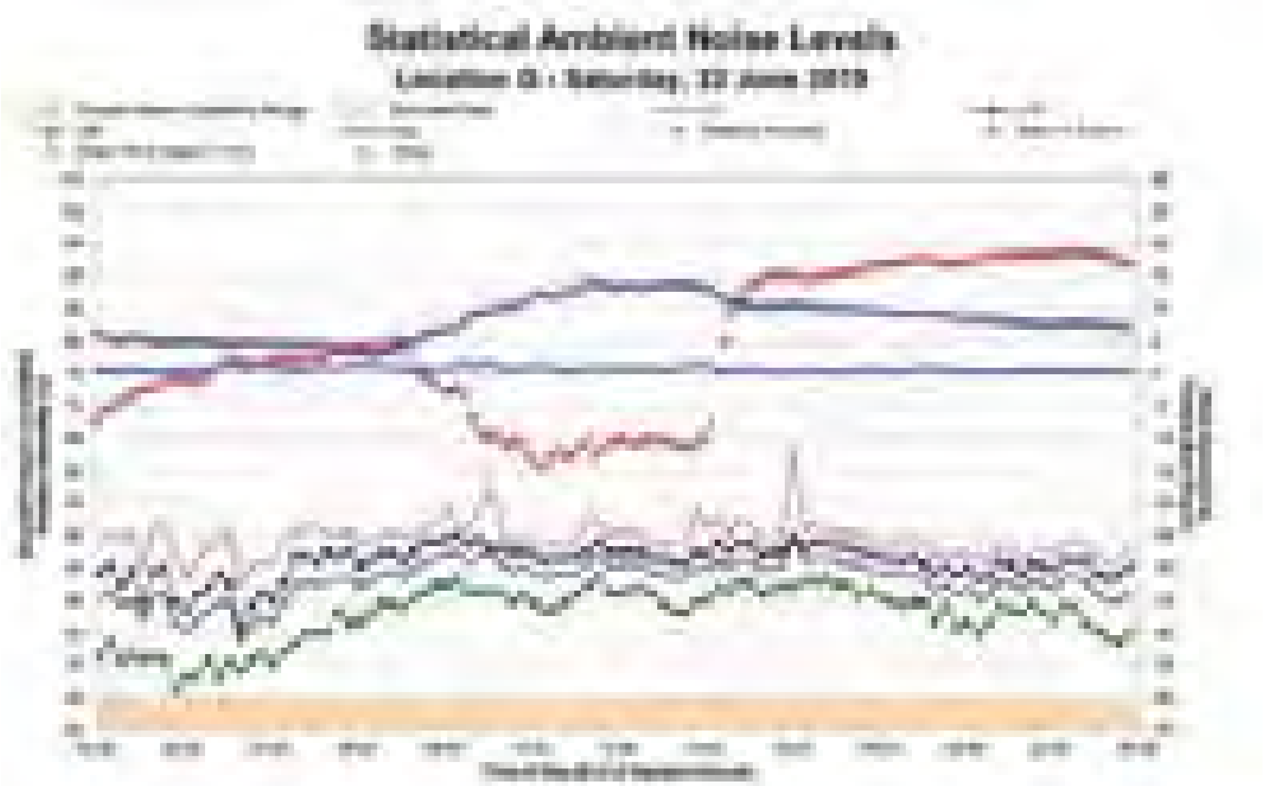
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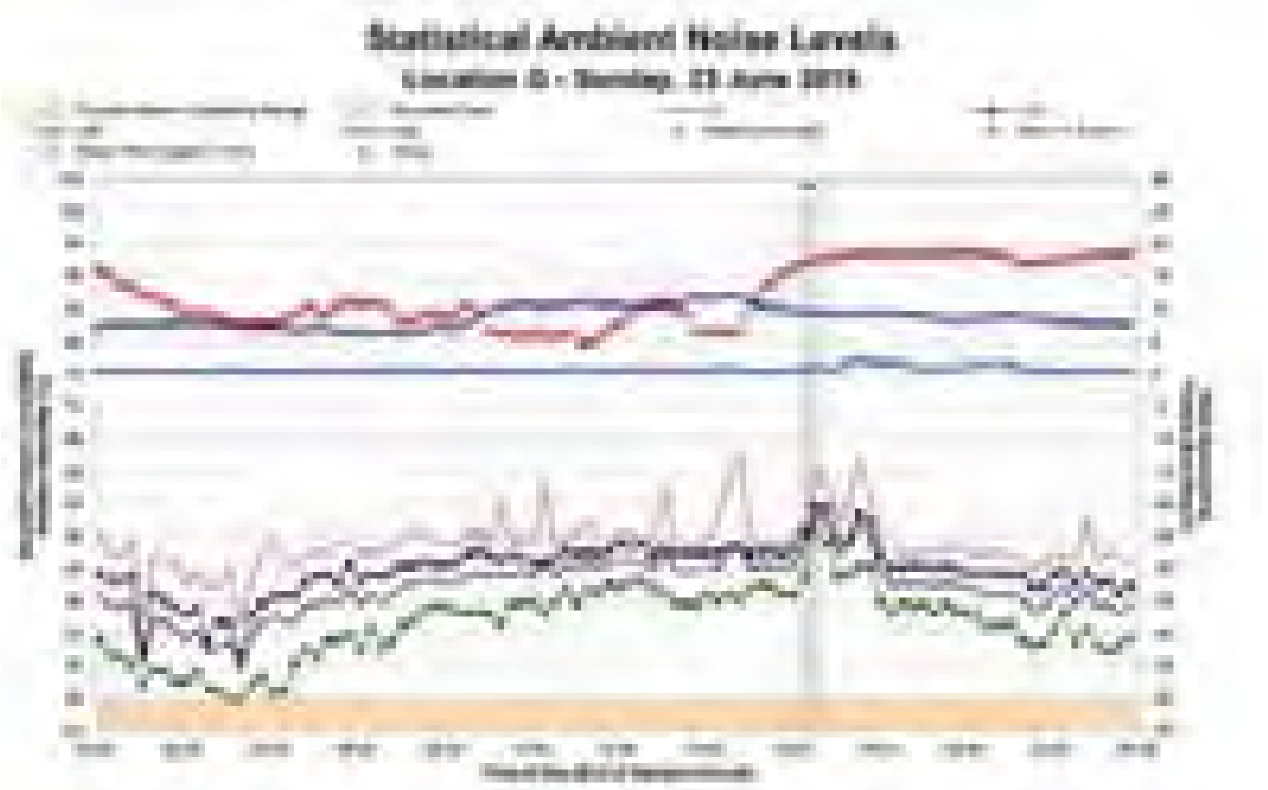
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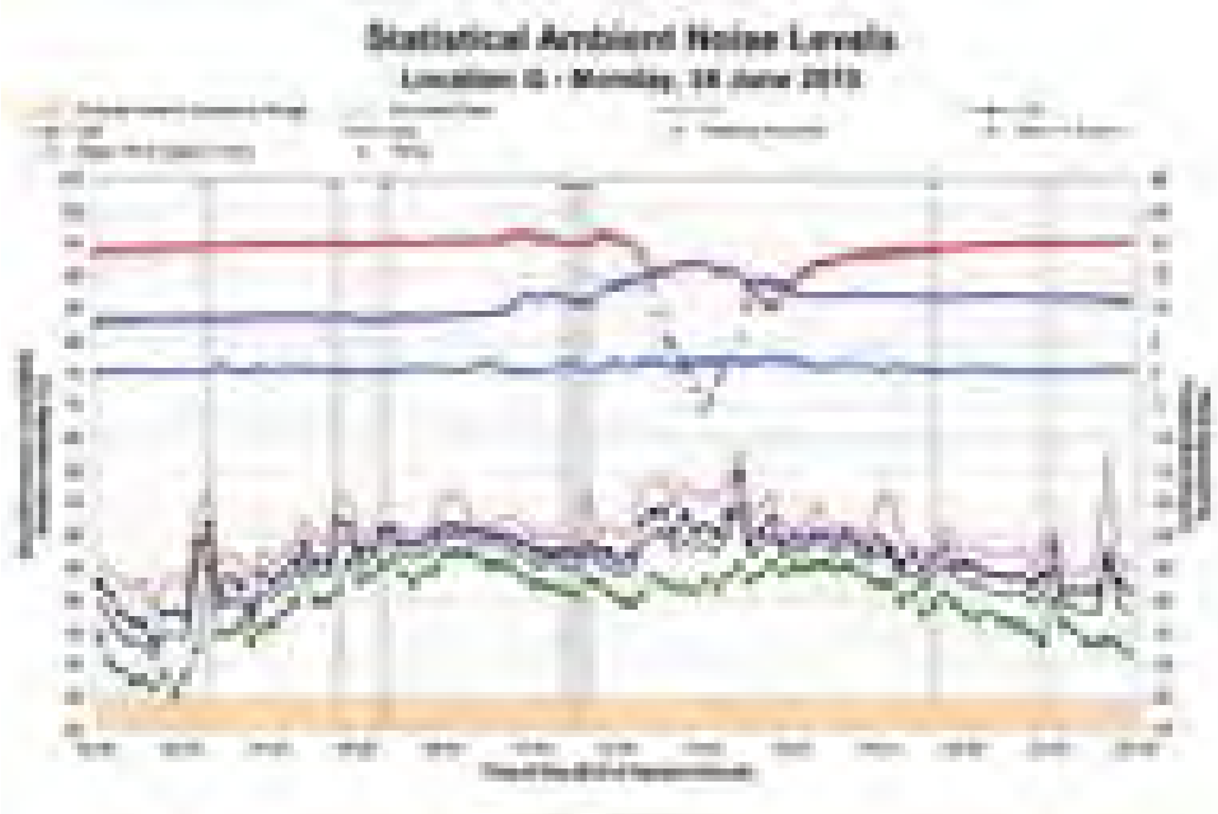
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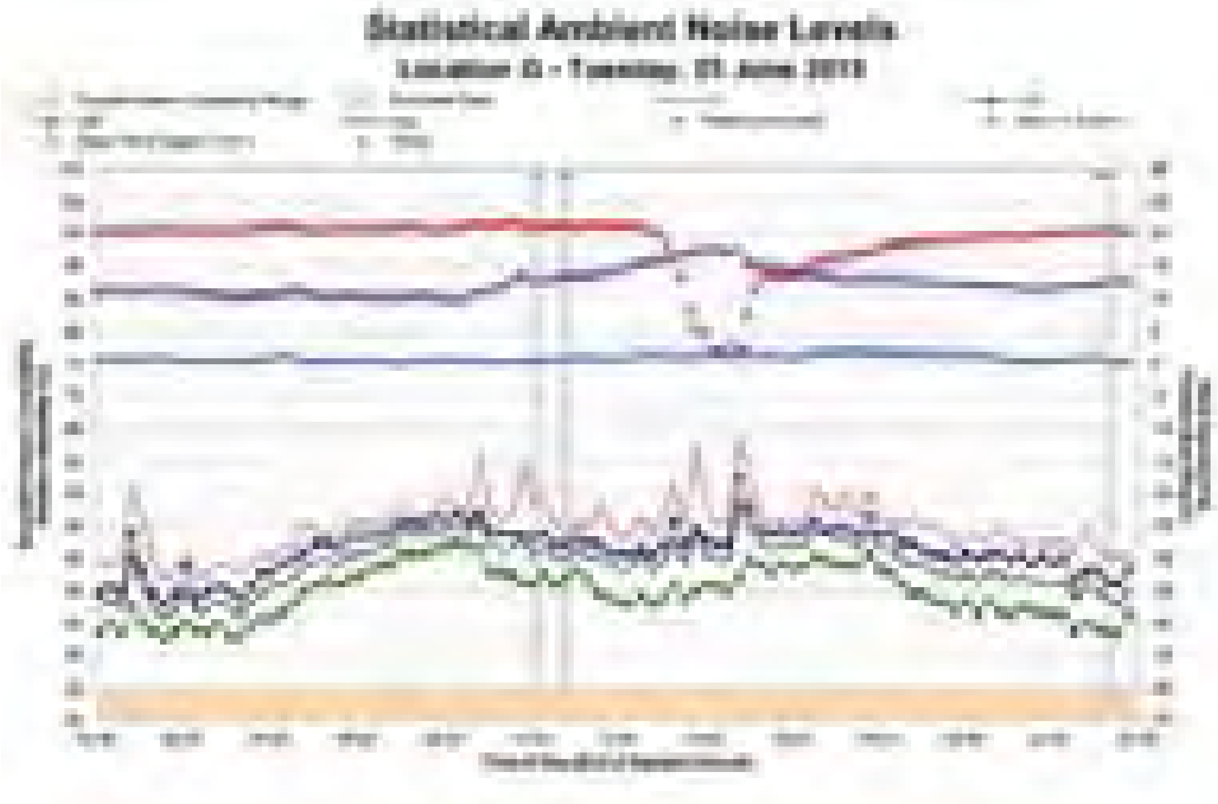
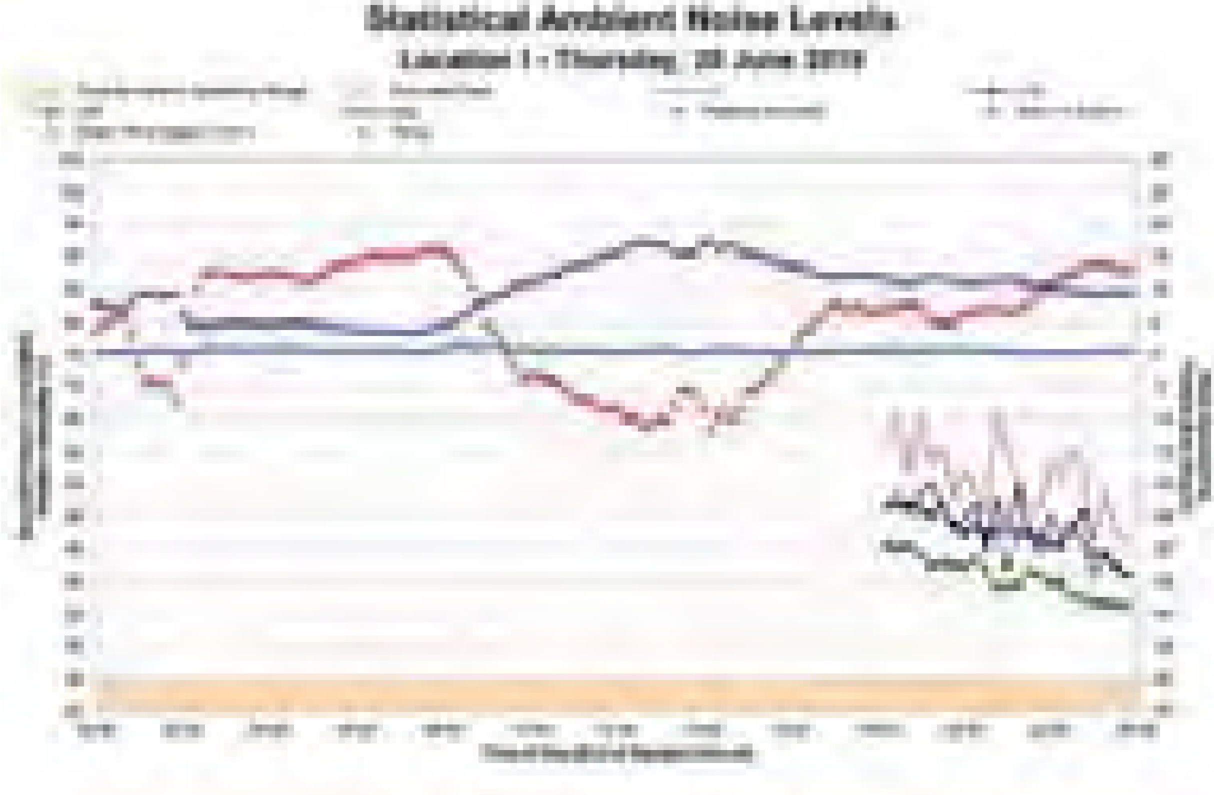

Statistical Ambient Noise Levels


Statistical Ambient Noise Levels


Statistical Ambient Noise Levels


Statistical Ambient Noise Levels
Location G - Friday, 28 June 2019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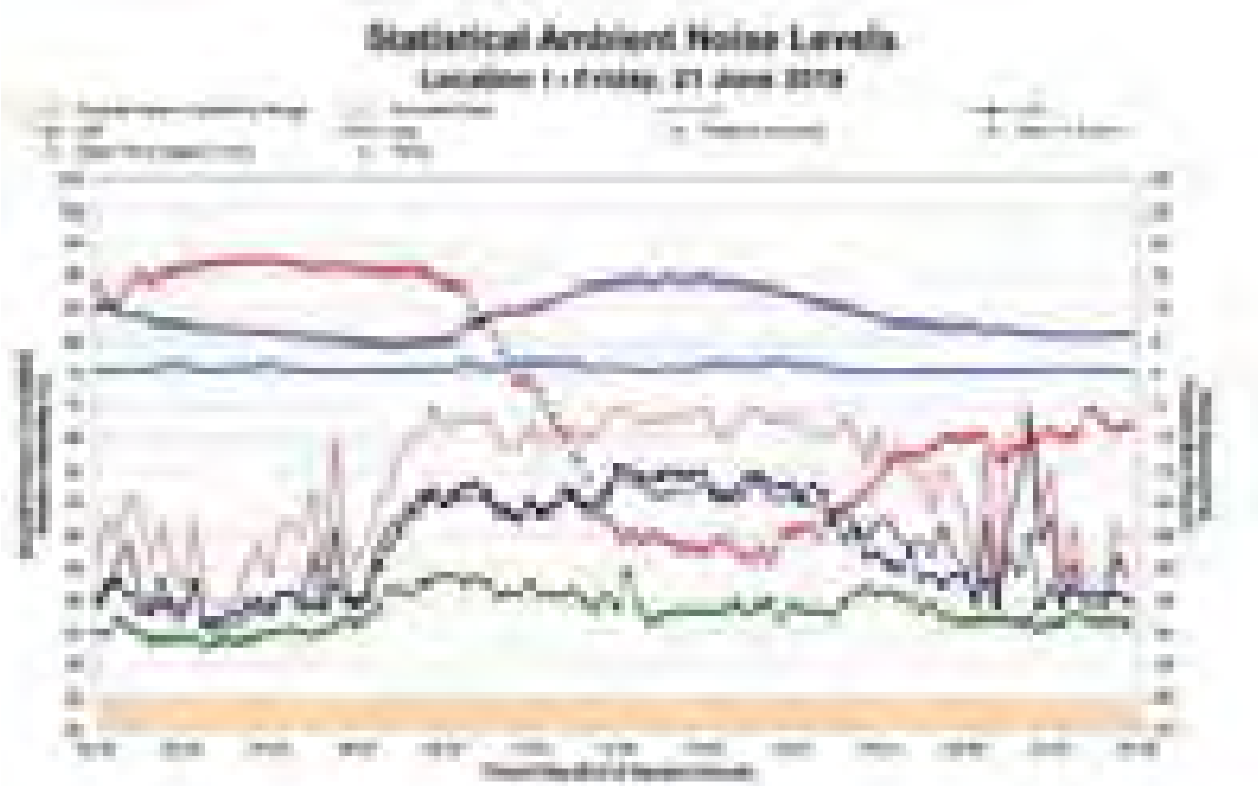
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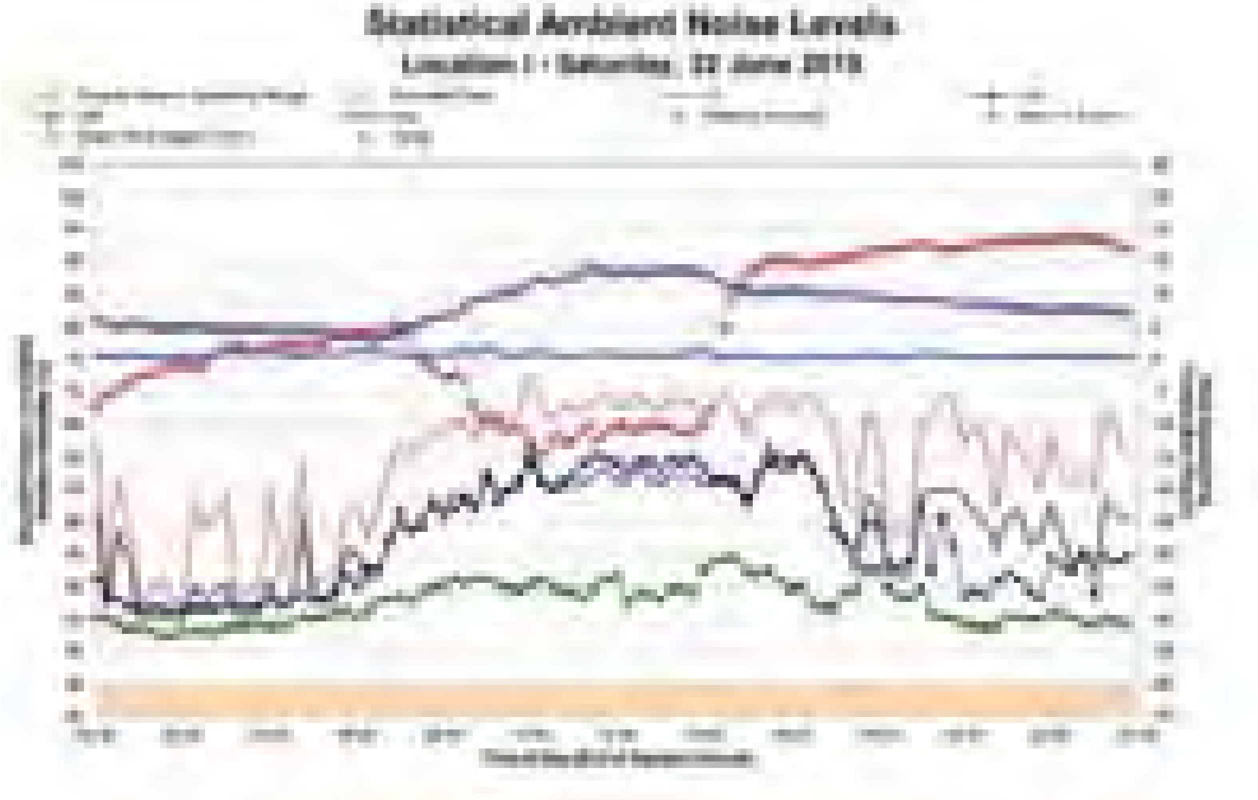
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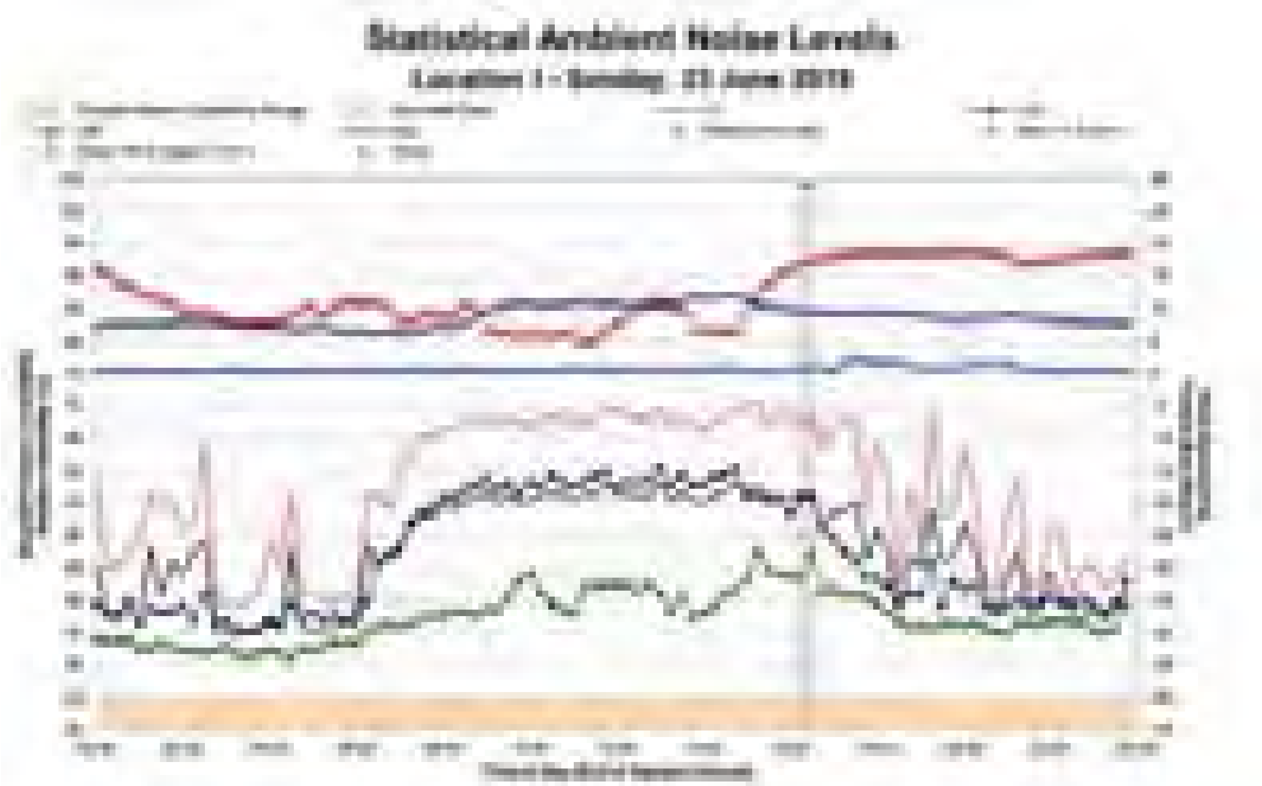
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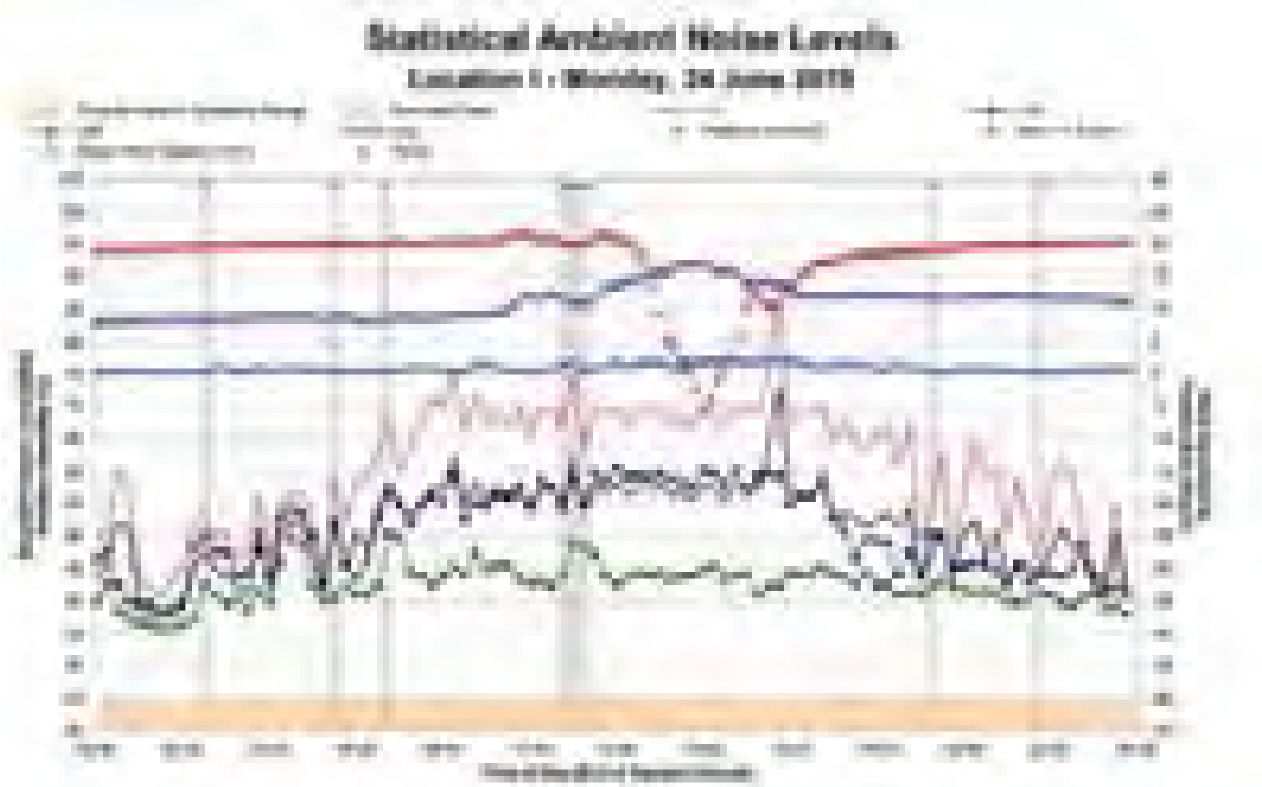
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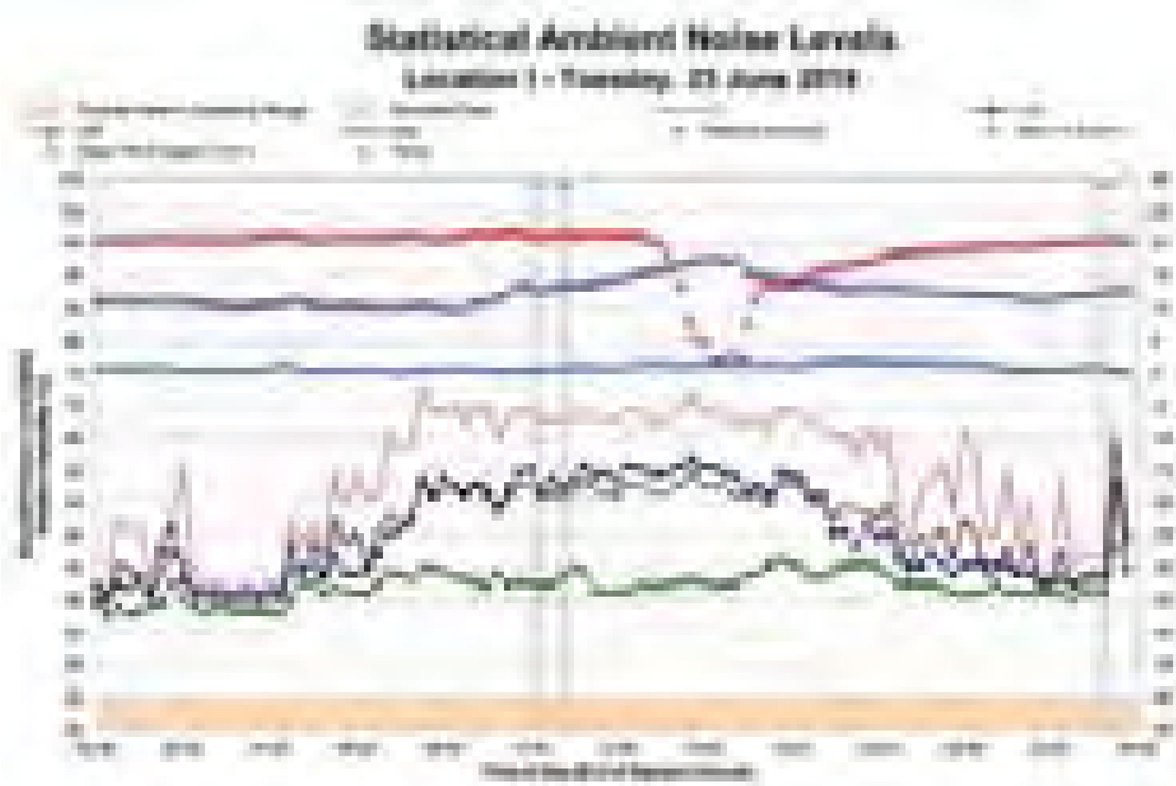
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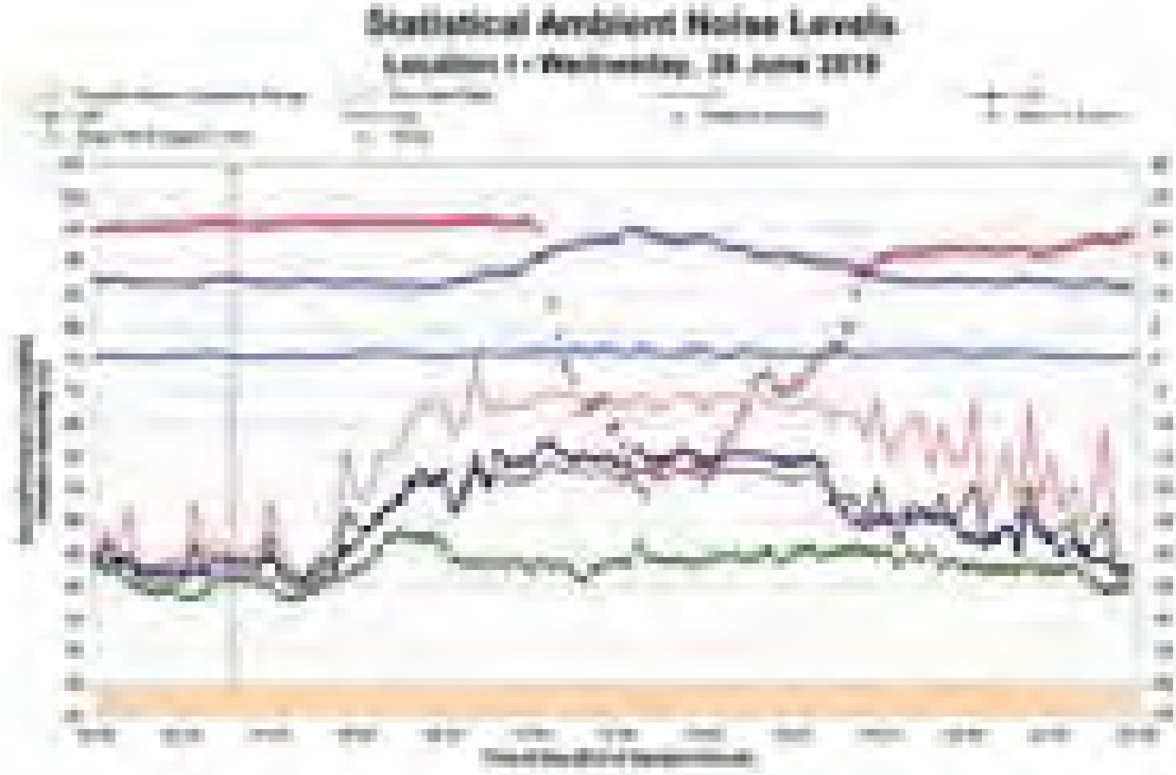
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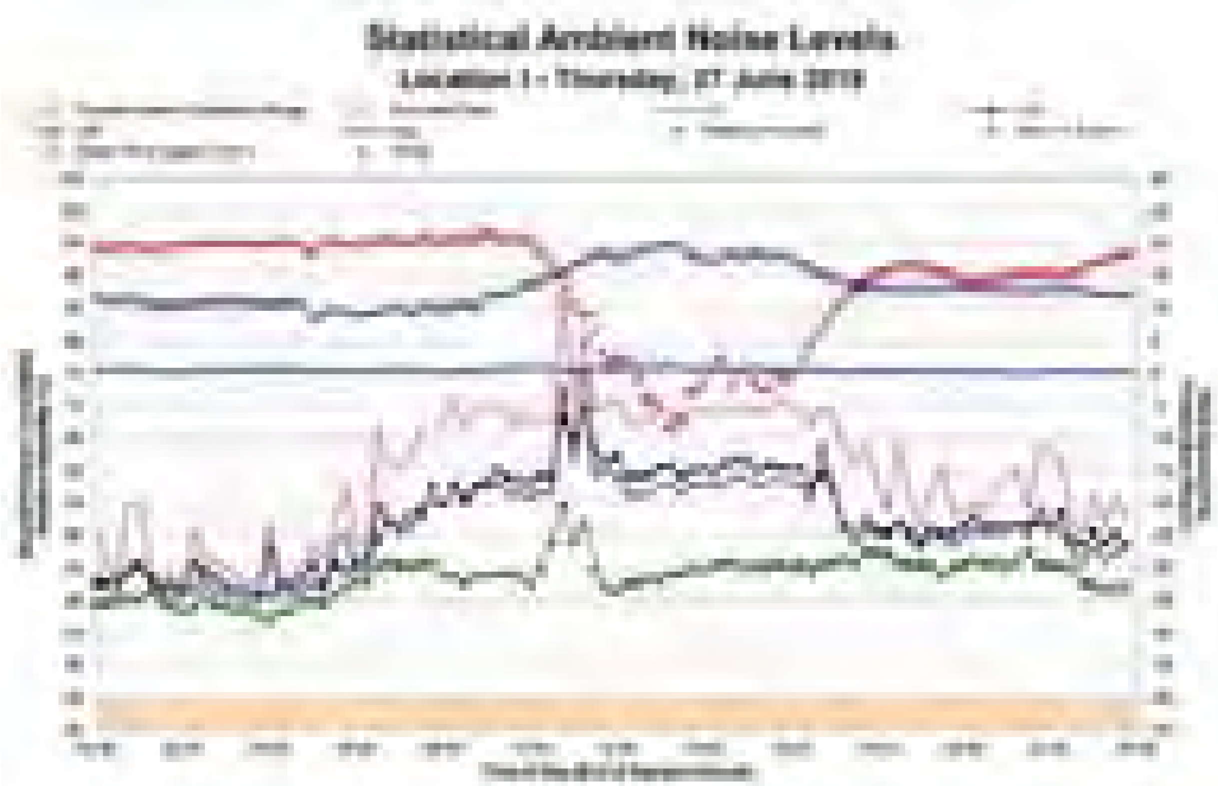
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Location 1 - Thursday, 27 June 2019


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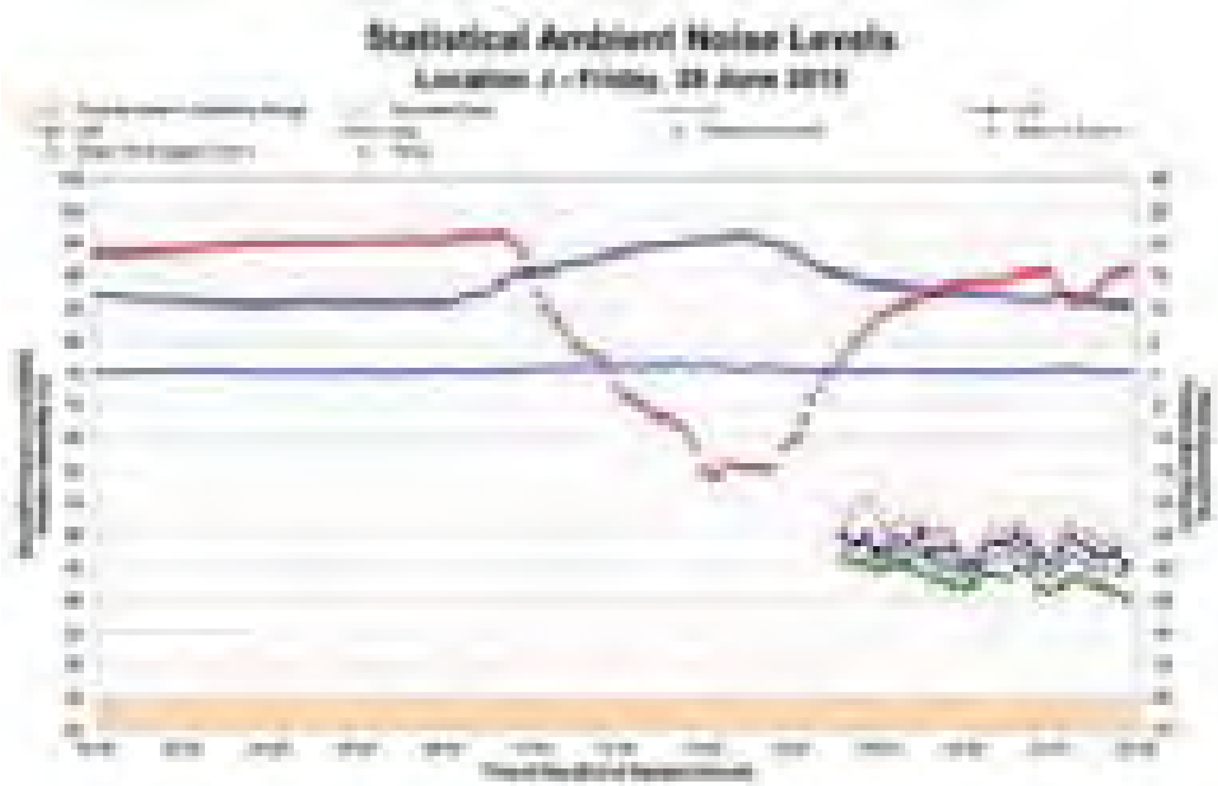
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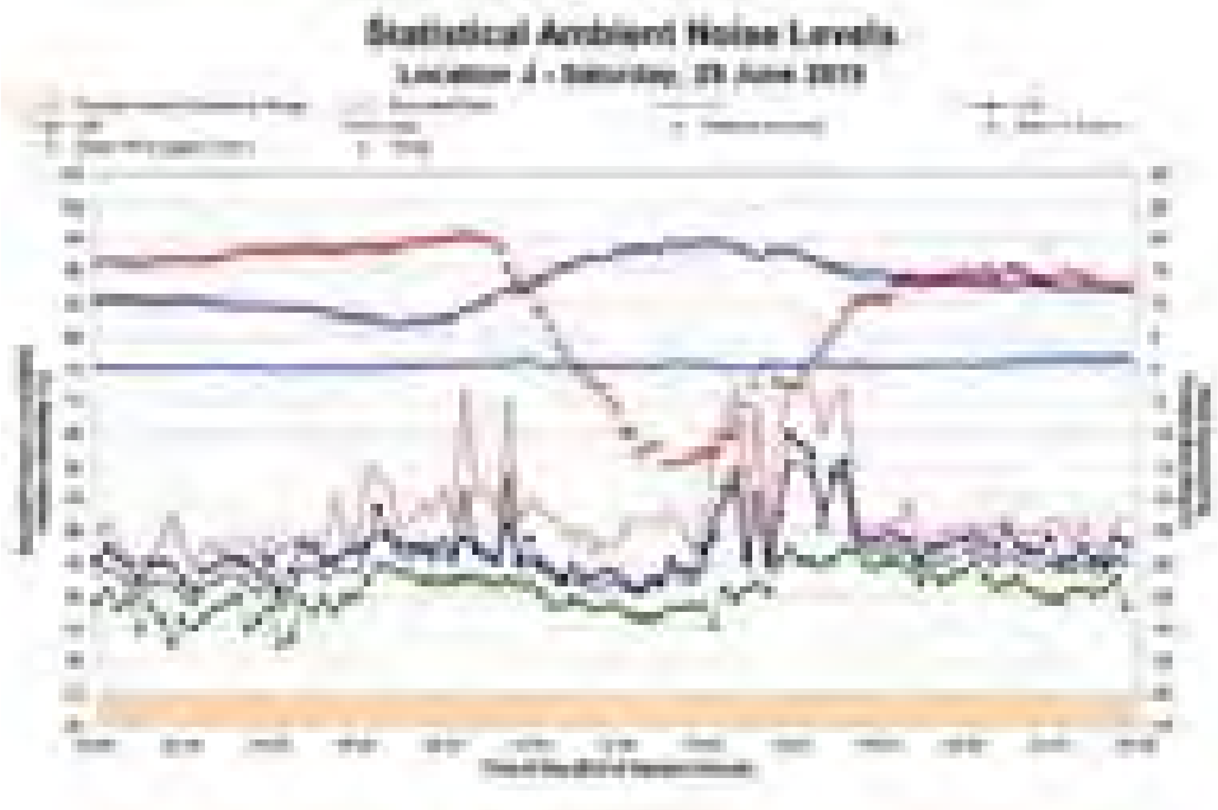
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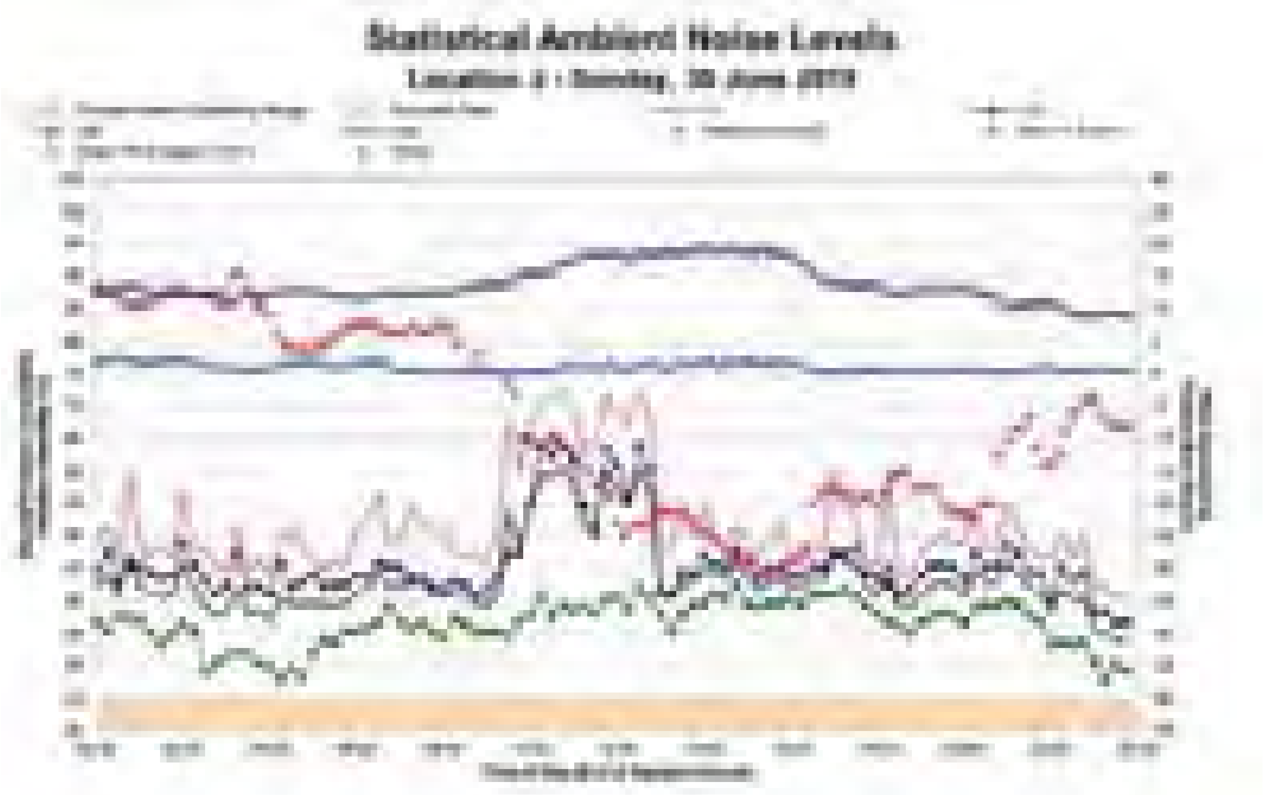
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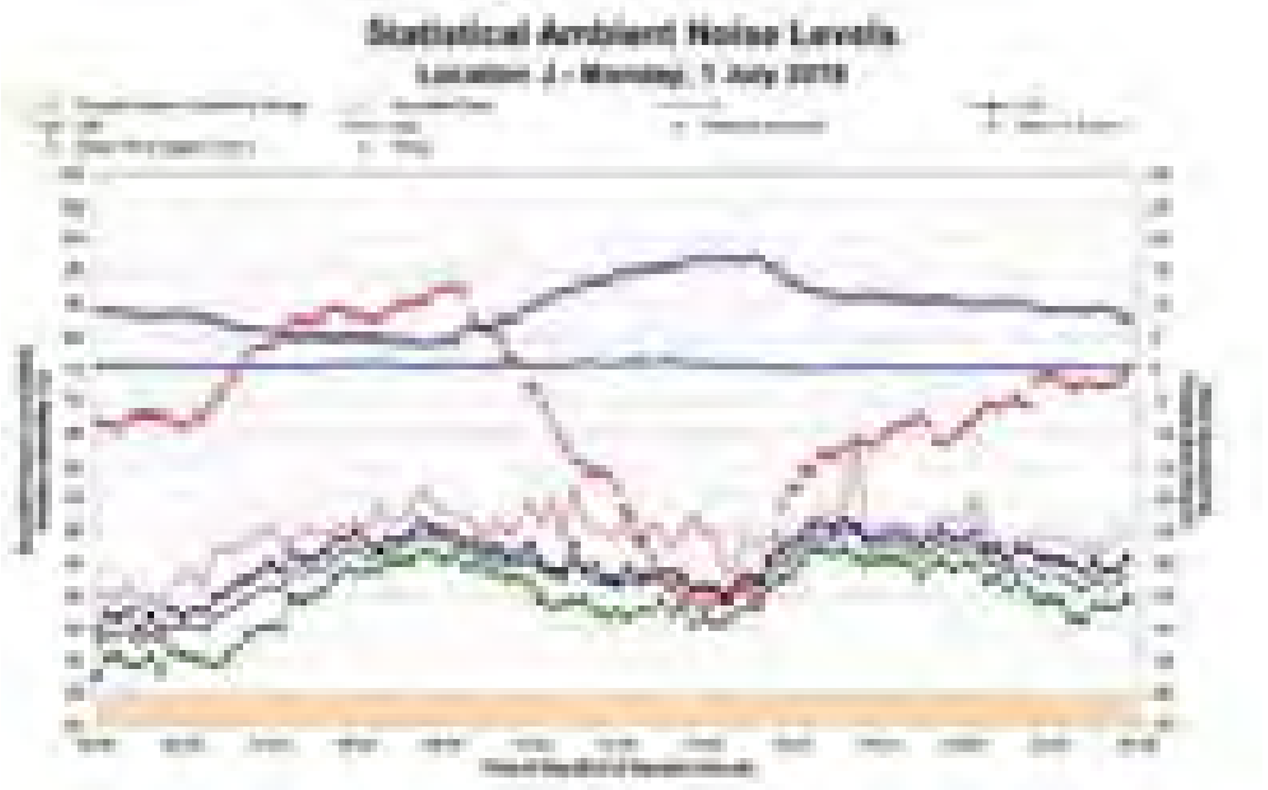
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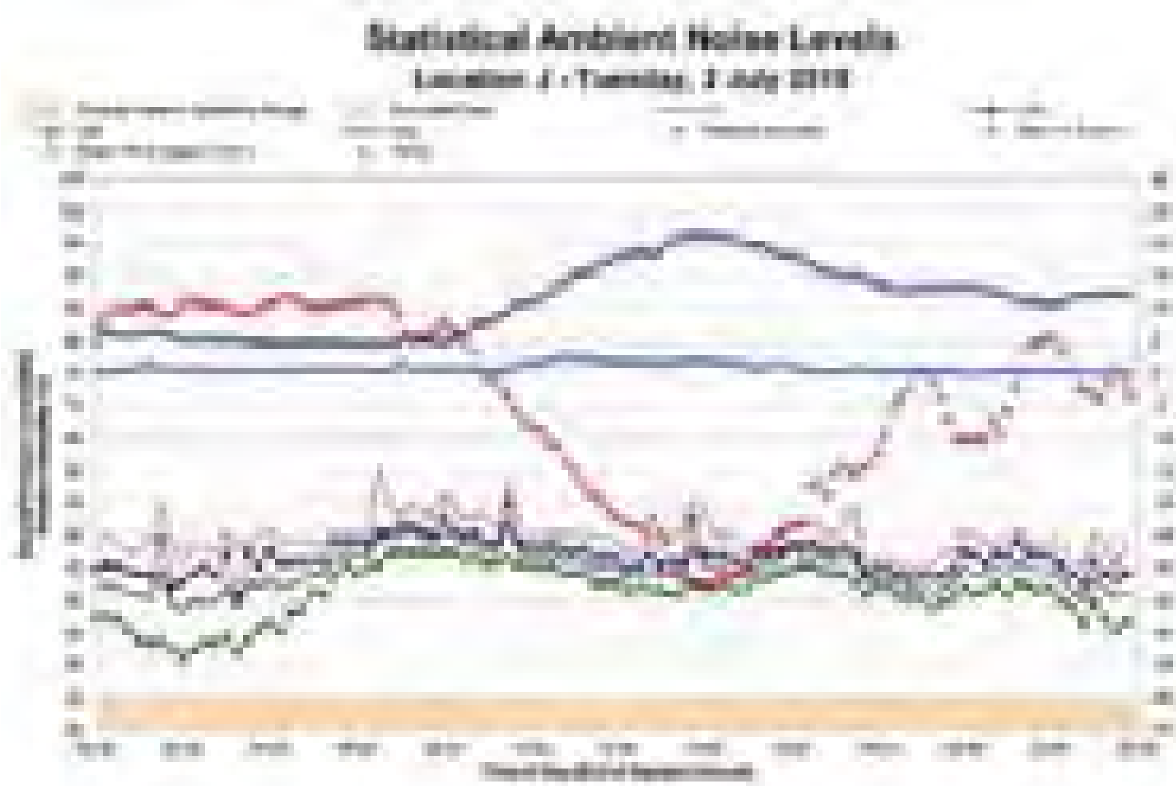
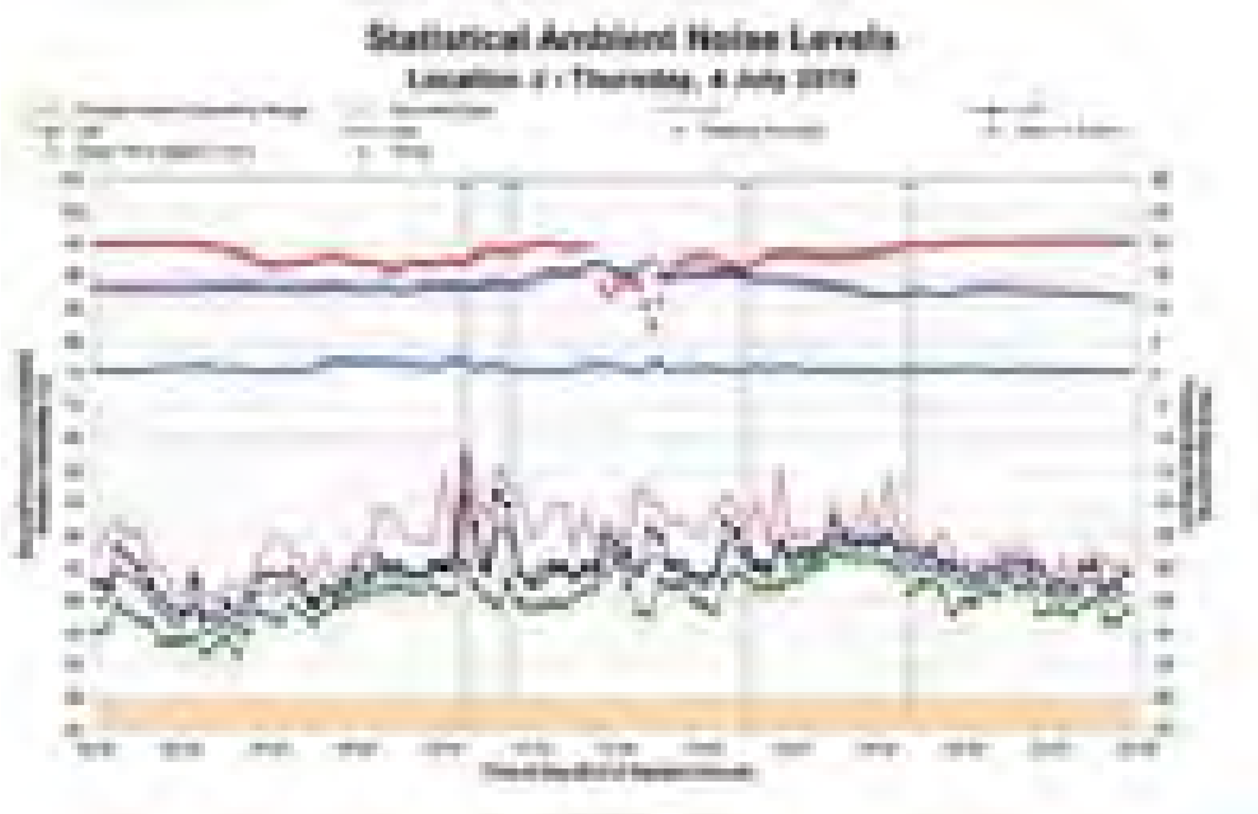

Statistical Ambient Noise Levels


Statistical Ambient Noise Levels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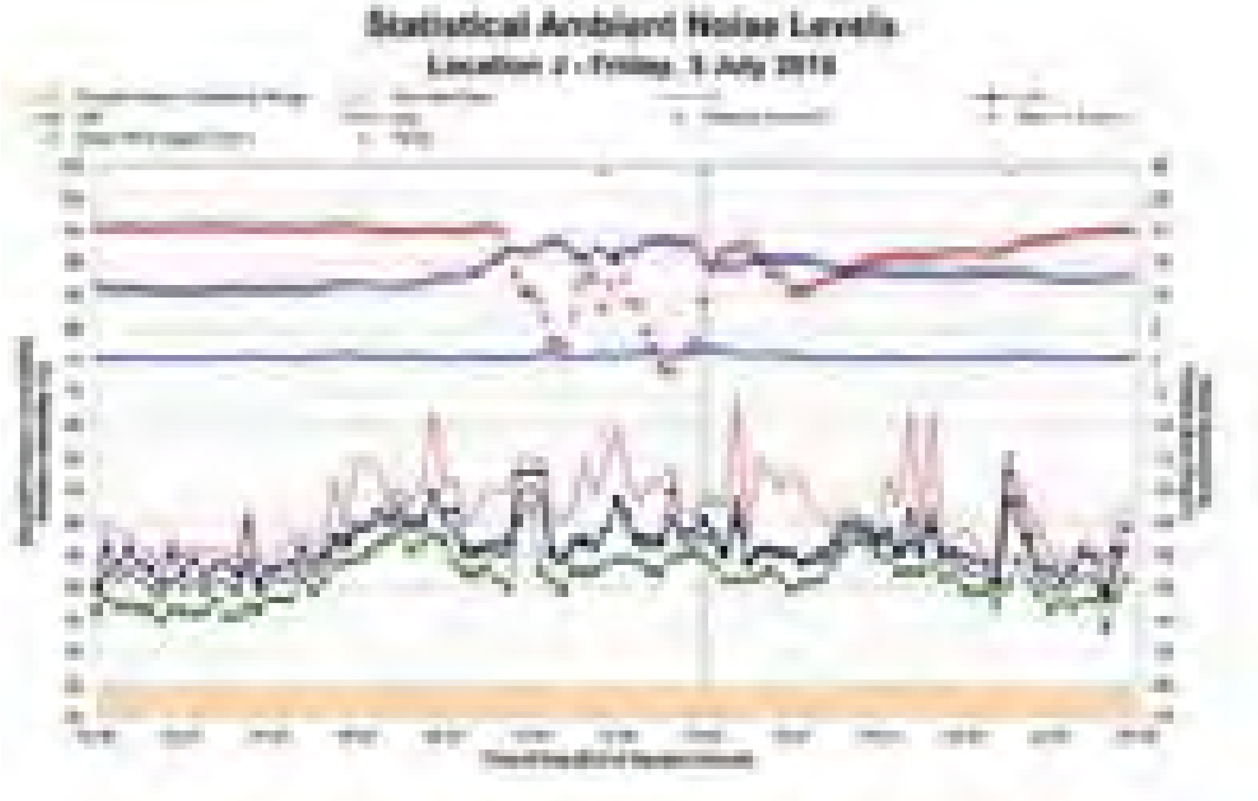
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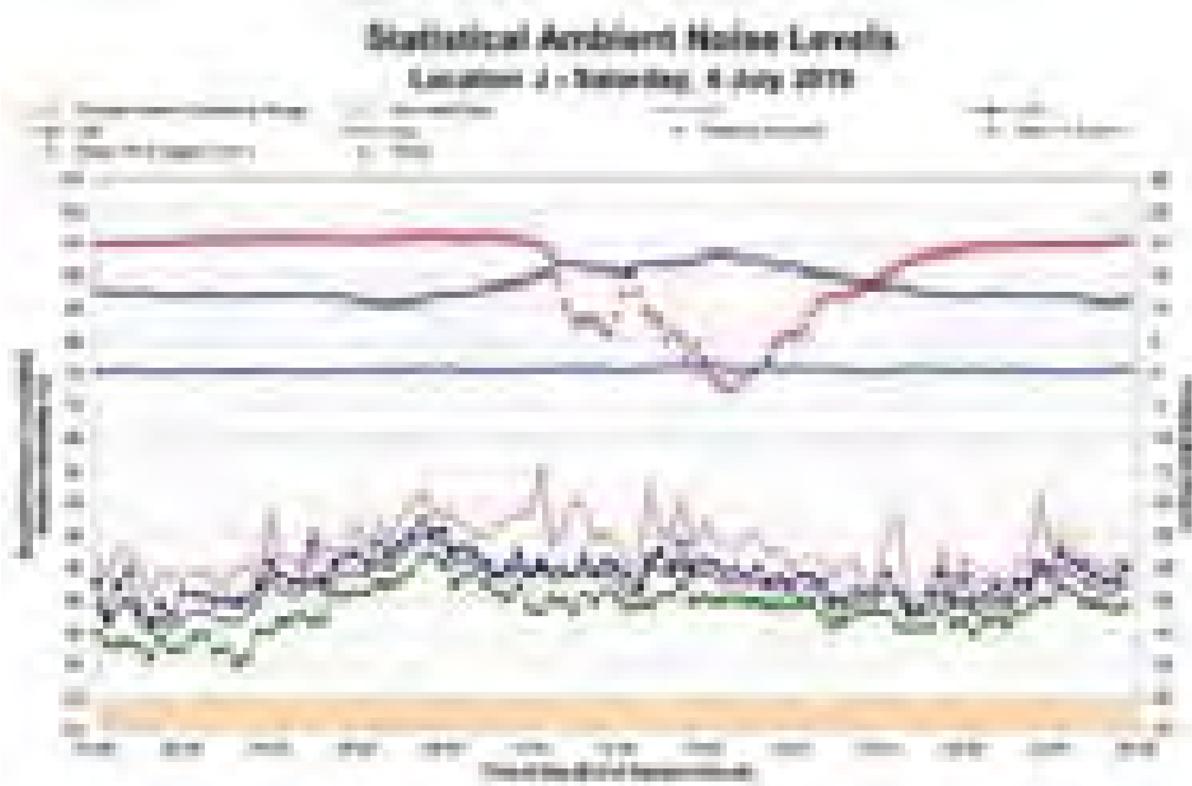
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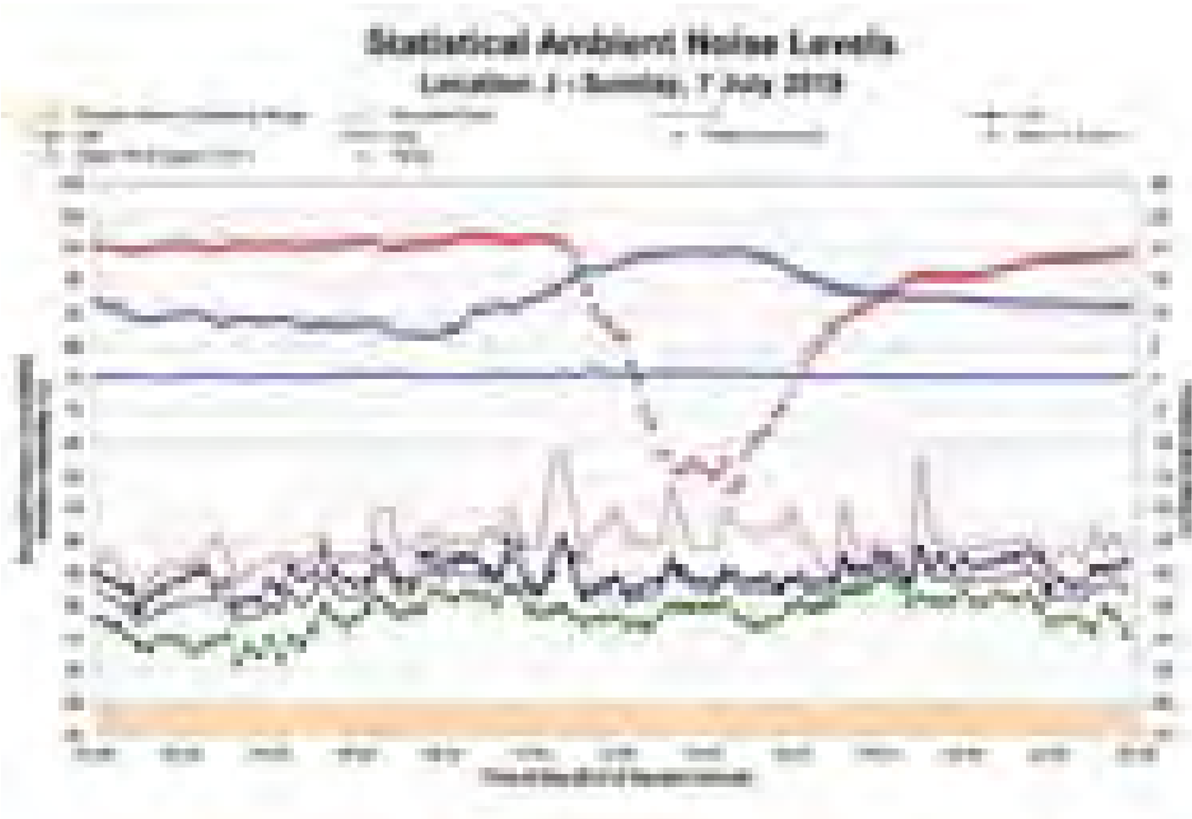
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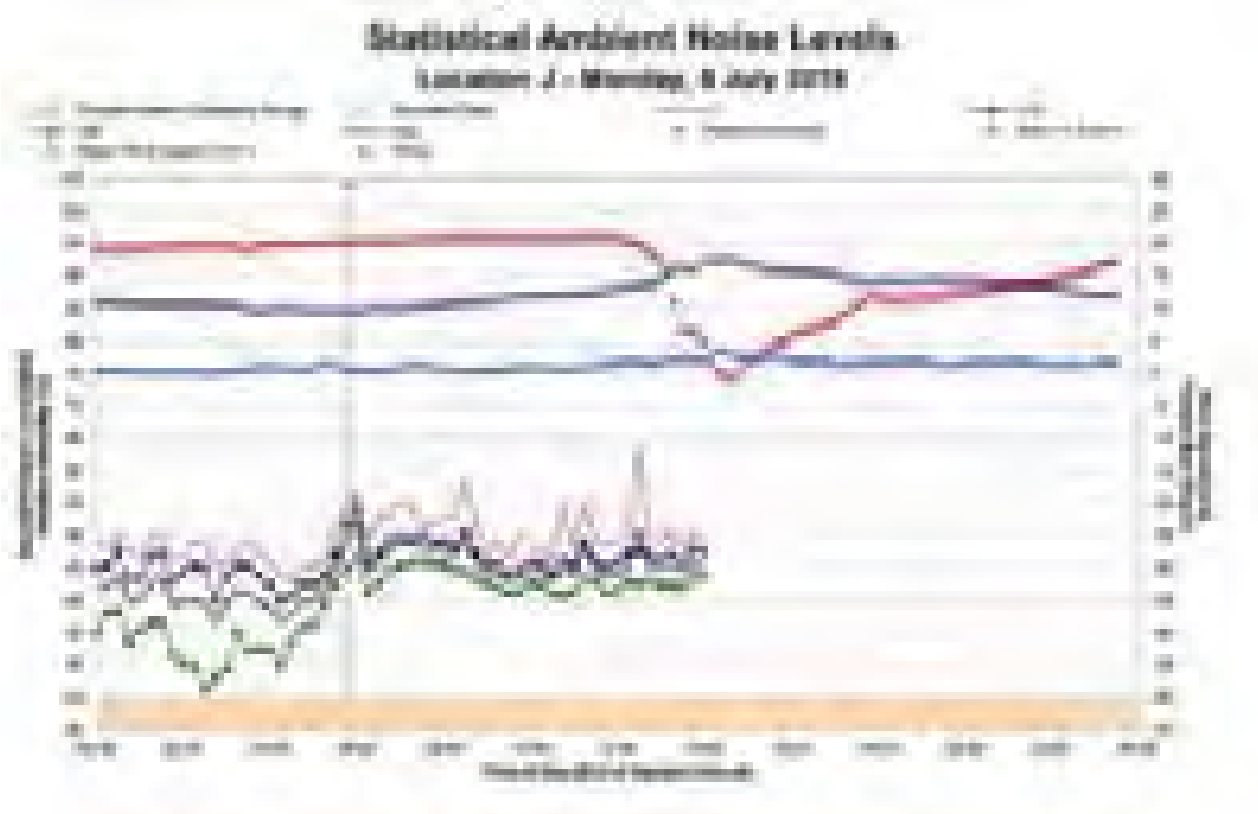
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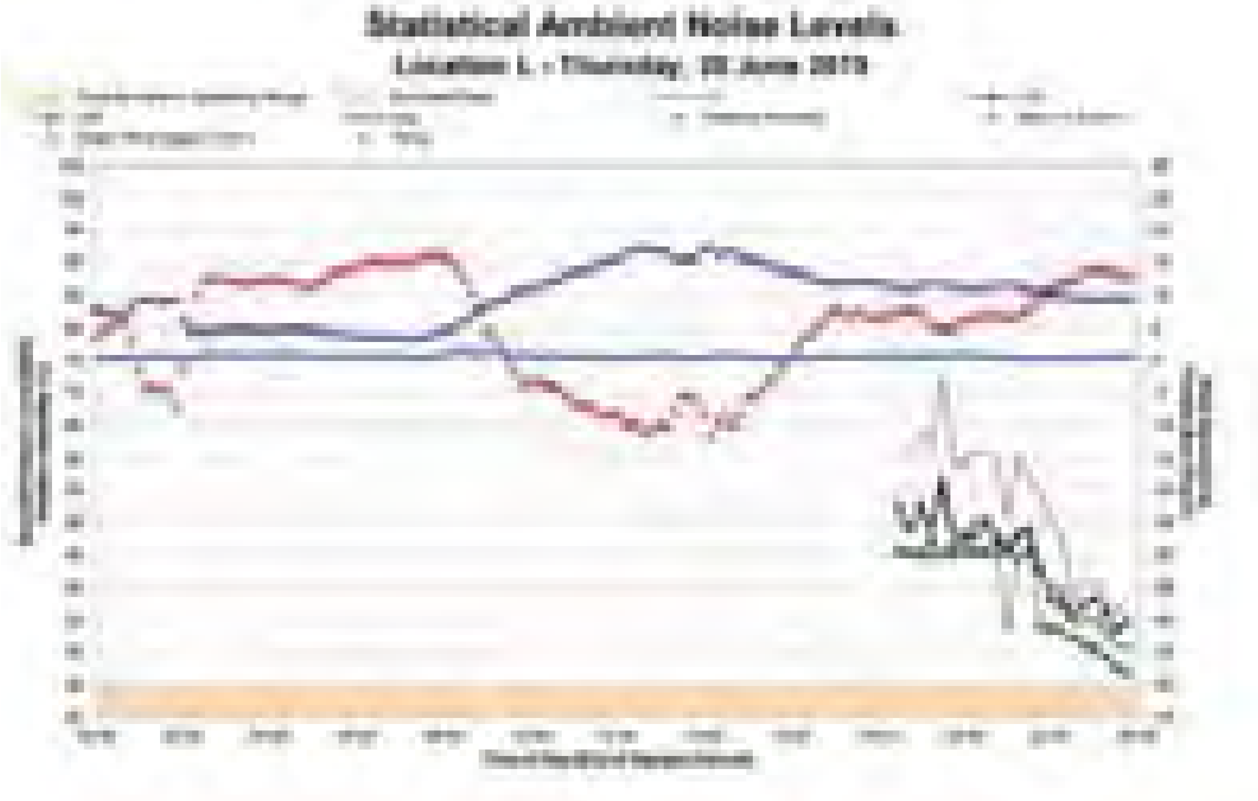
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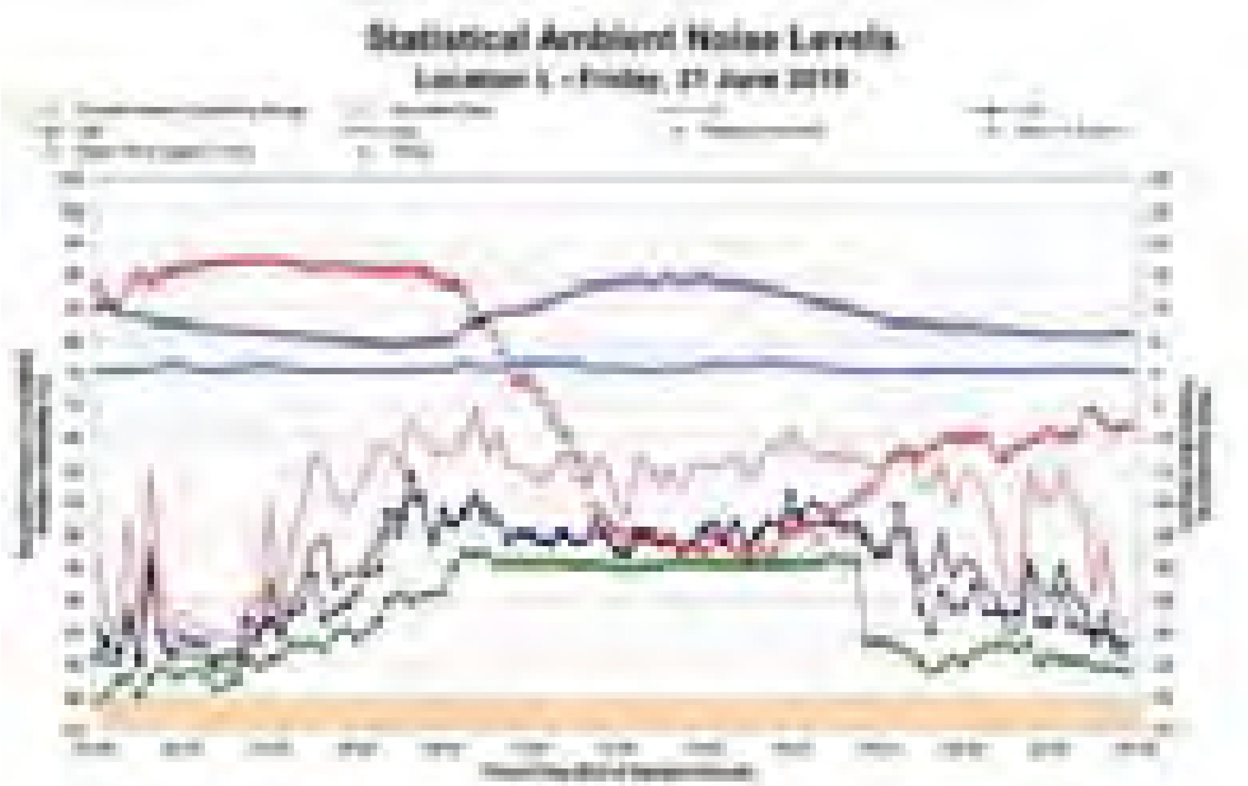
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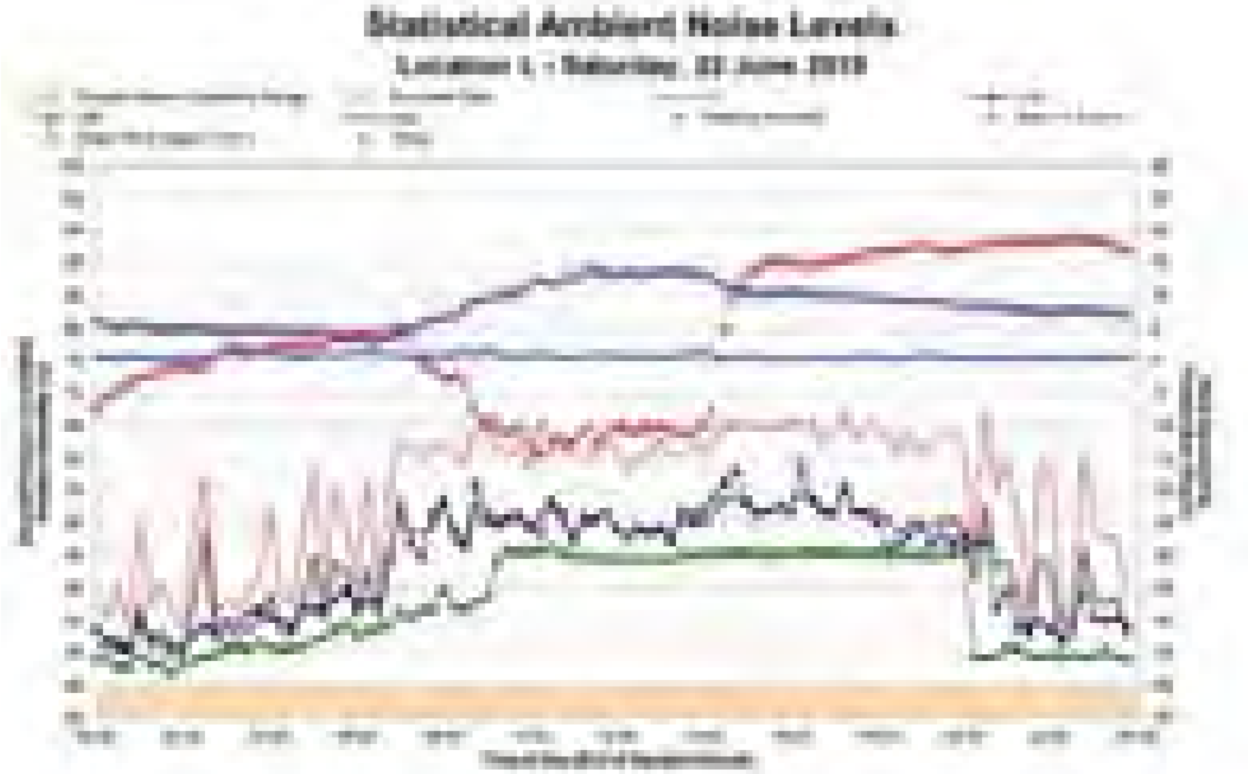
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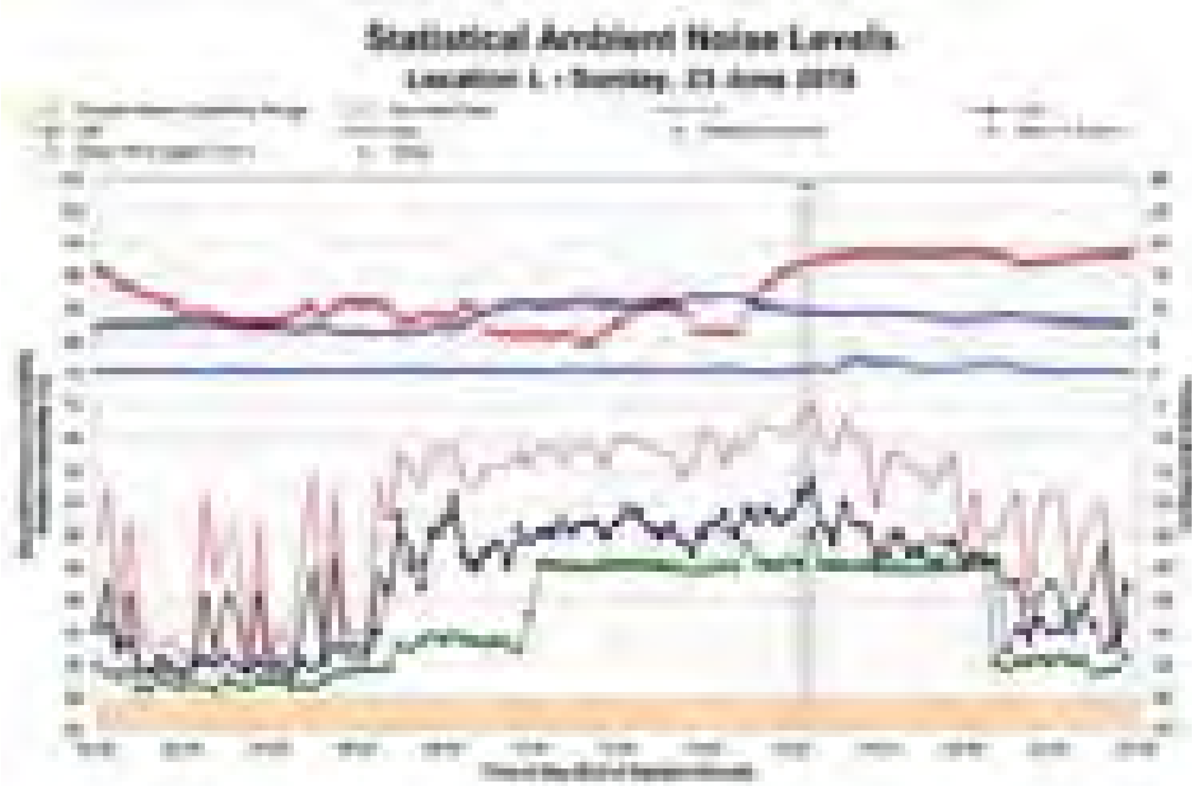
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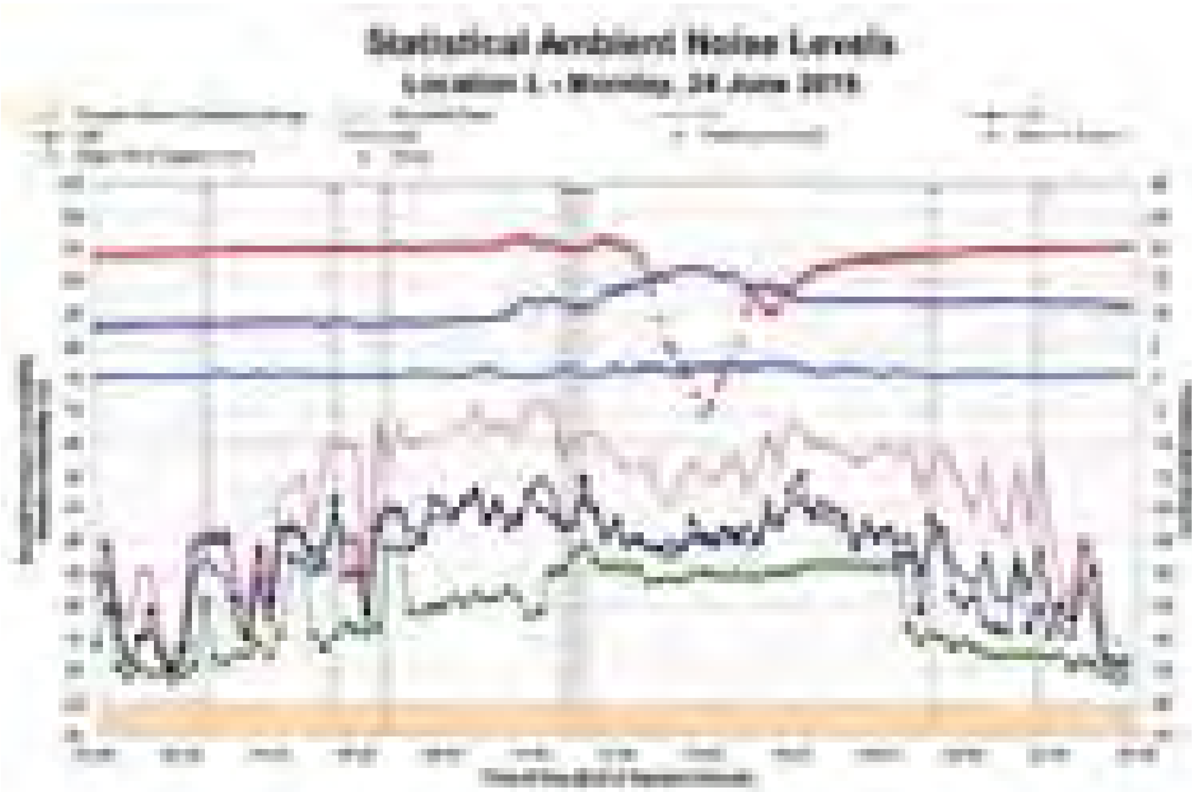
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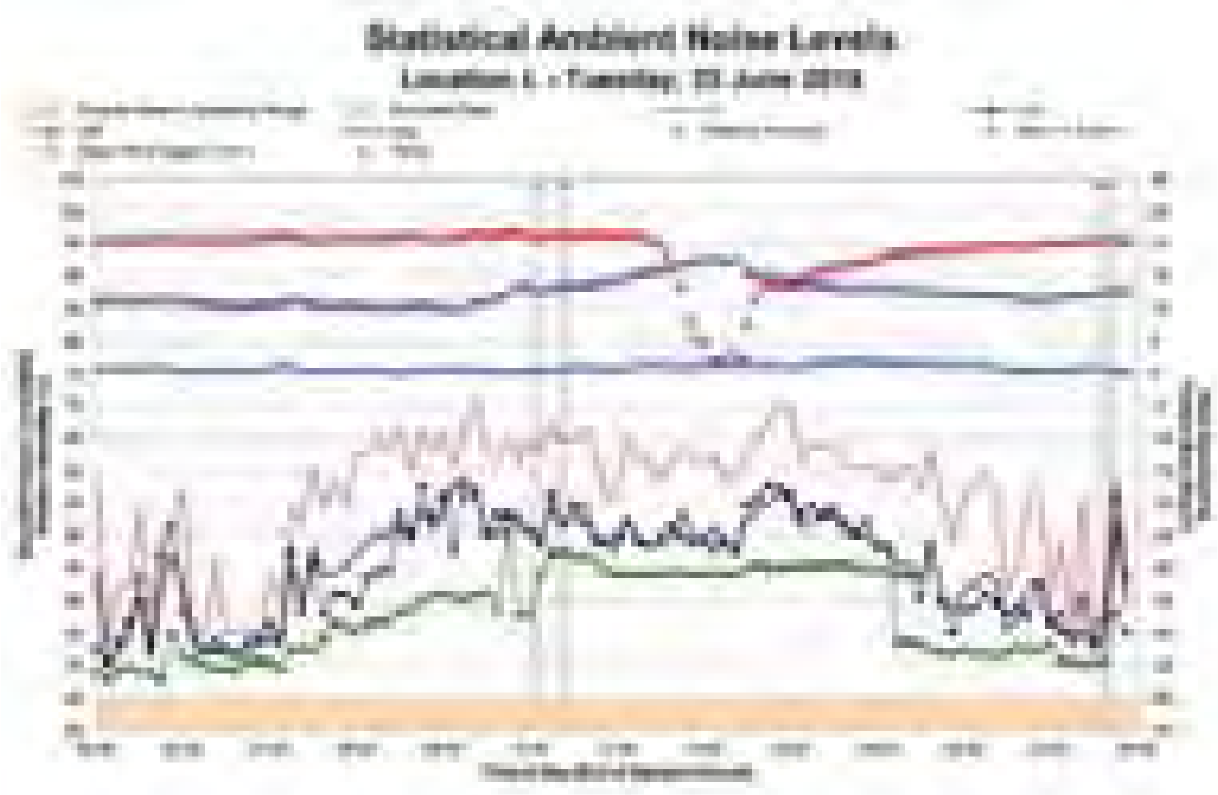
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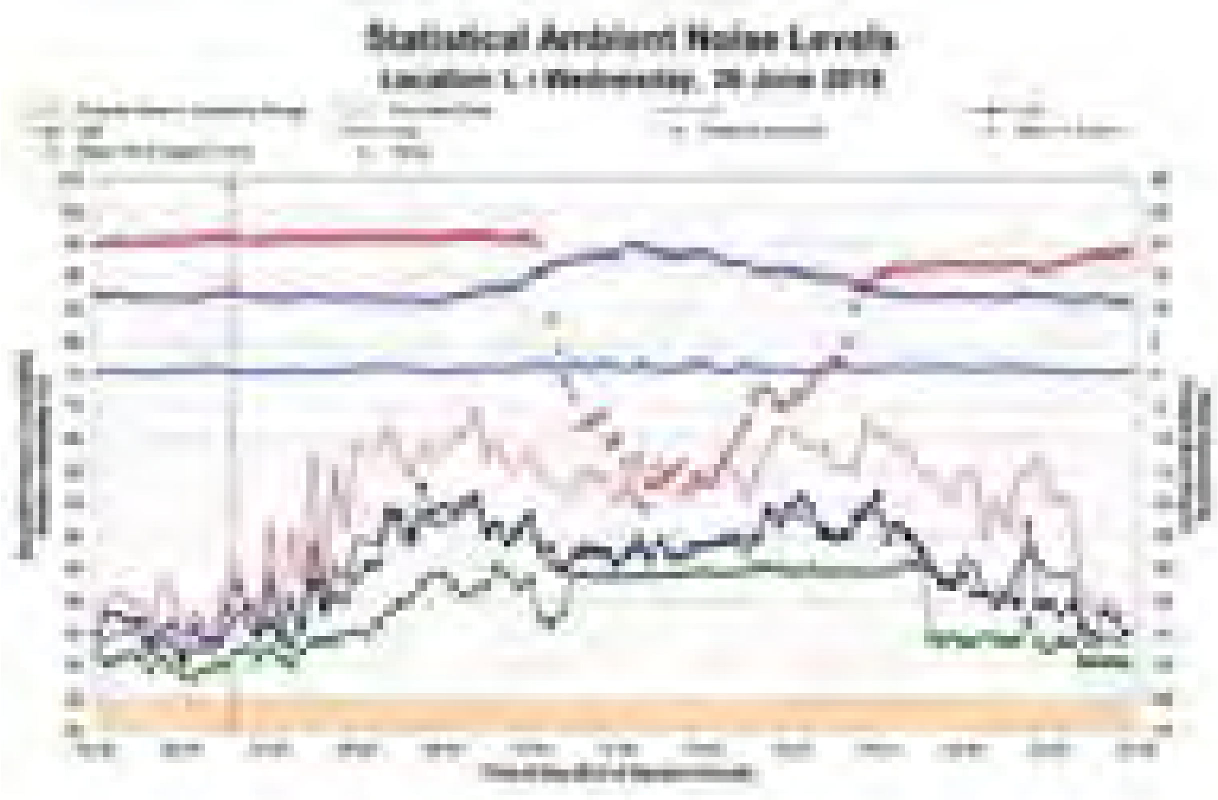
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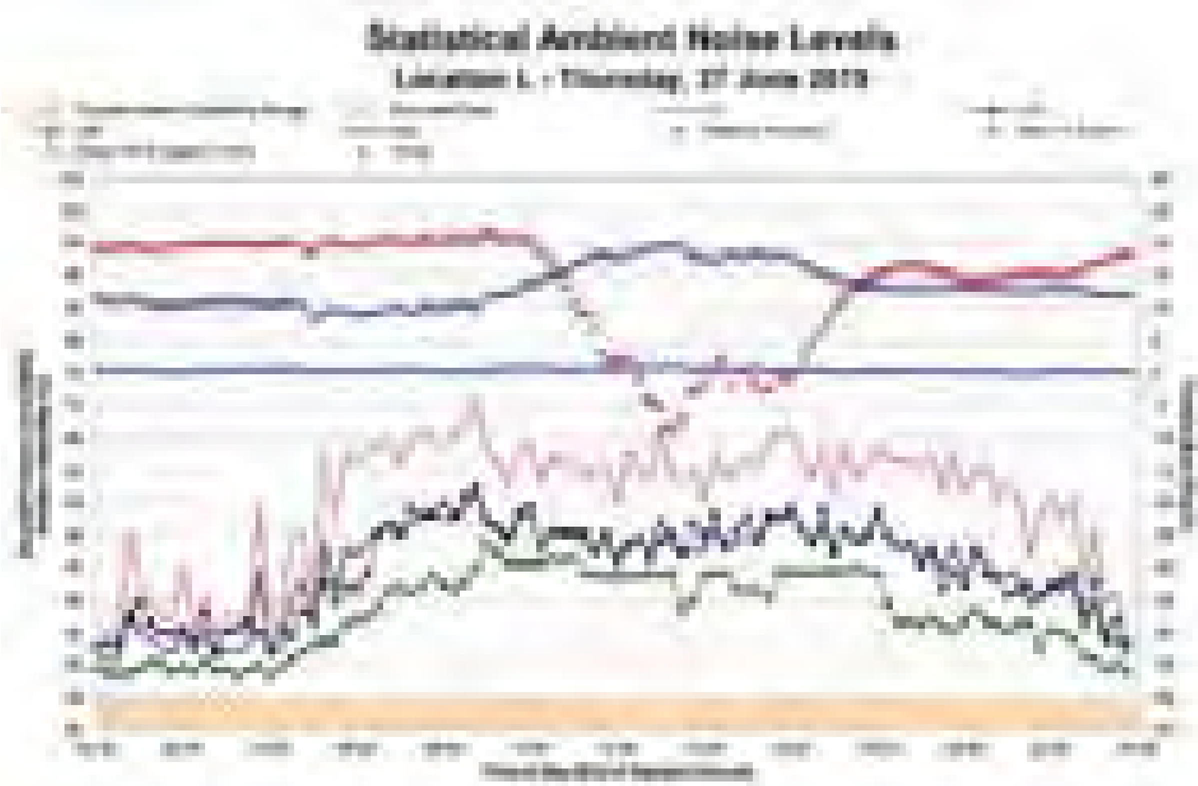
Statistical Ambient Noise Levels
Location L - Thursday, 27 June 2019


Statistical Ambient Noise Levels
Location L - Friday, 28 June 2019

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DONALDSON AND ABEL COAL MINES

Quarterly Noise Monitoring
Quarter Ending September 2019

Prepared for:

Donaldson Coal Pty Ltd
PO Box 675
Green Hills 2320

SLR Ref: Q75 630.01053-R01
Version No: -v1.0
January 2020

PREPARED BY

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BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Donaldson Coal Pty Ltd (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
Q75 630.01053-R01-v1.0	24 January 2020	Martin Davenport	Jordan Murray	Martin Davenport

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DOCUMENT REFERENCES

TABLES

FIGURES

APPENDICES

1 Introduction

1.1 Background

Donaldson Coal Pty Ltd has commissioned SLR Consulting Australia Pty Ltd (SLR) to conduct quarterly noise monitoring surveys for the Donaldson Coal Mine and Abel Coal Mine during the September 2019 quarter in accordance with the *Donaldson Coal Mine and Abel Underground Coal Mine - Noise Management Plan Care and Maintenance* (the NMP) dated 3 June 2019.

1.2 Objectives of this Report

The objectives of the noise monitoring survey for this operating quarter were as follows:

- Measure the ambient noise levels at six focus receptor locations (potentially worst affected) surrounding Donaldson Coal Mine and Abel Coal Mine.
- Qualify all sources of noise within each of the attended surveys, including estimated contribution or maximum level of individual noise sources.
- Assess the noise emissions of Donaldson Coal Mine and Abel Coal Mine with respect to the limits contained in the Development Consent.

1.3 Acoustic Terminology

The following report uses specialist acoustic terminology. An explanation of common terms is provided in **Appendix A**.

2 Development Consent Project Approval

Development consent was obtained by Donaldson Coal Pty Ltd for the Donaldson Mine in October 1999 following a Commission of Inquiry. Development Consent number N97/00147 was issued by the Minister for Urban Affairs pursuant to Section 101 of the Environmental Planning and Assessment Act 1979 (EP&A Act).

Project Approval (Application No. 05_0136) granted by the Minister of Planning was obtained by Donaldson Coal Pty Ltd for Abel Coal Mine in 2007.

2.1 Donaldson Coal Mine Development Consent Conditions

The Development Consent nominates hours of operation and mine noise emission goals in the Sections entitled "*Operation of Development, Condition No. 3(1) and 3(2)*", and *"Noise and Vibrational Noise Limits: Condition No. 15*" as follows:

3.(1) Subject to (2) the approved hours of operation are as follows:

Works	*Period*	*Hours*
Construction, including construction of any bunds	*Monday to Friday* *Saturday*	*7 am to 6 pm* *8 am to 1 pm*
Mining operations, including mining, haulage of waste to dumps and coal processing	*Monday to Friday* *Saturday, Sunday*	*24 hours per day* *7 am to 6 pm*
Road Transportation and stockpiling of coal	*7 days per week*	*24 hours per day*
Rail loading of coal	*7 days per week*	*7 am to 10 pm*
Maintenance of mobile and fixed plant	*7 days per week*	*24 hours per day*
Blasting, not involving closure of John Renshaw Drive	*Monday to Saturday*	*7 am to 5 pm*
Blasting, involving closure of John Renshaw Drive	*Monday to Saturday*	*10 am to 2 pm*

Notes: Restrictions on Public Holidays are the same as Sundays

(2) The Applicant shall submit a report to the Director-General's satisfaction demonstrating the noise limits in Condition 15 can be met while rail loading of coal is occurring during the period from 6 pm to 10 pm. If that report does not demonstrate that the noise limits can be met to the Director-General's satisfaction, then the hours of operation for rail loading of coal shall be restricted to 7 am to 6 pm."

15. *Unless subject to a negotiated agreement in accordance with Condition 23, the Applicant shall ensure that the noise emission from construction or mining operations, when measured or computed at the boundary of any dwelling not owned by the applicant (or within 30 metres of the dwelling, if the boundary is more than 30 metres from the dwelling), shall not exceed the following noise limits:*

Location	*$L_{A10(15minute)}$ Noise Limits (dBA)*	
	Daytime	Night-time
Beresfield area (residential)	*45*	*35*
Steggles Poultry Farm	*50*	*40*
Ebenezer Park Area	*46*	*41*
Black Hill Area	*40*	*38*
Buchanan and Louth Park Area	*38*	*36*
Ashtonfield Area	*41*	*35*
Thornton Area	*48*	*40*

Note: Daytime is 7 am to 10 pm Monday-Saturday, and 8 am to 10 pm Sundays and Public Holidays. Night-time is 10 pm to 7 am Monday-Saturday, and 10 pm to 8 am Sundays and Public Holidays.

The noise limits apply for prevailing meteorological conditions (winds up to 3 m/s), except under conditions of temperature inversions."

Other Conditions of Consent relevant to noise are as follows:

18. *The applicant shall survey and investigate noise reduction measures from plant and equipment and set targets for noise reduction in each Annual Environmental Management Report (AEMR), taking into consideration valid noise complaints received in the previous year. The Report shall also include remedial measures.*

19. *The Applicant shall revise the Noise Management Plan as necessary and provide an updated Plan five years after commencement of mining to the Director-General, the independent noise expert (Condition 48), EPA, Councils and the Community Consultative Committee.*

2.2 Abel Coal Mine – Project Approval

Approved Operations

The following operations are approved under the Abel Coal Mine Project Approval:

- Extraction of up to 6.1 Mtpa of Run of Mine (ROM) coal from the Abel Underground Coal Mine.
- Transport coal to the existing Bloomfield Coal Handling and Preparation Plant by private haul roads, or by coal conveyor, or by a combination of both methods.
- Operate the Bloomfield Coal Handling Processing Plant (CHPP) to process coal extracted from the Abel Coal Mine and the Bloomfield and Donaldson Coal Mines.
- Transportation of product coal from the Bloomfield site by rail via the Bloomfield rail loading facility.

The Project Approval was modified in June 2010 (05_0136 MOD 1) allowing construction and operation of a downcast ventilation fan. In May 2011 the Project Approval was modified again (05_0136 MOD 2) to allow the construction and operation of an upcast ventilation fan (and associated facilities). In December 2013 the Project Approval was further modified (05_0136 MOD3) to account for the increase in coal extracted including the upgrade of the Bloomfield CHPP.

Consent Conditions

The relevant conditions relating to noise from the Abel Coal Mine approval are reproduced below.

Schedule 4

NOISE

Operational Noise Criteria

1. *The Proponent shall ensure that the noise generated by the Project does not exceed the criteria in Table 4 at any residence on privately-owned land.*

Table 4: Operational Noise Criteria dB(A)

Location	Receiver Area	Day	Evening	Night	
		LAeq(15minute)	**LAeq(15minute)**	**LAeq(15minute)**	**LA1(1minute)**
Location I	Lord Howe Drive, Ashtonfield	*36*	*36*	*36*	*45*
Location K	Catholic Diocese Land	*37*	*37*	*37*	*45*
Location L	Kilshanny Avenue, Ashtonfield	*40*	*40*	*40*	*47*
All other Locations	All other privately owned Residences	*35*	*35*	*35*	*45*

Notes:

- *To interpret the locations referred to in Table 4, see plan in Appendix 3.*
- *Noise generated by the project is to be measured in accordance with the relevant requirements, and exemptions (including certain meteorological conditions), of the NSW Industrial Noise Policy. Appendix 4 sets out the meteorological conditions under which these criteria apply, and the requirements for evaluating compliance with these criteria.*

These noise criteria do not apply if the Proponent has an Agreement with the relevant landowner to generate higher noise levels, and the proponent has advised the Department in writing of the terms of this agreement.

Construction Noise Criteria

1. *The proponent shall ensure that the noise generated during the construction of the downcast ventilation shaft as described in EA (MOD3) does not exceed the criteria in Table 5.*

Table 5: Construction Noise Criteria dB(A)

Location	Receiver	Day
		LAeq(15minute)
Location R	*281 Lings Road, Buttai*	*50*
Location S	*189 Lings Road, Buttai*	*43*

Notes:

- *The criteria in Table 5 apply only whilst the downcast ventilation shaft is being constructed, and for a maximum of 12 weeks from the commencement of construction.*
- *To interpret the locations referred to in Table 5, see plan in Appendix 3* (attached to this report as **Appendix A**).
- *Noise generated by the project is to be measured in accordance with the relevant requirements, and exemptions (including certain meteorological conditions), of the NSW Industrial Noise Policy.*

However, these noise criteria do not apply if the Proponent has an Agreement with the relevant landowner to generate higher noise levels, and the proponent has advised the Department in writing of the terms of this agreement.

Rail Noise Criteria

1. *The proponent shall ensure that the noise from rail movements on the Bloomfield Rail Spur does not exceed the limits in Table 6 at any residence on privately owned land.*

Table 6: Rail Spur noise criteria dB (A)

Location	*Day*	*Evening*	*Night*
	LAeq(period)		
All privately-owned land	*55*	*45*	*40*

Cumulative Noise Criteria

1. *The proponent shall implement all reasonable and feasible measures to ensure that the noise generated by the project combined with noise generated by other mines does not exceed the criteria in Table 7 at any residence on privately-owned land.*

Table 7: Cumulative noise criteria dB (A)

Location	*Day*	*Evening*	*Night*
	LAeq(period)		
All privately-owned land	*55*	*45*	*40*

Notes: Cumulative noise is to be measured in accordance with the relevant requirements, and exemptions (including meteorological conditions), of the NSW Industrial Noise Policy. Appendix 4 sets out the metrological conditions under which these criteria apply and the requirements for evaluating compliance with these criteria.

Operating Conditions

1. *The proponent shall:*
    a. *Implement best management practise to minimise the construction, operational, road and rail noise of the project;*
    b. *Operate an on-site noise management system to ensure compliance with the relevant conditions of this approval;*
    c. *Minimise the noise impacts of the project during meteorological conditions under which the noise limits in this consent do not apply (see Appendix 4);*
    d. *Only receive and/or dispatch locomotives and rolling stock either on or from the site that are approved to operate on the NSW rail network in accordance with the noise limits in ARTC's EPL (No. 3142);*
    e. *Carry out regular monitoring to determine whether the project is complying with the noise criteria and other relevant conditions of approval, to the satisfaction of the Director-General.*

Noise Management Plan

2. *The proponent shall prepare and implement a Noise Management Plan for the project to the satisfaction of the Director-General. This plan must:*
    a. *Be prepared in consultation with the EPA, and be submitted to the Director-General for approval within 6 months of the date of approval of MOD 3;*
    b. *Describe the measures that would be implemented to ensure compliance with the noise criteria and operating conditions in this approval; Describe the proposed noise management system in detail; and*
    c. *Include a monitoring program that:*
        - *Uses attended monitoring to evaluate the compliance of the project against the noise criteria in this approval;*
        - *Evaluates and reports on:*
            - *The effectiveness of the on-site noise management system; and*
            - *Compliance against the noise operating conditions; and*

Defines what constitutes a noise incident, and includes protocol for identifying and notifying the Department and relevant stakeholders of any noise incidents. Appendix 4

Noise Compliance Assessment

Applicable Meteorological Conditions

1. *The noise criteria in Tables 4 and 7 are to apply under all metrological conditions except the following:*
    a. *During periods of rain or hail.*
    b. *Average wind speed at microphone height exceeds 5 m/s;*
    c. *Wind speeds greater than 3 m/s measured at 10m above ground level; or*
    d. *Temperature inversion conditions greater than $3^oC/100m$.*

Determination of metrological conditions

2. *Except for wind speed at microphone height, the data to be used for determining metrological conditions shall be that recorded by the meteorological station located on the site.*

Compliance monitoring

3. *Attended monitoring is to be used to evaluate compliance with the relevant conditions of this approval.*
4. *Unless otherwise agreed with the director-general, this monitoring is to be carried out in accordance with the relevant requirements for reviewing performance set out in the NSW Industrial Noise Policy (as amended from time to time), in particular the requirements relating to:*
    a. *Monitoring locations for the collection of representative noise data;*
    b. *Metrological conditions during which collection of noise data is not appropriate;*
    c. *Equipment used to collect noise data, and conformity with Australian Standards relevant to such equipment; and*
    d. *Modification to noise data collected, including for the exclusion of extraneous noise and/or penalties for modifying factors apart from adjustments for duration.*

Appendix 5

Statement of Commitments

3. Noise

3.1 Construction Activities

The following noise control measures will be implemented prior to commencement of construction of the Abel Underground Mine or the upgrade of the Bloomfield CHPP.

1. *Maintain all machinery and equipment in working order;*
    a. *No construction activities at the Abel pit top will take place on Sundays or Public Holidays;*
    b. *Where possible locate noisy site equipment behind structures that act as barriers or at the greatest distance from noise sensitive areas; and*
    c. *Orientate equipment so that noise emissions are directed away from noise sensitive areas.*

3.2 Noise Control Measures

a. *The following noise control measures will be implemented prior to the mining of coal from the Abel underground Mine:*
    i. *Orientation of the ventilation fans away from residential receivers and angle the output parallel to the ground.*
    ii. *The sound power level of the front end loader to be used near the portal should not exceed 113 dBA and will be fitted with a noise sensitive reversing alarm.*
b. *The following noise control measures will be implemented prior to the Bloomfield CHPP receiving any ROM coal from Able Underground Mine;*

i. Noise mitigation works including partial enclosure and noise screening of drives and conveyors of the Bloomfield CHPP to screen residences to the north of the site.

3.2 Monitoring

The Company will implement a Noise Monitoring Program for the Abel Underground Mine and the Bloomfield CHPP, to the satisfaction of the Director-General. The Noise Monitoring Program shall include a combination of real-time and supplementary attended monitoring measures, and a noise monitoring protocol for evaluating compliance with the noise environmental assessment. This plan will be integrated with the monitoring plans for the Tasman, Donaldson and Bloomfield Mines to provide a single integrated Noise Monitoring Program for all 4 mines.

3.4 Continuous Improvement

The Company shall:

a. Report on these investigations and implementation of any new noise mitigation measures on site in the AEMR, to the satisfaction of the Director General.

The operator of the Bloomfield CHPP shall:

b. Investigate ways to reduce the noise generated by the Bloomfield CHPP, including maximum noise levels which may result in sleep disturbance;

c. Implement all reasonable and feasible best practice noise mitigation measures on the site; and

d. Report on these investigations and the implementation of any new noise mitigation measures on site in the AEMR, to the satisfaction of the Director-General.

3 Noise Monitoring Methodology

3.1 General Requirements

The operational noise monitoring program was conducted with reference to Development Consent N97/00147 (Donaldson Coal Mine), Project Approval 05_0136 (Abel Coal Mine), the NMP and AS 1055-2018 *Acoustics - Description and Measurement of Environmental Noise*.

All acoustic instrumentation employed throughout the monitoring program has been designed to comply with the requirements of AS IEC 61672.1 – 2004 *Electroacoustics—Sound level meters – Specifications*, AS IEC 61672.2-2004, AS IEC 61672.3-2004 and carried current NATA or manufacturer calibration certificates. Certificates for acoustic instrumentation used during the September 2019 quarter is provided in **Appendix B**.

Instrument calibration was conducted before and after each measurement, with the variation in calibrated levels not exceeding ±0.5 dBA.

3.2 Monitoring Locations

Baseline and preceding operational quarterly surveys have been conducted at 11 locations surrounding the Donaldson Mine and Abel Coal Mine sites. With the experience of these previous surveys, it was decided to concentrate noise monitoring at six focus locations that represent the potentially most noise affected areas from Donaldson Mine and Abel Coal Mine. The details of the monitoring locations are contained within **Table 1**.

It is relevant to note that Donaldson Open Cut Mine has ceased production and all major earthworks on the site have been finalised. Furthermore, Abel mine was placed in Care & Maintenance on 28th April 2016 and there was no operations onsite during the September 2019 noise monitoring period.

Table 1 Monitoring Locations

Noise Monitoring Location	Description
D	Black Hill School, Black Hill
F	Lot 684 Black Hill Road, Black Hill
G	156 Buchannan Road, Buchannan
I	Magnetic Drive, Ashtonfield
J	Parish Drive, Thornton
L	65 Tipperary Dr, Ashtonfield

A map giving the approximate location of the noise monitoring sites is contained within **Appendix C**.

3.3 Unattended Continuous Noise Monitoring

An environmental noise logger was deployed for a minimum of a seven day period between Tuesday 24 September 2019 and Tuesday 1 October 2019 at each of the six (6) nominated locations given in Table 1.

All unattended monitoring equipment was programmed to continuously record statistical noise level indices in 15 minute intervals including the L_{Amax}, L_{A1}, L_{A10}, L_{A90}, L_{A99}, L_{Amin} and L_{Aeq}. The statistical noise exceedance levels (L_{AN}) are the levels exceeded for N% of the 15 minute interval. The L_{A90} represents the level exceeded for 90% of the interval period and is referred to as the average minimum or background noise level. The L_{A10} is the level exceeded for 10% of the time and is usually referred to as the average maximum noise level. The L_{Aeq} is the equivalent continuous sound pressure level and represents the steady sound level which is equal in energy to the fluctuating level over the interval period. The L_{Amax} is the maximum noise level recorded over the interval.

3.4 Operator Attended Noise Monitoring

Operator attended surveys were conducted at each of the six monitoring locations during the daytime, evening and night-time periods, to verify the unattended logging results and to determine the character and contribution of ambient noise sources.

4 Operator Attended Noise Monitoring

4.1 Results of Operator Attended Noise Monitoring

Operator attended noise measurements were conducted during the daytime period on Tuesday 24 September 2019 and the evening and night-time on Monday 30 September 2019. Operator attended noise surveys were conducted using a Brüel & Kjær Type 2270 (serial number 2679354) and Brüel & Kjær Type 2250L integrating sound level meter (serial number 3003389).

Ambient noise levels given in the tables include all noise sources such as traffic, insects, birds, and mine operations as well as any other industrial operations.

The tables provide the following information:

- Monitoring location.
- Date and start time.
- Wind velocity (m/s) and Temperature (ºC) at the measurement location.
- Typical maximum (L_{Amax}) and contributed noise levels.

Mine contributions listed in the tables are from the Abel Coal Mine and are stated only when a contribution could be quantified.

Table 2 Location D, Black Hill Public School, Black Hill

Period	Date/ Start time/Weather	Primary Noise Descriptor (dBA re 20 µPa)					Description of Noise Emission, Typical Maximum Noise Levels (LAmax – dBA)
		LAmax	LA1	LA10	LA90	LAeq	
Day	24/09/2019 13:48 21°C 1.3 m/s WNW	71	62	53	36	51	School playground 47-52 Road traffic 49-71 Birds 36-62 **Abel Mine Inaudible**
		Estimated Abel Mine Noise Contribution Inaudible					
Evening	30/09/2019 18:55 14°C 0.3 m/s SSE	76	57	45	41	50	Insects/frogs 42-50 Road traffic 40-76 **Abel Mine Inaudible**
		Estimated Abel Mine Noise Contribution Inaudible					
Night	30/09/2019 22:33 15°C 0.3 m/s SSE	75	63	44	41	50	Insects/frogs 40-43 Road traffic 38-75 **Abel Mine Inaudible**
		Estimated Abel Mine Noise Contribution Inaudible					

Table 3 Location F, Lot 684 Black Hill Road, Black Hill

Period	Date/ Start time/Weather	Primary Noise Descriptor (dBA re 20 µPa)					Description of Noise Emission, Typical Maximum Noise Levels (LAmax – dBA)
		LAmax	LA1	LA10	LA90	LAeq	
Day	24/09/2019 14:11 21°C 1.2 m/s W	88	72	59	45	62	Road traffic 44-88 Birdsong 39-52 **Abel Mine Inaudible**
		Estimated Abel Mine Noise Contribution Inaudible					
Evening	30/09/2019 19:15 14°C 0.7 m/s SSE	74	60	52	43	50	Aeroplane 61 Frogs/insects 39-48 Road traffic 40-74 **Abel Mine Inaudible**
		Estimated Abel Mine Noise Contribution Inaudible					
Night	30/09/2019 22:54 15°C 0.2 m/s SSE	64	57	48	41	46	Frogs/insects 40-46 Road traffic 41-64 **Abel Mine Inaudible**
		Estimated Abel Mine Noise Contribution Inaudible					

Table 4 Location G, Buchanan Road, Buchanan

<table>
<tr><th rowspan="2">Period</th><th rowspan="2">Date/
Start time/ Weather</th><th colspan="5">Primary Noise Descriptor
(dBA re 20 µPa)</th><th rowspan="2">Description of Noise Emission, Typical Maximum Noise Levels (LAmax – dBA)</th></tr>
<tr><th>LAmax</th><th>LA1</th><th>LA10</th><th>LA90</th><th>LAeq</th></tr>
<tr><td rowspan="2">Day</td><td rowspan="2">24/09/2019
15:31
21°C
1.2 m/s W</td><td>68</td><td>57</td><td>46</td><td>39</td><td>45</td><td rowspan="2">Road traffic 37-49
Birds 43-68
Abel Mine Inaudible</td></tr>
<tr><td colspan="5">Estimated Abel Mine Noise Contribution
Inaudible</td></tr>
<tr><td rowspan="2">Evening</td><td rowspan="2">30/09/2019
20:20
15°C
0.4 m/s SSE</td><td>60</td><td>50</td><td>46</td><td>37</td><td>43</td><td rowspan="2">Road traffic 35-57
Insects 32-36
Other industry 32-43
Abel Mine Inaudible</td></tr>
<tr><td colspan="5">Estimated Abel Mine Noise Contribution
Inaudible</td></tr>
<tr><td rowspan="2">Night</td><td rowspan="2">01/10/2019
00:00
14°C
0.5 m/s SSE</td><td>47</td><td>46</td><td>40</td><td>33</td><td>37</td><td rowspan="2">Road traffic 35-47
Insects 25-30
Other industry 28-43
Abel Mine Inaudible</td></tr>
<tr><td colspan="5">Estimated Abel Mine Noise Contribution
Inaudible</td></tr>
</table>

Table 5 Location I, Magnetic Drive, Ashtonfield

Period	Date/ Start time/Weather	Primary Noise Descriptor (dBA re 20 µPa)					Description of Noise Emission, Typical Maximum Noise Levels (LAmax – dBA)
		LAmax	LA1	LA10	LA90	LAeq	
Day	24/09/2019 12:52 21°C 0.5 m/s SSE	63	55	51	37	42	Road traffic 51-63 Birds 35-44 **Abel Mine Inaudible**
		Estimated Abel Mine Noise Contribution Inaudible					
Evening	30/09/2019 21:11 15°C 0.4 m/s SSE	67	52	47	42	46	Insects 42-47 Road Traffic 63-67 **Abel Mine Inaudible**
		Estimated Abel Mine Noise Contribution Inaudible					
Night	01/10/2019 00:49 14°C 0.5 m/s SSE	52	43	39	32	36	Insects 30-52 Distant road traffic 30-40 **Abel Mine Inaudible**
		Estimated Abel Mine Noise Contribution Inaudible					

Table 6 Location J, Parish Drive, Thornton

Period	Date/ Start time/Weather	Primary Noise Descriptor (dBA re 20 µPa)					Description of Noise Emission, Typical Maximum Noise Levels (LAmax – dBA)
		LAmax	LA1	LA10	LA90	LAeq	
Day	24/09/2019 13:51 21°C 0.8 m/s WNW	61	49	41	35	39	Road traffic 34-41 Birds 40-61 **Abel Mine Inaudible**
		Estimated Abel Mine Noise Contribution Inaudible					
Evening	30/09/2019 21:47 15°C 0.4 m/s SSE	50	40	37	34	36	Road traffic 34-50 **Abel Mine Inaudible**
		Estimated Abel Mine Noise Contribution Inaudible					
Night	30/09/2019 22:04 15°C 0.3 m/s SSE	60	42	40	34	37	Road traffic 34-60 **Abel Mine Inaudible**
		Estimated Abel Mine Noise Contribution Inaudible					

1 Table 7 Location L, 65 Tipperary Dr, Ashtonfield

Period	Date/ Start time/ Weather	Primary Noise Descriptor (dBA re 20 µPa)					Description of Noise Emission, Typical Maximum Noise Levels (LAmax – dBA)
		LAmax	LA1	LA10	LA90	LAeq	
Day	24/09/2019 12:25 20°C 1.3 m/s WSW	70	59	47	33	46	Road traffic 50-70 Birds 31-46 Wind in trees 30-33 Domestic noise 40-53 **Abel Mine Inaudible**
		Estimated Abel Mine Noise Contribution Inaudible					
Evening	30/09/2019 20:48 15°C 0.4 m/s SSE	67	47	36	33	42	Insects 25 Traffic 36-67 **Abel Mine Inaudible**
		Estimated Abel Mine Noise Contribution Inaudible					
Night	01/10/2019 00:27 14°C 0.5 m/s SSE	47	38	32	26	30	Insects 23-25 Traffic 25-47 **Abel Mine Inaudible**
		Estimated Bloomfield Colliery Noise Contribution Inaudible					

4.2 Operator Attended Noise Monitoring Summary

4.2.1 Donaldson Mine

Donaldson Open Cut Mine has ceased production and all major earthworks on the site have been finalised. Therefore, compliance noise monitoring for the Donaldson Open Cut Mine is no longer required.

4.2.2 Abel Coal Mine

Abel mine was placed in Care & Maintenance on 28th April 2016 and there was no operations onsite, excluding that from the Bloomfield CHPP which operates under the Abel Coal Mine project consent conditions.

The Bloomfield CHPP and stockpile area was inaudible during all operator attended noise surveys. Noise generated by local and distant traffic was a significant contributor to ambient noise levels at all monitored locations as well as 'natural' noises such as birds, insects.

4.3 Compliance Assessment and Discussion of Results

4.3.1 Operations

Results of the operational compliance assessment are given in **Table 8**.

Table 8 Compliance Noise Assessment – Operations

Location	Estimated Abel $L_{Aeq(15minute)}$ Contribution dBA			Consent Conditions			Compliance		
	Day	Eve	Night	Day	Eve	Night	Day	Eve	Night
D – Black Hill School, Black Hill	Inaudible	Inaudible	Inaudible	35	35	35	Yes	Yes	Yes
F – Black Hill Road, Black Hill	Inaudible	Inaudible	Inaudible	35	35	35	Yes	Yes	Yes
G – Buchanan Road, Buchanan	Inaudible	Inaudible	Inaudible	35	35	35	Yes	Yes	Yes
I – Magnetic Drive, Ashtonfield	Inaudible	Inaudible	Inaudible	36	36	36	Yes	Yes	Yes
J – Parish Drive, Thornton	Inaudible	Inaudible	Inaudible	35	35	35	Yes	Yes	Yes
L – 65 Tipperary Dr, Ashtonfield	Inaudible	Inaudible	Inaudible	40	40	40	Yes	Yes	Yes

Results presented in **Table 8** indicate that compliance with the relevant consent conditions was achieved at all noise monitoring locations during all periods.

4.3.2 Sleep Disturbance

Results of the sleep disturbance compliance assessment are given in **Table 9**.

Table 9 Compliance Noise Assessment – Sleep Disturbance

Location	Estimated Bloomfield $L_{A1(1minute)}$ Contribution dBA	Consent Conditions $L_{A1(1minute)}$ dBA	Compliance
D – Black Hill School, Black Hill	Inaudible	45	Yes
F – Black Hill Road, Black Hill	Inaudible	45	Yes
G – Buchanan Road, Buchanan	Inaudible	45	Yes
I – Magnetic Drive, Ashtonfield	Inaudible	45	Yes
J – Parish Drive, Thornton	Inaudible	45	Yes
L – 65 Tipperary Dr, Ashtonfield	Inaudible	47	Yes

Results presented in **Table 9** indicate that compliance with the sleep disturbance consent conditions was achieved at all noise monitoring locations during the night-time noise surveys.

5 Unattended Continuous Noise Monitoring

5.1 Results of Unattended Continuous Noise Monitoring

Unattended continuous noise monitoring was conducted between Tuesday 24 September 2019 and Tuesday 1 October 2019 at each of the six monitoring locations given in **Table 10**.

Table 10 Noise Logger and Noise Monitoring Locations

Location	Noise Logger Serial Number	Date of Logging
D – Black Hill School, Black Hill	ARL EL-316 16-207-044	24 September 2019 - 1 October 2019
F – Black Hill Road, Black Hill	ARL EL-316 16-203-508	24 September 2019 - 1 October 2019
G – Buchanan Road, Buchanan	ARL EL-316 16-207-050	24 September 2019 - 1 October 2019
I – Magnetic Drive, Ashtonfield	SVAN 957 20665	24 September 2019 - 1 October 2019
L – 65 Tipperary Dr, Ashtonfield	SVAN 957 21423	24 September 2019 - 1 October 2019
J – Parish Drive, Thornton[1]	ARL EL-316 16-103-494	24 September 2019 - 1 October 2019

The unattended ambient noise logger data from each monitoring location are presented graphically on a daily basis and are attached as **Appendix C**. A summary of the results of the unattended continuous noise monitoring is given in **Table 11.**

The ambient noise level data quantifies the overall noise level at a given location independent of its source or character.

The measured ambient noise levels were divided into three periods representing day, evening and night as designated in the NSW Noise Policy for Industry (NPfI).

Precautions were taken to minimise influences from extraneous noise sources (eg optimum placement of the loggers away from creeks, trees, houses, etc), however, not all these sources or their effects can be eliminated. This is particularly the case during the warmer times of year when noise from insects, frogs, birds and other animals can become quite prevalent.

Weather data for the subject area during the noise monitoring period was provided by Bloomfield Colliery. Noise data during periods of any rainfall and/or wind speeds in excess of 5 m/s were discarded in accordance with NPfI weather affected data exclusion methodology.

Table 11 Unattended Continuous Noise Monitoring Ambient Noise Levels (dBA)

Location	Period	Primary Noise Descriptor (dBA re 20 µPA)			
		L_{A1}	L_{A10}	L_{A90}	L_{Aeq}
D Black Hill School, Black Hill	Day	66	53	35	54
	Evening	58	48	42	50
	Night	51	43	31	48
F Lot 684 Black Hill Road, Black Hill	Day	71	56	43	58
	Evening	65	54	44	55
	Night	60	52	36	53
G 156 Buchanan Road, Buchanan	Day	54	50	41	48
	Evening	48	46	37	44
	Night	47	43	30	44
I 49 Magnetic Drive, Ashtonfield	Day	66	56	40	56
	Evening	62	57	43	55
	Night	56	47	30	51
L 65 Tipperary Dr, Ashtonfield	Day	60	49	32	51
	Evening	57	41	33	46
	Night	44	33	20	45
J 220 Parish Drive, Thornton	Day	50	46	37	45
	Evening	46	43	37	42
	Night	45	41	30	42

5.2 Long term Unattended Continuous Monitoring Summary for Donaldson Mine and Abel Coal Mine

5.2.1 Ambient LA90 Noise Levels

The long term ambient L_{A90} noise levels collected from each monitoring location are presented graphically in **Figure 1**, **Figure 2** and **Figure 3** for the daytime, evening and night-time periods respectively.

Figure 1 Long term Daytime L_{A90} Noise Levels

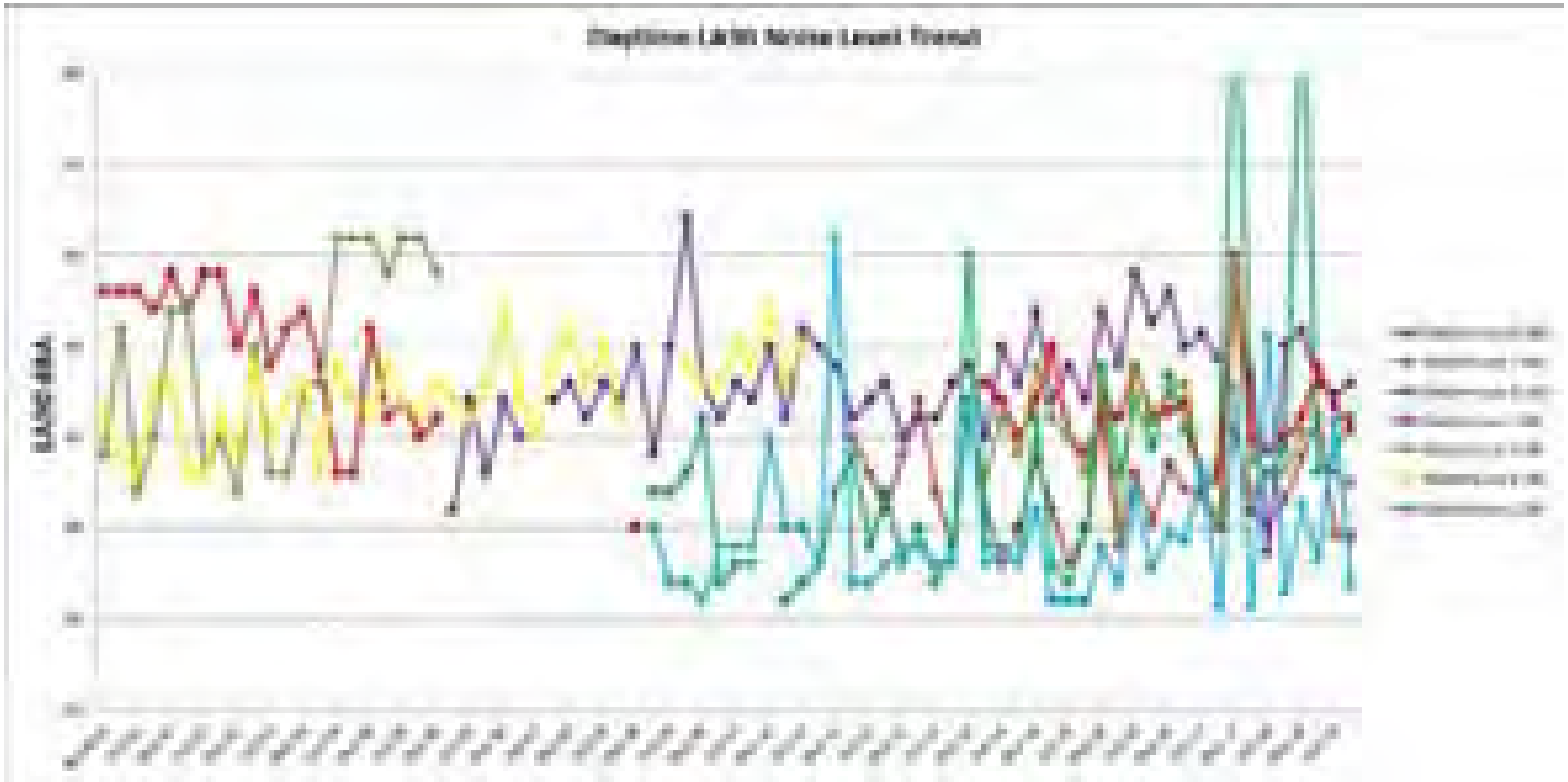


Figure 2 Long term Evening L_{A90} Noise Levels

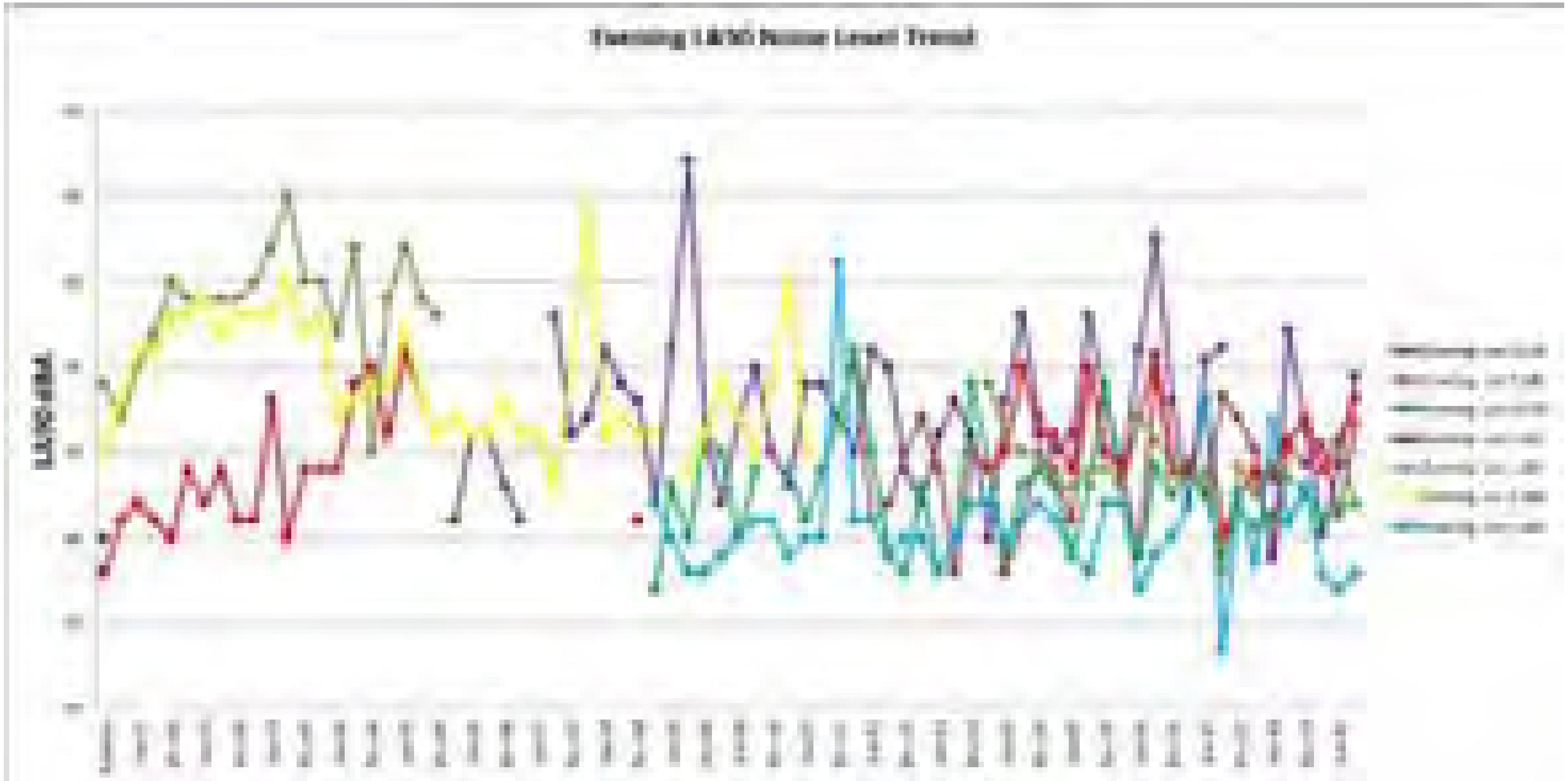
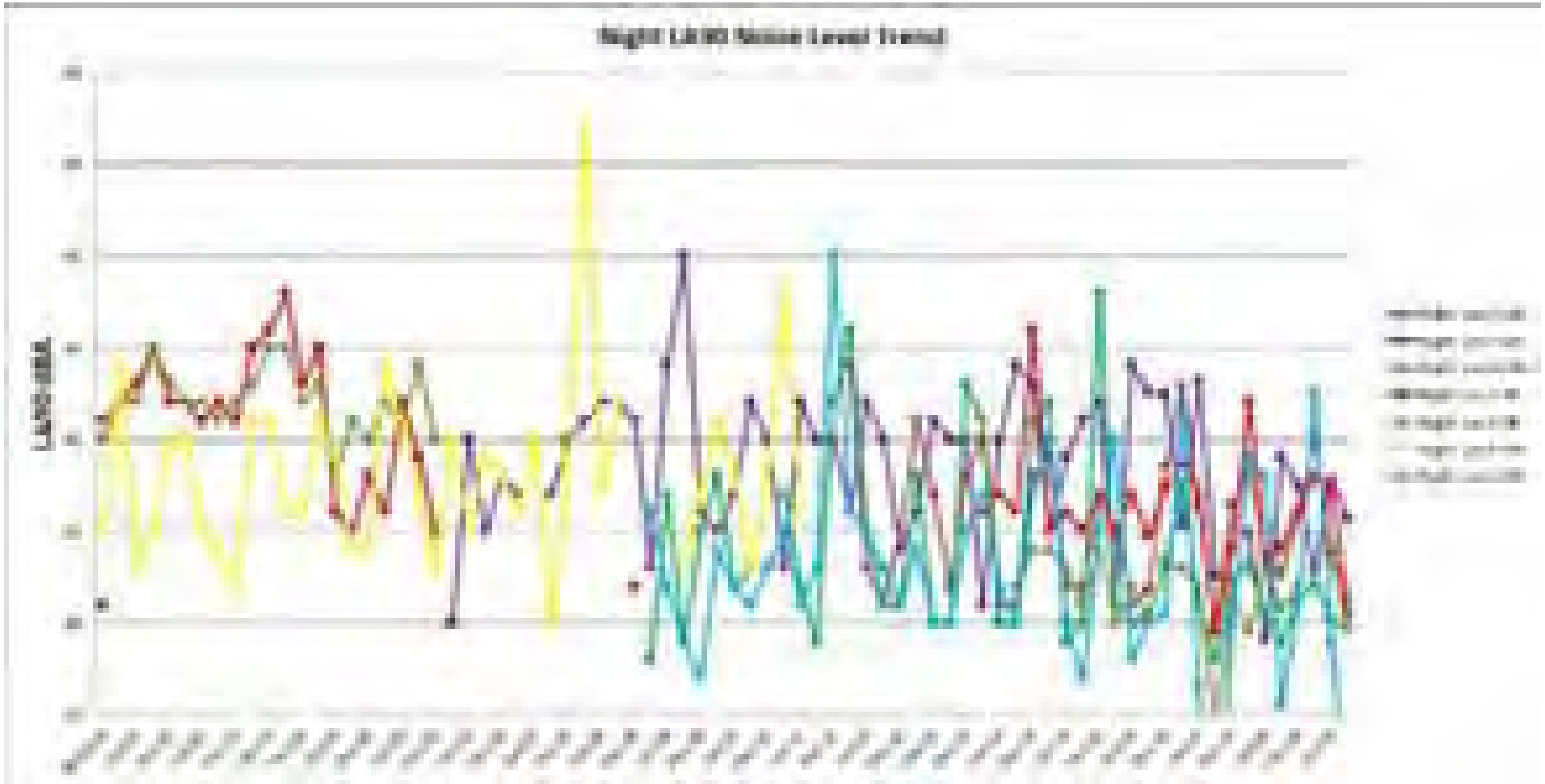


Figure 3 Long term Night-time L_{A90} Noise Levels



5.2.1.1 Baseline

The summary of results in **Table 12** shows the ambient LA90 noise levels recorded for the current monitoring period compared to the levels recorded during the baseline monitoring process (ie. prior to commencement of mining operation at Donaldson).

Table 12 LA90 Results Comparison – Baseline

Monitoring Location	Period[1]	Long term Night-time LA90 Noise Levels		Difference dB[3]
		Baseline	September 2019	
D Black Hill School, Black Hill	Day	N/A[2]	35	N/A[2]
	Evening	N/A[2]	42	N/A[2]
	Night	N/A[2]	31	N/A[2]
F Lot 684 Black Hill Road, Black Hill	Day	39	43	4
	Evening	35	44	9
	Night	31	36	5
G 156 Buchanan Road, Buchanan	Day	N/A[2]	41	N/A[2]
	Evening	N/A[2]	37	N/A[2]
	Night	N/A[2]	30	N/A[2]
I 49 Magnetic Drive, Ashtonfield	Day	48	41	-8
	Evening	33	43	10
	Night	41	31	-11
L 65 Tipperary Drive, Ashtonfield	Day	N/A[2]	32	N/A[2]
	Evening	N/A[2]	33	N/A[2]
	Night	N/A[2]	20	N/A[2]
J 220 Parish Drive, Thornton	Day	39	37	-2
	Evening	44	37	-7
	Night	40	30	-10

Note 1: Periods are as detailed the NPfI and are Daytime - 7.00 am to 6.00 pm Monday to Saturday, 8.00 am to 6.00 pm Sunday; Evening - 6.00 pm 10.00 pm; Night - 10.00 pm to 7.00 am pm Monday to Saturday, 10.00 pm to 8.00 am Sunday.

Note 2: No data was available during baseline measurements, no comparisons can be made.

Note 3: Rounded to the nearest whole dB.

5.2.1.2 Previous Quarter

Table 13 presents the ambient LA90 noise levels recorded for the current monitoring period compared to those measured in the previous monitoring period.

Table 13 LA90 Results Comparison – Previous Quarter

Monitoring Location	Period[1]	Long term Night-time LA90 Noise Levels		Difference dB[2]
		June 2019	September 2019	
D Black Hill School, Black Hill	Day	35	35	0
	Evening	36	42	6
	Night	34	31	-3
F Lot 684 Black Hill Road, Black Hill	Day	42	43	1
	Evening	39	44	5
	Night	38	36	-2
G 156 Buchanan Road, Buchanan	Day	39	41	2
	Evening	37	37	0
	Night	30	30	-1
I 49 Magnetic Drive, Ashtonfield	Day	42	41	-1
	Evening	41	43	3
	Night	37	31	-7
L 65 Tipperary Drive, Ashtonfield	Day	41	32	-9
	Evening	32	33	1
	Night	29	20	-9
J 220 Parish Drive, Thornton	Day	38	37	-1
	Evening	40	37	-3
	Night	33	30	-4

Note 1: 1. Periods are as detailed in the Industrial Noise Policy (INP) and are Daytime - 7.00 am to 6.00 pm Monday to Saturday, 8.00 am to 6.00 pm Sunday; Evening - 6.00 pm 10.00 pm; Night - 10.00 pm to 7.00 am pm Monday to Saturday, 10.00 pm to 8.00 am Sunday.

Note 2: Rounded to the nearest whole dB.

5.2.1.3 Coinciding Period Last Year

Table 14 presents the ambient L_{A90} noise levels recorded for the current monitoring period compared to those measured during the coinciding monitoring period last year.

Table 14 L_{A90} Results Comparison – Coinciding Period Last Year

Monitoring Location	Period[1]	Long term Night-time L_{A90} Noise Levels		Difference dB[2]
		September 2018	September 2019	
D Black Hill School, Black Hill	Day	37	35	-2
	Evening	40	42	1
	Night	33	31	-1
F Lot 684 Black Hill Road, Black Hill	Day	45	43	-2
	Evening	47	44	-3
	Night	39	36	-3
G 156 Buchanan Road, Buchanan	Day	39	41	2
	Evening	36	37	1
	Night	29	30	1
I 49 Magnetic Drive, Ashtonfield	Day	40	41	1
	Evening	41	43	3
	Night	34	31	-4
L 65 Tipperary Drive, Ashtonfield	Day	31	32	1
	Evening	36	33	-3
	Night	26	20	-5
J 220 Parish Drive, Thornton	Day	38	37	-1
	Evening	38	37	-1
	Night	31	30	-1

Note 1: Periods are as detailed in the Industrial Noise Policy (INP) and are Daytime - 7.00 am to 6.00 pm Monday to Saturday, 8.00 am to 6.00 pm Sunday; Evening - 6.00 pm 10.00 pm; Night - 10.00 pm to 7.00 am pm Monday to Saturday, 10.00 pm to 8.00 am Sunday.

Note 2: Rounded to the nearest whole dB.

5.2.2 Ambient L_{A10} Noise Comparison

The long term ambient L_{A10} noise levels collected from each monitoring location are presented graphically in **Figure 4**, **Figure 5** and **Figure 6** for the daytime, evening and night-time respectively.

Figure 4 Long term Daytime L_{A10} Noise Levels

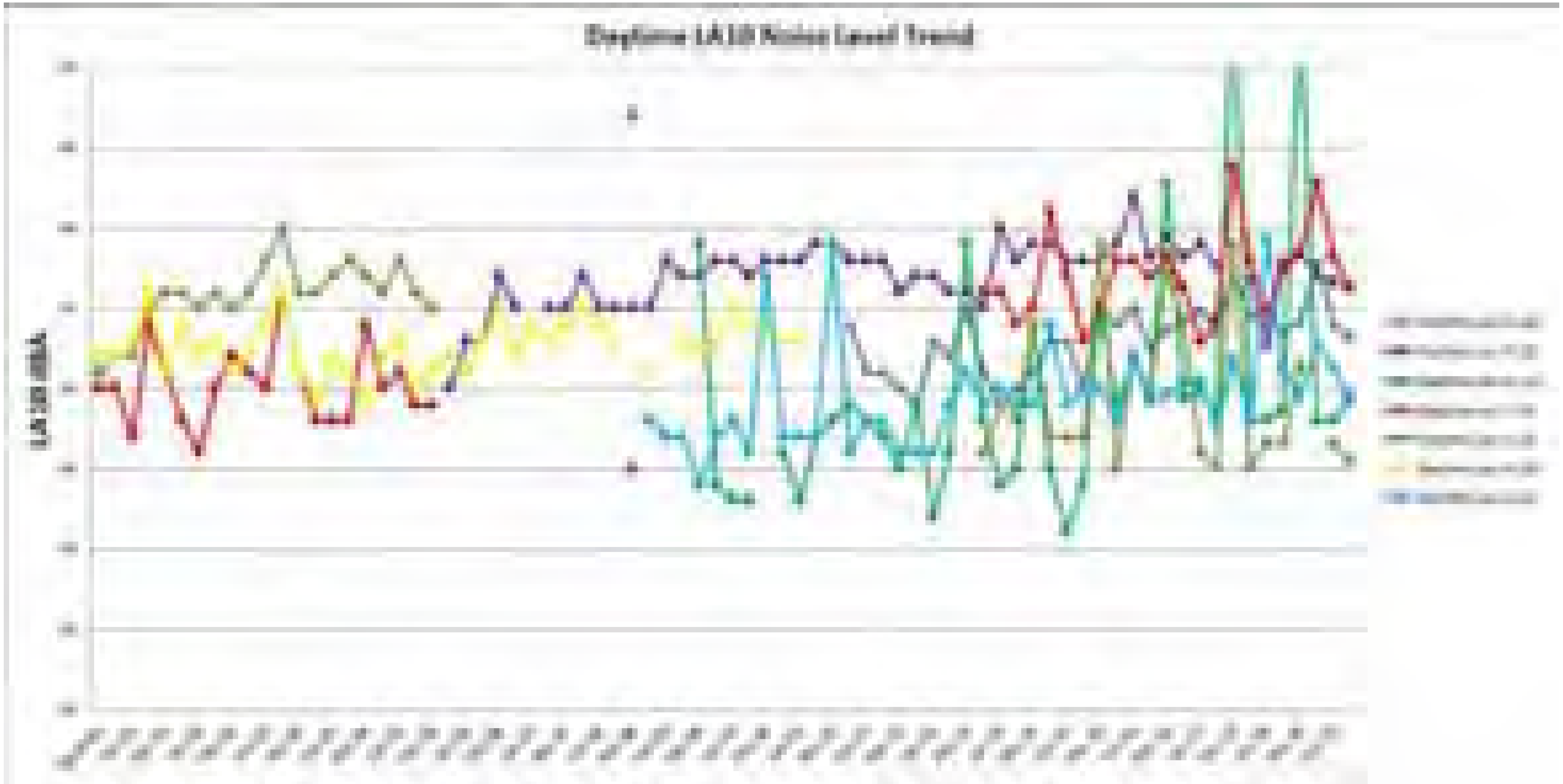


Figure 5 Long term Evening L_{A10} Noise Levels

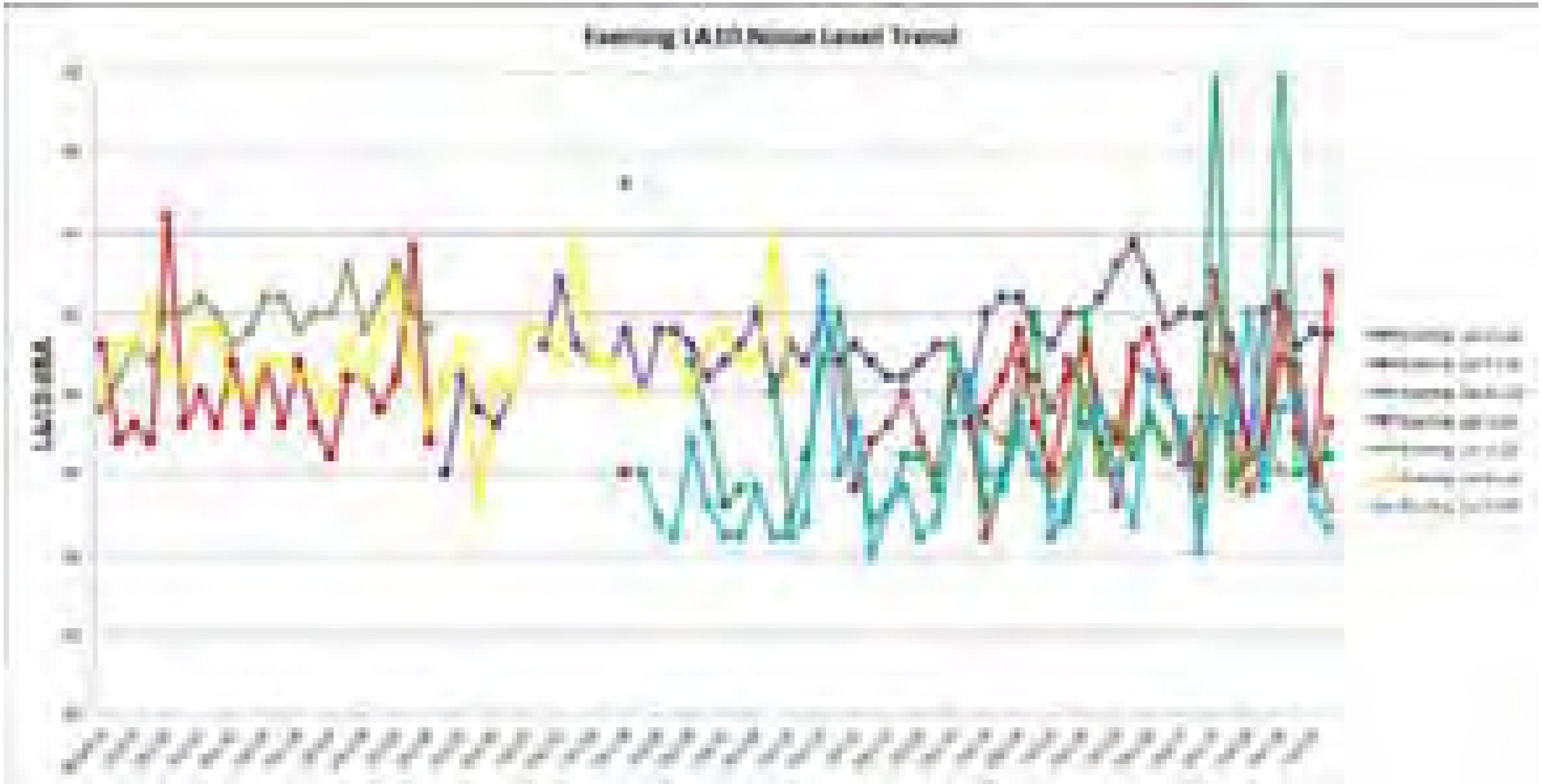
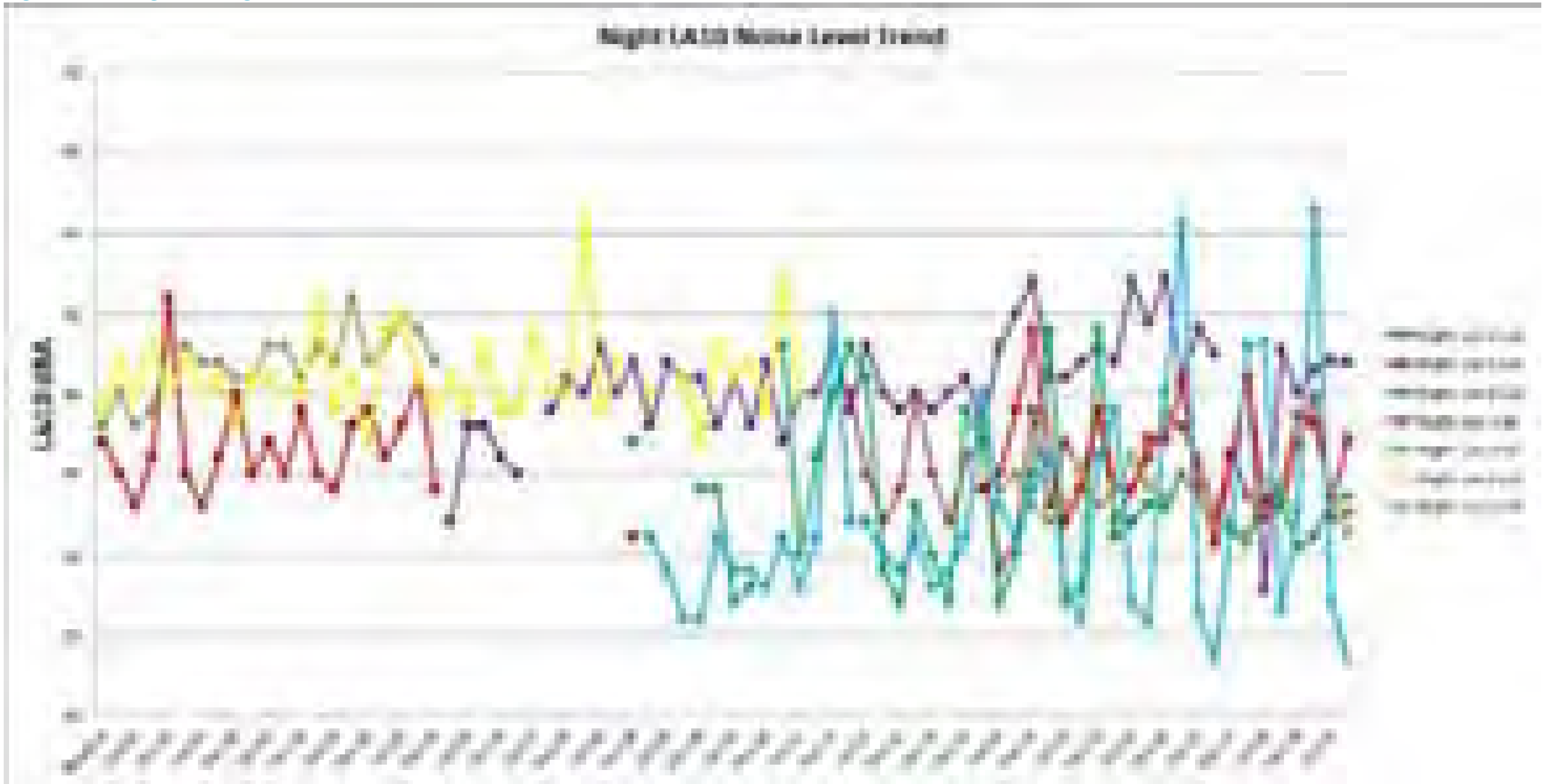


Figure 6 Long term Night L_{A10} Noise Levels



Baseline

Table 15 presents the ambient LA10 noise levels recorded for the current monitoring period compared to the levels recorded during the baseline monitoring period.

Table 15 LA10 Results Comparison – Baseline

<table>
<tr><th rowspan="2">Monitoring Location</th><th rowspan="2">Period[1]</th><th colspan="2">Long term Night-time LA10 Noise Levels</th><th rowspan="2">Difference dB[3]</th></tr>
<tr><th>Baseline</th><th>September 2019</th></tr>
<tr><td rowspan="3">D
Black Hill School, Black Hill</td><td>Day</td><td>N/A[2]</td><td>53</td><td>N/A</td></tr>
<tr><td>Evening</td><td>N/A[2]</td><td>48</td><td>N/A</td></tr>
<tr><td>Night</td><td>N/A[2]</td><td>43</td><td>N/A</td></tr>
<tr><td rowspan="3">F
Lot 684 Black Hill Road, Black Hill</td><td>Day</td><td>51</td><td>56</td><td>5</td></tr>
<tr><td>Evening</td><td>49</td><td>54</td><td>5</td></tr>
<tr><td>Night</td><td>48</td><td>52</td><td>4</td></tr>
<tr><td rowspan="3">G
156 Buchanan Road, Buchanan</td><td>Day</td><td>N/A[2]</td><td>50</td><td>N/A</td></tr>
<tr><td>Evening</td><td>N/A[2]</td><td>46</td><td>N/A</td></tr>
<tr><td>Night</td><td>N/A[2]</td><td>44</td><td>N/A</td></tr>
<tr><td rowspan="3">I
49 Magnetic Drive, Ashtonfield</td><td>Day</td><td>50</td><td>56</td><td>6</td></tr>
<tr><td>Evening</td><td>53</td><td>57</td><td>4</td></tr>
<tr><td>Night</td><td>47</td><td>47</td><td>0</td></tr>
<tr><td rowspan="3">L
65 Tipperary Drive, Ashtonfield</td><td>Day</td><td>N/A[2]</td><td>49</td><td>N/A</td></tr>
<tr><td>Evening</td><td>N/A[2]</td><td>42</td><td>N/A</td></tr>
<tr><td>Night</td><td>N/A[2]</td><td>33</td><td>N/A</td></tr>
<tr><td rowspan="3">J
220 Parish Drive, Thornton</td><td>Day</td><td>51</td><td>46</td><td>-6</td></tr>
<tr><td>Evening</td><td>49</td><td>43</td><td>-6</td></tr>
<tr><td>Night</td><td>48</td><td>41</td><td>-7</td></tr>
</table>

Note 1: Periods are as detailed in the Industrial Noise Policy (INP) and are Daytime - 7.00 am to 6.00 pm Monday to Saturday, 8.00 am to 6.00 pm Sunday; Evening - 6.00 pm 10.00 pm; Night - 10.00 pm to 7.00 am pm Monday to Saturday, 10.00 pm to 8.00 am Sunday.

Note 2: No data was available during baseline measurements, no comparisons can be made.

Note 3: Rounded to the nearest whole dB.

5.2.2.2 Previous Quarter

Table 16 presents the ambient L_{A10} noise levels recorded for the current monitoring period compared to those measured during the previous monitoring period.

Table 16 L_{A10} Results Comparison – Previous Quarter

Monitoring Location	Period[1]	Long term Night-time L_{A10} Noise Levels		Difference dB[2]
		June 2019	September 2019	
D Black Hill School, Black Hill	Day	54	53	-1
	Evening	44	48	4
	Night	42	43	0
F Lot 684 Black Hill Road, Black Hill	Day	57	56	0
	Evening	54	54	0
	Night	52	52	0
G 156 Buchanan Road, Buchanan	Day	48	50	1
	Evening	46	46	0
	Night	43	44	0
I 49 Magnetic Drive, Ashtonfield	Day	58	56	-2
	Evening	45	57	12
	Night	44	47	4
L 65 Tipperary Drive, Ashtonfield	Day	51	49	-2
	Evening	43	42	-1
	Night	37	33	-4
J 220 Parish Drive, Thornton	Day	47	46	-1
	Evening	46	43	-4
	Night	44	41	-3

Note 1: Periods are as detailed in the Industrial Noise Policy (INP) and are Daytime - 7.00 am to 6.00 pm Monday to Saturday, 8.00 am to 6.00 pm Sunday; Evening - 6.00 pm 10.00 pm; Night - 10.00 pm to 7.00 am pm Monday to Saturday, 10.00 pm to 8.00 am Sunday.

Note 2: Rounded to the nearest whole dB.

5.2.2.3 Coinciding Period Last Year

Table 17 presents the ambient L_{A10} noise levels recorded for the current monitoring period compared to those measured during the coinciding monitoring period last year.

Table 17 L_{A10} Result Comparison – Coinciding Period Last Year

Monitoring Location	Period[1]	Long term Night-time L_{A10} Noise Levels		Difference dB[2]
		September 2018	September 2019	
D Black Hill School, Black Hill	Day	54	53	-1
	Evening	46	48	2
	Night	43	43	0
F Lot 684 Black Hill Road, Black Hill	Day	58	56	-2
	Evening	55	54	-2
	Night	53	52	-1
G 156 Buchanan Road, Buchanan	Day	49	50	1
	Evening	46	46	0
	Night	43	44	0
I 49 Magnetic Drive, Ashtonfield	Day	57	56	-1
	Evening	47	57	10
	Night	44	47	3
L 65 Tipperary Dr, Ashtonfield	Day	51	49	-2
	Evening	44	42	-3
	Night	37	33	-3
J 220 Parish Drive, Thornton	Day	47	46	-1
	Evening	46	43	-3
	Night	44	41	-3

Note 1: Periods are as detailed in the Industrial Noise Policy (INP) and are Daytime - 7.00 am to 6.00 pm Monday to Saturday, 8.00 am to 6.00 pm Sunday; Evening - 6.00 pm 10.00 pm; Night - 10.00 pm to 7.00 am pm Monday to Saturday, 10.00 pm to 8.00 am Sunday.

Note 2: Rounded to the nearest whole dB.

5.3 Rail Noise Monitoring

In order to determine compliance with the rail noise criteria, a noise logger was positioned at Location J, however no train movements occurred during the monitoring period.

6 Conclusion

SLR was engaged by Donaldson Coal Pty Ltd to conduct quarterly noise monitoring surveys for Donaldson Coal Mine and Abel Coal Mine in accordance with the NMP, dated 3 June 2019.

Donaldson Open Cut Mine has ceased production and all major earthworks on the site have been finalised. Therefore, compliance noise monitoring for the Donaldson Open Cut Mine is no longer required.

Abel mine was placed in Care & Maintenance on 28th April 2016 and there was no operations onsite, excluding that from the Bloomfield CHPP which operates under the Abel Coal Mine project consent conditions.

Operator-attended and unattended noise measurements were conducted for the September 2019 quarter at six focus locations surrounding the mine.

Abel portal operations were not observed to be audible at any locations during the monitoring period. Contributed noise levels from Abel Mine did not exceed noise emission goals (including night-time sleep arousal criteria) and compliance with the Abel Mine *Project Approval* was indicated at all locations.

A comparison of ambient L_{A10} and L_{A90} noise levels recorded during the current monitoring period (September 2019), the baseline monitoring period, the last monitoring period (June 2019), and the coinciding monitoring period from last year (September 2018) has been conducted.

No rail movements occurred on the Bloomfield Rail Spur during the noise monitoring period.

APPENDIX A

Acoustic Terminology

1. Sound Level or Noise Level

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

Sound (or noise) consists of minute fluctuations in atmospheric pressure. The human ear responds to changes in sound pressure over a very wide range with the loudest sound pressure to which the human ear can respond being ten million times greater than the softest. The decibel (abbreviated as dB) scale reduces this ratio to a more manageable size by the use of logarithms.

The symbols SPL, L or LP are commonly used to represent Sound Pressure Level. The symbol LA represents A-weighted Sound Pressure Level. The standard reference unit for Sound Pressure Levels expressed in decibels is 2 x 10^{-5} Pa.

2. 'A' Weighted Sound Pressure Level

The overall level of a sound is usually expressed in terms of dBA, which is measured using a sound level meter with an 'A-weighting' filter. This is an electronic filter having a frequency response corresponding approximately to that of human hearing.

People's hearing is most sensitive to sounds at mid frequencies (500 Hz to 4,000 Hz), and less sensitive at lower and higher frequencies. Different sources having the same dBA level generally sound about equally loud.

A change of 1 dB or 2 dB in the level of a sound is difficult for most people to detect, whilst a 3 dB to 5 dB change corresponds to a small but noticeable change in loudness. A 10 dB change corresponds to an approximate doubling or halving in loudness. The table below lists examples of typical noise levels.

Sound Pressure Level (dBA)	Typical Source	Subjective Evaluation
130	Threshold of pain	Intolerable
120	Heavy rock concert	Extremely noisy
110	Grinding on steel	
100	Loud car horn at 3 m	Very noisy
90	Construction site with pneumatic hammering	
80	Kerbside of busy street	Loud
70	Loud radio or television	
60	Department store	Moderate to quiet
50	General Office	
40	Inside private office	Quiet to very quiet
30	Inside bedroom	
20	Recording studio	Almost silent

Other weightings (eg B, C and D) are less commonly used than A-weighting. Sound Levels measured without any weighting are referred to as 'linear', and the units are expressed as dB(lin) or dB.

3. Sound Power Level

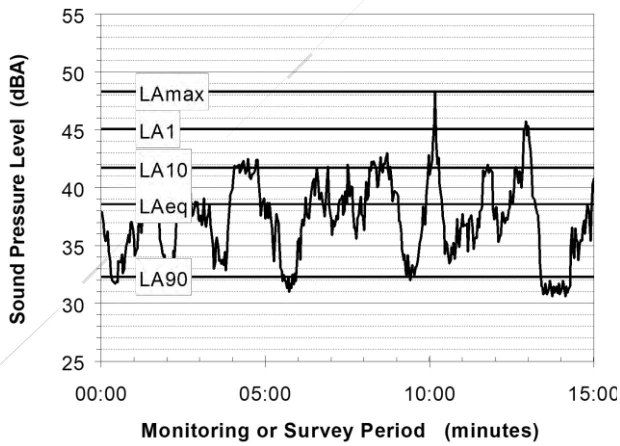
The Sound Power of a source is the rate at which it emits acoustic energy. As with Sound Pressure Levels, Sound Power Levels are expressed in decibel units (dB or dBA), but may be identified by the symbols SWL or LW, or by the reference unit 10^{-12} W.

The relationship between Sound Power and Sound Pressure is similar to the effect of an electric radiator, which is characterised by a power rating but has an effect on the surrounding environment that can be measured in terms of a different parameter, temperature.

4. Statistical Noise Levels

Sounds that vary in level over time, such as road traffic noise and most community noise, are commonly described in terms of the statistical exceedance levels LAN, where LAN is the A-weighted sound pressure level exceeded for N% of a given measurement period. For example, the LA1 is the noise level exceeded for 1% of the time, LA10 the noise exceeded for 10% of the time, and so on.

The following figure presents a hypothetical 15 minute noise survey, illustrating various common statistical indices of interest.



Of particular relevance, are:

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

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

LA90 The noise level exceeded for 90% of the sample period. This noise level is described as the average minimum background sound level (in the absence of the source under consideration), or simply the background level.

LAeq The A-weighted equivalent noise level (basically, the average noise level). It is defined as the steady sound level that contains the same amount of acoustical energy as the corresponding time-varying sound.

5. Frequency Analysis

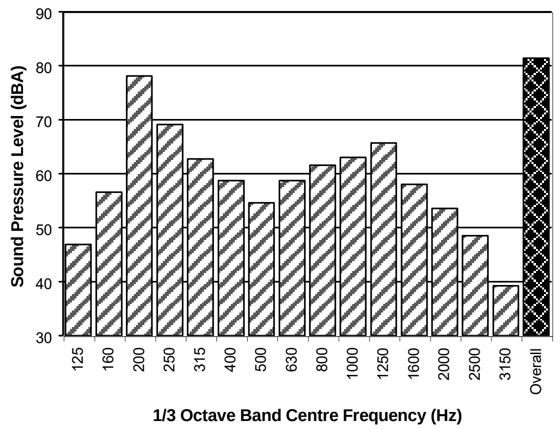
Frequency analysis is the process used to examine the tones (or frequency components) which make up the overall noise or vibration signal.

The units for frequency are Hertz (Hz), which represent the number of cycles per second.

Frequency analysis can be in:

- Octave bands (where the centre frequency and width of each band is double the previous band)
- 1/3 octave bands (three bands in each octave band)
- Narrow band (where the spectrum is divided into 400 or more bands of equal width)

The following figure shows a 1/3 octave band frequency analysis where the noise is dominated by the 200 Hz band. Note that the indicated level of each individual band is less than the overall level, which is the logarithmic sum of the bands.



6. Annoying Noise (Special Audible Characteristics)

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

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

7. Vibration

Vibration may be defined as cyclic or transient motion. This motion can be measured in terms of its displacement, velocity or acceleration. Most assessments of human response to vibration or the risk of damage to buildings use measurements of vibration velocity. These may be expressed in terms of 'peak' velocity or 'rms' velocity.

The former is the maximum instantaneous velocity, without any averaging, and is sometimes referred to as 'peak particle velocity', or PPV. The latter incorporates 'root mean squared' averaging over some defined time period.

Vibration measurements may be carried out in a single axis or alternatively as triaxial measurements (ie vertical, longitudinal and transverse).

The common units for velocity are millimetres per second (mm/s). As with noise, decibel units can also be used, in which case the reference level should always be stated. A vibration level V, expressed in mm/s can be converted to decibels by the formula 20 log (V/Vo), where Vo is the reference level (10^{-9} m/s). Care is required in this regard, as other reference levels may be used.

8. Human Perception of Vibration

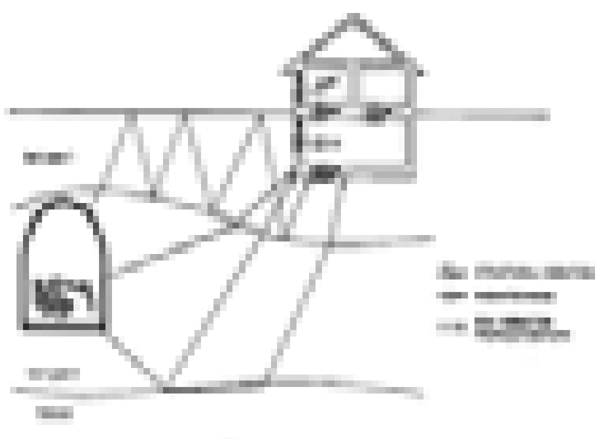
People are able to 'feel' vibration at levels lower than those required to cause even superficial damage to the most susceptible classes of building (even though they may not be disturbed by the motion). An individual's perception of motion or response to vibration depends very strongly on previous experience and expectations, and on other connotations associated with the perceived source of the vibration. For example, the vibration that a person responds to as 'normal' in a car, bus or train is considerably higher than what is perceived as 'normal' in a shop, office or dwelling.

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

Noise that propagates through a structure as vibration and is radiated by vibrating wall and floor surfaces is termed 'structure-borne noise', 'ground-borne noise' or 'regenerated noise'. This noise originates as vibration and propagates between the source and receiver through the ground and/or building structural elements, rather than through the air.

Typical sources of ground-borne or structure-borne noise include tunnelling works, underground railways, excavation plant (eg rockbreakers), and building services plant (eg fans, compressors and generators).

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



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

APPENDIX B

Noise Monitoring Locations

D:\Quick Jobs\Martin Davenport\Donaldson\SLR630010530120_AB_MonitoringLocations_01.mxd

SLR
10 KINGS ROAD
NEW LAMBTON
NEW SOUTH WALES 2305
AUSTRALIA
T: 61 2 4037 3200
F: 61 2 4037 3201
www.slrconsulting.com

Project No.:	630.01053.01200
Date:	11/01/2018
Drawn by:	NT
Scale:	1:45,000
Sheet Size:	A4
Projection:	GDA 1994 MGA Zone 56

LEGEND

Noise Monitoring Locations

N W E S

0 500 1,000 1,500 2,000 m

Donaldson Coal

Noise Monitoring

Noise Monitoring Locations

APPENDIX B

APPENDIX C

Calibration Certificates

CERTIFICATE OF CALIBRATION

CERTIFICATE NO.: **SLM 25532 & FILT 5408**

Equipment Description: Sound Level Meter

Manufacturer: B & K

Model No: 2270 **Serial No:** 2679354

Microphone Type: 4189 **Serial No:** 2695417

Preamplifier Type: ZC0032 **Serial No:** 12254

Filter Type: 1/3 Octave **Serial No:** 2679354

Comments: All tests passed for class 1.
(See over for details)

Owner: SLR Consulting Australia Pty Ltd
Level 2, 2 Lincoln Street
Lane Cove, NSW 2066

Ambient Pressure: 998 hPa ±1.5 hPa

Temperature: 23 °C ±2° C **Relative Humidity:** 26% ±5%

Date of Calibration: 09/09/2019 **Issue Date:** 09/09/2019

Acu-Vib Test Procedure: AVP10 (SLM) & AVP06 (Filters)

CHECKED BY: NKB **AUTHORISED SIGNATURE:** .... Jack Kielt

Accredited for compliance with ISO/IEC 17025 - Calibration
The results of the tests, calibration and/or measurements included in this document are traceable to Australian/national standards.

NATA WORLD RECOGNISED ACCREDITATION

ACU-VIB ELECTRONICS

HEAD OFFICE
Unit 14, 22 Hudson Ave. Castle Hill NSW 2154
Tel: (02) 96808133 Fax: (02)96808233
Mobile: 0413 809806
web site: www.acu-vib.com.au

Accredited Lab. No. 9262
Acoustic and Vibration Measurements

CERTIFICATE NO.: SLM 25532 & FILT 5408

The performance characteristics listed below were tested. The tests are based on the relevant clauses of IEC 61672-3:2013

Tests Performed:	*Clause*	*Result*
Absolute Calibration	10	Pass
Acoustical Frequency Weighting	12	Pass
Self Generated Noise	11.1	Entered
Electrical Noise	11.2	Entered
Long Term Stability	15	Pass
Electrical Frequency Weightings	13	Pass
Frequency and Time Weightings	14	Pass
Reference Level Linearity	16	Pass
Range Level Linearity	17	NA
Toneburst	18	Pass
Peak C Sound Level	19	Pass
Overload Indicator	20	Pass
High Level Stability	21	Pass

Statement of Compliance: The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2013, for the environmental conditions under which the tests were performed. As public evidence was available, from an independent organization responsible for approving the results of pattern evaluation tests performed in accordance with IEC 61672-2:2013, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2013, the sound level meter submitted for testing conforms to the class 1 requirements of IEC61672-1:2013.
A full technical report is available if required.

This Sound Level Meter included an Octave Filter Set. Tests were based on IEC 1260: 1995 and AS/NZS 4476 - 1997 and were conducted to test the following performance characteristics:

1. Relative attenuation clause 5.3

Date of Calibration: 09/09/2019 **Issue Date:** 09/09/2019

Checked by: KB

Accredited for compliance with ISO/IEC 17025 - Calibration
The results of the tests, calibration and/or measurements included in this document are traceable to Australian/national standards.

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Accredited Lab. No. 9262
Acoustic and Vibration Measurements

ACU-VIB
ELECTRONICS
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Mobile: 0413 809806
web site: www.acu-vib.com.au

CERTIFICATE OF CALIBRATION

CERTIFICATE NO: 25534

EQUIPMENT TESTED: 1/2" Microphone
Manufacturer: B & K
Type No: 4197 **Serial No:** 3077697 (Part 2)
Owner: SLR Consulting Australia Pty Ltd
Level 2, 2 Lincoln Street
Lane Cove, NSW 2066
Tests Performed: Acoustic Microphone Frequency Response with Inverse A Weighting

CONDITION OF TEST:

Ambient Pressure: 997 hPa ±1.5 hPa **Relative Humidity:** 24 % ±5%
Temperature: 23 °C ±2° C
Date of Calibration: 09/09/2019 **Issue Date** 09/09/2019
Acu-Vib Test Procedure: AVP05 (Microphone Acoustic Frequency Response)

CHECKED BY: VKB **AUTHORISED SIGNATURE:** ....

Accredited for compliance with ISO/IEC 17025 - Calibration
The results of the tests, calibration and/or measurements included in this document are traceable to Australian/national standards.
The uncertainties quoted are calculated in accordance with the methods of the ISO Guide to the Uncertainty of Measurement and quoted at a coverage factor of 2 with a confidence interval of approximately 95%.

NATA
WORLD RECOGNISED ACCREDITATION

Accredited Lab. 9262
Acoustic and Vibration Measurements

ACU-VIB
ELECTRONICS

HEAD OFFICE
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Tel: (02) 96808133 Fax: (02)96808233
Mobile: 0413 809806
Web site: www.acu-vib.com.au

Acoustic Tests, Microphone response

Job No: 13678 Test No: 255334

Microphone type: B&K 4197 Serial No,: 3077697 (Part 2)

Preamplifier type: 2683 Serial No. : 2792513

SLM body (if appropriate): SVAN 912 AE Serial No: 4396

Ambient Temperature: 23C ±2° C, Relative Humidity: 997 RH ±5% RH,

Ambient Pressure: 24 hPa ±1.5 hPa

Frequency Hz	Deviation re 1 kHz	Type 2 Tol.	Type 1 Tol.	U95 dB	P/F
31.5 Hz	0.11dB	± 3.0 dB	± 1.5 dB dB	0.12	P
63 Hz	-0.01dB	± 2.0 dB	± 1.5 dB dB	0.10	P
125 Hz	-0.08dB	± 1.5 dB	± 1.0 dB dB	0.09	P
250 Hz	-0.15dB	± 1.5 dB	± 1.0 dB dB	0.09	P
500 Hz	-0.14dB	± 1.5 dB	± 1.0 dB dB	0.09	P
1 kHz Ref	0.00dB	± 1.5 dB	± 1.0 dB dB	0.09	P
2 kHz	0.05dB	± 2.0 dB	± 1.0 dB dB	0.07	P
4 kHz	-0.25dB	± 3.0 dB	± 1.0 dB dB	0.13	P
8 kHz	-0.21dB	± 5.0 dB	+1.5;-3.0 dB	0.13	P
12.5 kHz	-0.10dB	+ 5.0; - ∞ dB	+3.0;-6.0 dB	0.19	P
16 kHz	0.61dB	+ 5.0; - ∞ dB	+ 3.0; - ∞ dB	0.30	P

Tolerances from AS1259-1990 part 1, (IEC 60651).

Notes:

Signed (Testing Officer) ______________ Date:09/09/2019

Checked by: VKB ______________ Date:09/09/2019

Acoustic test WS 1 results

CERTIFICATE OF CALIBRATION

CERTIFICATE NO: 25533

EQUIPMENT TESTED: 1/2" Microphone
Manufacturer: B & K
Type No: 4197 **Serial No:** 3077697 (Part 1)
Owner: SLR Consulting Australia Pty Ltd
Level 2, 2 Lincoln Street
Lane Cove, NSW 2066
Tests Performed: Acoustic Microphone Frequency Response with Inverse A Weighting

CONDITION OF TEST:

Ambient Pressure: 997 hPa ±1.5 hPa **Relative Humidity:** 24 % ±5%
Temperature: 23 °C ±2° C
Date of Calibration: 09/09/2019 **Issue Date** 09/09/2019
Acu-Vib Test Procedure: AVP05 (Microphone Acoustic Frequency Response)

CHECKED BY: JKB **AUTHORISED SIGNATURE:** ....
Jack Kielt

Accredited for compliance with ISO/IEC 17025 - Calibration
The results of the tests, calibration and/or measurements included in this document are traceable to Australian/national standards.
The uncertainties quoted are calculated in accordance with the methods of the ISO Guide to the Uncertainty of Measurement and quoted at a coverage factor of 2 with a confidence interval of approximately 95%.

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Mobile: 0413 809806
Web site: www.acu-vib.com.au

Acoustic Tests, Microphone response

Job No: 13678 Test No: 25533

Microphone type: B&K 4197 Serial No,: 3077697 (Part 1)

Preamplifier type: 2683 Serial No. : 2792513

SLM body (if appropriate): SVAN 912 AE Serial No: 4396

Ambient Temperature: 23C ±2° C, Relative Humidity: 997 RH ±5% RH,

Ambient Pressure: 24 hPa ±1.5 hPa

Frequency Hz	Deviation re 1 kHz	Type 2 Tol.	Type 1 Tol.	U95 dB	P/F
31.5 Hz	0.11dB	± 3.0 dB	± 1.5 dB dB	0.12	P
63 Hz	-0.11dB	± 2.0 dB	± 1.5 dB dB	0.10	P
125 Hz	-0.18dB	± 1.5 dB	± 1.0 dB dB	0.09	P
250 Hz	-0.25dB	± 1.5 dB	± 1.0 dB dB	0.09	P
500 Hz	-0.24dB	± 1.5 dB	± 1.0 dB dB	0.09	P
1 kHz Ref	0.00dB	± 1.5 dB	± 1.0 dB dB	0.09	P
2 kHz	0.05dB	± 2.0 dB	± 1.0 dB dB	0.07	P
4 kHz	-0.25dB	± 3.0 dB	+ 1.0 dB dB	0.13	P
8 kHz	-0.31dB	± 5.0 dB	+1.5;-3.0 dB	0.13	P
12.5 kHz	-0.20dB	+ 5.0; - ∞ dB	+3.0;-6.0 dB	0.19	P
16 kHz	0.51dB	+ 5.0; - ∞ dB	+ 3.0; - ∞ dB	0.30	P

Tolerances from AS1259-1990 part 1, (IEC 60651).

Notes:

Signed (Testing Officer) ____________ Date:09/09/2019

Checked by: ____________ Date:09/09/2019

Acoustic test WS 1 results

CERTIFICATE OF CALIBRATION

CERTIFICATE NO.: **SLM 23293 & FILT 4792**

Equipment Description:	Sound & Vibration Analyser		
Manufacturer:	B&K		
Model No:	2250	**Serial No:**	3003389
Microphone Type:	4950	**Serial No:**	2913816
Preamplifier Type:	ZC0032	**Serial No:**	20519
Filter Type:	1/3 Octave	**Serial No:**	3003389
Comments:	All tests passed for class 1. (See over for details)		
Owner:	SLR Consulting Australia Pty Ltd Level 2, 2 Lincoln Street Lane Cove, NSW 2066		
Ambient Pressure:	990 hPa ±1.5 hPa		
Temperature:	25 °C ±2° C	**Relative Humidity:**	29% ±5%
Date of Calibration:	06/08/2018	**Issue Date:**	07/08/2018
Acu-Vib Test Procedure:	AVP10 (SLM) & AVP06 (Filters)		

CHECKED BY: ..JK..... **AUTHORISED SIGNATURE:** ....
Jack Kielt

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web site: www.acu-vib.com.au

CERTIFICATE NO.: SLM 23293 & FILT 4792

The performance characteristics listed below were tested. The tests are based on the relevant clauses of IEC 61672-3:2013

Tests Performed:	*Clause*	*Result*
Absolute Calibration	10	Pass
Acoustical Frequency Weighting	12	Pass
Self Generated Noise	11.1	Entered
Electrical Noise	11.2	Entered
Long Term Stability	15	Pass
Electrical Frequency Weightings	13	Pass
Frequency and Time Weightings	14	Pass
Reference Level Linearity	16	Pass
Range Level Linearity	17	NA
Toneburst	18	Pass
Peak C Sound Level	19	Pass
Overload Indicator	20	Pass
High Level Stability	21	Pass

Statement of Compliance: The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2013, for the environmental conditions under which the tests were performed. As public evidence was available, from an independent organization responsible for approving the results of pattern evaluation tests performed in accordance with IEC 61672-2:2013, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2013, the sound level meter submitted for testing conforms to the class 1 requirements of IEC61672-1:2013.
A full technical report is available if required.

This Sound Level Meter included an Octave Filter Set. Tests were based on IEC 1260: 1995 and AS/NZS 4476 - 1997 and were conducted to test the following performance characteristics:

1. Relative attenuation clause 5.3

Date of Calibration: 06/08/2018 **Issue Date:** 07/08/2018

Checked by: [signature]

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Certificate Of Calibration

Certificate No.: **SLM 42109**

Equipment Description: Noise Logger

Manufacturer: ARL

Model No: EL-316 **Serial No:** 16-207-050

Microphone Type: UC-53A **Serial No:** 318219

Preamplifier Type: NA **Serial No:** NA

Comments: All tests passed for type 1.
(See over for details)

Owner: SLR Consulting Australia Pty Ltd
Level 2, 2 Lincoln Street
Lane Cove, NSW 2066

Ambient Pressure: 1019 hPa ±1.5 hPa

Temperature: 23 °C ±2° C **Relative Humidity:** 53 % ±5%

Date of Calibration: 27/06/2019 **Issue Date:** 27/06/2019

Acu-Vib Test Procedure: AVP05 (SLM)

Checked by: [redacted] **Authorised Signature:** ......[redacted]........
Jack Kielt

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CERTIFICATE NO.: SLM 42109

The performance characteristics listed below were tested. The tests are based on the relevant clauses of A.S. 1259.1 and A.S. 1259.2 - 1990

1. RMS Performance	clause 10.4.5
2. Time Weighting Response, F&S	clause 10.4.2
3. Time Weighting I	clause 10.4.3 NA
4. Time Weighting P	clause 10.4.4 NA
5. Input Attenuator Accuracy	clause 10.3.3
6. Detector & Differential Linearity	clause 10.4.1
7. Weighting Networks & Linearity	clause 10.2.3
8. Overload Indication	clause 10.3.2
9. AC Output & Weighted Noise Level	clause 11. (c). (ii) 10.3.4
10. Time Averaging	clause 9.3.2
11. Absolute Sensitivity	clause 10.2.2

Note: Absolute Sensitivity as found was 95.8 dB and adjusted to 94.0 dB
Uncertainty: ±0.13dB (at 95% c.l.) k=2

Date of Calibration: 27/06/2019 **Issue Date:** 27/06/2019

Checked by:

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CERTIFICATE OF CALIBRATION

CERTIFICATE NO.: **SLM 42108**

Equipment Description:	Noise Logger		
Manufacturer:	ARL		
Model No:	EL-316	**Serial No:**	16-207-044
Microphone Type:	UC-53A	**Serial No:**	321979
Preamplifier Type:	NA	**Serial No:**	NA

Comments: All tests passed for type 1.
(See over for details)

Owner: SLR Consulting Australia Pty Ltd
Level 2, 2 Lincoln Street
Lane Cove, NSW 2066

Ambient Pressure: 1019 hPa ±1.5 hPa

Temperature: 23 °C ±2° C **Relative Humidity:** 53 % ±5%

Date of Calibration: 27/06/2019 **Issue Date:** 27/06/2019

Acu-Vib Test Procedure: AVP05 (SLM)

CHECKED BY: .... **AUTHORISED SIGNATURE:** ....

Jack Kielt

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CERTIFICATE NO.: **SLM 42108**

The performance characteristics listed below were tested. The tests are based on the relevant clauses of A.S. 1259.1 and A.S. 1259.2 - 1990

1. RMS Performance	clause 10.4.5
2. Time Weighting Response, F&S	clause 10.4.2
3. Time Weighting I	clause 10.4.3 NA
4. Time Weighting P	clause 10.4.4 NA
5. Input Attenuator Accuracy	clause 10.3.3
6. Detector & Differential Linearity	clause 10.4.1
7. Weighting Networks & Linearity	clause 10.2.3
8. Overload Indication	clause 10.3.2
9. AC Output & Weighted Noise Level	clause 11. (c). (ii) 10.3.4
10. Time Averaging	clause 9.3.2
11. Absolute Sensitivity	clause 10.2.2

Note: Absolute Sensitivity as found was 88.1 dB and adjusted to 94.0 dB
Uncertainty: ±0.13dB (at 95% c.l.) k=2

Date of Calibration: 27/06/2019 **Issue Date:** 27/06/2019

Checked by:

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Acoustic Research Labs Pty Ltd
Level 7 Building 2 423 Pennant Hills Rd
Pennant Hills NSW AUSTRALIA 2120
Ph: [illegible] A.B.N [illegible]
www.acousticresearch.com.au

Sound Level Meter
AS 1259.1:1990 - AS 1259.2:1990
Calibration Certificate

Calibration Number C18314

Client Details	SLR Consulting [illegible] [illegible]
Equipment Tested/ Model Number :	ARL EL-316
Instrument Serial Number :	16-207-[illegible]
Microphone Serial Number :	519[illegible]
Pre-amplifier Serial Number :	[illegible]

Atmospheric Conditions

Ambient Temperature :	21.7°C
Relative Humidity :	[illegible]%
Barometric Pressure :	[illegible]kPa

Calibration Technician :	Lucky [illegible]	Secondary Check:	[illegible]
Calibration Date :	14 Jun 2018	Report Issue Date :	14 Jun 2018

Approved Signatory : Ken Williams

Clause and Characteristic Tested	Result	Clause and Characteristic Tested	Result
10.2.2: Absolute sensitivity	Pass	[illegible] reference level	Pass
10.2.3: Frequency weighting	Pass	10.4.2: Time weighting characteristic F and S	Pass
10.3.2: Overload indication	Pass	10.4.3: Time weighting characteristic I	Pass
10.3.3: Accuracy of level range control	Pass	10.4.5: R.M.S performance	Pass
8.9: Detector-indicator linearity	Pass	9.3.2: Time averaging	Pass
8.10: Differential level linearity	Pass	9.3.5: [illegible] indication	Pass

Least Uncertainties of Measurement

Acoustic Tests		Environmental Conditions	
[illegible]	[illegible]	Temperature	[illegible]
[illegible] kHz	[illegible]	Relative Humidity	[illegible]
16kHz	[illegible]	Barometric Pressure	[illegible]
Electrical Tests			
[illegible]	[illegible]		

All uncertainties are derived at the 95% confidence level with a coverage factor of 2

[illegible] and AS 1259.2:1990 for the tests stated [illegible]

[illegible]

[illegible] NATA Accredited [illegible]

[illegible]

NATA [illegible]

Acoustic Research Labs Pty Ltd
Level 7 Building 2 423 Pennant Hills Rd
Pennant Hills NSW AUSTRALIA [illegible]
Ph: +61 [illegible]
www.acousticresearch.com.au

Sound Level Meter

AS 1259.1:1990 - AS 1259.2:1990

Calibration Certificate

Calibration Number C[illegible]

Client Details	SLR Consulting Suite [illegible] Dorcas Avenue Hawthorn Vic 3122
Equipment Tested/ Model Number :	ARL EL-316
Instrument Serial Number :	16-103-[illegible]
Microphone Serial Number :	317[illegible]
Pre-amplifier Serial Number :	780[illegible]

Atmospheric Conditions

Ambient Temperature :	[illegible] °C
Relative Humidity :	42 %
Barometric Pressure :	99.[illegible] kPa

Calibration Technician :	[illegible]	Secondary Check:	Lewis [illegible]
Calibration Date :	14 Jun 2018	Report Issue Date :	14 Jun 2018

Approved Signatory : Ken Williams

Clause and Characteristic Tested	Result	Clause and Characteristic Tested	Result
10.2.2: Absolute sensitivity	Pass	10.3.[illegible] [illegible]	Pass
10.2.3: Frequency weighting	Pass	10.4.2: Time weighting characteristic F and S	Pass
10.3.2: Overload indication	Pass	10.4.[illegible]: Time weighting characteristic I	Pass
10.3.3: Accuracy of level range control	Pass	[illegible]: R.M.S performance	Pass
8.[illegible]: Detector-indicator linearity	Pass	9.3.2: Time averaging	Pass
[illegible] 10: Differential level linearity	Pass	9.3.[illegible]: Overload indication	Pass

Least Uncertainties of Measurement -

Acoustic Tests		Environmental Conditions	
31.5 Hz to 8kHz	±0.15dB	Temperature	±[illegible]°C
12.5kHz	±0.2dB	Relative Humidity	±[illegible]%
16kHz	±0.3dB	Barometric Pressure	±0.0[illegible]kPa
Electrical Tests			
31.5 Hz to 20 kHz	±0.12dB		

All uncertainties are derived at the 95% confidence level with a coverage factor of 2

The sound level meter under test has been shown to conform to the test requirements for [illegible] AS 1259.1:1990 and AS 1259.2:1990 for the tests stated above.

This calibration certificate is to be read in conjunction with the calibration test report.

Acoustic Research Labs Pty Ltd is NATA Accredited Laboratory Number 14172. Accredited for compliance with ISO/IEC 17025 - calibration.

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NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration and inspection reports.

CERTIFICATE OF CALIBRATION

CERTIFICATE NO.: SLM 25138 & FILT 5298

Equipment Description:	Sound & Vibration Analyser		
Manufacturer:	Svantek		
Model No:	Svan-957	**Serial No:**	20665
Microphone Type:	7052E	**Serial No:**	50614
Preamplifier Type:	SV12L	**Serial No:**	18987
Filter Type:	1/1 Octave	**Serial No:**	20665

Comments: All tests passed for class 1.
(See over for details)

Owner: SLR Consulting Australia Pty Ltd
Level 2, 2 Lincoln Street
Lane Cove, NSW 2066

Ambient Pressure: 999 hPa ±1.5 hPa

Temperature: 25 °C ±2° C **Relative Humidity:** 32% ±5%

Date of Calibration: 12/07/2019 **Issue Date:** 15/07/2019

Acu-Vib Test Procedure: AVP10 (SLM) & AVP06 (Filters)

CHECKED BY: ..VB **AUTHORISED SIGNATURE:** .... Jack Kielt

Accredited for compliance with ISO/IEC 17025 - Calibration
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Accredited Lab. No. 9262
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Measurements

CERTIFICATE NO.: SLM 25138 & FILT 5298

The performance characteristics listed below were tested. The tests are based on the relevant clauses of IEC 61672-3:2013

Tests Performed:	*Clause*	*Result*
Absolute Calibration	10	Pass
Acoustical Frequency Weighting	12	Pass
Self Generated Noise	11.1	Entered
Electrical Noise	11.2	Entered
Long Term Stability	15	Pass
Electrical Frequency Weightings	13	Pass
Frequency and Time Weightings	14	Pass
Reference Level Linearity	16	Pass
Range Level Linearity	17	Pass
Toneburst	18	Pass
Peak C Sound Level	19	Pass
Overload Indicator	20	Pass
High Level Stability	21	Pass

Statement of Compliance: The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2013, for the environmental conditions under which the tests were performed. As public evidence was available, from an independent organization responsible for approving the results of pattern evaluation tests performed in accordance with IEC 61672-2:2013, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2013, the sound level meter submitted for testing conforms to the class 1 requirements of IEC61672-1:2013.
A full technical report is available if required.

This Sound Level Meter included an Octave Filter Set. Tests were based on IEC 1260: 1995 and AS/NZS 4476 - 1997 and were conducted to test the following performance characteristics:

1. Relative attenuation clause 5.3

Date of Calibration: 12/07/2019 **Issue Date:** 15/07/2019

Checked by: VKB

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CERTIFICATE OF CALIBRATION

CERTIFICATE NO.: SLM 25127 & FILT 5297

Equipment Description: Sound & Vibration Analyser

Manufacturer: Svantek

Model No: Svan-957 **Serial No:** 21423

Microphone Type: 7052H **Serial No:** 74013

Preamplifier Type: SV12L **Serial No:** 22284

Filter Type: 1/3 Octave **Serial No:** 21423

Comments: All tests passed for class 1.
(See over for details)

Owner: SLR Consulting Australia Pty Ltd
Level 2, 2 Lincoln Street
Lane Cove, NSW 2066

Ambient Pressure: 996 hPa ±1.5 hPa

Temperature: 24 °C ±2° C **Relative Humidity:** 32% ±5%

Date of Calibration: 11/07/2019 **Issue Date:** 11/07/2019

Acu-Vib Test Procedure: AVP10 (SLM) & AVP06 (Filters)

CHECKED BY: .... **AUTHORISED SIGNATURE:** ....
Jack Kiel

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Accredited Lab. No. 9262
Acoustic and Vibration
Measurements

Certificate No.: SLM 25127 & FILT 5297

The performance characteristics listed below were tested. The tests are based on the relevant clauses of IEC 61672-3:2013

Tests Performed:	*Clause*	*Result*
Absolute Calibration	10	Pass
Acoustical Frequency Weighting	12	Pass
Self Generated Noise	11.1	Entered
Electrical Noise	11.2	Entered
Long Term Stability	15	Pass
Electrical Frequency Weightings	13	Pass
Frequency and Time Weightings	14	Pass
Reference Level Linearity	16	Pass
Range Level Linearity	17	Pass
Toneburst	18	Pass
Peak C Sound Level	19	Pass
Overload Indicator	20	Pass
High Level Stability	21	Pass

Statement of Compliance: The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2013, for the environmental conditions under which the tests were performed. As public evidence was available, from an independent organization responsible for approving the results of pattern evaluation tests performed in accordance with IEC 61672-2:2013, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2013, the sound level meter submitted for testing conforms to the class 1 requirements of IEC61672-1:2013.
A full technical report is available if required.

This Sound Level Meter included an Octave Filter Set. Tests were based on IEC 1260: 1995 and AS/NZS 4476 - 1997 and were conducted to test the following performance characteristics:

1. Relative attenuation clause 5.3

Date of Calibration: 11/07/2019 **Issue Date:** 11/07/2019

Checked by:

Accredited for compliance with ISO/IEC 17025 - Calibration
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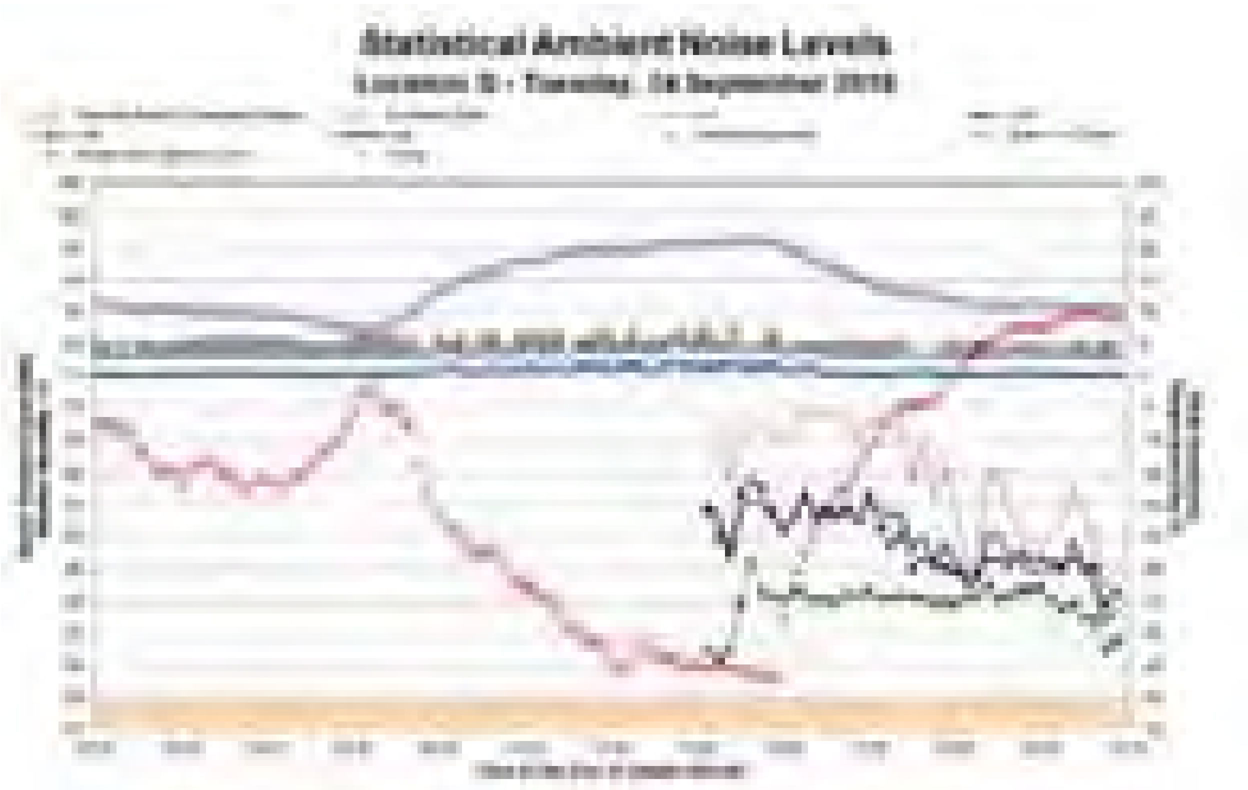
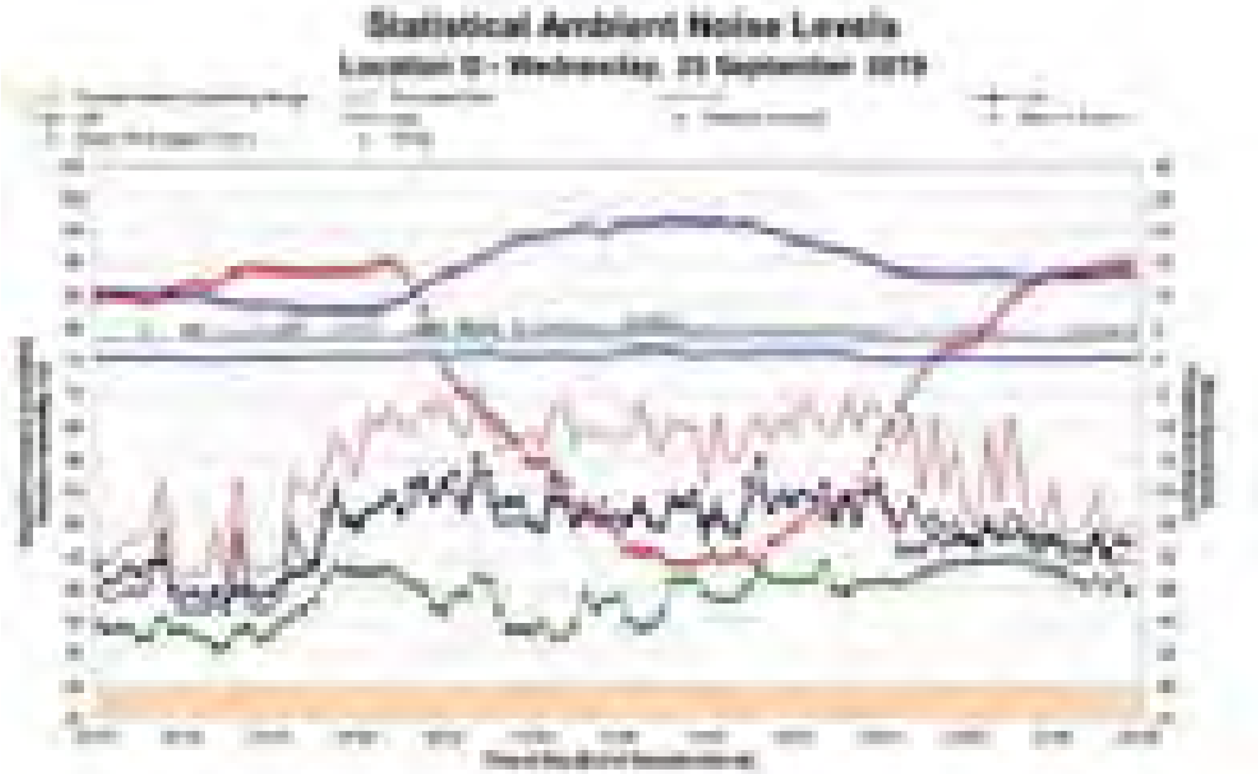
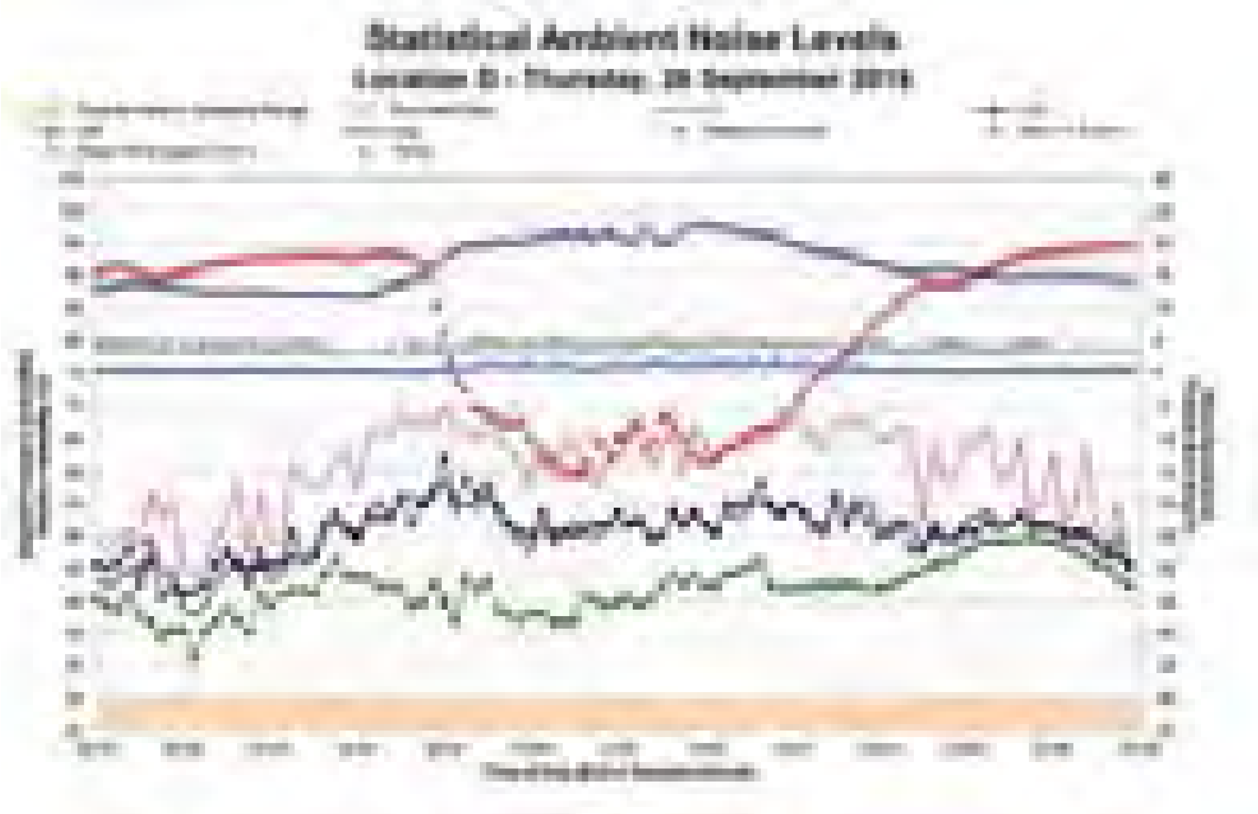
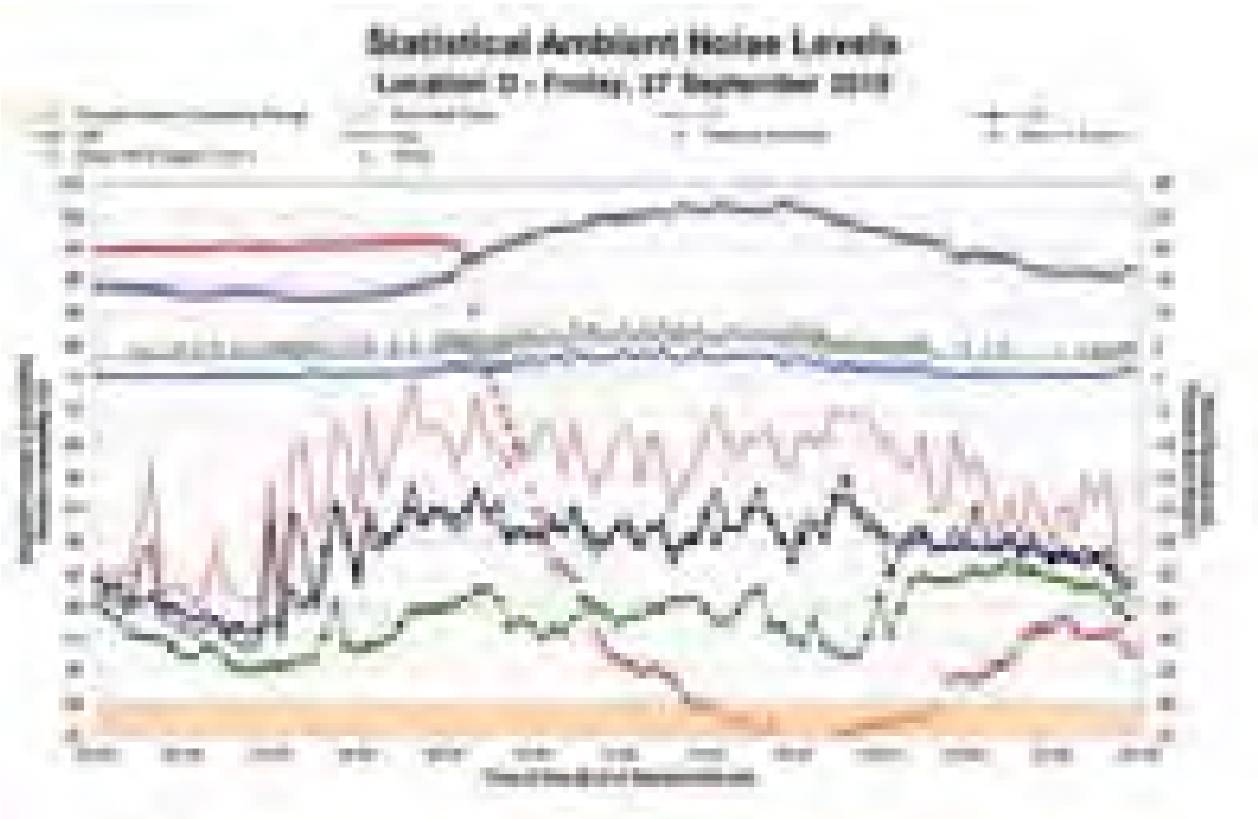
APPENDIX D

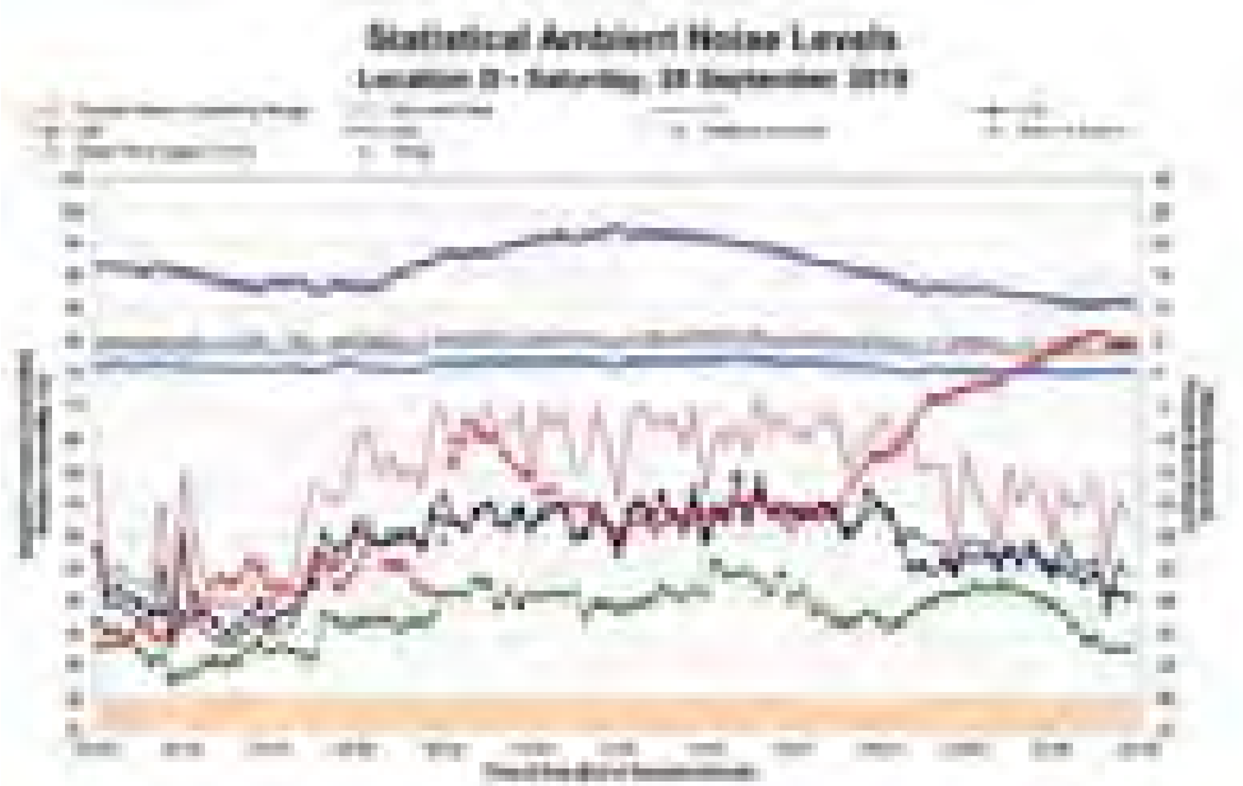
Statistical Ambient Noise Levels

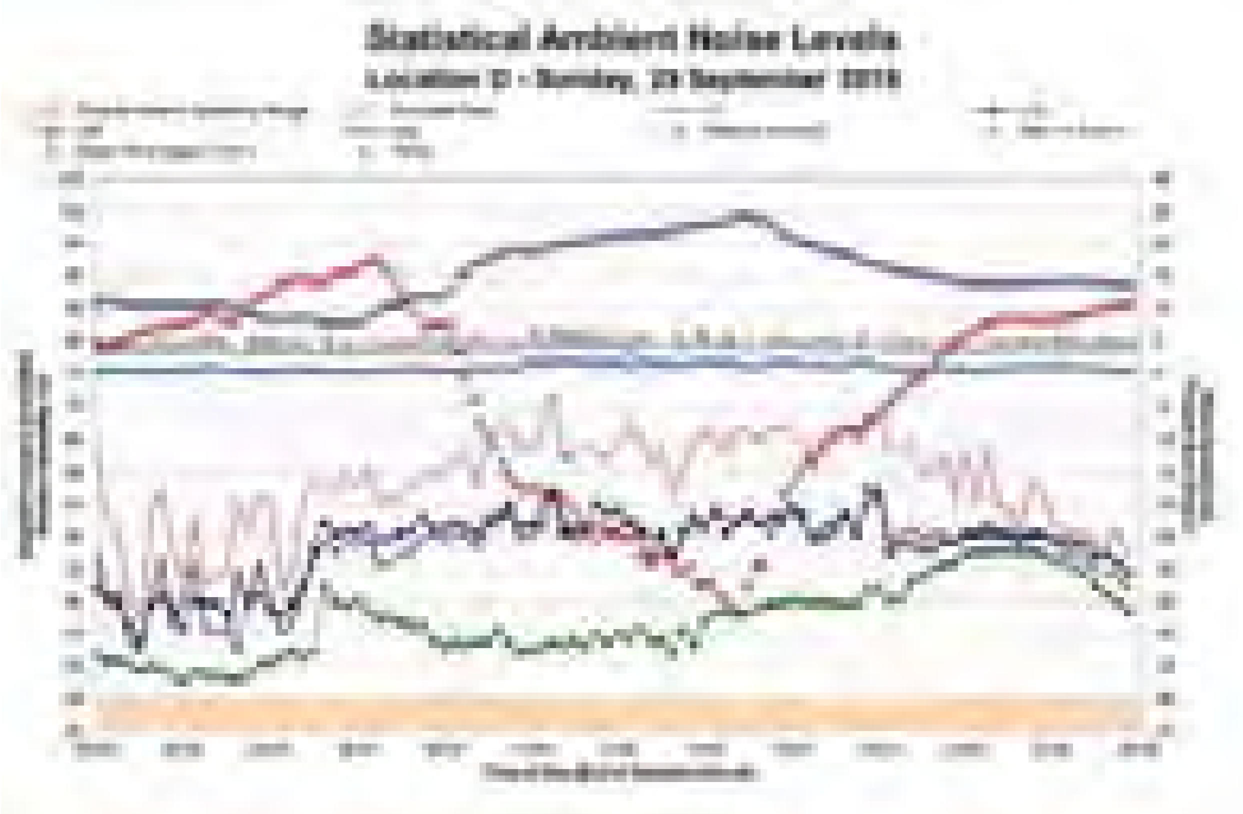

Statistical Ambient Noise Levels
Location D - Tuesday, 24 September 2019

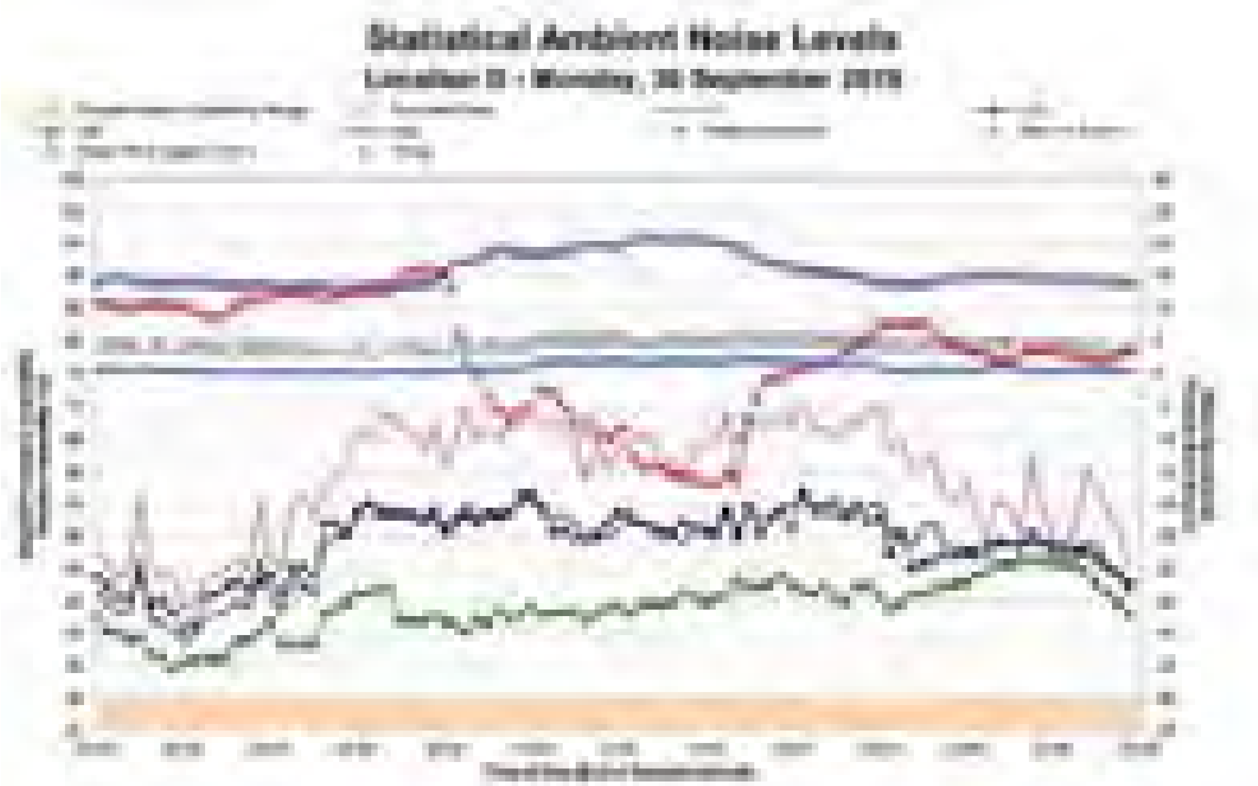

Statistical Ambient Noise Levels
Location D - Wednesday, 25 September 2019

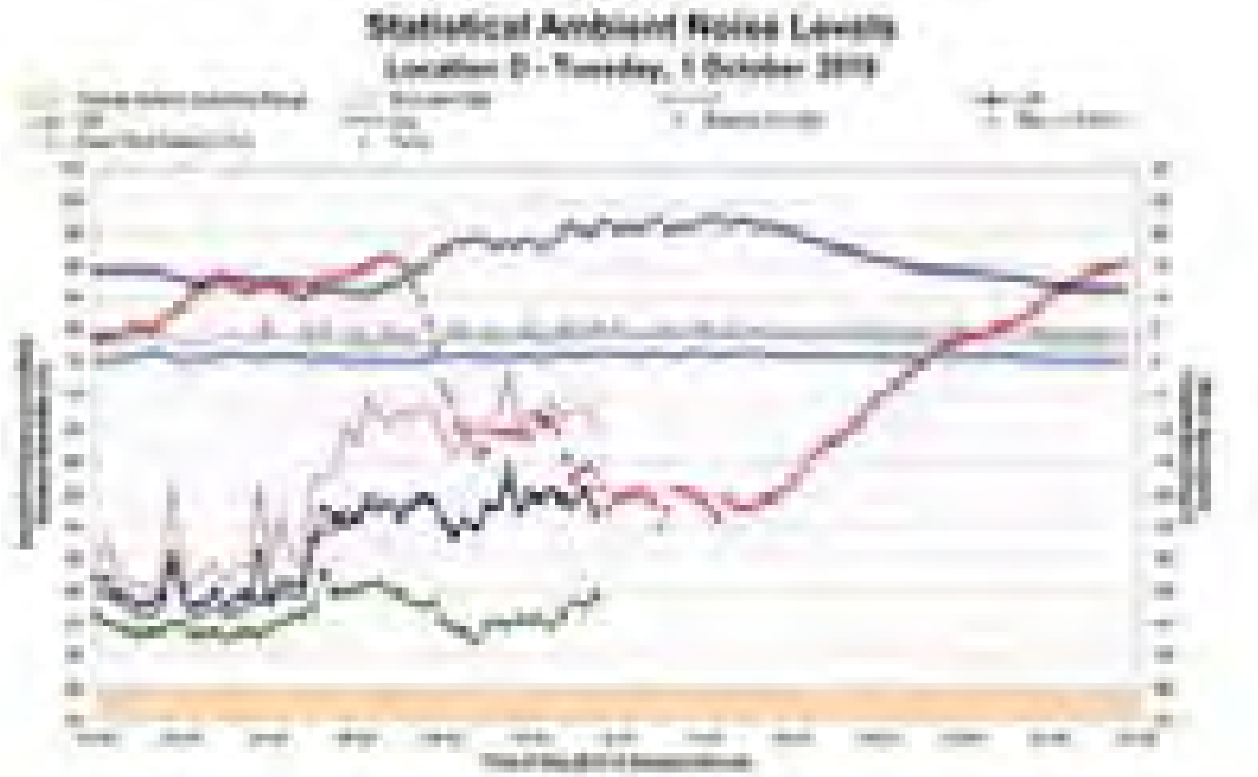

Statistical Ambient Noise Levels


Statistical Ambient Noise Levels


Statistical Ambient Noise Levels
Location D - Saturday, 28 September 2019


Statistical Ambient Noise Levels
Location D - Sunday, 29 September 2019


Statistical Ambient Noise Levels
Location D - Monday, 30 September 2019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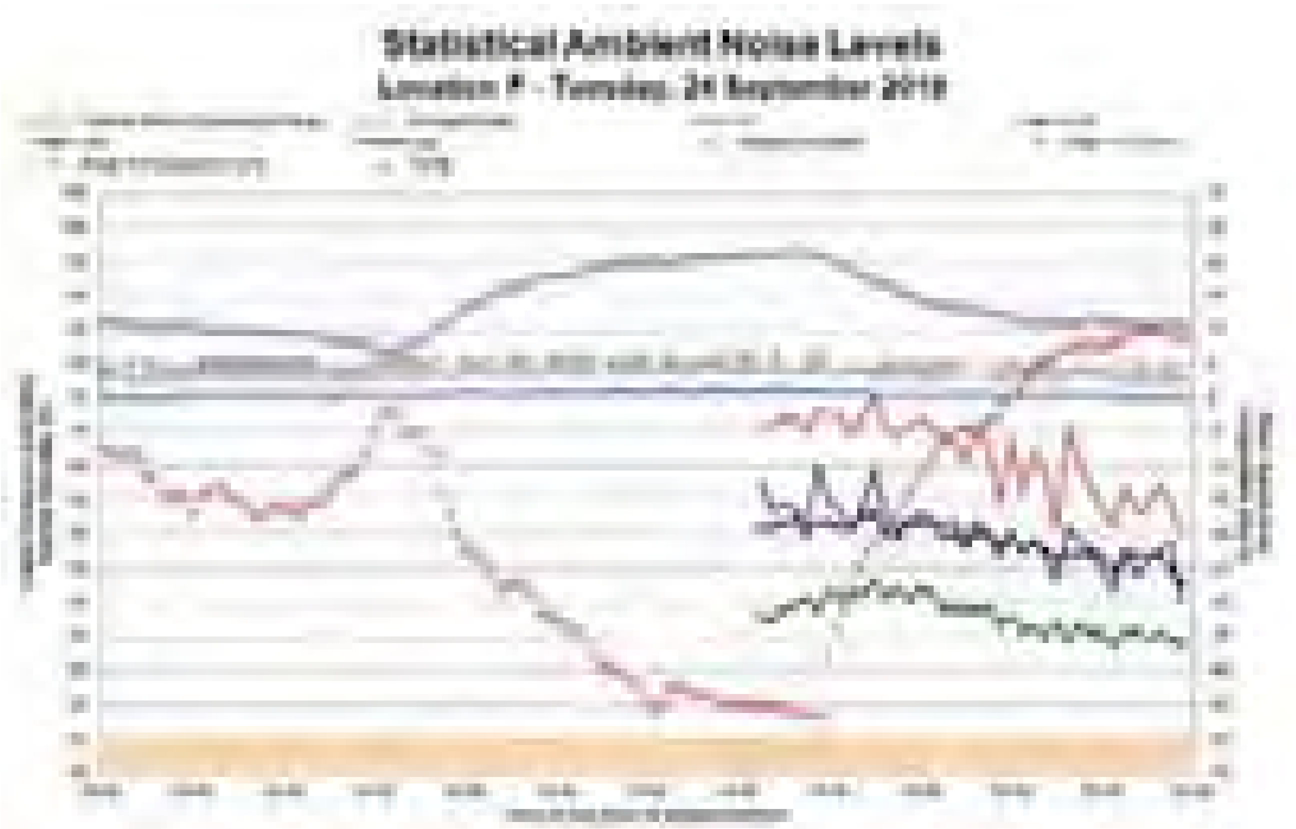
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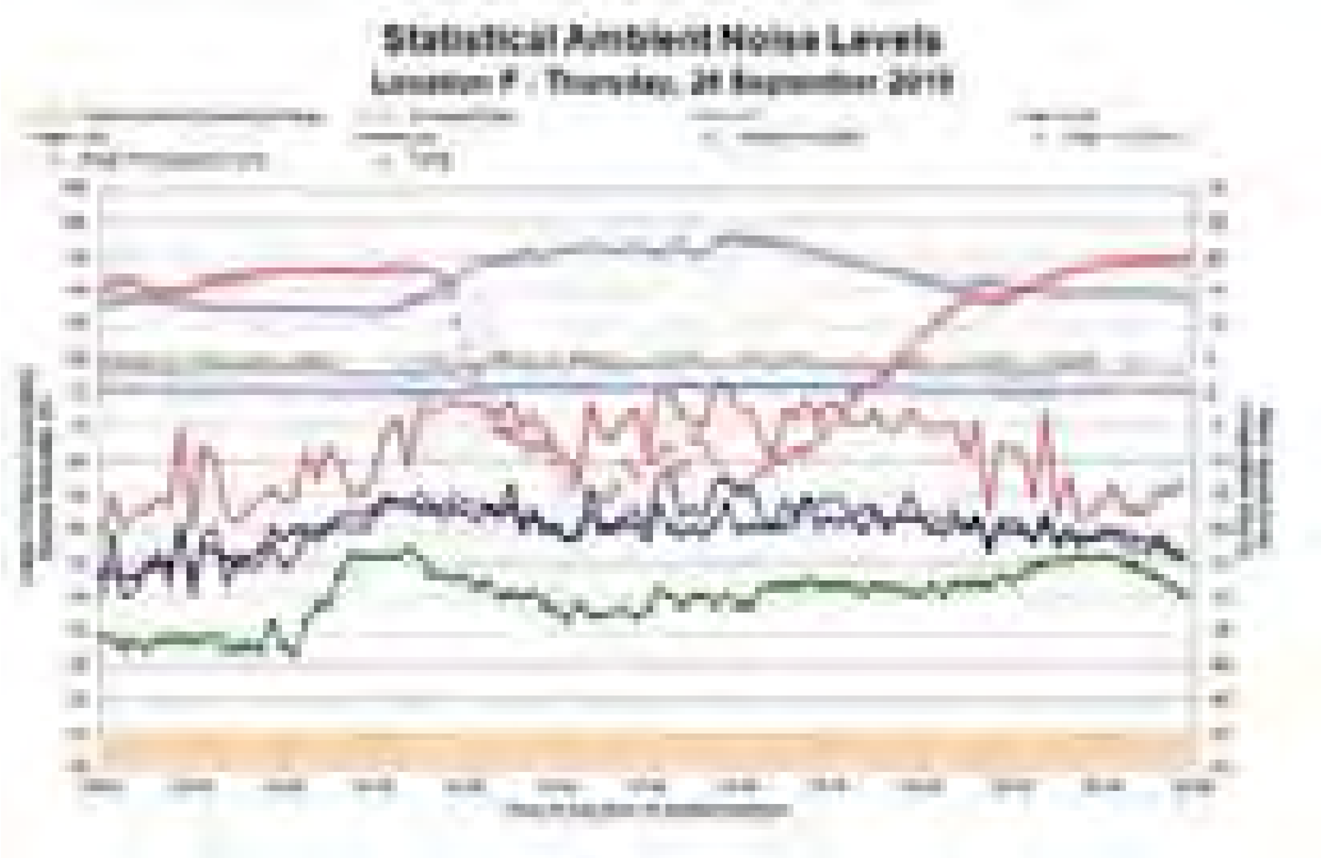
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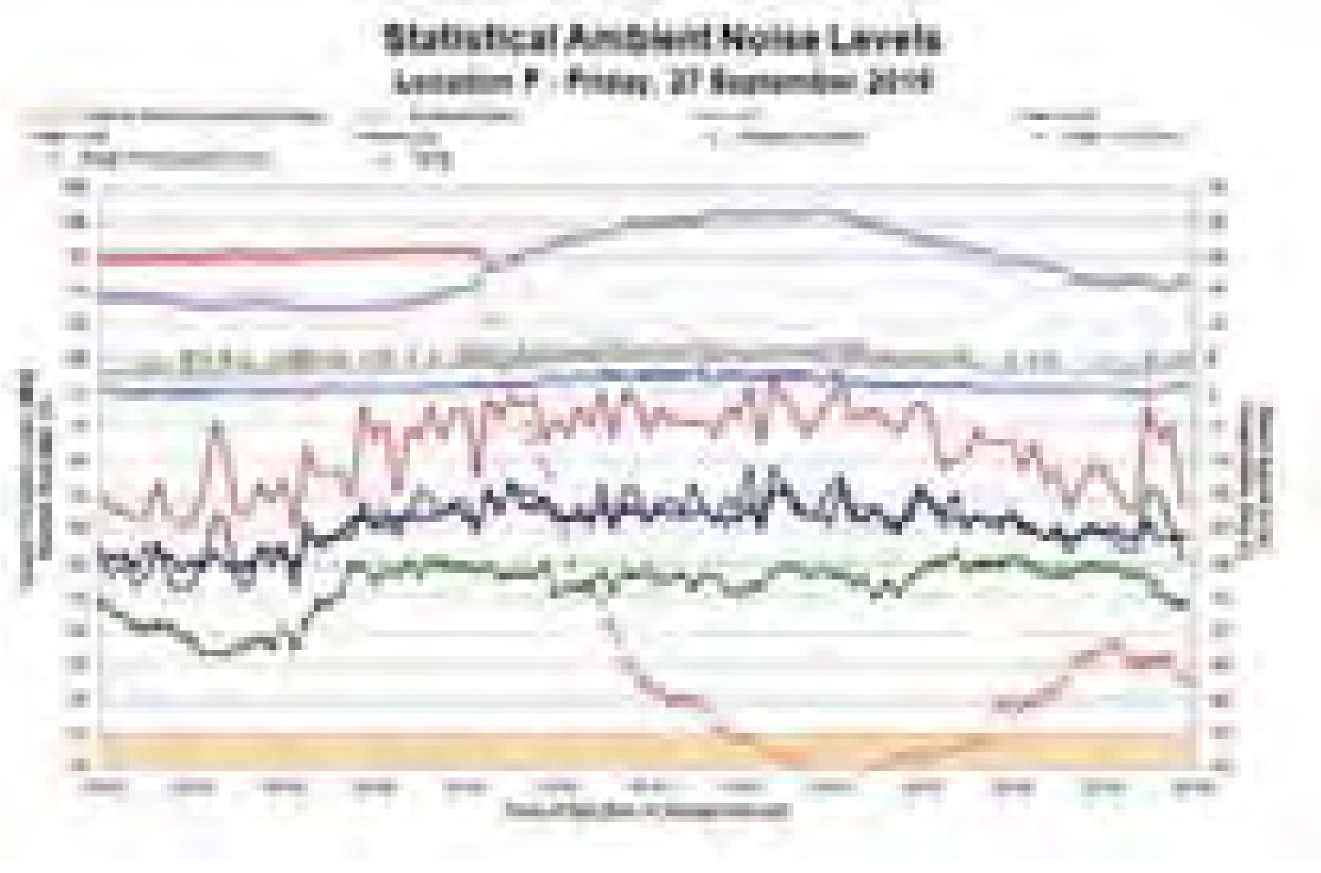
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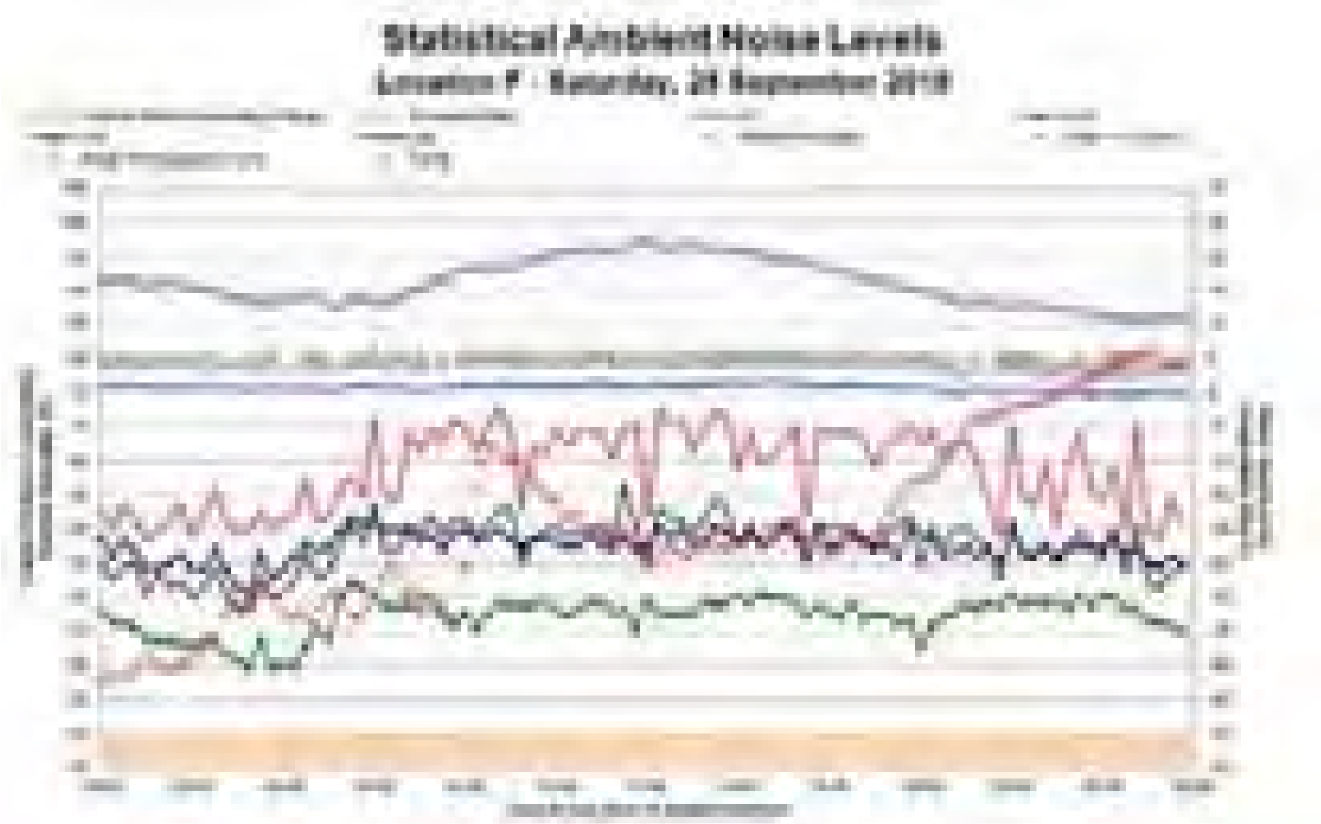
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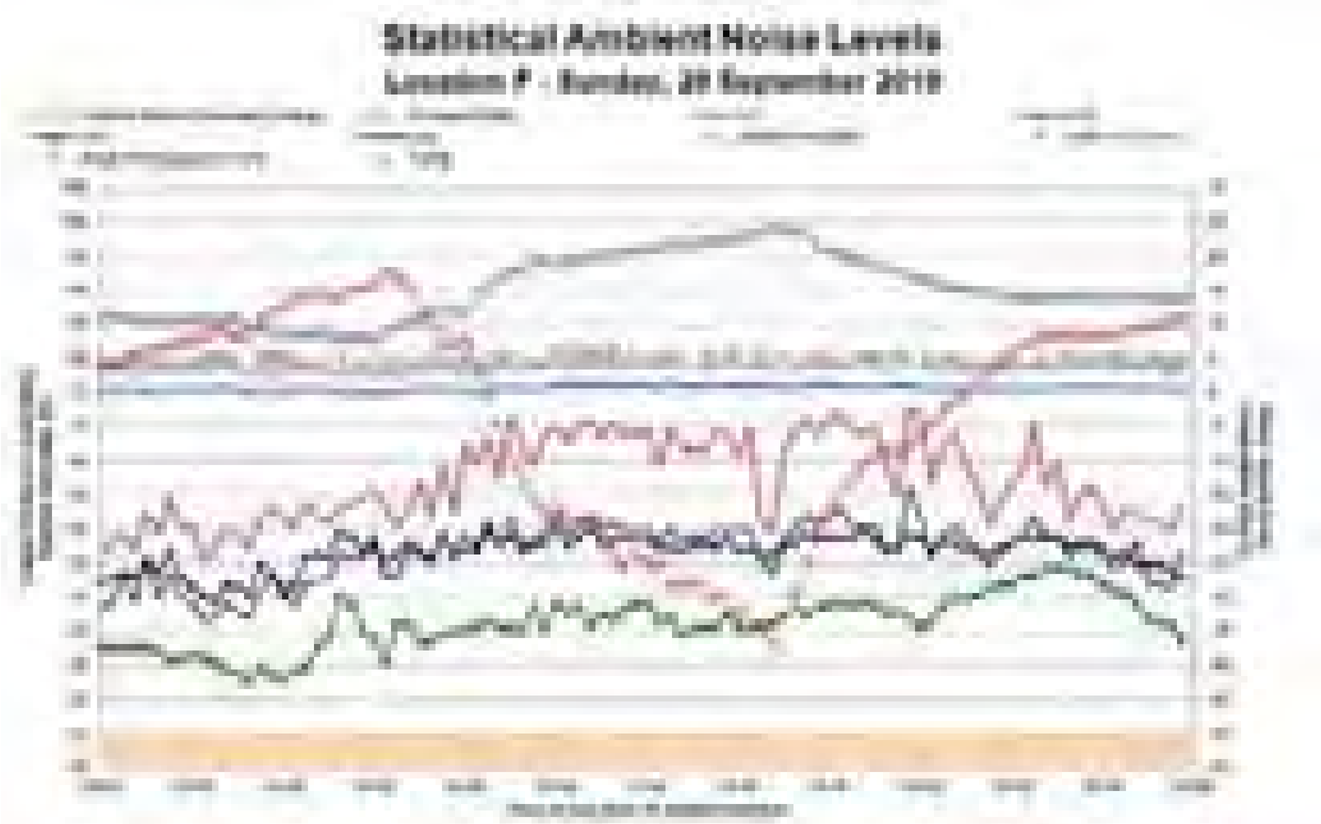
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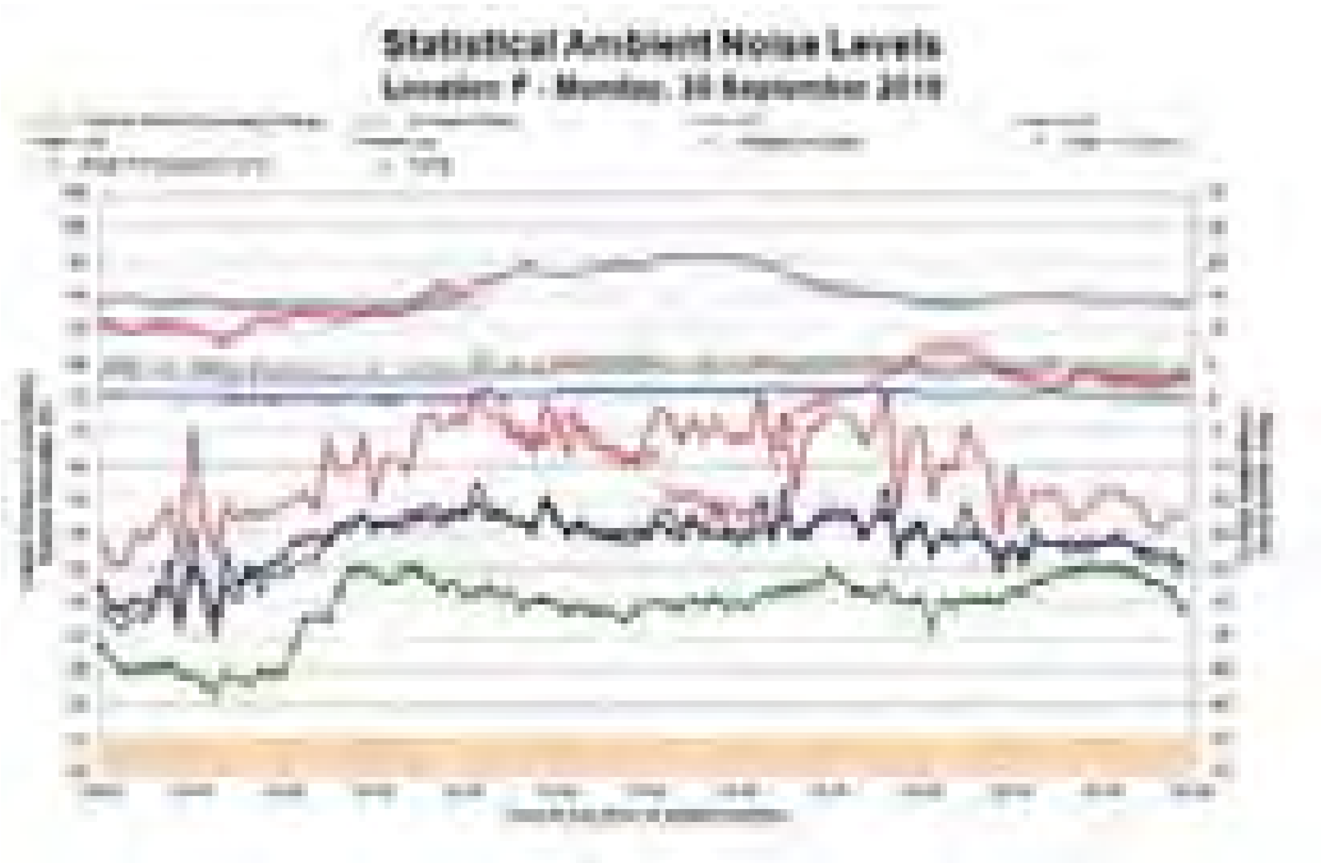
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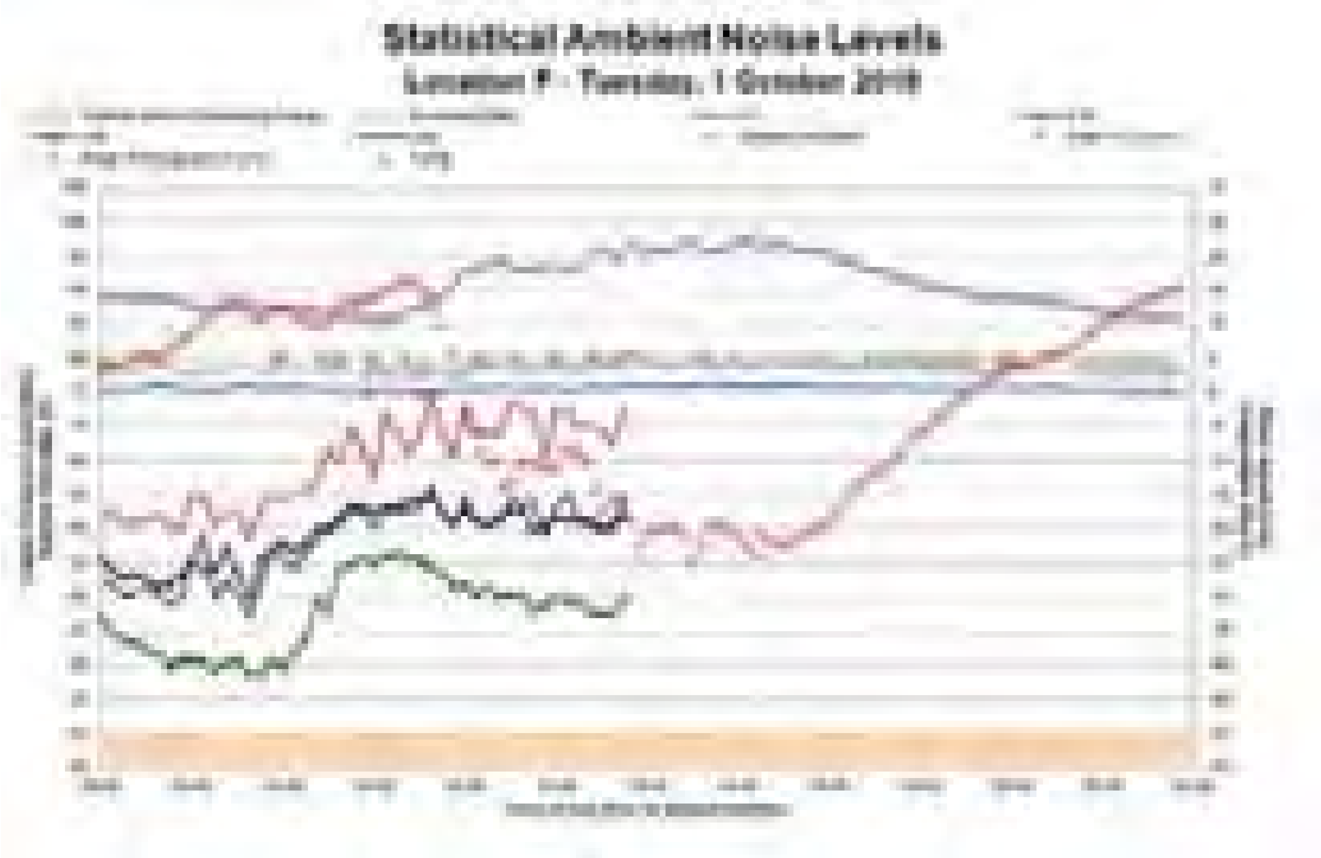
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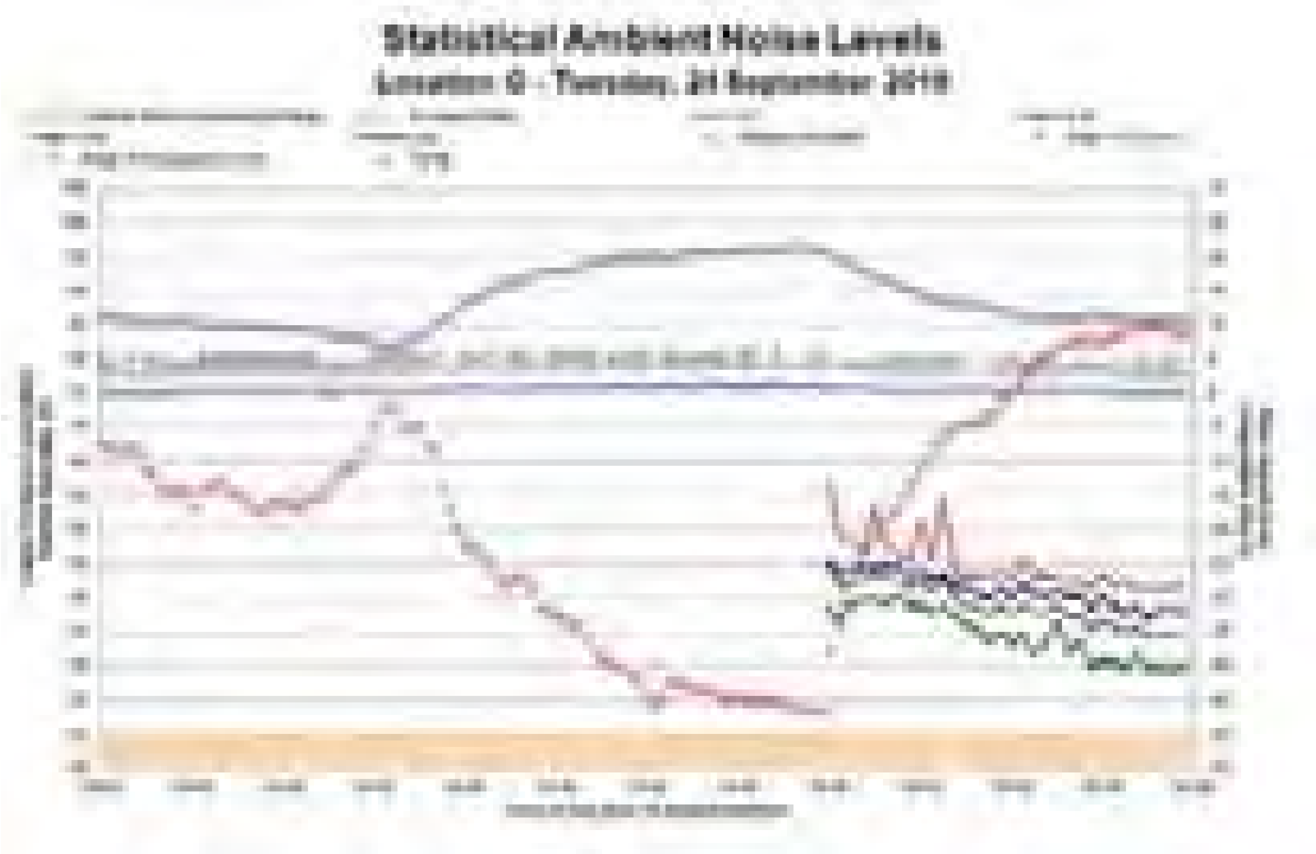
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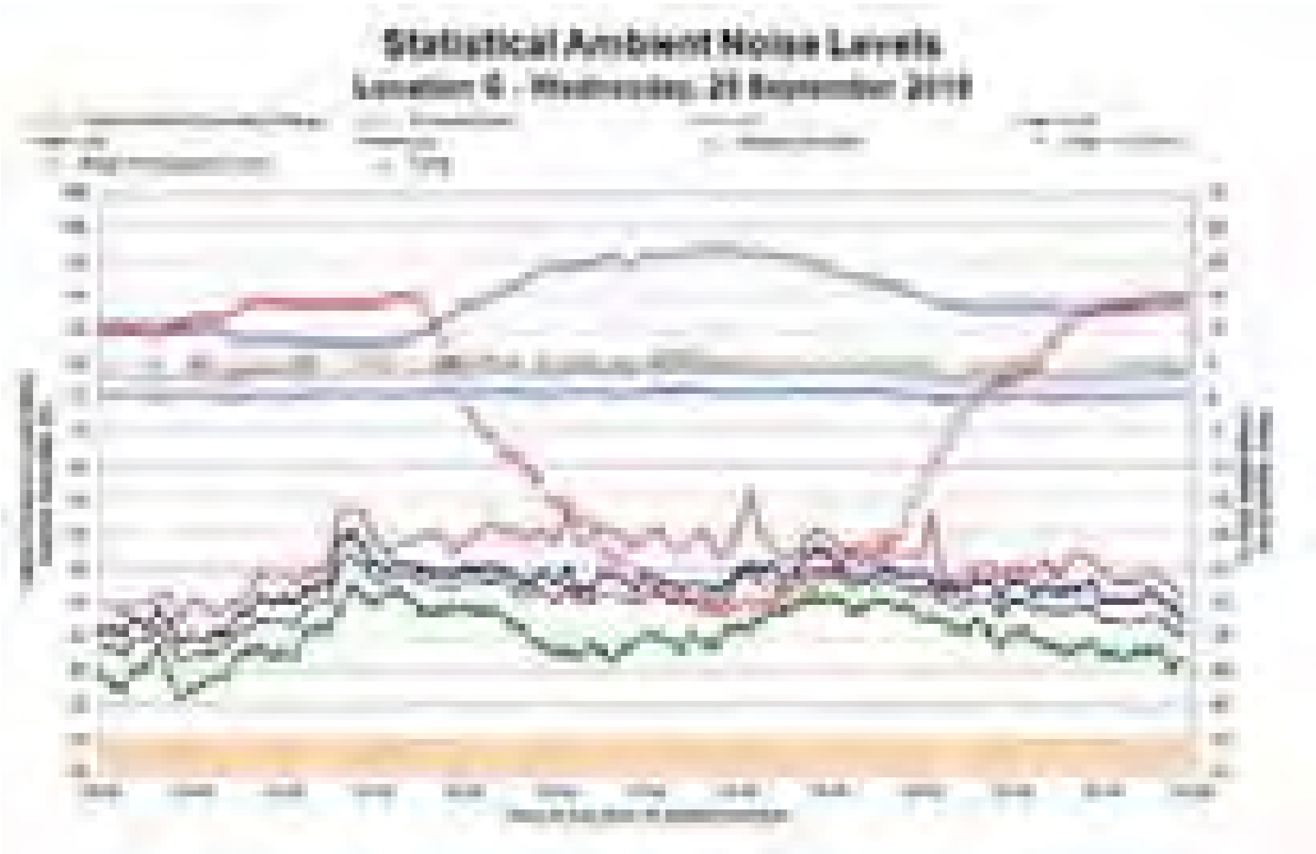
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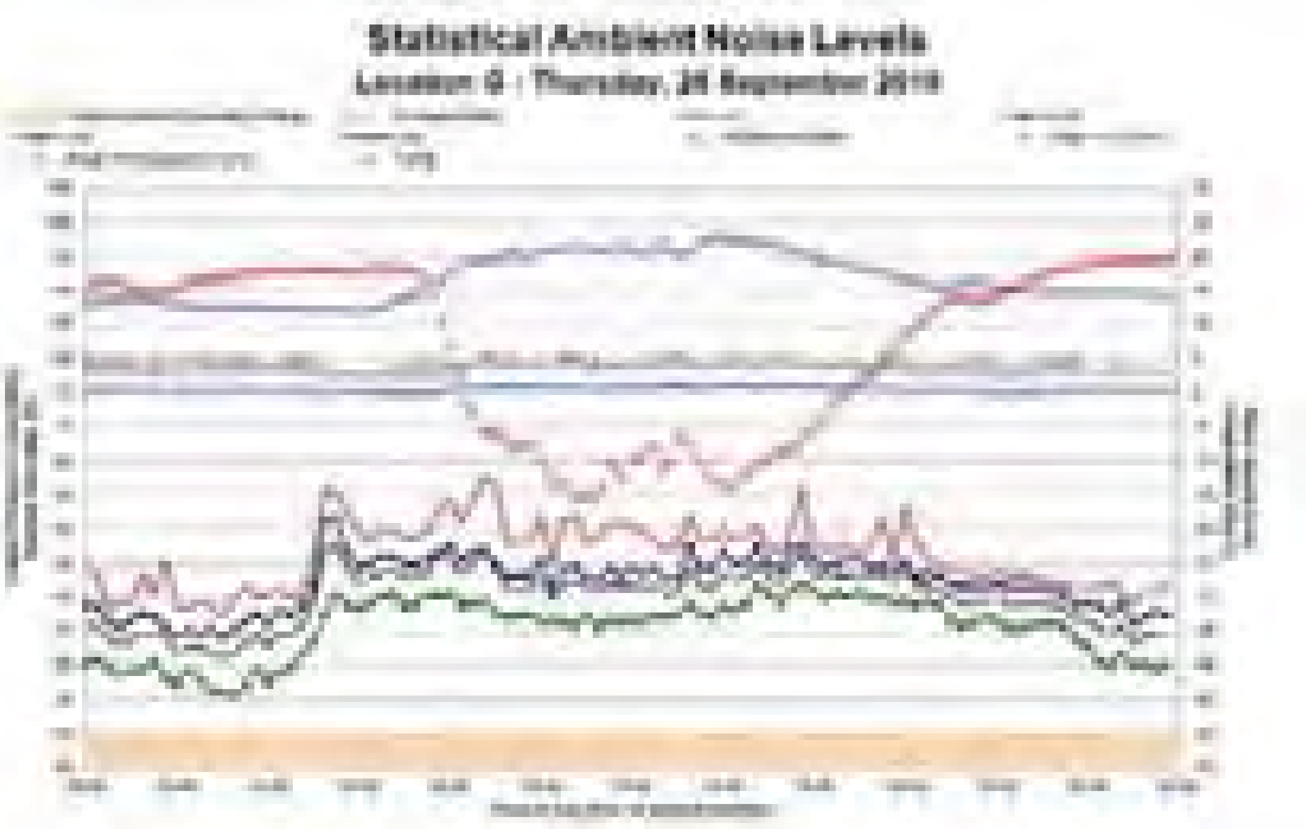
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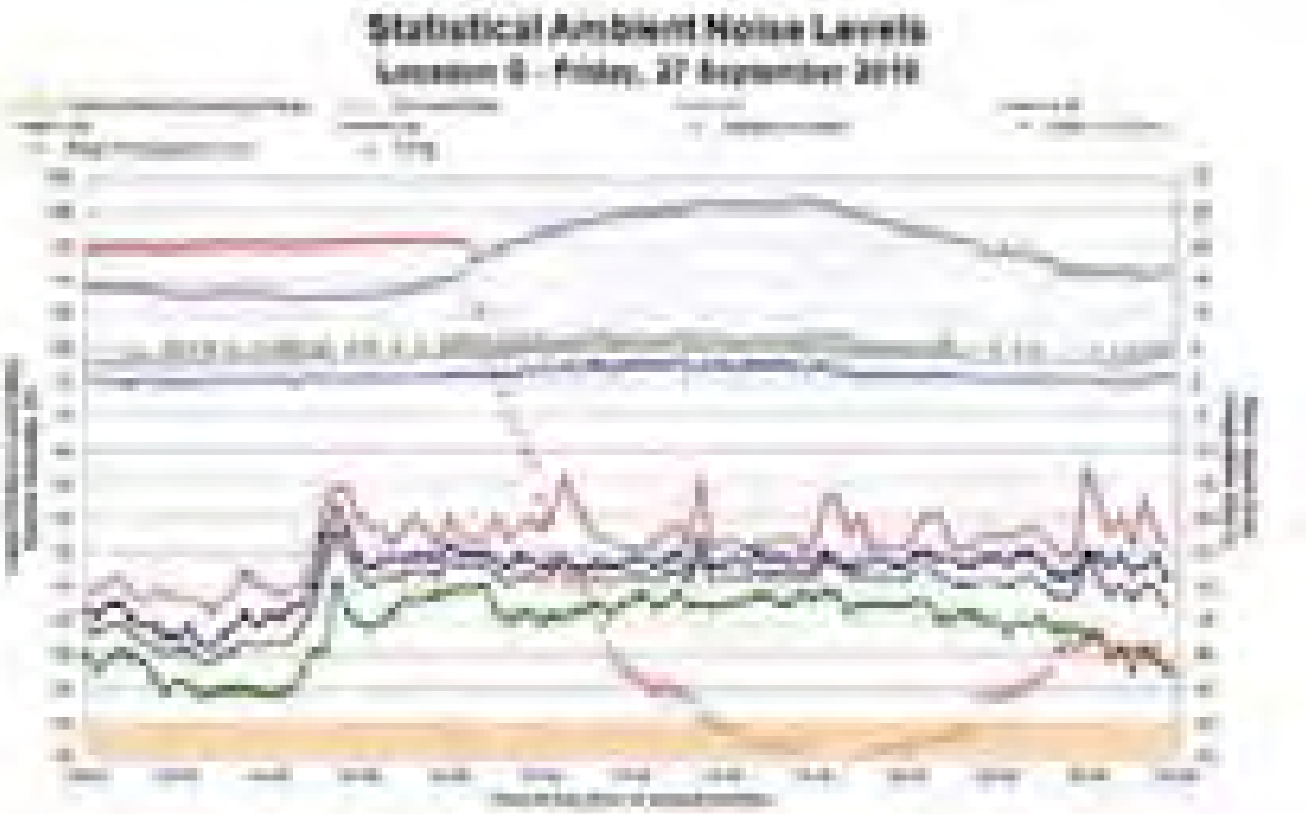
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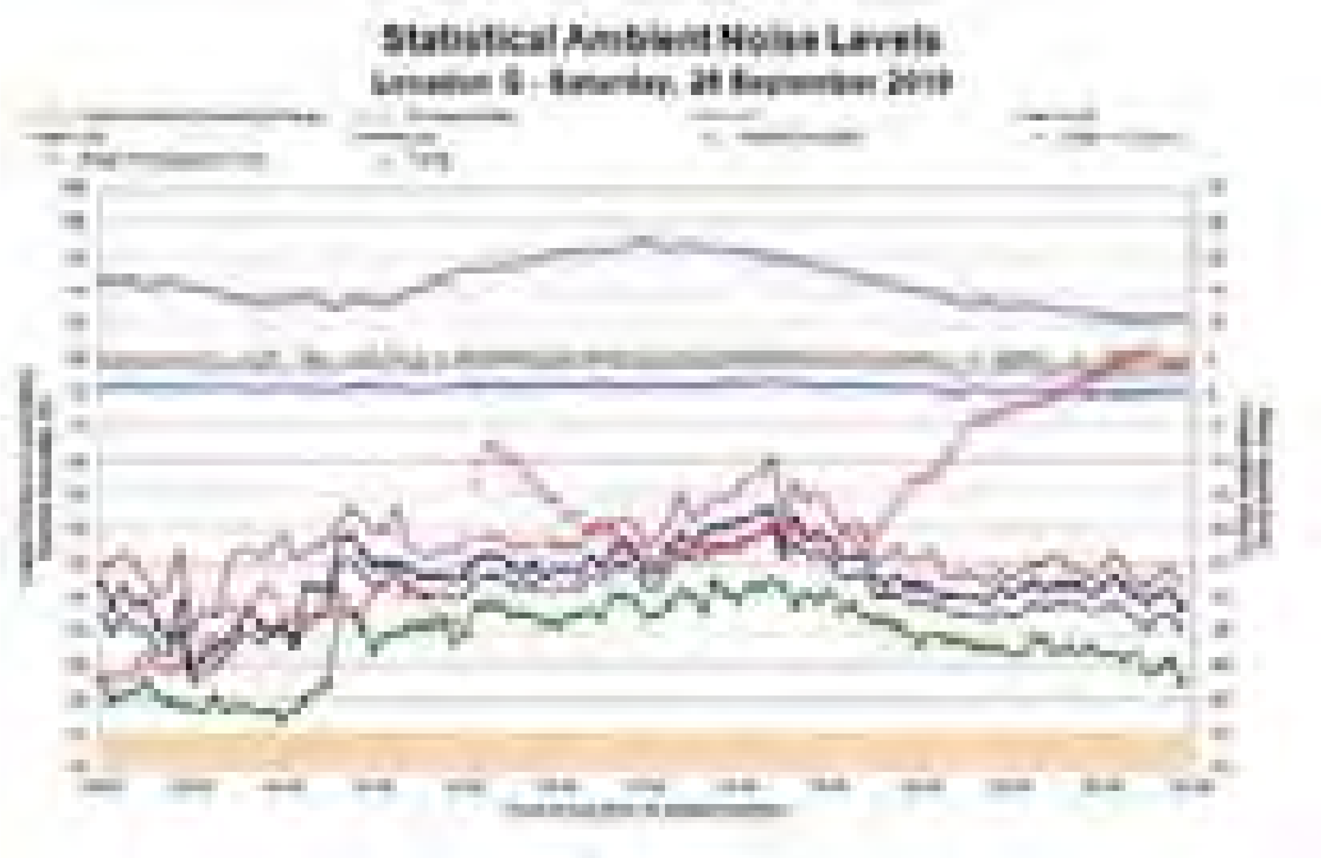
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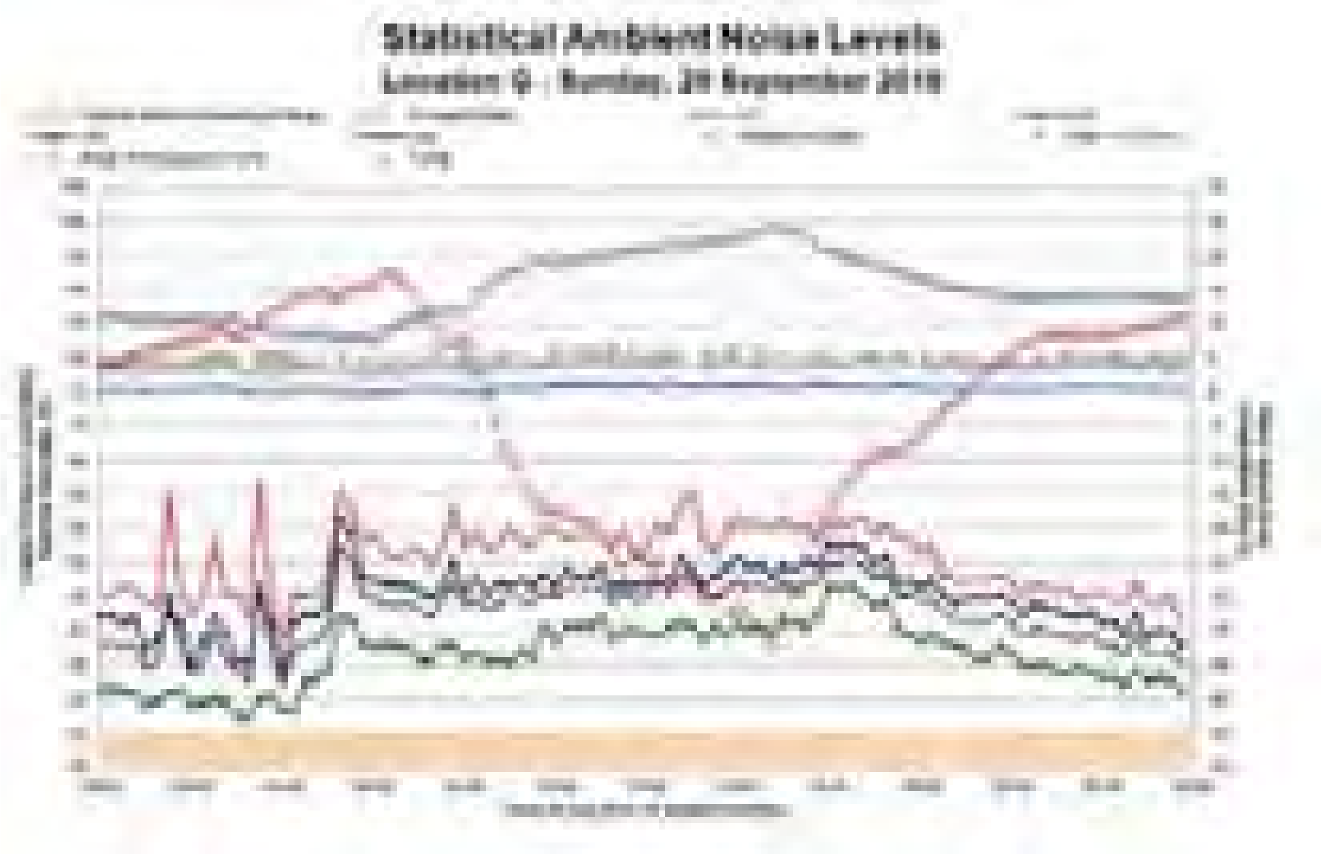
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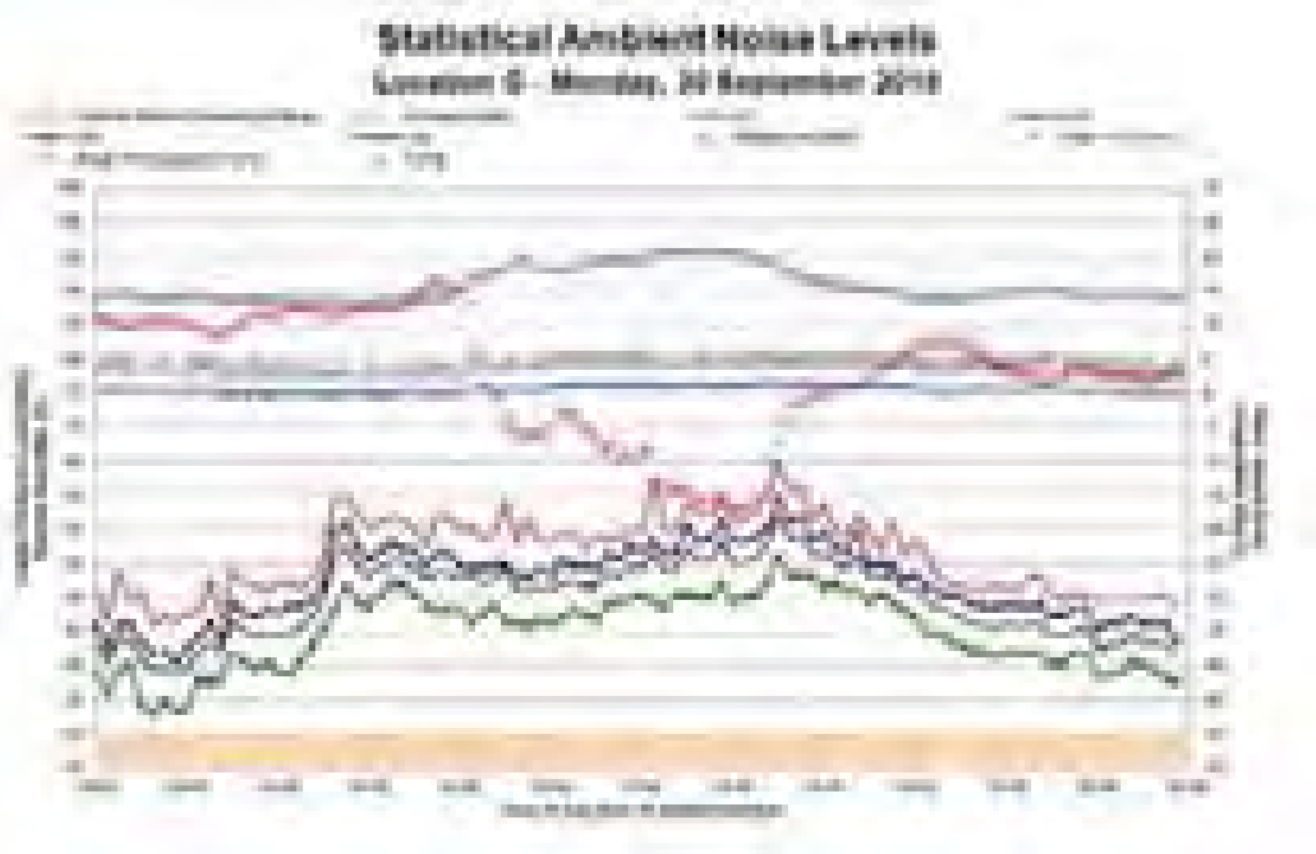
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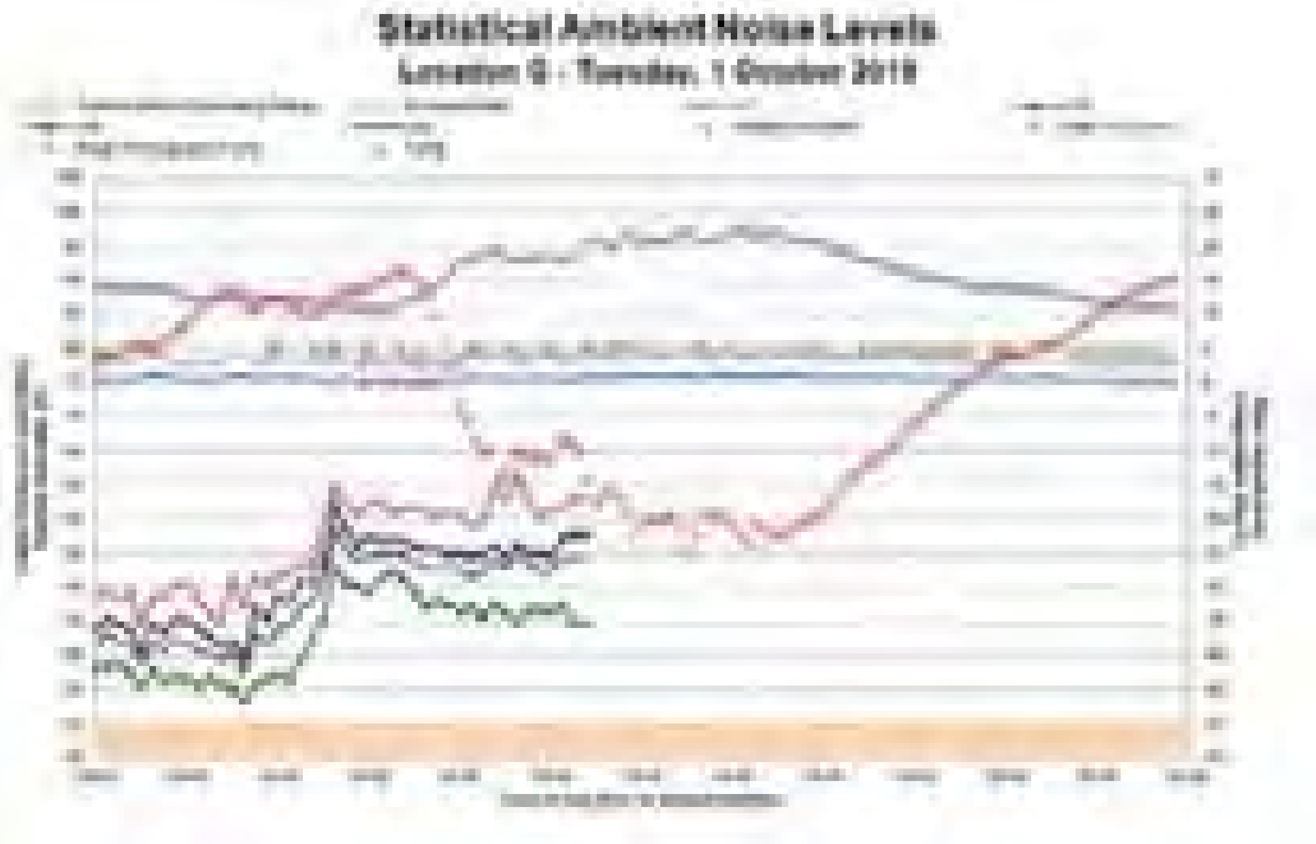
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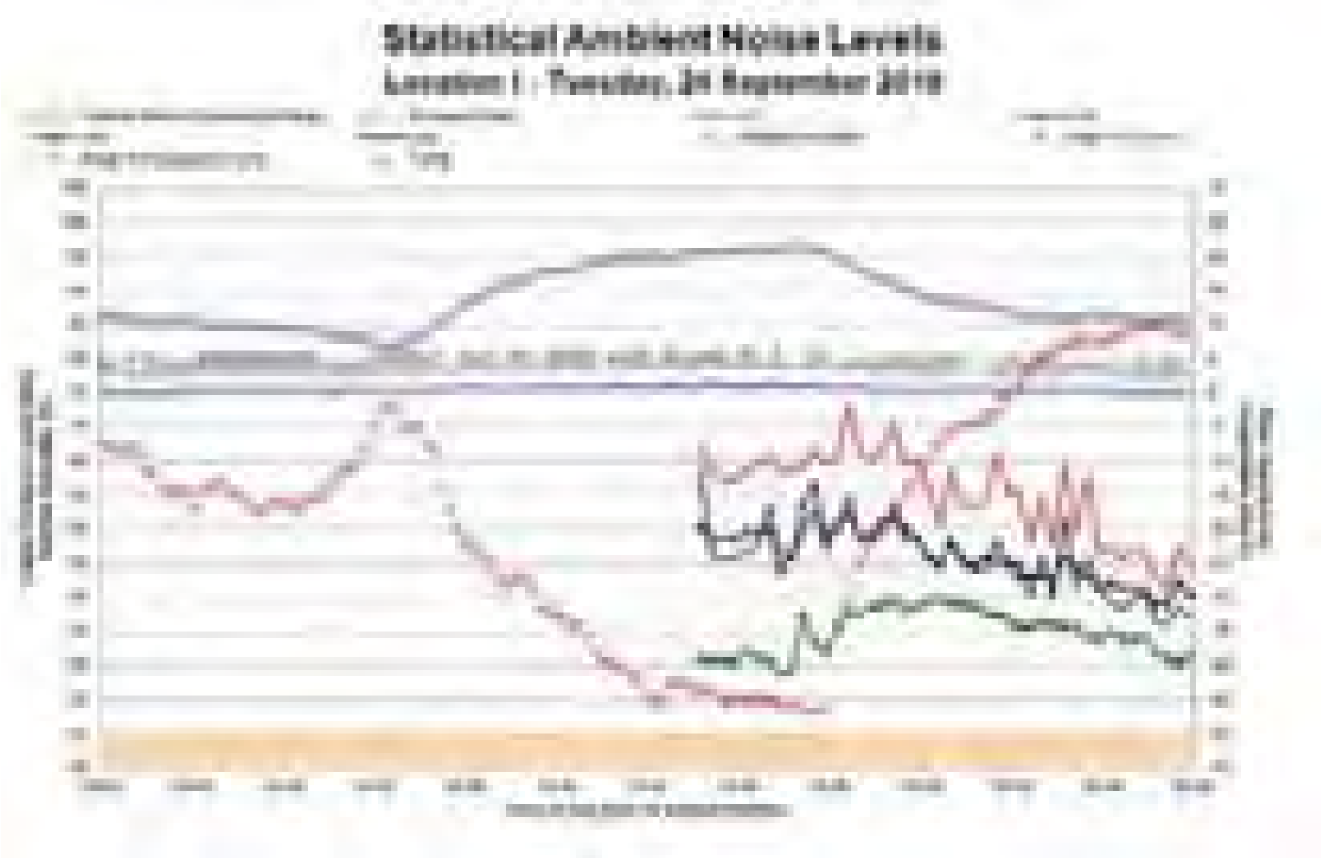
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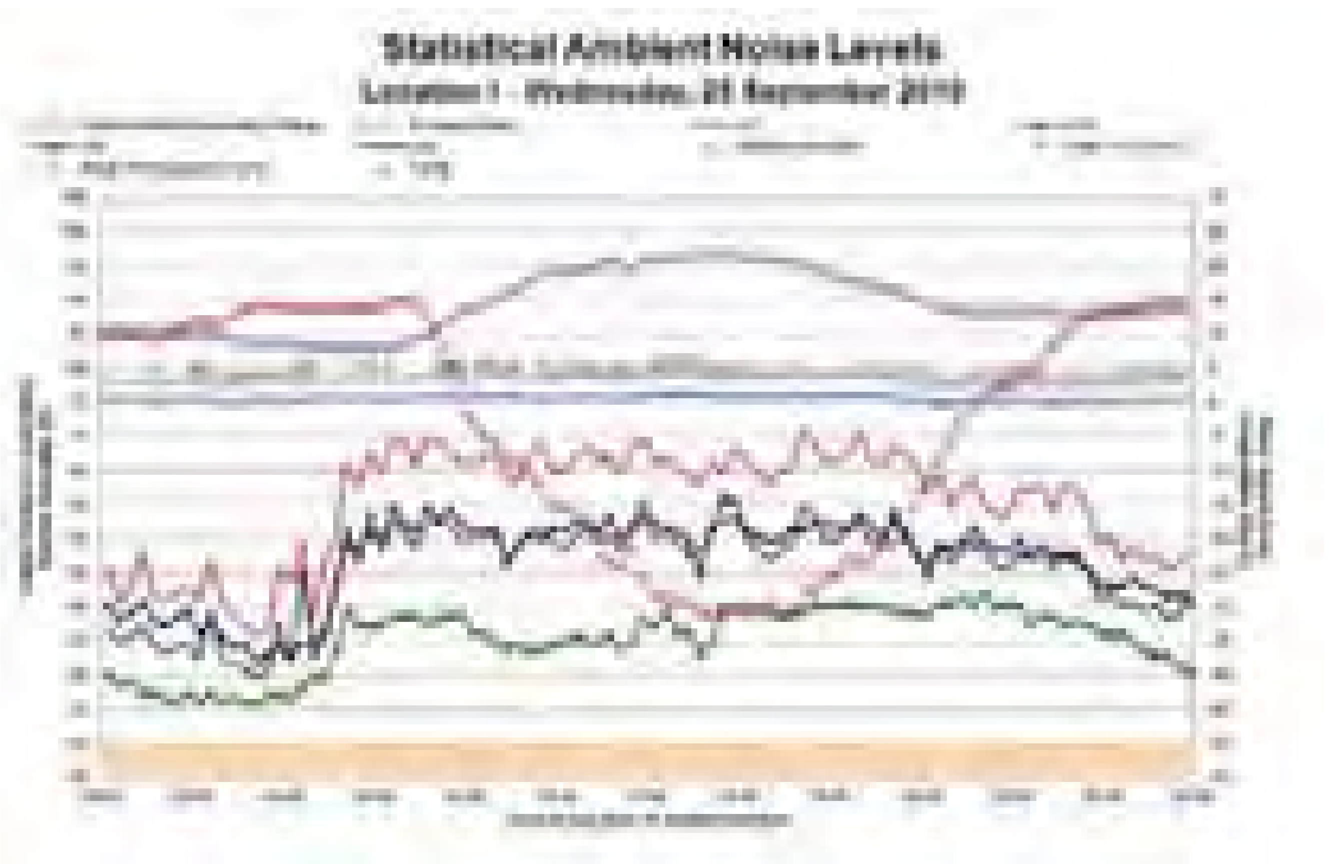
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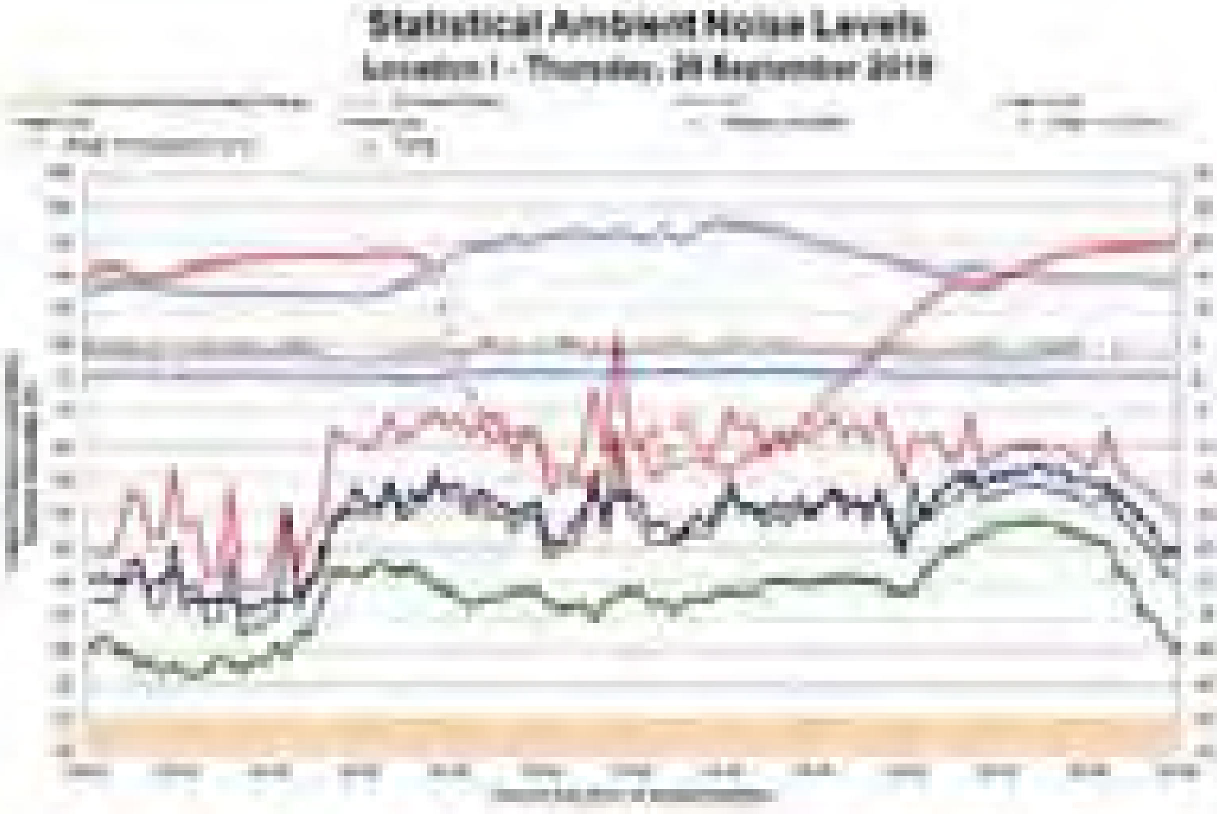
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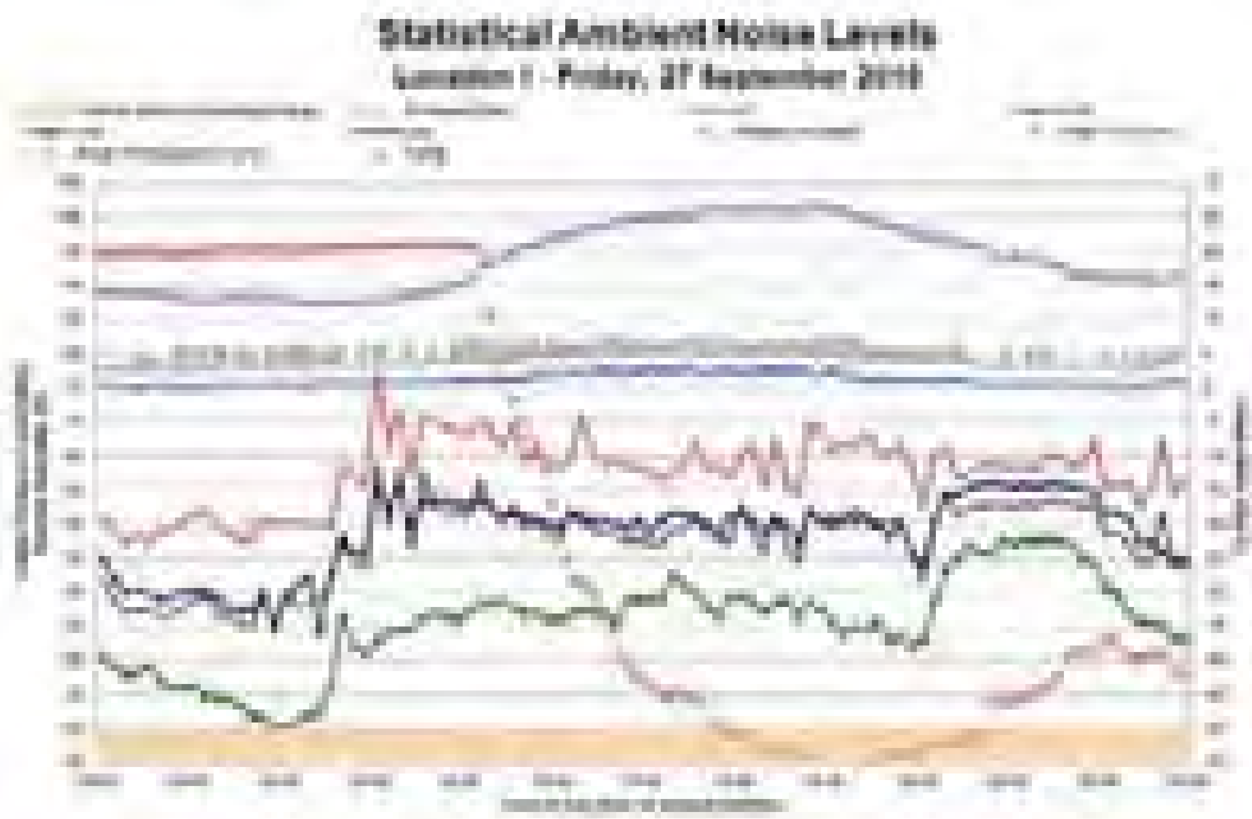
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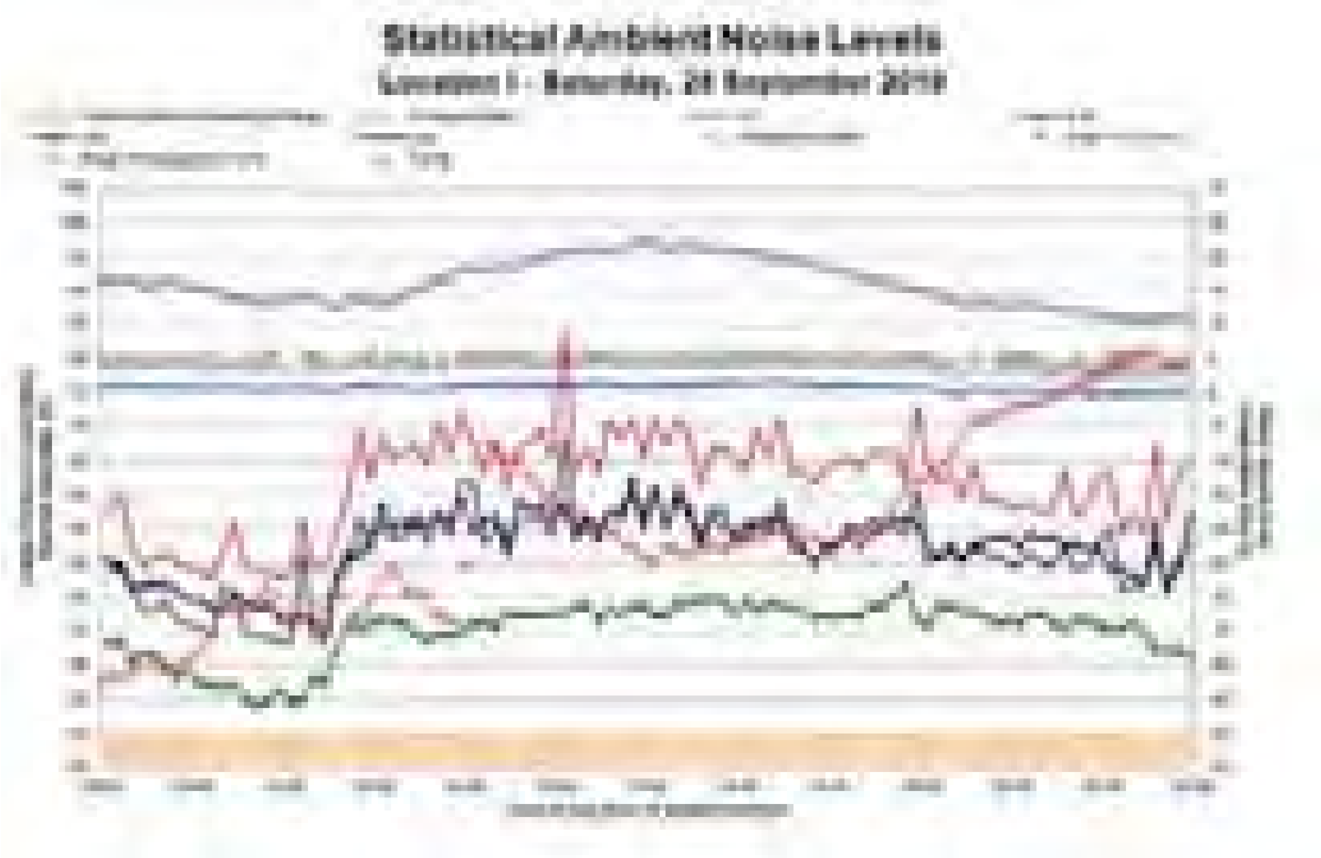
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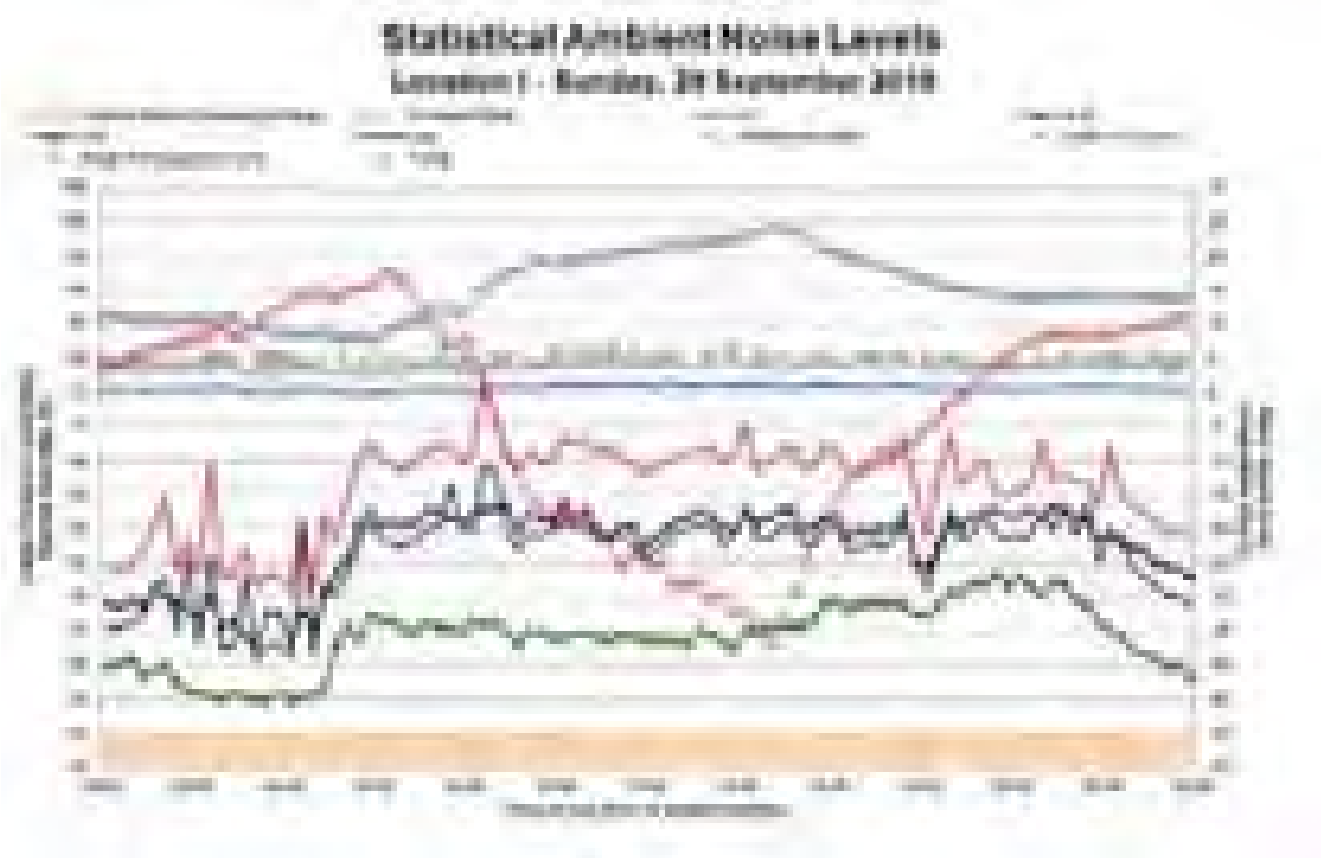
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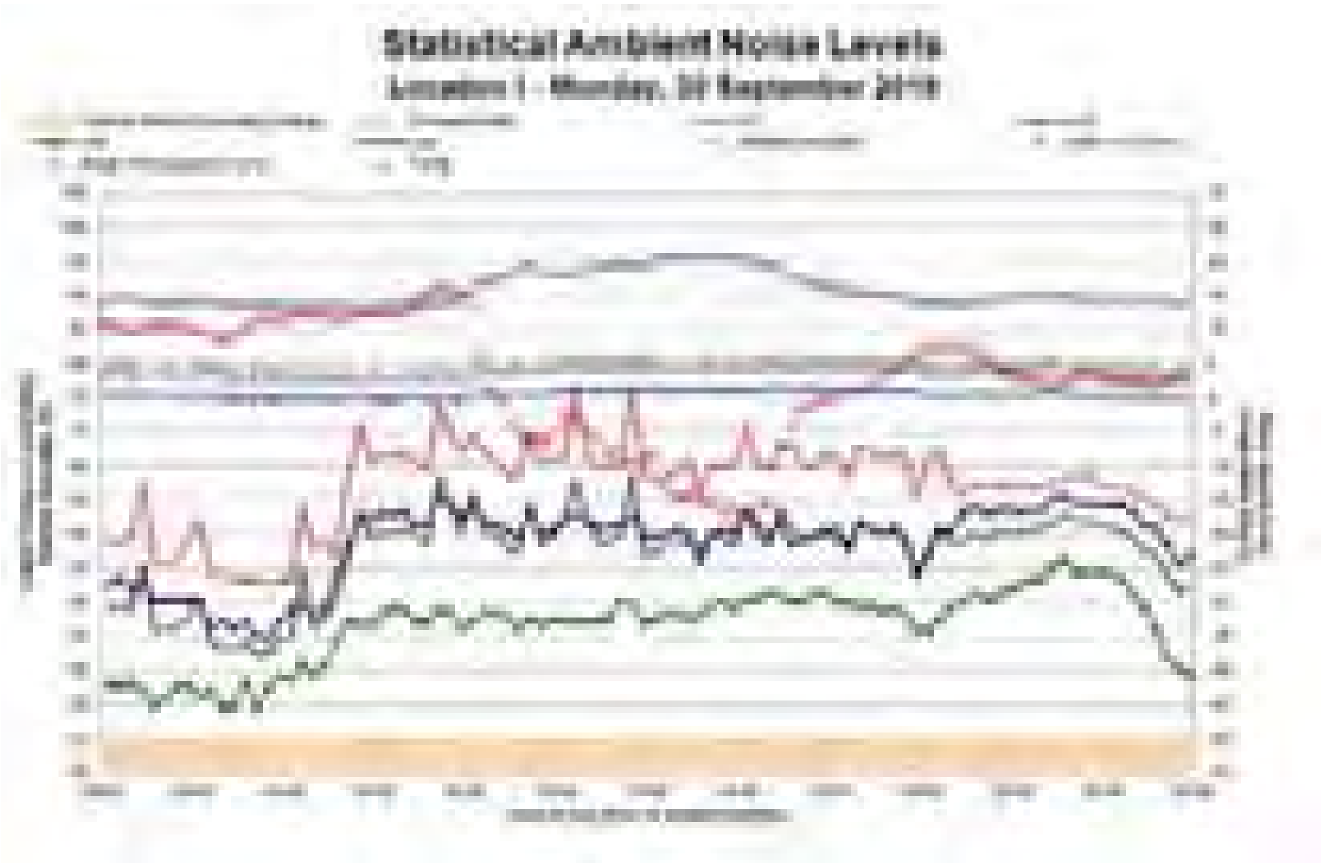
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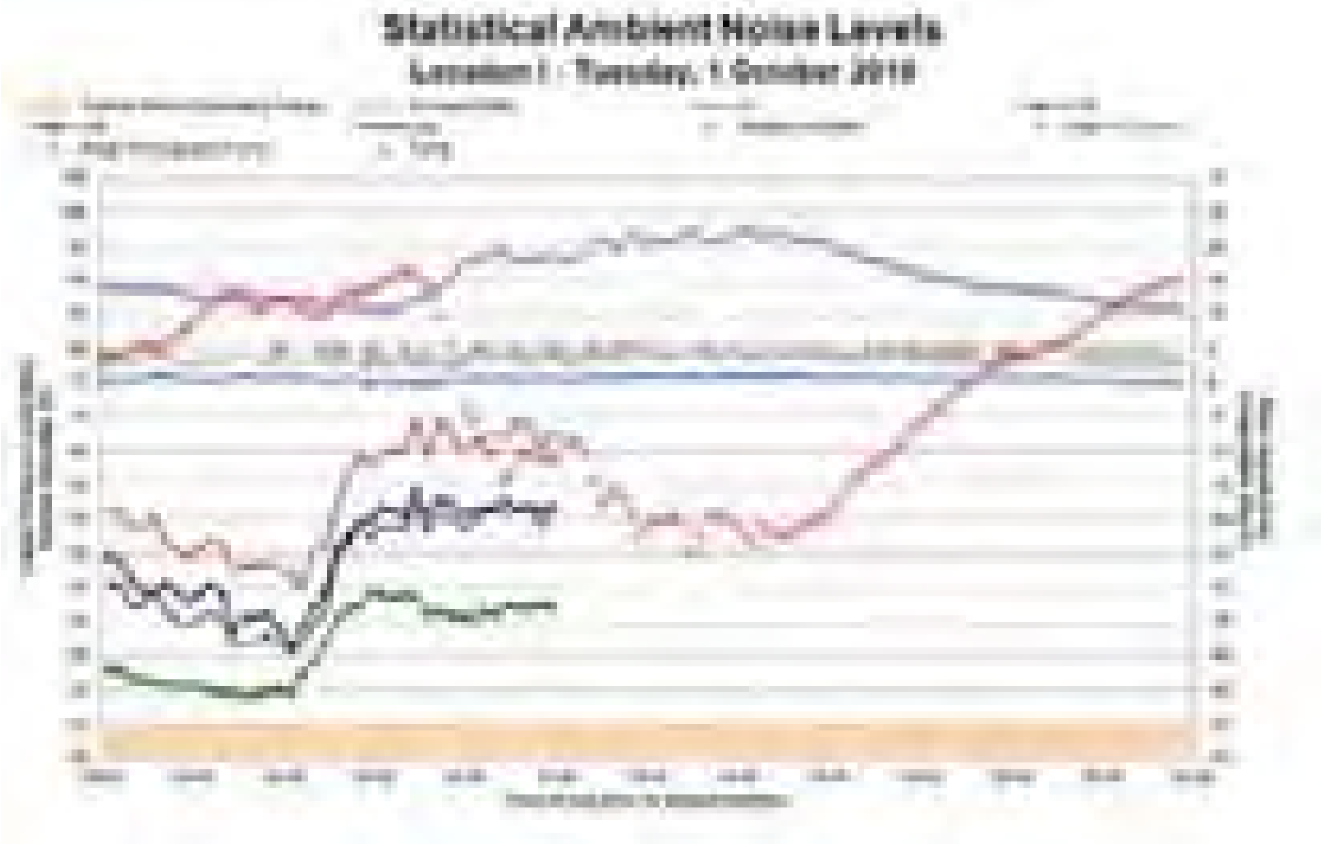
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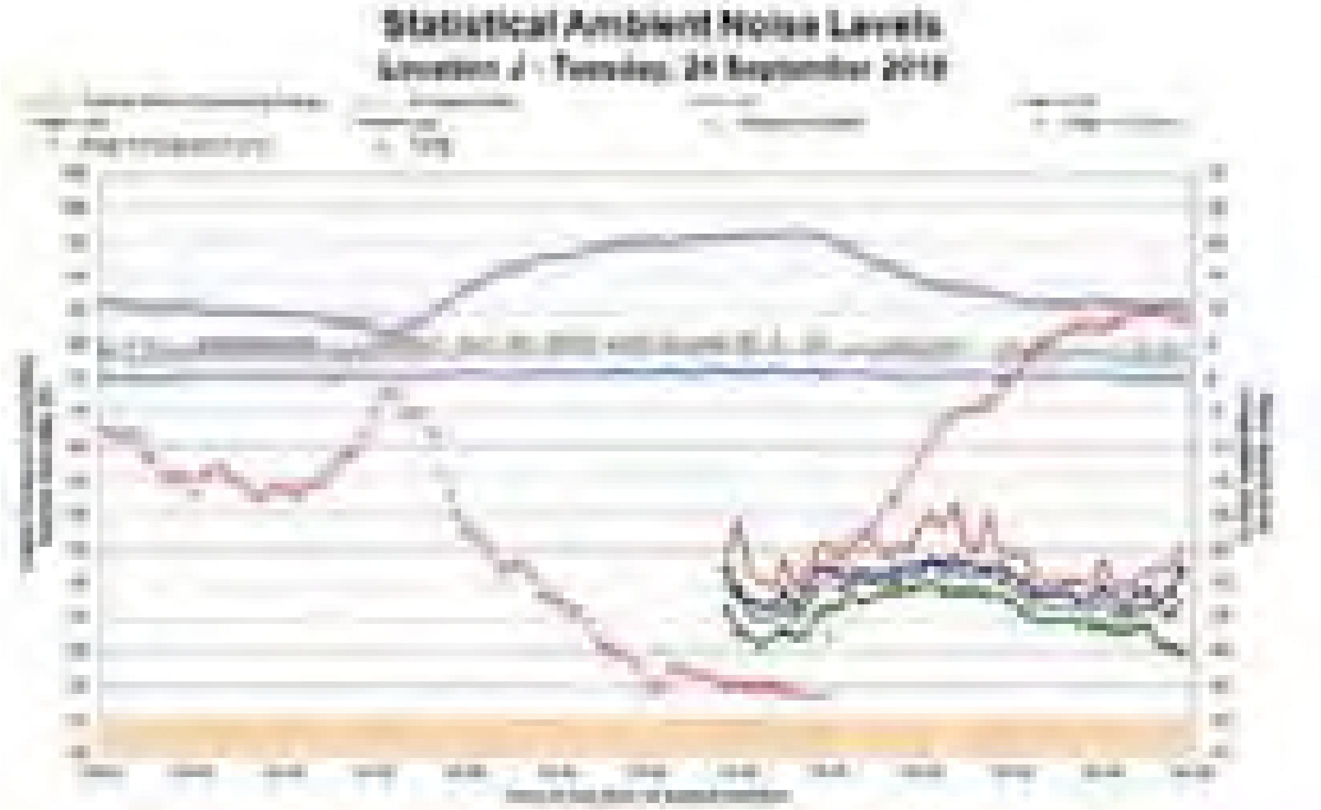
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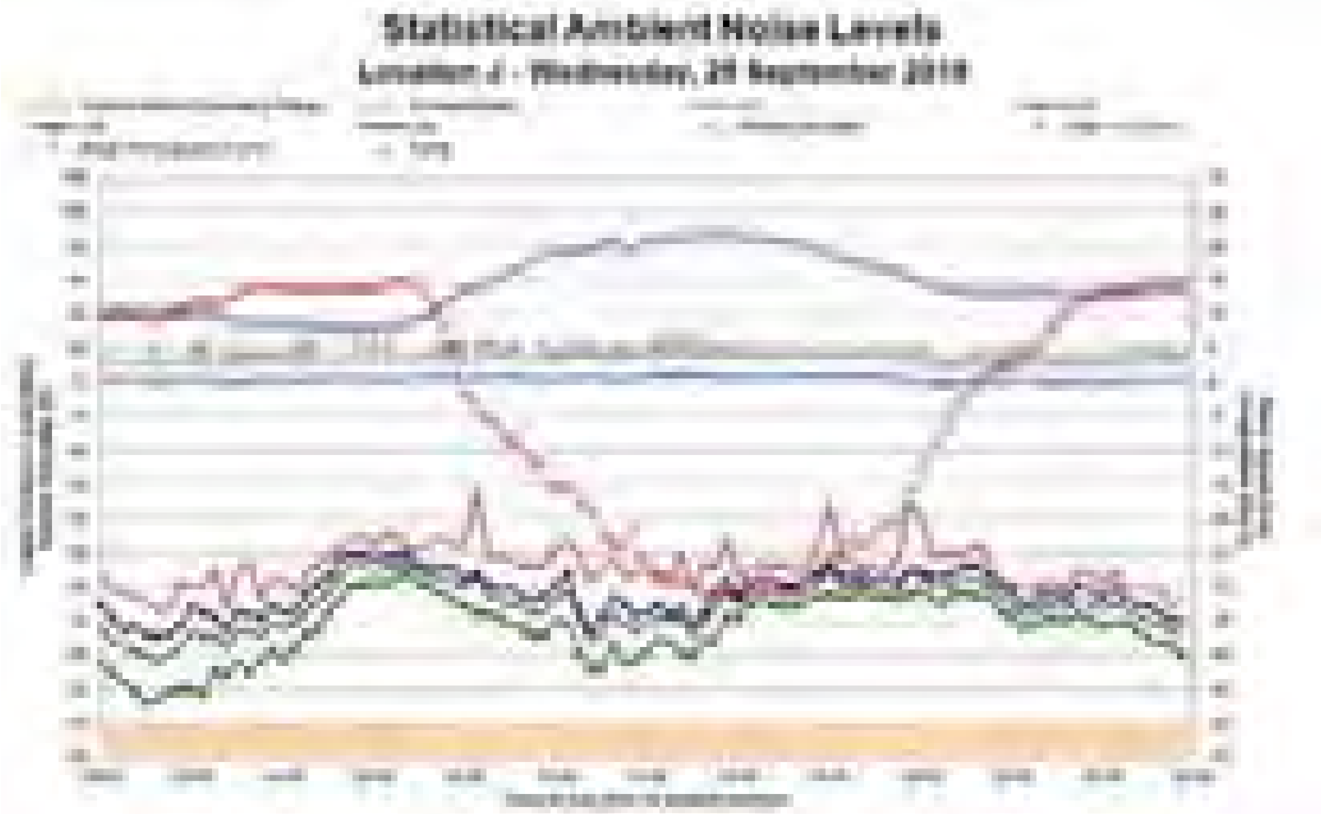
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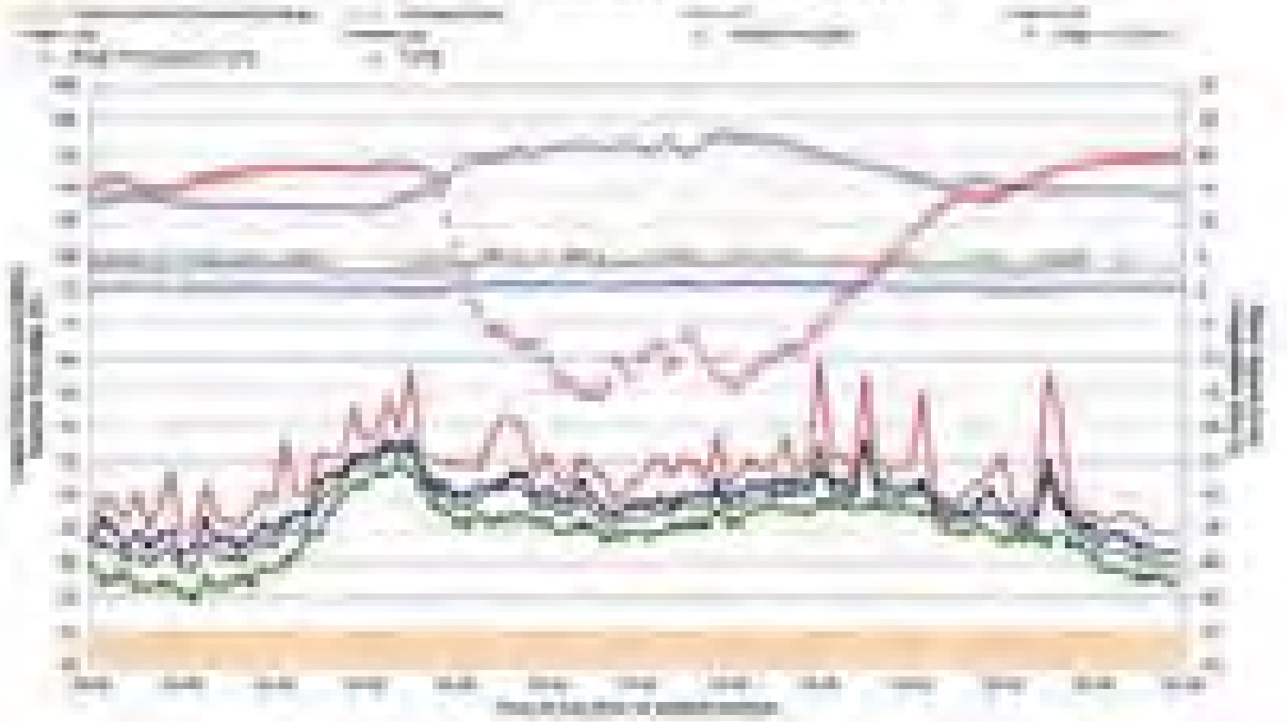

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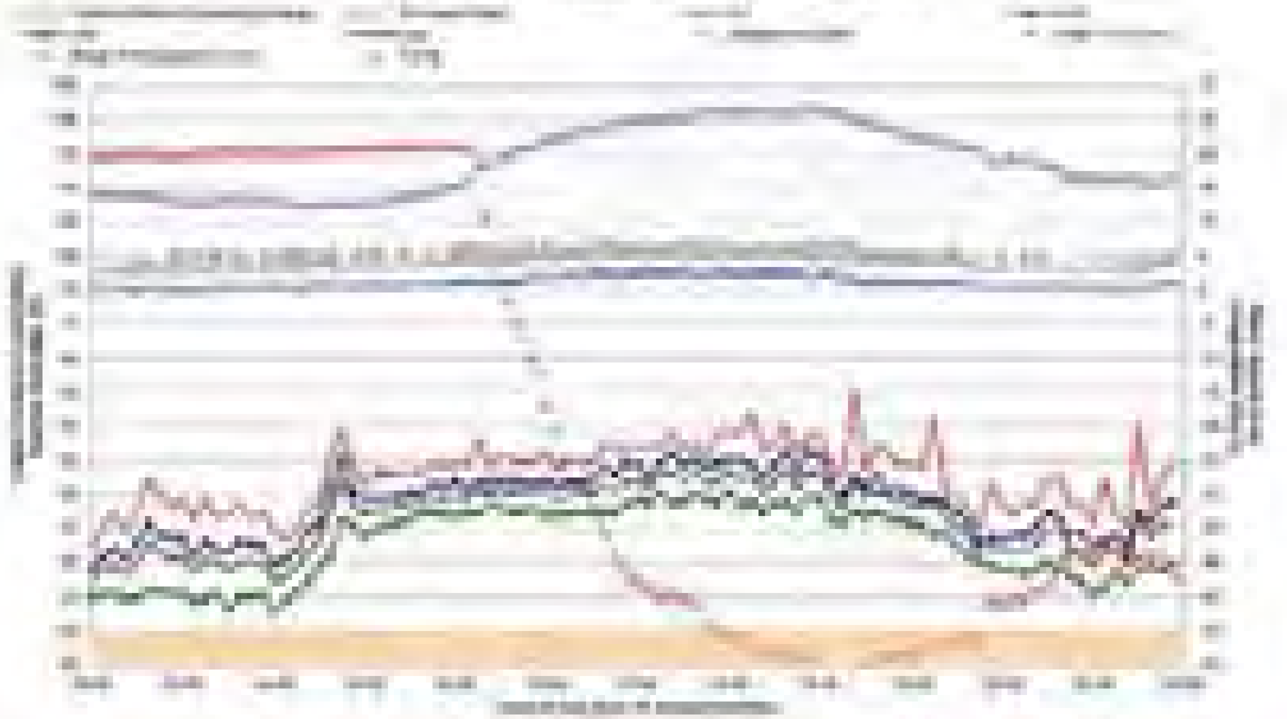

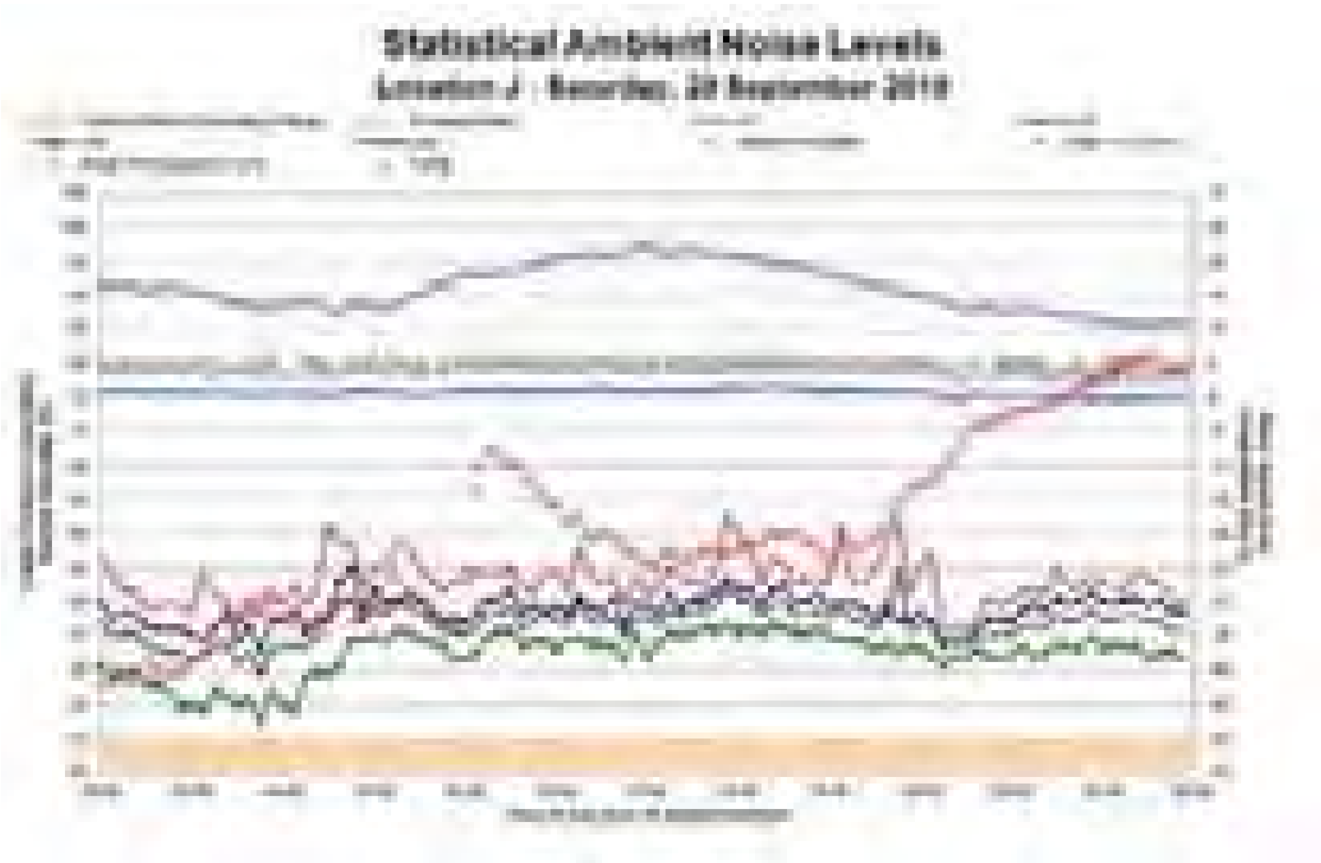
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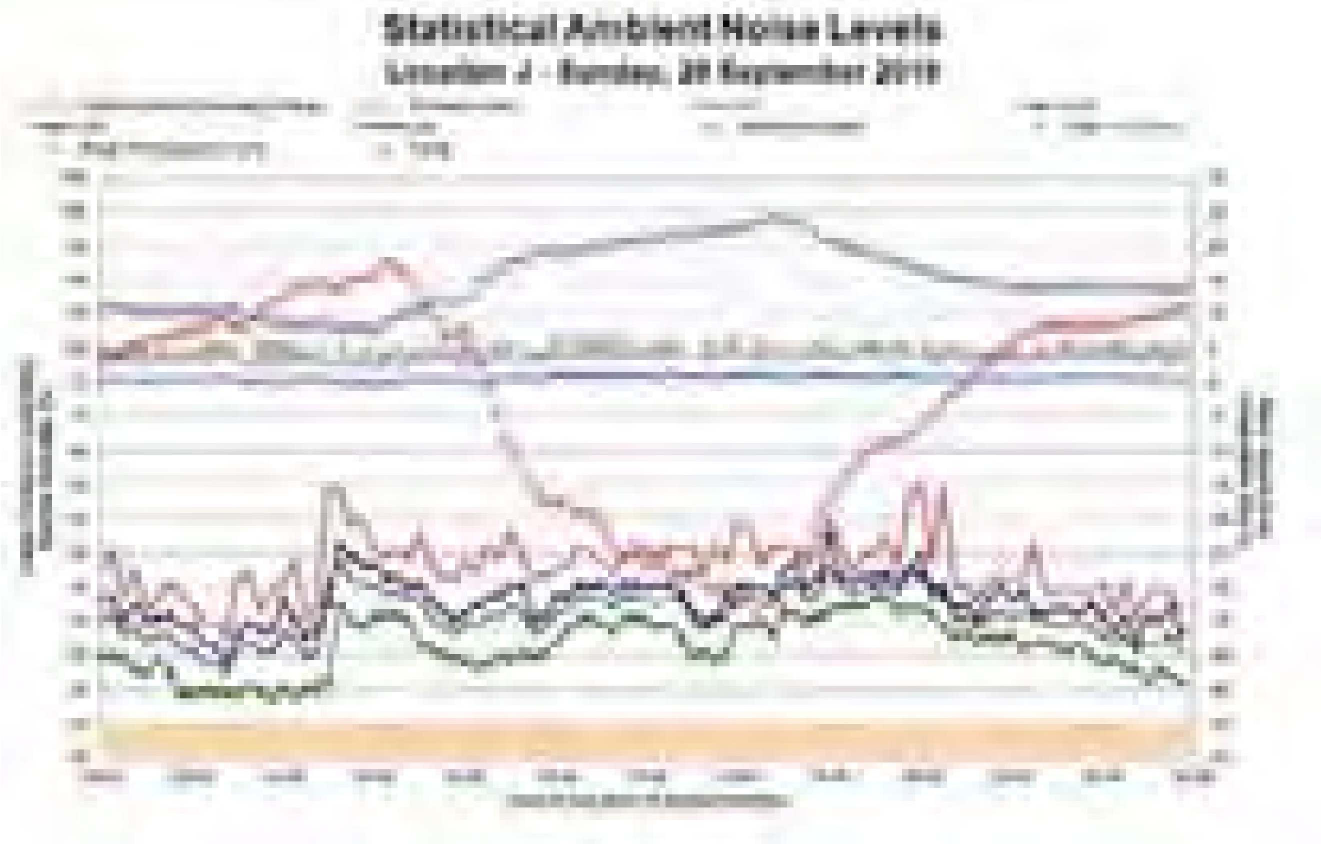
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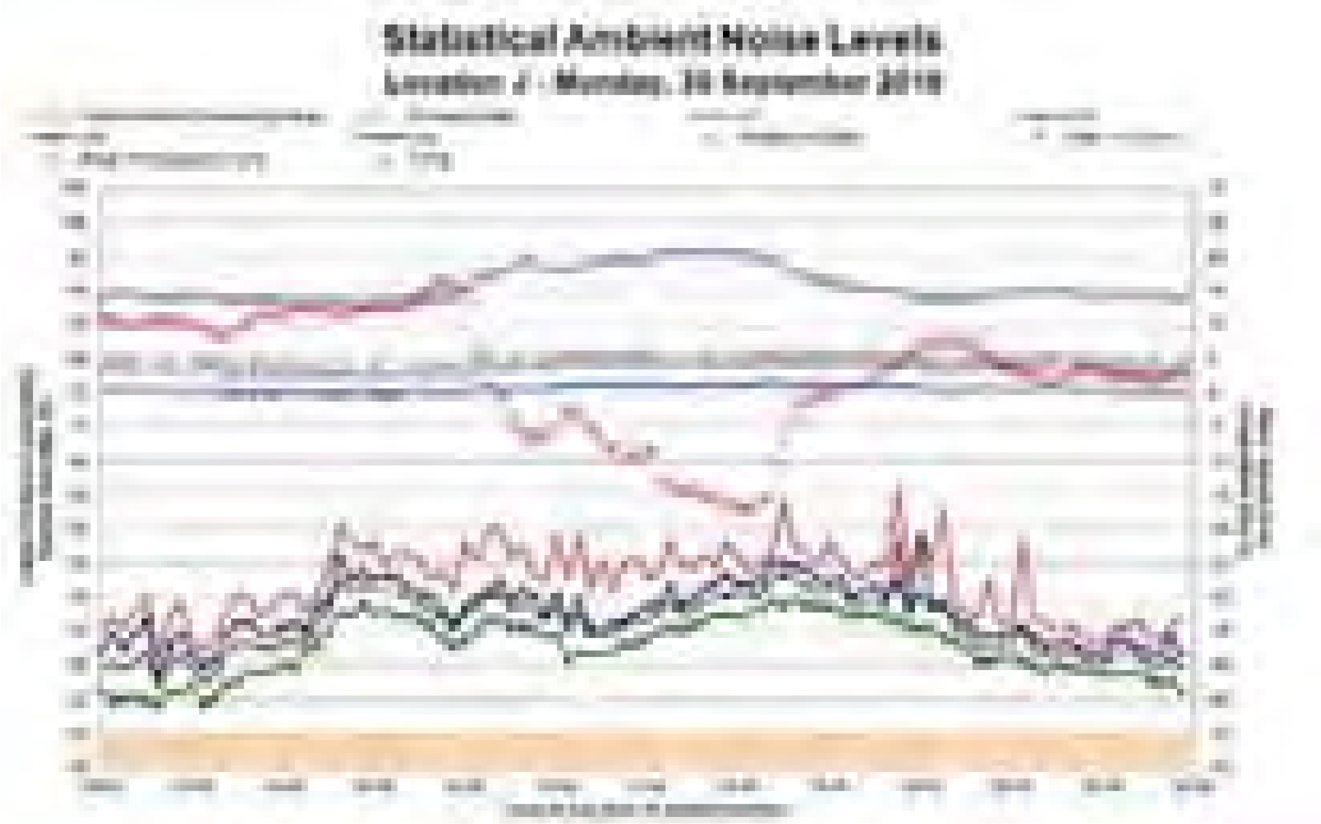
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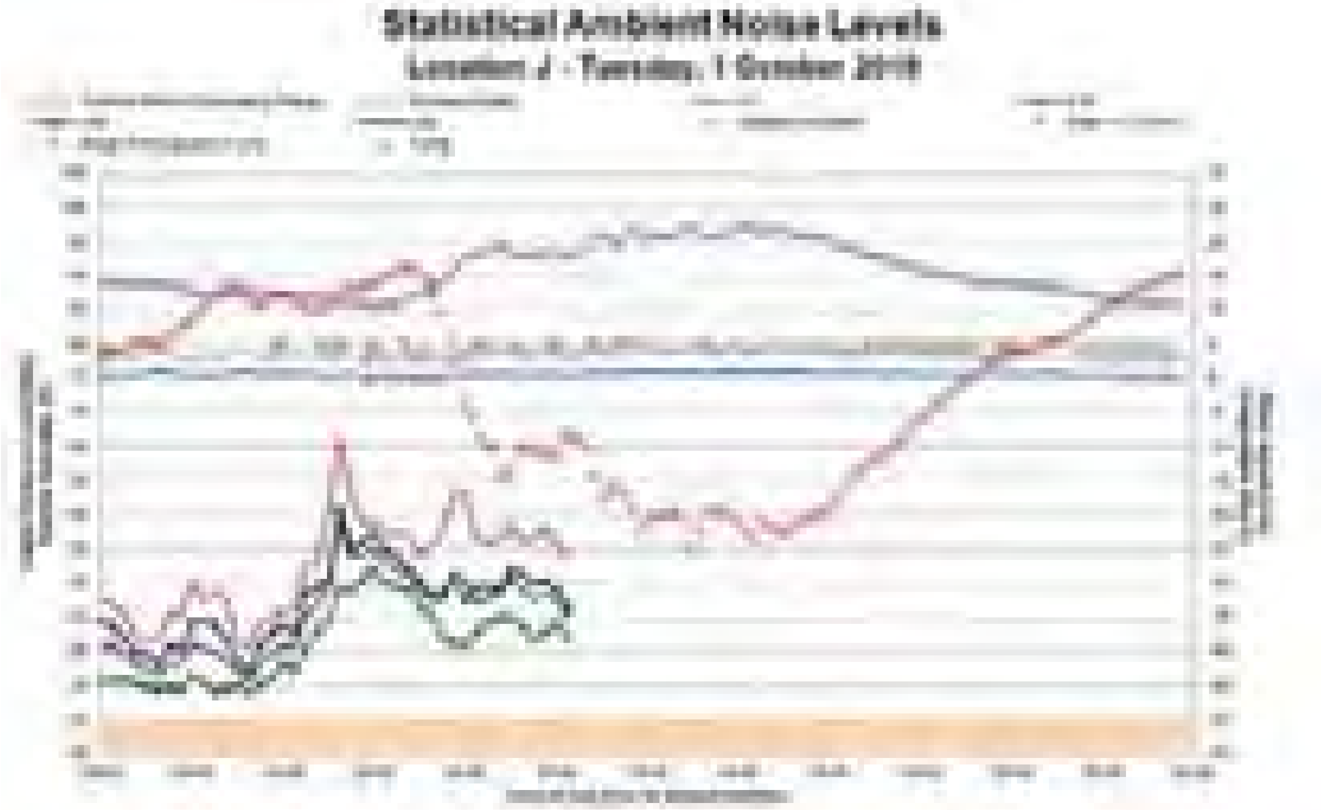
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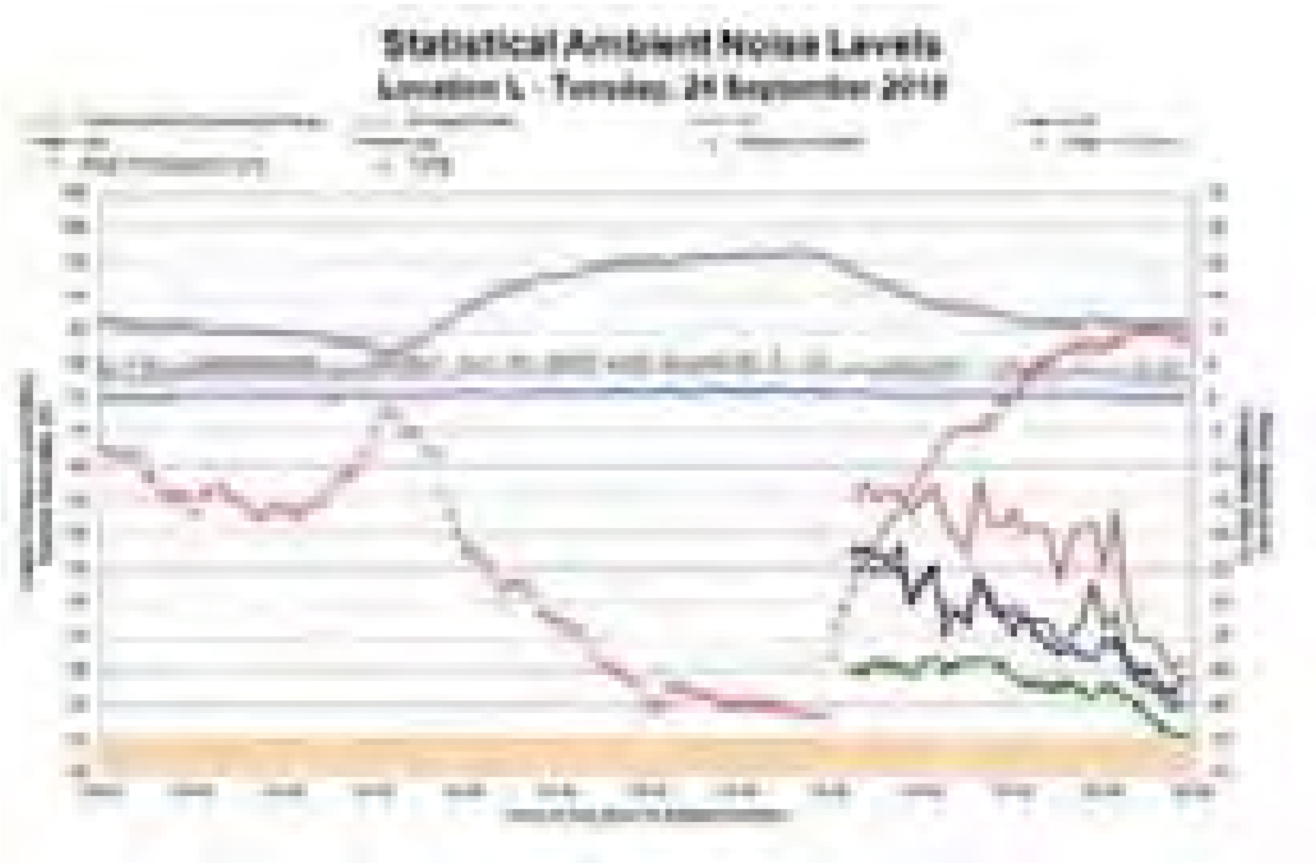
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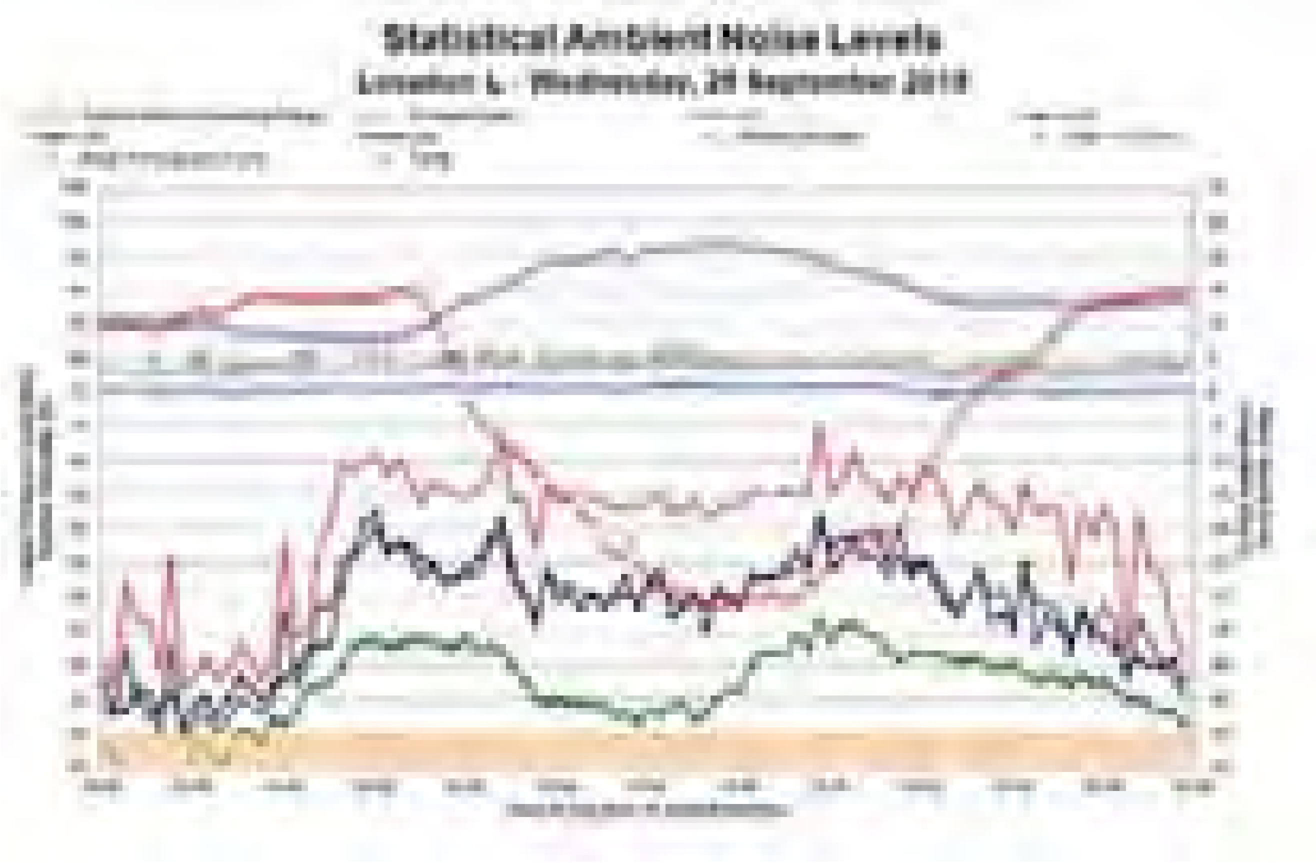
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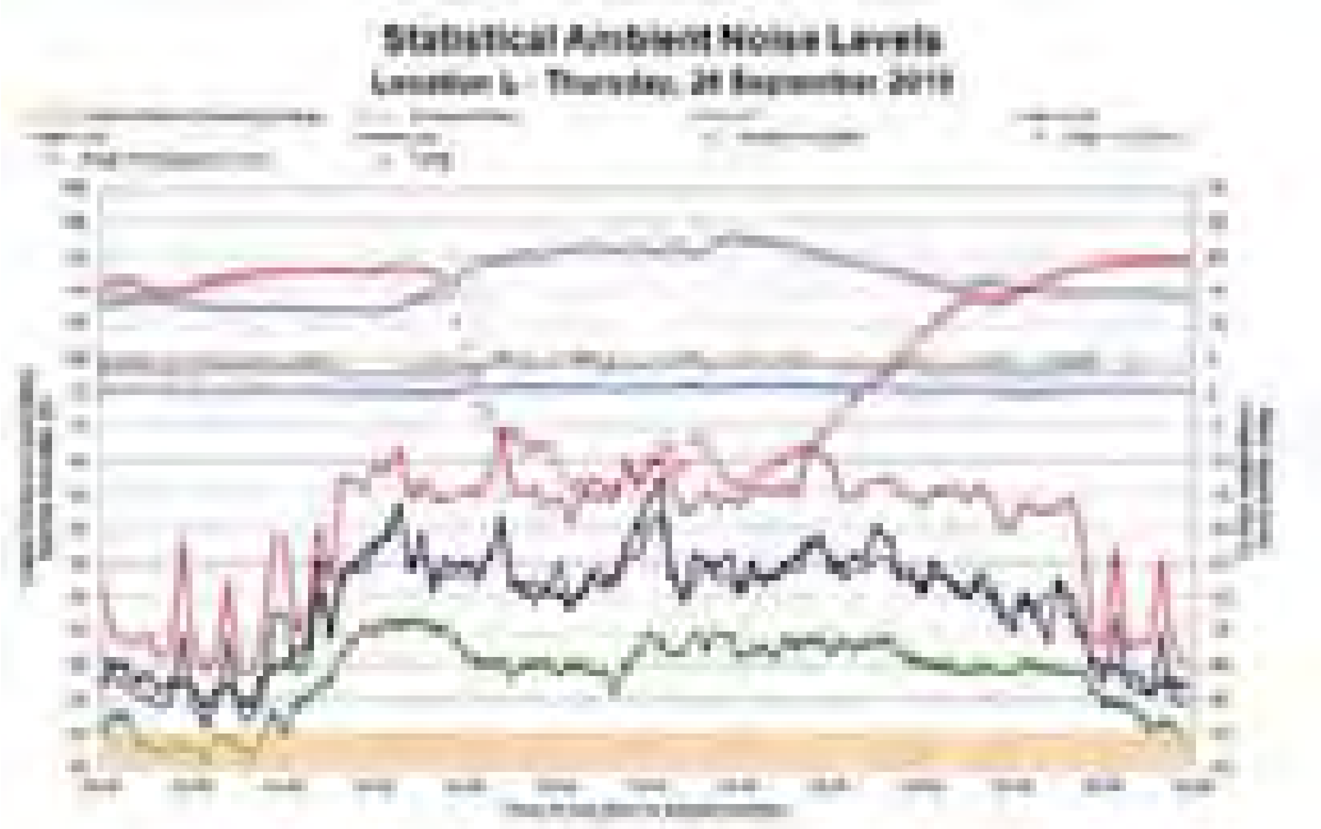
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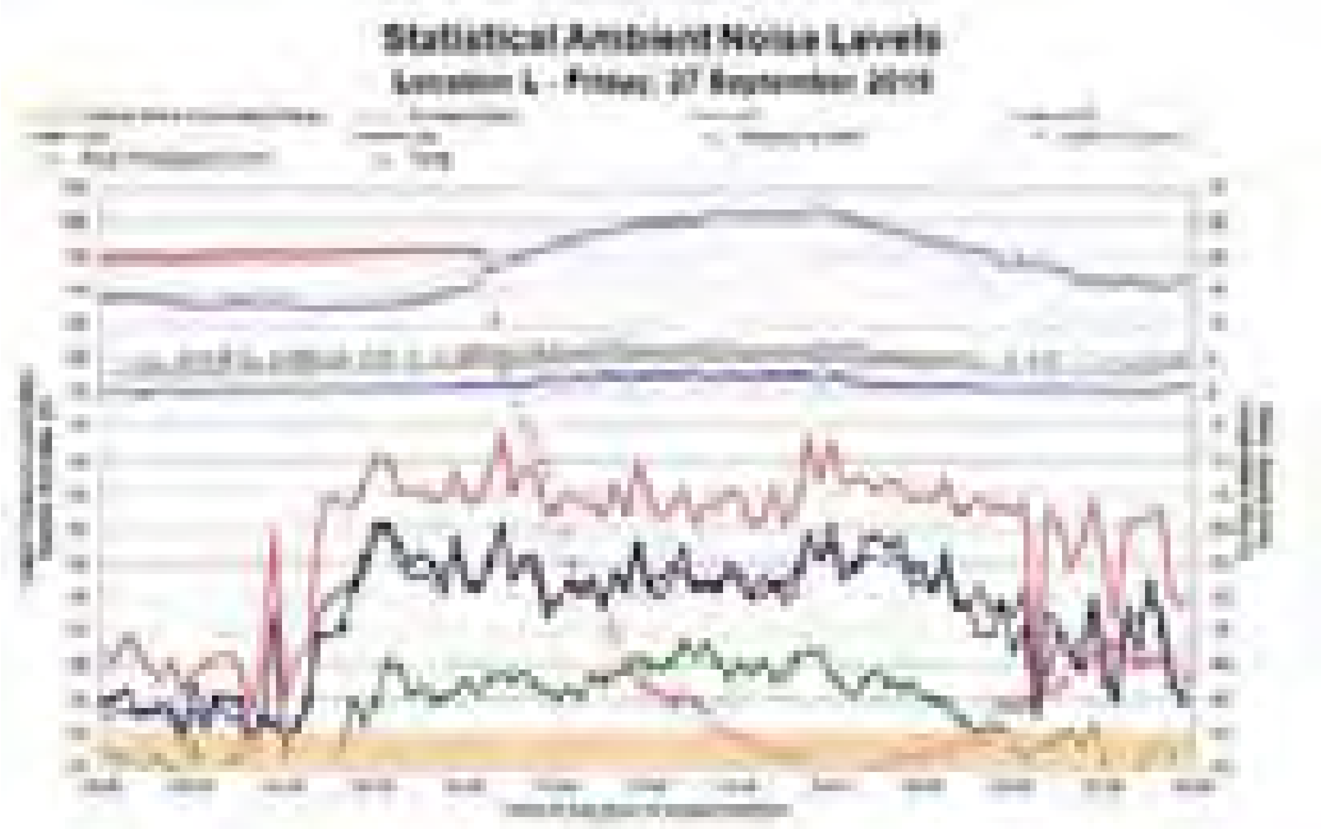
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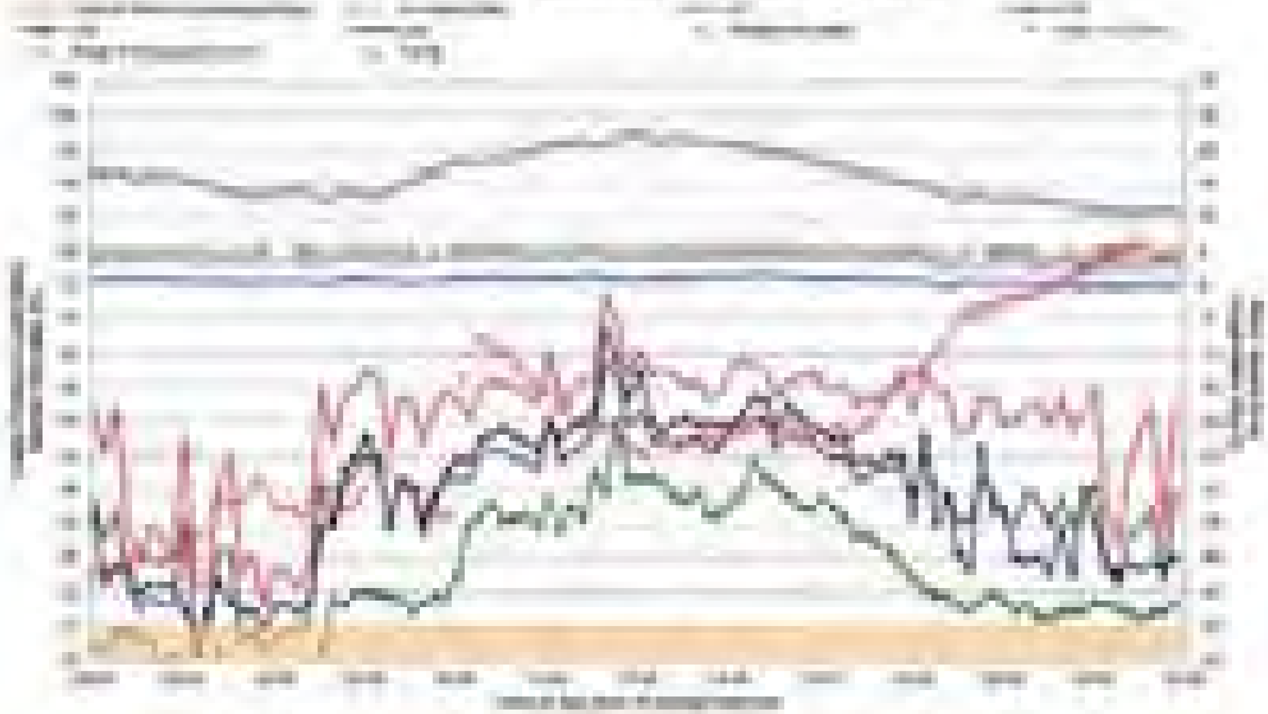

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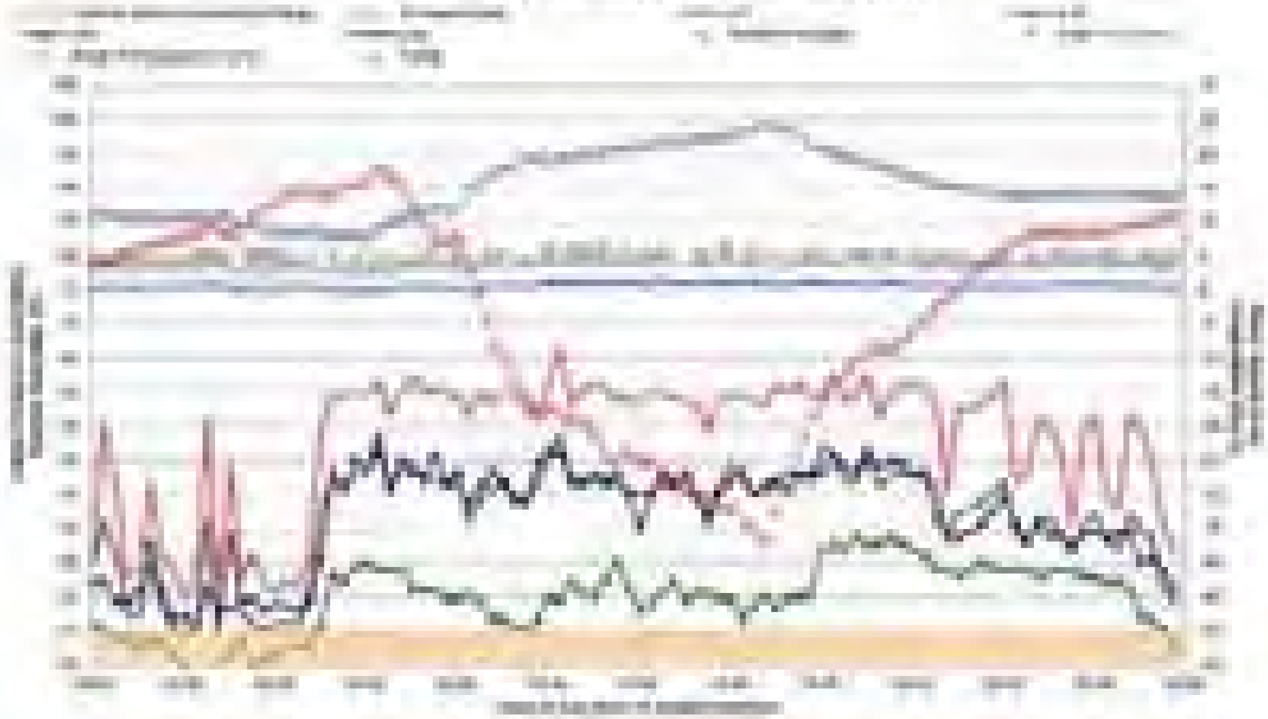

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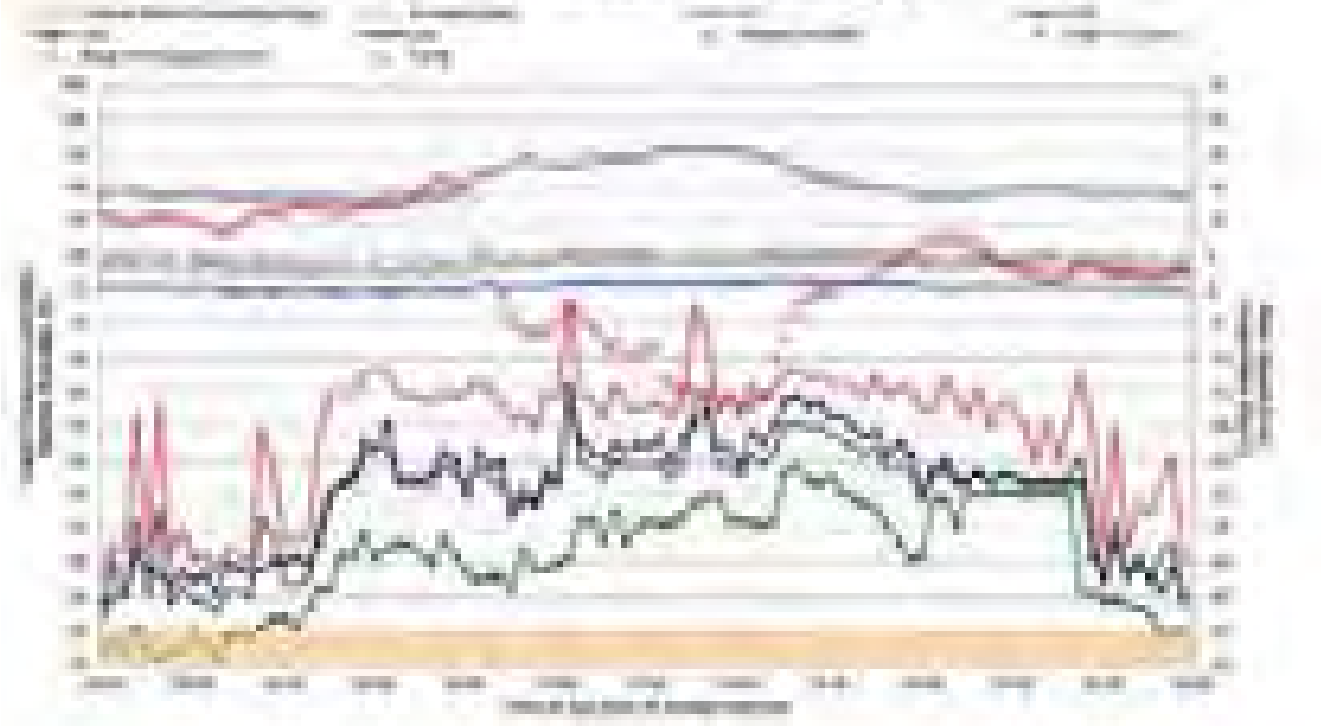

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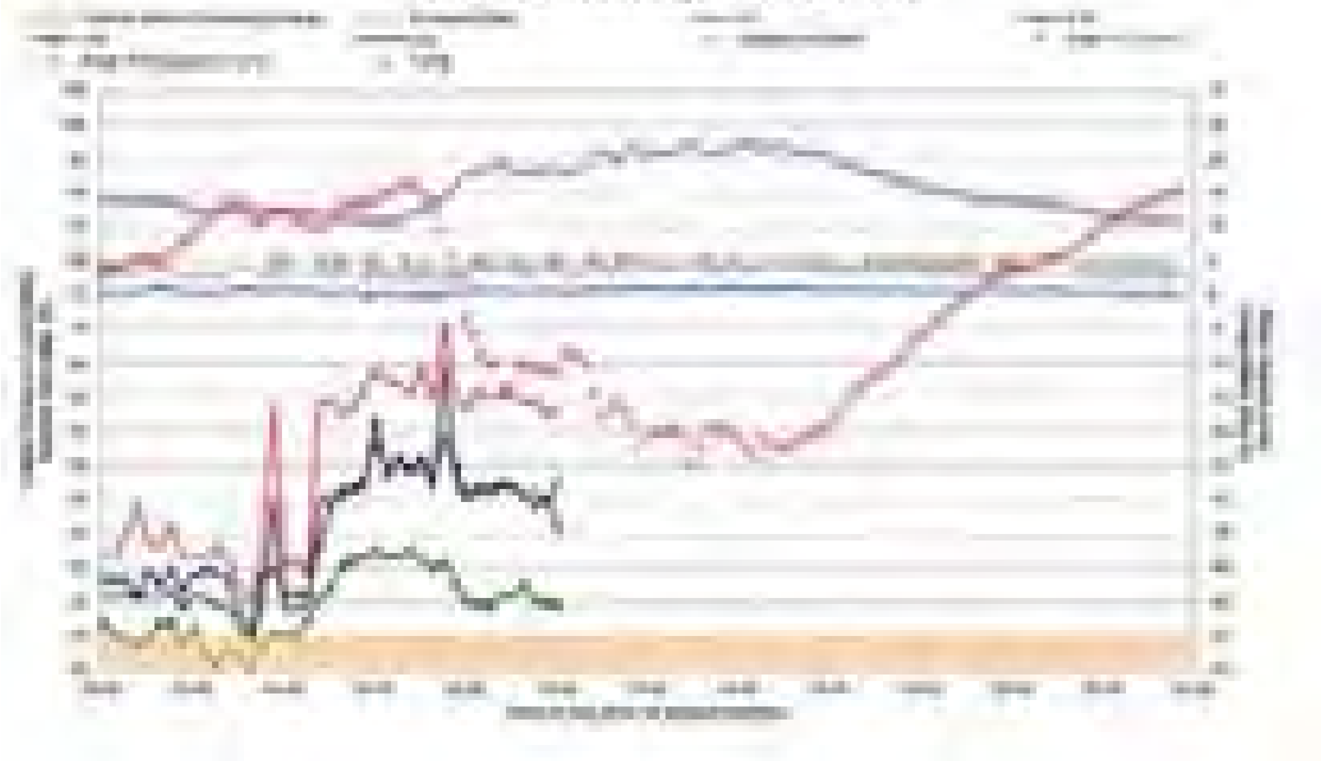

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DONALDSON AND ABEL COAL MINES

Quarterly Noise Monitoring
Quarter Ending December 2019

Prepared for:

Donaldson Coal Pty Ltd
PO Box 675
Green Hills 2320

SLR Ref: Q75 630.01053-R01
Version No: -v1.0
February 2020

PREPARED BY

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BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Donaldson Coal Pty Ltd (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
Q75 630.01053-R01-v1.0	24 February 2020	Martin Davenport	Jordan Murray	Martin Davenport

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FIGURES

APPENDICES

1 Introduction

1.1 Background

Donaldson Coal Pty Ltd has commissioned SLR Consulting Australia Pty Ltd (SLR) to conduct quarterly noise monitoring surveys for the Donaldson Coal Mine and Abel Coal Mine during the December 2019 quarter in accordance with the Donaldson Coal Mine and Abel Underground Coal Mine - Noise Management Plan Care and Maintenance (the NMP) dated 3 June 2019.

1.2 Objectives of this Report

The objectives of the noise monitoring survey for this operating quarter were as follows:

- Measure the ambient noise levels at six focus receptor locations (potentially worst affected) surrounding Donaldson Coal Mine and Abel Coal Mine.
- Qualify all sources of noise within each of the attended surveys, including estimated contribution or maximum level of individual noise sources.
- Assess the noise emissions of Donaldson Coal Mine and Abel Coal Mine with respect to the limits contained in the Development Consent.

1.3 Acoustic Terminology

The following report uses specialist acoustic terminology. An explanation of common terms is provided in Appendix A.

2 Development Consent Project Approval

Development consent was obtained by Donaldson Coal Pty Ltd for the Donaldson Mine in October 1999 following a Commission of Inquiry. Development Consent number N97/00147 was issued by the Minister for Urban Affairs pursuant to Section 101 of the Environmental Planning and Assessment Act 1979 (EP&A Act).

Project Approval (Application No. 05_0136) granted by the Minister of Planning was obtained by Donaldson Coal Pty Ltd for Abel Coal Mine in 2007.

2.1 Donaldson Coal Mine Development Consent Conditions

The Development Consent nominates hours of operation and mine noise emission goals in the Sections entitled "Operation of Development, Condition No. 3(1) and 3(2)", and "Noise and Vibrational Noise Limits: Condition No. 15" as follows:

3.(1) Subject to (2) the approved hours of operation are as follows:

Works	Period	Hours
Construction, including construction of any bunds	Monday to Friday Saturday	7 am to 6 pm 8 am to 1 pm
Mining operations, including mining, haulage of waste to dumps and coal processing	Monday to Friday Saturday, Sunday	24 hours per day 7 am to 6 pm
Road Transportation and stockpiling of coal	7 days per week	24 hours per day
Rail loading of coal	7 days per week	7 am to 10 pm
Maintenance of mobile and fixed plant	7 days per week	24 hours per day
Blasting, not involving closure of John Renshaw Drive	Monday to Saturday	7 am to 5 pm
Blasting, involving closure of John Renshaw Drive	Monday to Saturday	10 am to 2 pm

Notes: Restrictions on Public Holidays are the same as Sundays

(2) The Applicant shall submit a report to the Director-General's satisfaction demonstrating the noise limits in Condition 15 can be met while rail loading of coal is occurring during the period from 6 pm to 10 pm. If that report does not demonstrate that the noise limits can be met to the Director-General's satisfaction, then the hours of operation for rail loading of coal shall be restricted to 7 am to 6 pm."

15. Unless subject to a negotiated agreement in accordance with Condition 23, the Applicant shall ensure that the noise emission from construction or mining operations, when measured or computed at the boundary of any dwelling not owned by the applicant (or within 30 metres of the dwelling, if the boundary is more than 30 metres from the dwelling), shall not exceed the following noise limits:

Location	$L_{A10(15minute)}$ Noise Limits (dBA)	
	Daytime	Night-time
Beresfield area (residential)	45	35
Steggles Poultry Farm	50	40
Ebenezer Park Area	46	41
Black Hill Area	40	38
Buchanan and Louth Park Area	38	36
Ashtonfield Area	41	35
Thornton Area	48	40

Note: Daytime is 7 am to 10 pm Monday-Saturday, and 8 am to 10 pm Sundays and Public Holidays. Night-time is 10 pm to 7 am Monday-Saturday, and 10 pm to 8 am Sundays and Public Holidays.

The noise limits apply for prevailing meteorological conditions (winds up to 3 m/s), except under conditions of temperature inversions."

Other Conditions of Consent relevant to noise are as follows:

18. The applicant shall survey and investigate noise reduction measures from plant and equipment and set targets for noise reduction in each Annual Environmental Management Report (AEMR), taking into consideration valid noise complaints received in the previous year. The Report shall also include remedial measures.

19. The Applicant shall revise the Noise Management Plan as necessary and provide an updated Plan five years after commencement of mining to the Director-General, the independent noise expert (Condition 48), EPA, Councils and the Community Consultative Committee.

2.2 Abel Coal Mine – Project Approval

Approved Operations

The following operations are approved under the Abel Coal Mine Project Approval:

- Extraction of up to 6.1 Mtpa of Run of Mine (ROM) coal from the Abel Underground Coal Mine.
- Transport coal to the existing Bloomfield Coal Handling and Preparation Plant by private haul roads, or by coal conveyor, or by a combination of both methods.
- Operate the Bloomfield Coal Handling Processing Plant (CHPP) to process coal extracted from the Abel Coal Mine and the Bloomfield and Donaldson Coal Mines.
- Transportation of product coal from the Bloomfield site by rail via the Bloomfield rail loading facility.

The Project Approval was modified in June 2010 (05_0136 MOD 1) allowing construction and operation of a downcast ventilation fan. In May 2011 the Project Approval was modified again (05_0136 MOD 2) to allow the construction and operation of an upcast ventilation fan (and associated facilities). In December 2013 the Project Approval was further modified (05_0136 MOD3) to account for the increase in coal extracted including the upgrade of the Bloomfield CHPP.

Consent Conditions

The relevant conditions relating to noise from the Abel Coal Mine approval are reproduced below.

Schedule 4

NOISE

Operational Noise Criteria

1. The Proponent shall ensure that the noise generated by the Project does not exceed the criteria in Table 4 at any residence on privately-owned land.

Table 4: Operational Noise Criteria dB(A)

Location	Receiver Area	Day	Evening	Night	
		$L_{Aeq(15minute)}$	$L_{Aeq(15minute)}$	$L_{Aeq(15minute)}$	$L_{A1(1minute)}$
Location I	Lord Howe Drive, Ashtonfield	36	36	36	45
Location K	Catholic Diocese Land	37	37	37	45
Location L	Kilshanny Avenue, Ashtonfield	40	40	40	47
All other Locations	All other privately owned Residences	35	35	35	45

Notes:

- To interpret the locations referred to in Table 4, see plan in Appendix 3.
- Noise generated by the project is to be measured in accordance with the relevant requirements, and exemptions (including certain meteorological conditions), of the NSW Industrial Noise Policy. Appendix 4 sets out the meteorological conditions under which these criteria apply, and the requirements for evaluating compliance with these criteria.

These noise criteria do not apply if the Proponent has an Agreement with the relevant landowner to generate higher noise levels, and the proponent has advised the Department in writing of the terms of this agreement.

Construction Noise Criteria

1. The proponent shall ensure that the noise generated during the construction of the downcast ventilation shaft as described in EA (MOD3) does not exceed the criteria in Table 5.

Table 5: Construction Noise Criteria dB(A)

Location	Receiver	Day
		LAeq(15minute)
Location R	281 Lings Road, Buttai	50
Location S	189 Lings Road, Buttai	43

Notes:

- The criteria in Table 5 apply only whilst the downcast ventilation shaft is being constructed, and for a maximum of 12 weeks from the commencement of construction.
- To interpret the locations referred to in Table 5, see plan in Appendix 3 (attached to this report as Appendix A).
- Noise generated by the project is to be measured in accordance with the relevant requirements, and exemptions (including certain meteorological conditions), of the NSW Industrial Noise Policy.

However, these noise criteria do not apply if the Proponent has an Agreement with the relevant landowner to generate higher noise levels, and the proponent has advised the Department in writing of the terms of this agreement.

Rail Noise Criteria

1. The proponent shall ensure that the noise from rail movements on the Bloomfield Rail Spur does not exceed the limits in Table 6 at any residence on privately owned land.

Table 6: Rail Spur noise criteria dB (A)

Location	Day	Evening	Night
	LAeq(period)		
All privately-owned land	55	45	40

Cumulative Noise Criteria

1. The proponent shall implement all reasonable and feasible measures to ensure that the noise generated by the project combined with noise generated by other mines does not exceed the criteria in Table 7 at any residence on privately-owned land.

Table 7: Cumulative noise criteria dB (A)

Location	Day	Evening	Night
	LAeq(period)		
All privately-owned land	55	45	40

Notes: Cumulative noise is to be measured in accordance with the relevant requirements, and exemptions (including meteorological conditions), of the NSW Industrial Noise Policy. Appendix 4 sets out the metrological conditions under which these criteria apply and the requirements for evaluating compliance with these criteria.

Operating Conditions

1. The proponent shall:
    a. Implement best management practise to minimise the construction, operational, road and rail noise of the project;
    b. Operate an on-site noise management system to ensure compliance with the relevant conditions of this approval;
    c. Minimise the noise impacts of the project during meteorological conditions under which the noise limits in this consent do not apply (see Appendix 4);
    d. Only receive and/or dispatch locomotives and rolling stock either on or from the site that are approved to operate on the NSW rail network in accordance with the noise limits in ARTC's EPL (No. 3142);
    e. Carry out regular monitoring to determine whether the project is complying with the noise criteria and other relevant conditions of approval, to the satisfaction of the Director-General.

Noise Management Plan

2. The proponent shall prepare and implement a Noise Management Plan for the project to the satisfaction of the Director-General. This plan must:
    a. Be prepared in consultation with the EPA, and be submitted to the Director-General for approval within 6 months of the date of approval of MOD 3;
    b. Describe the measures that would be implemented to ensure compliance with the noise criteria and operating conditions in this approval; Describe the proposed noise management system in detail; and
    c. Include a monitoring program that:
        - Uses attended monitoring to evaluate the compliance of the project against the noise criteria in this approval;
        - Evaluates and reports on:
            - The effectiveness of the on-site noise management system; and
            - Compliance against the noise operating conditions; and

Defines what constitutes a noise incident, and includes protocol for identifying and notifying the Department and relevant stakeholders of any noise incidents. Appendix 4

Noise Compliance Assessment

Applicable Meteorological Conditions

1. The noise criteria in Tables 4 and 7 are to apply under all metrological conditions except the following:
    a. During periods of rain or hail.
    b. Average wind speed at microphone height exceeds 5 m/s;
    c. Wind speeds greater than 3 m/s measured at 10m above ground level; or
    d. Temperature inversion conditions greater than 3ºC/100m.

Determination of metrological conditions

2. Except for wind speed at microphone height, the data to be used for determining metrological conditions shall be that recorded by the meteorological station located on the site.

Compliance monitoring

3. Attended monitoring is to be used to evaluate compliance with the relevant conditions of this approval.
4. Unless otherwise agreed with the director-general, this monitoring is to be carried out in accordance with the relevant requirements for reviewing performance set out in the NSW Industrial Noise Policy (as amended from time to time), in particular the requirements relating to:
    a. Monitoring locations for the collection of representative noise data;
    b. Metrological conditions during which collection of noise data is not appropriate;
    c. Equipment used to collect noise data, and conformity with Australian Standards relevant to such equipment; and
    d. Modification to noise data collected, including for the exclusion of extraneous noise and/or penalties for modifying factors apart from adjustments for duration.

Appendix 5

Statement of Commitments

3. Noise

3.1 Construction Activities

The following noise control measures will be implemented prior to commencement of construction of the Abel Underground Mine or the upgrade of the Bloomfield CHPP.

1. Maintain all machinery and equipment in working order;
    a. No construction activities at the Abel pit top will take place on Sundays or Public Holidays;
    b. Where possible locate noisy site equipment behind structures that act as barriers or at the greatest distance from noise sensitive areas; and
    c. Orientate equipment so that noise emissions are directed away from noise sensitive areas.

3.2 Noise Control Measures

a. The following noise control measures will be implemented prior to the mining of coal from the Abel underground Mine:
    i. Orientation of the ventilation fans away from residential receivers and angle the output parallel to the ground.
    ii. The sound power level of the front end loader to be used near the portal should not exceed 113 dBA and will be fitted with a noise sensitive reversing alarm.
b. The following noise control measures will be implemented prior to the Bloomfield CHPP receiving any ROM coal from Able Underground Mine;

i. Noise mitigation works including partial enclosure and noise screening of drives and conveyors of the Bloomfield CHPP to screen residences to the north of the site.

3.2 Monitoring

The Company will implement a Noise Monitoring Program for the Abel Underground Mine and the Bloomfield CHPP, to the satisfaction of the Director-General. The Noise Monitoring Program shall include a combination of real-time and supplementary attended monitoring measures, and a noise monitoring protocol for evaluating compliance with the noise environmental assessment. This plan will be integrated with the monitoring plans for the Tasman, Donaldson and Bloomfield Mines to provide a single integrated Noise Monitoring Program for all 4 mines.

3.4 Continuous Improvement

The Company shall:

a. Report on these investigations and implementation of any new noise mitigation measures on site in the AEMR, to the satisfaction of the Director General.

The operator of the Bloomfield CHPP shall:

b. Investigate ways to reduce the noise generated by the Bloomfield CHPP, including maximum noise levels which may result in sleep disturbance;

c. Implement all reasonable and feasible best practice noise mitigation measures on the site; and

d. Report on these investigations and the implementation of any new noise mitigation measures on site in the AEMR, to the satisfaction of the Director-General.

3 Noise Monitoring Methodology

3.1 General Requirements

The operational noise monitoring program was conducted with reference to Development Consent N97/00147 (Donaldson Coal Mine), Project Approval 05_0136 (Abel Coal Mine), the NMP and AS 1055-2018 Acoustics - Description and Measurement of Environmental Noise.

All acoustic instrumentation employed throughout the monitoring program has been designed to comply with the requirements of AS IEC 61672.1 – 2004 Electroacoustics—Sound level meters – Specifications, AS IEC 61672.2-2004, AS IEC 61672.3-2004 and carried current NATA or manufacturer calibration certificates. Certificates for acoustic instrumentation used during the December 2019 quarter is provided in Appendix B.

Instrument calibration was conducted before and after each measurement, with the variation in calibrated levels not exceeding ±0.5 dBA.

3.2 Monitoring Locations

Baseline and preceding operational quarterly surveys have been conducted at 11 locations surrounding the Donaldson Mine and Abel Coal Mine sites. With the experience of these previous surveys, it was decided to concentrate noise monitoring at six focus locations that represent the potentially most noise affected areas from Donaldson Mine and Abel Coal Mine. The details of the monitoring locations are contained within Table 1.

It is relevant to note that Donaldson Open Cut Mine has ceased production and all major earthworks on the site have been finalised. Furthermore, Abel mine was placed in Care & Maintenance on 28th April 2016 and there was no operations onsite during the December 2019 noise monitoring period.

Table 1 Monitoring Locations

Noise Monitoring Location	Description
D	Black Hill School, Black Hill
F	Lot 684 Black Hill Road, Black Hill
G	156 Buchannan Road, Buchannan
I	Magnetic Drive, Ashtonfield
J	Parish Drive, Thornton
L	65 Tipperary Dr, Ashtonfield

A map giving the approximate location of the noise monitoring sites is contained within Appendix C.

3.3 Unattended Continuous Noise Monitoring

An environmental noise logger was deployed for a minimum of a seven day period between Thursday 12 December 2019 and Friday 20 December 2019 at each of the six (6) nominated locations given in Table 1.

All unattended monitoring equipment was programmed to continuously record statistical noise level indices in 15 minute intervals including the L_{Amax}, L_{A1}, L_{A10}, L_{A90}, L_{A99}, L_{Amin} and L_{Aeq}. The statistical noise exceedance levels (L_{AN}) are the levels exceeded for N% of the 15 minute interval. The L_{A90} represents the level exceeded for 90% of the interval period and is referred to as the average minimum or background noise level. The L_{A10} is the level exceeded for 10% of the time and is usually referred to as the average maximum noise level. The L_{Aeq} is the equivalent continuous sound pressure level and represents the steady sound level which is equal in energy to the fluctuating level over the interval period. The L_{Amax} is the maximum noise level recorded over the interval.

3.4 Operator Attended Noise Monitoring

Operator attended surveys were conducted at each of the six monitoring locations during the daytime, evening and night-time periods, to verify the unattended logging results and to determine the character and contribution of ambient noise sources.

4 Operator Attended Noise Monitoring

4.1 Results of Operator Attended Noise Monitoring

Operator attended noise measurements were commenced on Thursday 19 December 2019 finishing on Friday 20 December 2019. Operator attended noise surveys were conducted using a Brüel & Kjær Type 2270 (serial number 2679354).

Ambient noise levels given in the tables include all noise sources such as traffic, insects, birds, and mine operations as well as any other industrial operations.

The tables provide the following information:

- Monitoring location.
- Date and start time.
- Wind velocity (m/s) and Temperature (ºC) at the measurement location.
- Typical maximum (L_{Amax}) and contributed noise levels.

Mine contributions listed in the tables are from the Abel Coal Mine and are stated only when a contribution could be quantified.

Table 2 Location D, Black Hill Public School, Black Hill

Period	Date/ Start time/Weather	Primary Noise Descriptor (dBA re 20 µPa)					Description of Noise Emission, Typical Maximum Noise Levels (LAmax – dBA)
		LAmax	LA1	LA10	LA90	LAeq	
Day	20/12/2019 15:10 28°C 2.0 m/s ESE	81	70	53	41	57	Road traffic 49-81 Birds 43-60 Wind in trees 41-43 Abel Mine Inaudible
		Estimated Abel Mine Noise Contribution Inaudible					
Evening	19/12/2019 18:40 28°C 6 m/s S	72	65	60	52	57	Wind in trees 52-64 Road traffic 72 Abel Mine Inaudible
		Estimated Abel Mine Noise Contribution Inaudible					
Night	19/12/2019 22:50 23°C 3 m/s S	76	64	47	39	52	Insects/frogs 32-38 Road traffic 35-66 Abel Mine Inaudible
		Estimated Abel Mine Noise Contribution Inaudible					

Table 3 Location F, Lot 684 Black Hill Road, Black Hill

Period	Date/ Start time/Weather	Primary Noise Descriptor (dBA re 20 µPa)					Description of Noise Emission, Typical Maximum Noise Levels (LAmax – dBA)
		LAmax	LA1	LA10	LA90	LAeq	
Day	20/12/2019 15:30 28°C 1.8 m/s SE	73	66	55	45	54	Road traffic 45-73 Birdsong 39-49 Insects 35 Wind in trees 45-55 Abel Mine Inaudible
		Estimated Abel Mine Noise Contribution Inaudible					
Evening	19/12/2019 19:02 26°C 5 m/s SSE	72	65	60	52	57	Road traffic 72 Wind 52-64 Abel Mine Inaudible
		Estimated Abel Mine Noise Contribution Inaudible					
Night	19/12/2019 22:50 22°C 3 m/s S	66	60	50	35	48	Frogs/insects 40-46 Road traffic 41-66 Wind in trees 41 Abel Mine Inaudible
		Estimated Abel Mine Noise Contribution Inaudible					

Table 4 Location G, Buchanan Road, Buchanan

Period	Date/ Start time/ Weather	Primary Noise Descriptor (dBA re 20 µPa)					Description of Noise Emission, Typical Maximum Noise Levels (LAmax – dBA)
		LAmax	LA1	LA10	LA90	LAeq	
Day	20/12/2019 16:43 27°C 2.2 m/s SSE	74	58	54	46	51	Branch 74 Road traffic 42-52 Wind in trees 46-54 Abel Mine Inaudible
		Estimated Abel Mine Noise Contribution Inaudible					
Evening	19/12/2019 20:06 24°C 4 m/s S	64	63	58	47	55	Road traffic 40-57 Insects 50-64 Abel Mine Inaudible
		Estimated Abel Mine Noise Contribution Inaudible					
Night	19/12/2019 23:56 22°C 1.4 m/s S	45	41	39	33	36	Road traffic 35-45 Wind in trees 35 Insects 25-35 Other Industry 25-32 Abel Mine Inaudible
		Estimated Abel Mine Noise Contribution Inaudible					

Table 5 Location I, Magnetic Drive, Ashtonfield

Period	Date/ Start time/Weather	Primary Noise Descriptor (dBA re 20 µPa)					Description of Noise Emission, Typical Maximum Noise Levels (LAmax – dBA)
		LAmax	LA1	LA10	LA90	LAeq	
Day	20/12/2019 17:30 25°C 1.8 m/s SSE	72	66	57	43	54	Road traffic 51-68 Birds 60-72 Abel Mine Inaudible
		Estimated Abel Mine Noise Contribution Inaudible					
Evening	19/12/2019 20:56 24°C 4 m/s S	72	62	48	40	50	Insects 32-38 Road Traffic 63-72 Wind in trees 40-45 Abel Mine Inaudible
		Estimated Abel Mine Noise Contribution Inaudible					
Night	20/12/2019 00:47 21°C 1.3 m/s S	56	47	38	33	37	Birdsong 56 Insects 30-52 Distant road traffic 30-47 Abel Mine Barely Audible
		Estimated Abel Mine Noise Contribution LAeq(15minute) <25 dB LA1(1minute) <25 dB					

Table 6 Location J, Parish Drive, Thornton

Period	Date/ Start time/Weather	Primary Noise Descriptor (dBA re 20 µPa)					Description of Noise Emission, Typical Maximum Noise Levels (LAmax – dBA)
		LAmax	LA1	LA10	LA90	LAeq	
Day	20/12/2019 17:53 24°C 2 m/s SE	67	55	49	43	47	Road traffic 40-45 Wind in trees 40-54 Insects 36 Birds 50-67 Abel Mine Inaudible
		Estimated Abel Mine Noise Contribution Inaudible					
Evening	19/12/2019 21:35 23°C 3 m/s S	50	49	45	36	42	Wind in trees 38-48 Birdsong 50 Insects 47 Abel Mine Inaudible
		Estimated Abel Mine Noise Contribution Inaudible					
Night	19/12/2019 22:00 23°C 2.8 m/s S	52	45	42	35	39	Wind in trees 38-48 Birdsong 40-52 Insects 39 Abel Mine Inaudible
		Estimated Abel Mine Noise Contribution Inaudible					

1 Table 7 Location L, 65 Tipperary Dr, Ashtonfield

Period	Date/ Start time/ Weather	Primary Noise Descriptor (dBA re 20 µPa)					Description of Noise Emission, Typical Maximum Noise Levels (LAmax – dBA)
		LAmax	LA1	LA10	LA90	LAeq	
Day	20/12/2019 17:09 26C 1.8 m/s SE	73	68	51	38	54	Road traffic 45-73 Wind in trees 30-33 Abel Mine Inaudible
		Estimated Abel Mine Noise Contribution Inaudible					
Evening	19/12/2019 20:34 24°C 3.3 m/s S	74	61	52	44	52	Wind in trees 44-52 Traffic 70-74 Abel Mine Inaudible
		Estimated Abel Mine Noise Contribution Inaudible					
Night	20/12/2019 00:23 14°C 0.5 m/s SSE	57	45	39	32	37	Insects 28-32 Birdsong 41-57 Road traffic 35-49 Abel Mine Audible CHPP operations 30-41
		Estimated Abel Mine Noise Contribution LAeq(15minute) 33 dB LA1(1minute) 41 dB					

4.2 Operator Attended Noise Monitoring Summary

4.2.1 Donaldson Mine

Donaldson Open Cut Mine has ceased production and all major earthworks on the site have been finalised. Therefore, compliance noise monitoring for the Donaldson Open Cut Mine is no longer required.

4.2.2 Abel Coal Mine

Abel mine was placed in Care & Maintenance on 28th April 2016 and there was no operations onsite, excluding that from the Bloomfield CHPP which operates under the Abel Coal Mine project consent conditions.

The Bloomfield CHPP and stockpile area was inaudible during all operator attended noise surveys with the exception of Location I and Location L during the night-time period. Noise generated by local and distant traffic was a significant contributor to ambient noise levels at all monitored locations as well as 'natural' noises such as birds, insects.

4.3 Compliance Assessment and Discussion of Results

4.3.1 Operations

Results of the operational compliance assessment are given in Table 8.

Table 8 Compliance Noise Assessment – Operations

Location	Estimated Abel $L_{Aeq(15minute)}$ Contribution dBA			Consent Conditions			Compliance		
	Day	Eve	Night	Day	Eve	Night	Day	Eve	Night
D – Black Hill School, Black Hill	Inaudible	Inaudible	Inaudible	35	35	35	Yes	Yes	Yes
F – Black Hill Road, Black Hill	Inaudible	Inaudible	Inaudible	35	35	35	Yes	Yes	Yes
G – Buchanan Road, Buchanan	Inaudible	Inaudible	Inaudible	35	35	35	Yes	Yes	Yes
I – Magnetic Drive, Ashtonfield	Inaudible	Inaudible	Barely Audible <25	36	36	36	Yes	Yes	Yes
J – Parish Drive, Thornton	Inaudible	Inaudible	Inaudible	35	35	35	Yes	Yes	Yes
L – 65 Tipperary Dr, Ashtonfield	Inaudible	Inaudible	33	40	40	40	Yes	Yes	Yes

Results presented in Table 8 indicate that compliance with the relevant consent conditions was achieved at all noise monitoring locations during all periods.

4.3.2 Sleep Disturbance

Results of the sleep disturbance compliance assessment are given in Table 9.

Table 9 Compliance Noise Assessment – Sleep Disturbance

Location	Estimated Bloomfield $L_{A1(1minute)}$ Contribution dBA	Consent Conditions $L_{A1(1minute)}$ dBA	Compliance
D – Black Hill School, Black Hill	Inaudible	45	Yes
F – Black Hill Road, Black Hill	Inaudible	45	Yes
G – Buchanan Road, Buchanan	Inaudible	45	Yes
I – Magnetic Drive, Ashtonfield	Barely Audible <25	45	Yes
J – Parish Drive, Thornton	Inaudible	45	Yes
L – 65 Tipperary Dr, Ashtonfield	41	47	Yes

Results presented in Table 9 indicate that compliance with the sleep disturbance consent conditions was achieved at all noise monitoring locations during the night-time noise surveys.

5 Unattended Continuous Noise Monitoring

5.1 Results of Unattended Continuous Noise Monitoring

Unattended continuous noise monitoring was conducted between Thursday 12 December 2019 and Friday 20 December 2019 at each of the six monitoring locations given in Table 10.

Table 10 Noise Logger and Noise Monitoring Locations

Location	Noise Logger Serial Number	Date of Logging
D – Black Hill School, Black Hill	ARL EL-316 16-203-525	12 December 2019 -20 December 2019
F – Black Hill Road, Black Hill	ARL EL-316 16-207-050	12 December 2019 -20 December 2019
G – Buchanan Road, Buchanan	SVAN 977 69756	12 December 2019 -20 December 2019
I – Magnetic Drive, Ashtonfield	ARL EL-316 16-103-494	12 December 2019 -20 December 2019
L – 65 Tipperary Dr, Ashtonfield	ARL EL-316 16-203-508	12 December 2019 -20 December 2019
J – Parish Drive, Thornton[1]	ARL EL-316 16-207-044	12 December 2019 -20 December 2019

The unattended ambient noise logger data from each monitoring location are presented graphically on a daily basis and are attached as Appendix C. A summary of the results of the unattended continuous noise monitoring is given in Table 11. Due to a technical issue no results are available for Location D.

The ambient noise level data quantifies the overall noise level at a given location independent of its source or character.

The measured ambient noise levels were divided into three periods representing day, evening and night as designated in the NSW Noise Policy for Industry (NPfI).

Precautions were taken to minimise influences from extraneous noise sources (eg optimum placement of the loggers away from creeks, trees, houses, etc), however, not all these sources or their effects can be eliminated. This is particularly the case during the warmer times of year when noise from insects, frogs, birds and other animals can become quite prevalent.

Weather data for the subject area during the noise monitoring period was provided by Bloomfield Colliery. Noise data during periods of any rainfall and/or wind speeds in excess of 5 m/s were discarded in accordance with NPfI weather affected data exclusion methodology.

Table 11 Unattended Continuous Noise Monitoring Ambient Noise Levels (dBA)

Location	Period	Primary Noise Descriptor (dBA re 20 µPA)			
		L_{A1}	L_{A10}	L_{A90}	L_{Aeq}
F Lot 684 Black Hill Road, Black Hill	Day	79	63	49	66
	Evening	74	60	43	63
	Night	65	57	35	59
G 156 Buchanan Road, Buchanan	Day	58	52	39	53
	Evening	50	46	35	50
	Night	45	41	28	43
I 49 Magnetic Drive, Ashtonfield	Day	68	58	42	57
	Evening	64	53	39	53
	Night	48	42	30	49
L 65 Tipperary Dr, Ashtonfield	Day	60	49	33	52
	Evening	58	48	33	54
	Night	50	45	28	45
J 220 Parish Drive, Thornton	Day	53	48	39	47
	Evening	49	44	38	47
	Night	44	38	29	42

5.2 Long term Unattended Continuous Monitoring Summary for Donaldson Mine and Abel Coal Mine

5.2.1 Ambient LA90 Noise Levels

The long term ambient L_{A90} noise levels collected from each monitoring location are presented graphically in Figure 1, Figure 2 and Figure 3 for the daytime, evening and night-time periods respectively.

Figure 1 Long term Daytime LA90 Noise Levels

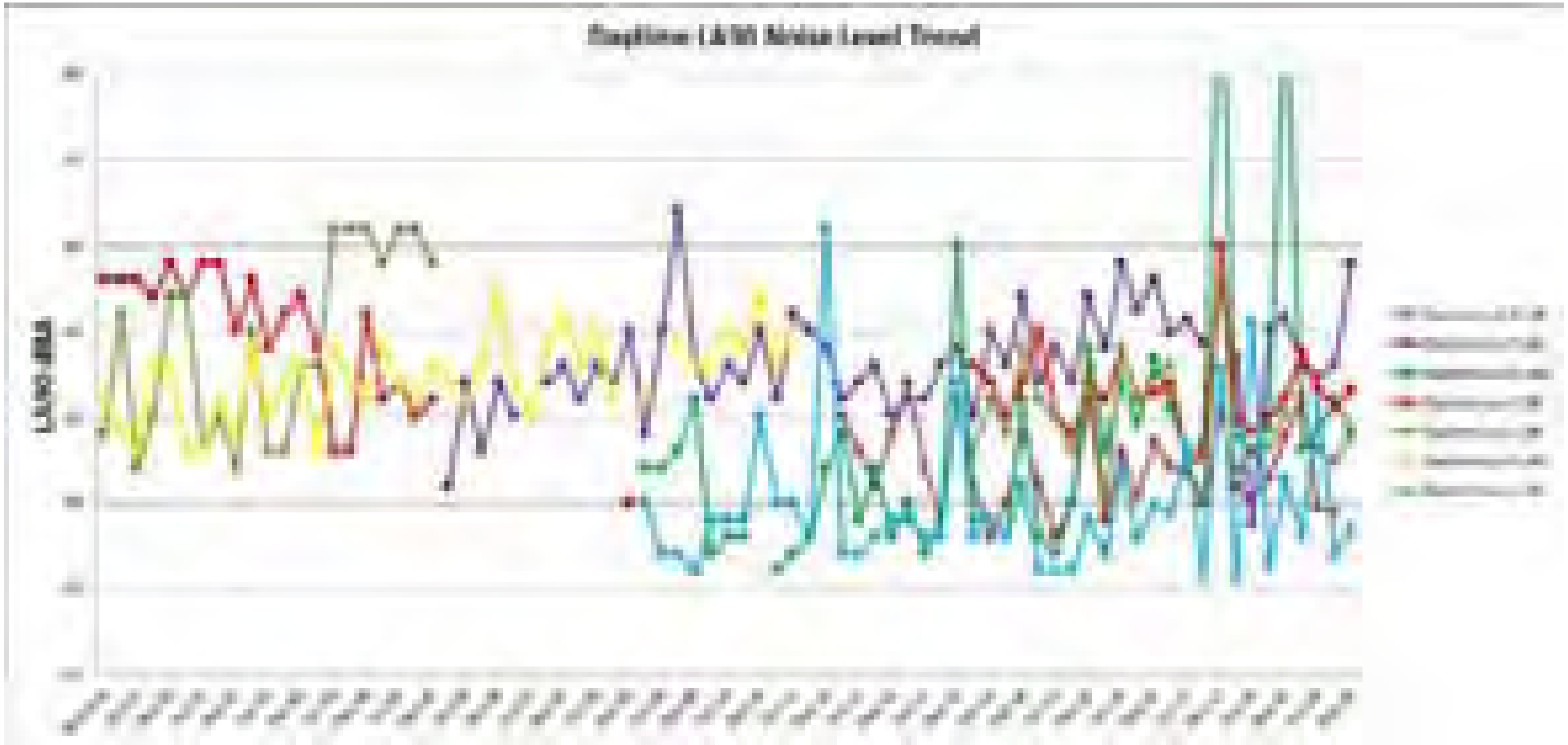


Figure 2 Long term Evening LA90 Noise Levels

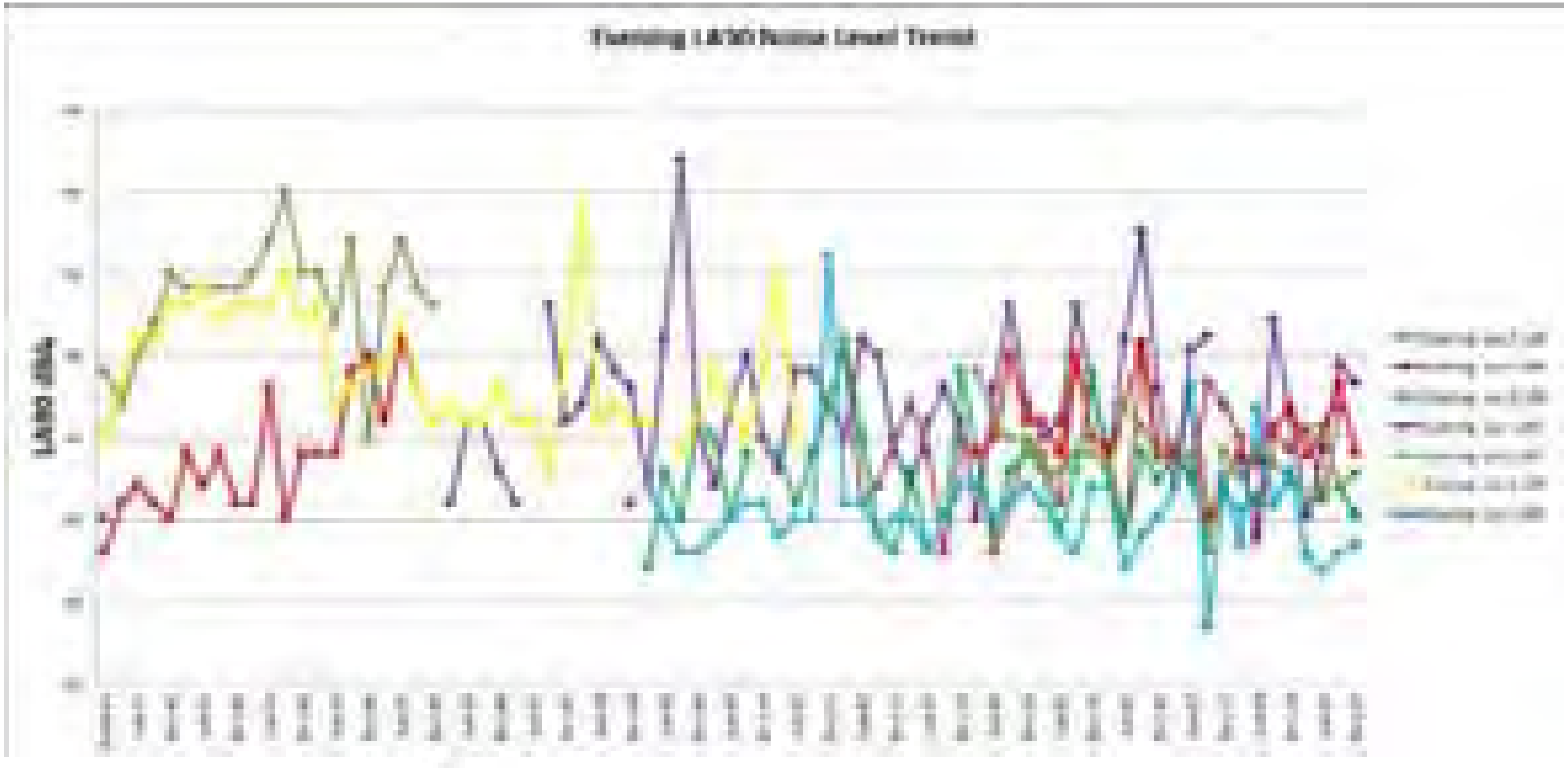
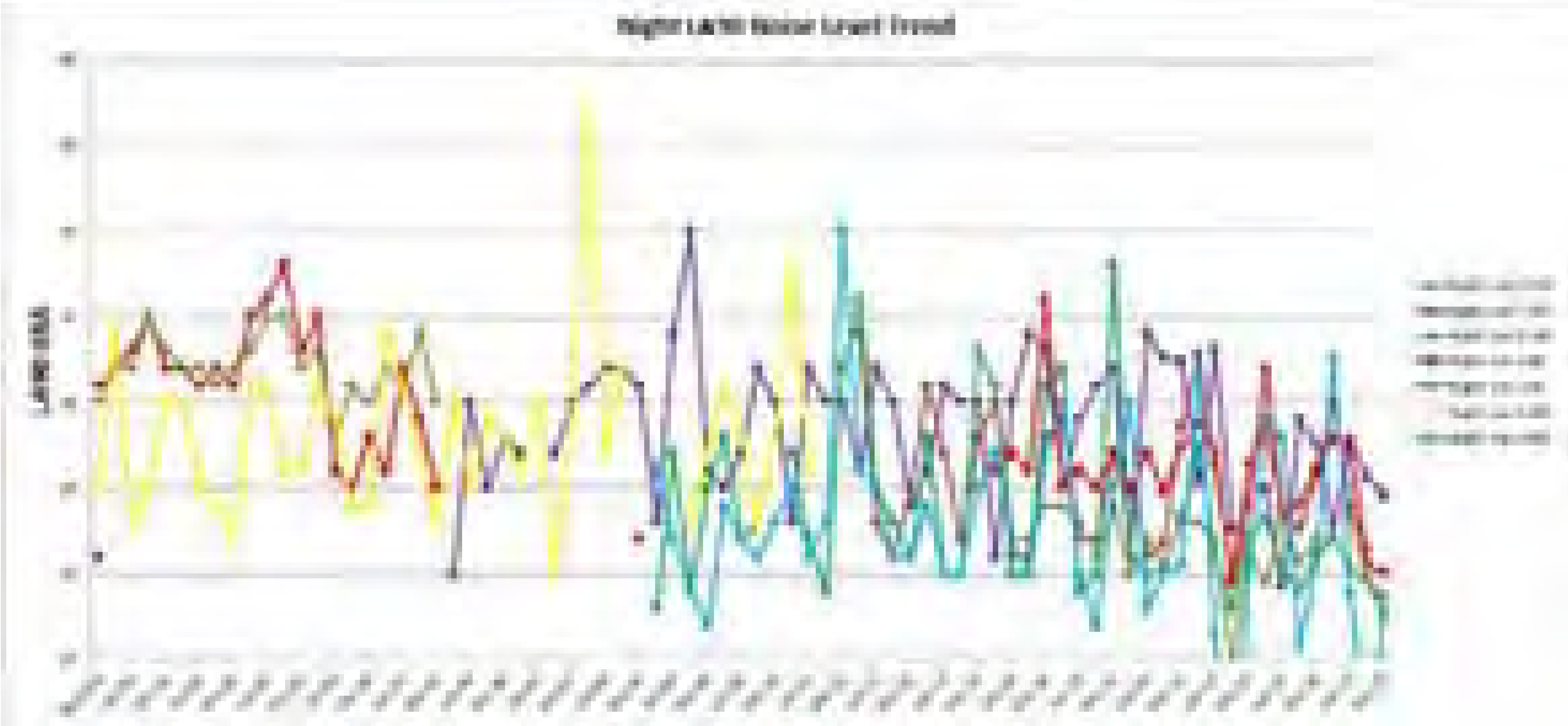


Figure 3 Long term Night-time LA90 Noise Levels



5.2.1.1 Baseline

The summary of results in Table 12 shows the ambient LA90 noise levels recorded for the current monitoring period compared to the levels recorded during the baseline monitoring process (ie. prior to commencement of mining operation at Donaldson).

Table 12 LA90 Results Comparison – Baseline

Monitoring Location	Period[1]	Long term Night-time LA90 Noise Levels		Difference dB[3]
		Baseline	December 2019	
D Black Hill School, Black Hill	Day	N/A[2]	No result	N/A[2]
	Evening	N/A[2]	No result	N/A[2]
	Night	N/A[2]	No result	N/A[2]
F Lot 684 Black Hill Road, Black Hill	Day	39	49	10
	Evening	35	43	8
	Night	31	35	4
G 156 Buchanan Road, Buchanan	Day	N/A[2]	39	N/A[2]
	Evening	N/A[2]	35	N/A[2]
	Night	N/A[2]	28	N/A[2]
I 49 Magnetic Drive, Ashtonfield	Day	48	42	-7
	Evening	33	39	6
	Night	41	30	-11
L 65 Tipperary Drive, Ashtonfield	Day	N/A[2]	33	N/A[2]
	Evening	N/A[2]	33	N/A[2]
	Night	N/A[2]	28	N/A[2]
J 220 Parish Drive, Thornton	Day	39	39	0
	Evening	44	38	-6
	Night	40	29	-11

Note 1: Periods are as detailed the NPfI and are Daytime - 7.00 am to 6.00 pm Monday to Saturday, 8.00 am to 6.00 pm Sunday; Evening - 6.00 pm 10.00 pm; Night - 10.00 pm to 7.00 am pm Monday to Saturday, 10.00 pm to 8.00 am Sunday.

Note 2: No data was available during baseline measurements, no comparisons can be made.

Note 3: Rounded to the nearest whole dB.

5.2.1.2 Previous Quarter

Table 13 presents the ambient L_{A90} noise levels recorded for the current monitoring period compared to those measured in the previous monitoring period.

Table 13 L_{A90} Results Comparison – Previous Quarter

Monitoring Location	Period[1]	Long term Night-time L_{A90} Noise Levels		Difference dB[2]
		September 2019	December 2019	
D Black Hill School, Black Hill	Day	35	No result	-
	Evening	42	No result	-
	Night	31	No result	-
F Lot 684 Black Hill Road, Black Hill	Day	43	49	6
	Evening	44	43	-1
	Night	36	35	-1
G 156 Buchanan Road, Buchanan	Day	41	39	-2
	Evening	37	35	-2
	Night	30	28	-2
I 49 Magnetic Drive, Ashtonfield	Day	41	42	1
	Evening	43	39	-4
	Night	31	30	0
L 65 Tipperary Drive, Ashtonfield	Day	32	33	2
	Evening	33	33	1
	Night	20	28	8
J 220 Parish Drive, Thornton	Day	37	39	1
	Evening	37	38	1
	Night	30	29	-1

Note 1: 1. Periods are as detailed in the Industrial Noise Policy (INP) and are Daytime - 7.00 am to 6.00 pm Monday to Saturday, 8.00 am to 6.00 pm Sunday; Evening - 6.00 pm 10.00 pm; Night - 10.00 pm to 7.00 am pm Monday to Saturday, 10.00 pm to 8.00 am Sunday.

Note 2: Rounded to the nearest whole dB.

5.2.1.3 Coinciding Period Last Year

Table 14 presents the ambient LA90 noise levels recorded for the current monitoring period compared to those measured during the coinciding monitoring period last year.

Table 14 LA90 Results Comparison – Coinciding Period Last Year

Monitoring Location	Period[1]	Long term Night-time LA90 Noise Levels		Difference dB[2]
		December 2018	December 2019	
D Black Hill School, Black Hill	Day	39	No result	-
	Evening	39	No result	-
	Night	36	No result	-1
F Lot 684 Black Hill Road, Black Hill	Day	46	49	3
	Evening	42	43	2
	Night	38	35	-3
G 156 Buchanan Road, Buchanan	Day	66	39	-27
	Evening	38	35	-3
	Night	31	28	-4
I 49 Magnetic Drive, Ashtonfield	Day	41	42	0
	Evening	42	39	-3
	Night	36	30	-6
L 65 Tipperary Drive, Ashtonfield	Day	36	33	-3
	Evening	38	33	-4
	Night	31	28	-3
J 220 Parish Drive, Thornton	Day	40	39	-2
	Evening	38	38	0
	Night	32	29	-3

Note 1: Periods are as detailed in the Industrial Noise Policy (INP) and are Daytime - 7.00 am to 6.00 pm Monday to Saturday, 8.00 am to 6.00 pm Sunday; Evening - 6.00 pm 10.00 pm; Night - 10.00 pm to 7.00 am pm Monday to Saturday, 10.00 pm to 8.00 am Sunday.

Note 2: Rounded to the nearest whole dB.

5.2.2 Ambient LA10 Noise Comparison

The long term ambient LA10 noise levels collected from each monitoring location are presented graphically in Figure 4, Figure 5 and Figure 6 for the daytime, evening and night-time respectively.

Figure 4 Long term Daytime L_{A10} Noise Levels

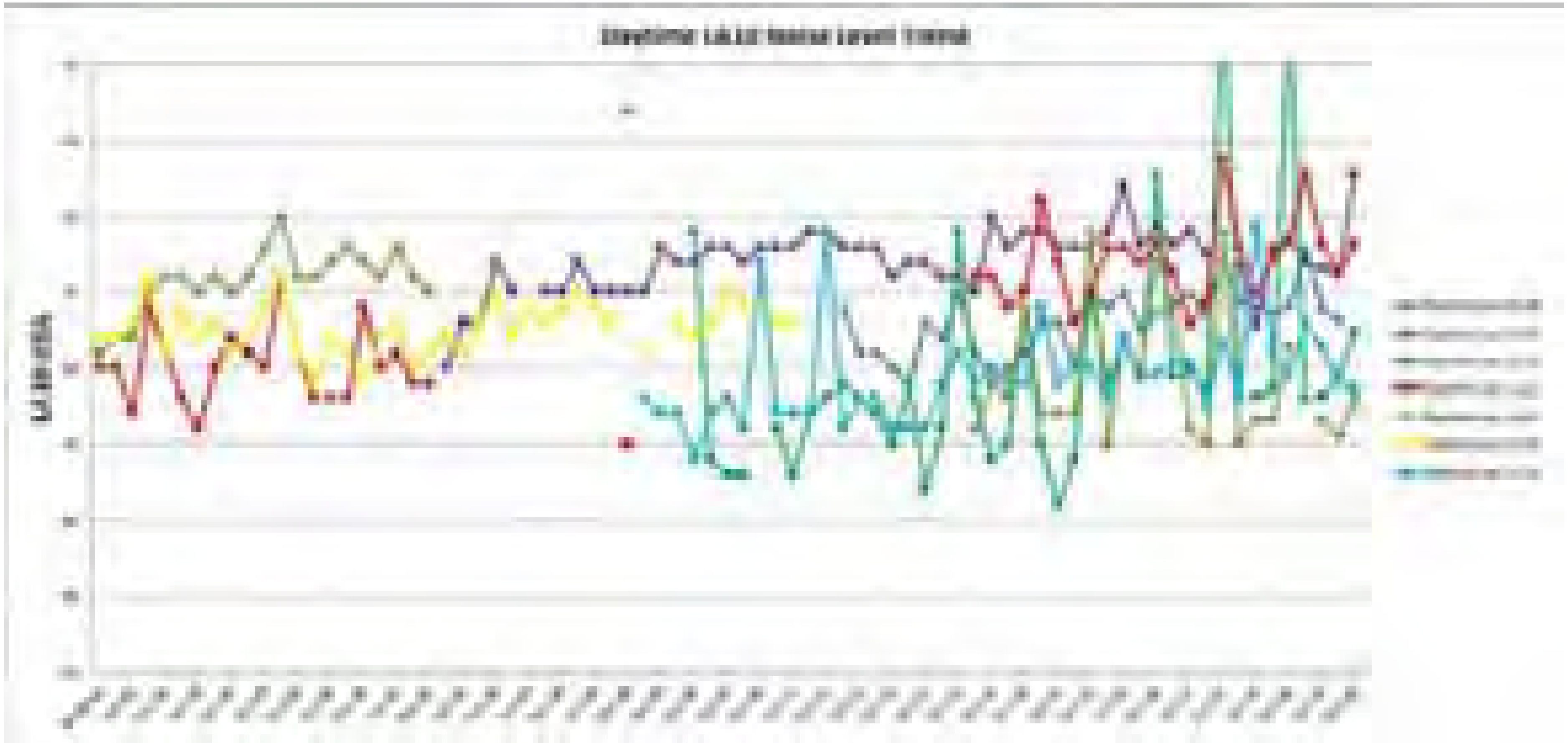
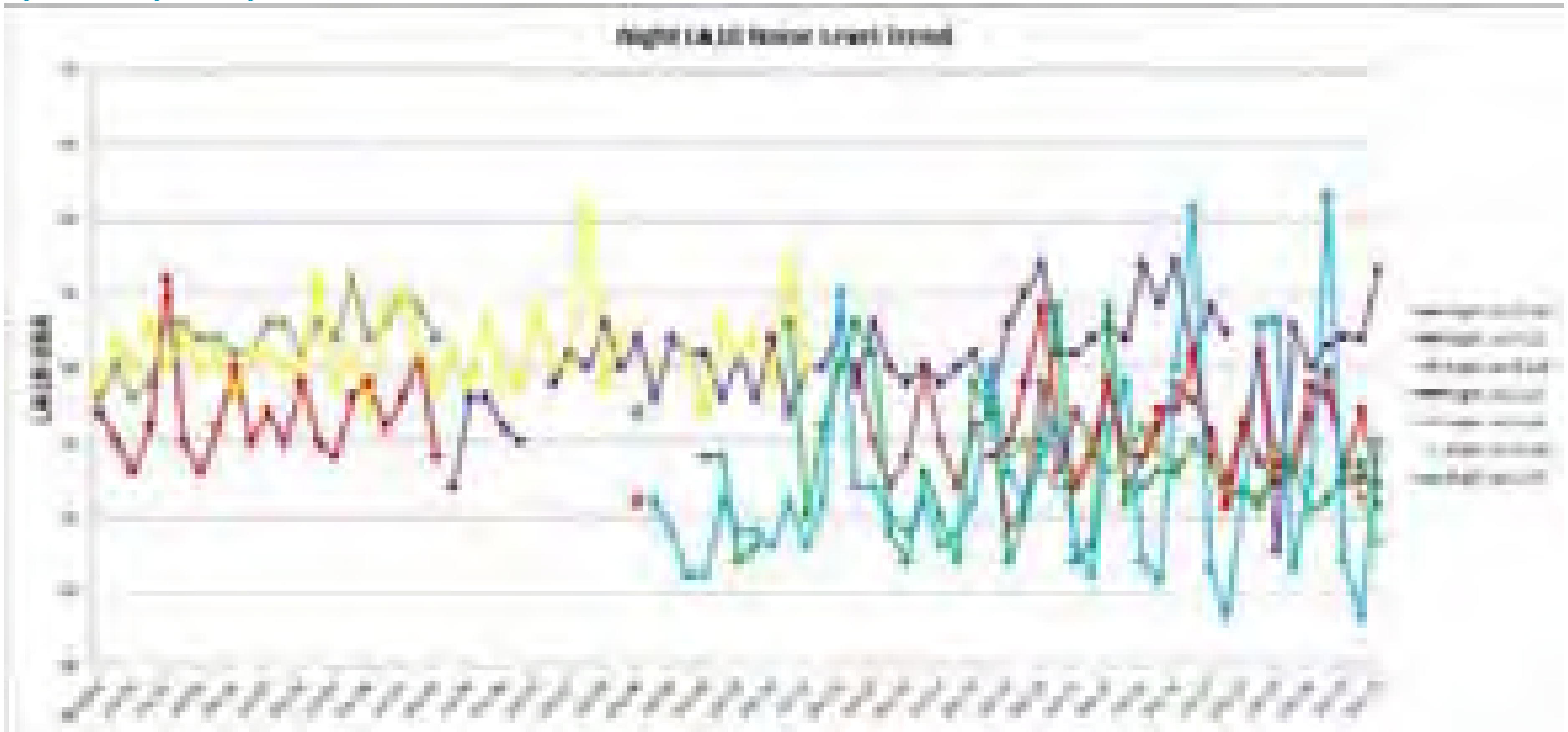


Figure 5 Long term Evening L_{A10} Noise Levels

Figure 6 Long term Night LA10 Noise Levels



Baseline

Table 15 presents the ambient LA10 noise levels recorded for the current monitoring period compared to the levels recorded during the baseline monitoring period.

Table 15 LA10 Results Comparison – Baseline

Monitoring Location	Period[1]	Long term Night-time LA10 Noise Levels		Difference dB[3]
		Baseline	December 2019	
D Black Hill School, Black Hill	Day	N/A[2]	No result	N/A
	Evening	N/A[2]	No result	N/A
	Night	N/A[2]	No result	N/A
F Lot 684 Black Hill Road, Black Hill	Day	51	63	12
	Evening	49	60	11
	Night	48	57	9
G 156 Buchanan Road, Buchanan	Day	N/A[2]	52	N/A
	Evening	N/A[2]	46	N/A
	Night	N/A[2]	41	N/A
I 49 Magnetic Drive, Ashtonfield	Day	50	58	8
	Evening	53	53	0
	Night	47	42	-5
L 65 Tipperary Drive, Ashtonfield	Day	N/A[2]	49	N/A
	Evening	N/A[2]	48	N/A
	Night	N/A[2]	45	N/A
J 220 Parish Drive, Thornton	Day	51	48	-3
	Evening	49	44	-5
	Night	48	38	-10

Note 1: Periods are as detailed in the Industrial Noise Policy (INP) and are Daytime - 7.00 am to 6.00 pm Monday to Saturday, 8.00 am to 6.00 pm Sunday; Evening - 6.00 pm 10.00 pm; Night - 10.00 pm to 7.00 am pm Monday to Saturday, 10.00 pm to 8.00 am Sunday.

Note 2: No data was available during baseline measurements, no comparisons can be made.

Note 3: Rounded to the nearest whole dB.

5.2.2.2 Previous Quarter

Table 16 presents the ambient L_{A10} noise levels recorded for the current monitoring period compared to those measured during the previous monitoring period.

Table 16 L_{A10} Results Comparison – Previous Quarter

Monitoring Location	Period[1]	Long term Night-time L_{A10} Noise Levels		Difference dB[2]
		September 2019	December 2019	
D Black Hill School, Black Hill	Day	53	No result	-
	Evening	48	No result	-
	Night	43	No result	-
F Lot 684 Black Hill Road, Black Hill	Day	56	63	7
	Evening	54	60	7
	Night	52	57	5
G 156 Buchanan Road, Buchanan	Day	50	52	3
	Evening	46	46	0
	Night	44	41	-3
I 49 Magnetic Drive, Ashtonfield	Day	56	58	2
	Evening	57	53	-5
	Night	47	42	-5
L 65 Tipperary Drive, Ashtonfield	Day	49	49	0
	Evening	42	48	6
	Night	33	45	12
J 220 Parish Drive, Thornton	Day	46	48	3
	Evening	43	44	2
	Night	41	38	-3

Note 1: Periods are as detailed in the Industrial Noise Policy (INP) and are Daytime - 7.00 am to 6.00 pm Monday to Saturday, 8.00 am to 6.00 pm Sunday; Evening - 6.00 pm 10.00 pm; Night - 10.00 pm to 7.00 am pm Monday to Saturday, 10.00 pm to 8.00 am Sunday.

Note 2: Rounded to the nearest whole dB.

5.2.2.3 Coinciding Period Last Year

Table 17 presents the ambient L_{A10} noise levels recorded for the current monitoring period compared to those measured during the coinciding monitoring period last year.

Table 17 L_{A10} Result Comparison – Coinciding Period Last Year

Monitoring Location	Period[1]	Long term Night-time L_{A10} Noise Levels		Difference dB[2]
		December 2018	December 2019	
D Black Hill School, Black Hill	Day	54	No result	-
	Evening	52	No result	-
	Night	47	No result	-
F Lot 684 Black Hill Road, Black Hill	Day	58	63	4
	Evening	56	60	4
	Night	50	57	7
G 156 Buchanan Road, Buchanan	Day	74	52	-22
	Evening	73	46	-27
	Night	41	41	0
I 49 Magnetic Drive, Ashtonfield	Day	58	58	0
	Evening	55	53	-3
	Night	49	42	-7
L 65 Tipperary Dr, Ashtonfield	Day	50	49	-1
	Evening	49	48	-1
	Night	43	45	2
J 220 Parish Drive, Thornton	Day	51	48	-3
	Evening	45	44	-1
	Night	43	38	-4

Note 1: Periods are as detailed in the Industrial Noise Policy (INP) and are Daytime - 7.00 am to 6.00 pm Monday to Saturday, 8.00 am to 6.00 pm Sunday; Evening - 6.00 pm 10.00 pm; Night - 10.00 pm to 7.00 am pm Monday to Saturday, 10.00 pm to 8.00 am Sunday.

Note 2: Rounded to the nearest whole dB.

5.3 Rail Noise Monitoring

In order to determine compliance with the rail noise criteria, a noise logger was positioned at Location J, however no train movements occurred during the monitoring period.

6 Conclusion

SLR was engaged by Donaldson Coal Pty Ltd to conduct quarterly noise monitoring surveys for Donaldson Coal Mine and Abel Coal Mine in accordance with the NMP, dated 3 June 2019.

Donaldson Open Cut Mine has ceased production and all major earthworks on the site have been finalised. Therefore, compliance noise monitoring for the Donaldson Open Cut Mine is no longer required.

Abel mine was placed in Care & Maintenance on 28th April 2016 and there was no operations onsite, excluding that from the Bloomfield CHPP which operates under the Abel Coal Mine project consent conditions.

Operator-attended and unattended noise measurements were conducted for the December 2019 quarter at six focus locations surrounding the mine.

Abel portal operations were not observed to be audible at any locations during the monitoring period with CHPP operations audible at Location L during the night-time attended noise survey. Contributed noise levels from Abel Mine did not exceed noise emission goals (including night-time sleep arousal criteria) and compliance with the Abel Mine Project Approval was indicated at all locations.

A comparison of ambient L_{A10} and L_{A90} noise levels recorded during the current monitoring period (December 2019), the baseline monitoring period, the last monitoring period (September 2019), and the coinciding monitoring period from last year (December 2018) has been conducted.

No rail movements occurred on the Bloomfield Rail Spur during the noise monitoring period.

APPENDIX A

Acoustic Terminology

1. Sound Level or Noise Level

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

Sound (or noise) consists of minute fluctuations in atmospheric pressure. The human ear responds to changes in sound pressure over a very wide range with the loudest sound pressure to which the human ear can respond being ten million times greater than the softest. The decibel (abbreviated as dB) scale reduces this ratio to a more manageable size by the use of logarithms.

The symbols SPL, L or LP are commonly used to represent Sound Pressure Level. The symbol LA represents A-weighted Sound Pressure Level. The standard reference unit for Sound Pressure Levels expressed in decibels is 2 x 10^{-5} Pa.

2. ‘A’ Weighted Sound Pressure Level

The overall level of a sound is usually expressed in terms of dBA, which is measured using a sound level meter with an ‘A-weighting’ filter. This is an electronic filter having a frequency response corresponding approximately to that of human hearing.

People’s hearing is most sensitive to sounds at mid frequencies (500 Hz to 4,000 Hz), and less sensitive at lower and higher frequencies. Different sources having the same dBA level generally sound about equally loud.

A change of 1 dB or 2 dB in the level of a sound is difficult for most people to detect, whilst a 3 dB to 5 dB change corresponds to a small but noticeable change in loudness. A 10 dB change corresponds to an approximate doubling or halving in loudness. The table below lists examples of typical noise levels.

Sound Pressure Level (dBA)	Typical Source	Subjective Evaluation
130	Threshold of pain	Intolerable
120	Heavy rock concert	Extremely noisy
110	Grinding on steel	
100	Loud car horn at 3 m	Very noisy
90	Construction site with pneumatic hammering	
80	Kerbside of busy street	Loud
70	Loud radio or television	
60	Department store	Moderate to quiet
50	General Office	
40	Inside private office	Quiet to very quiet
30	Inside bedroom	
20	Recording studio	Almost silent

Other weightings (eg B, C and D) are less commonly used than A-weighting. Sound Levels measured without any weighting are referred to as ‘linear’, and the units are expressed as dB(lin) or dB.

3. Sound Power Level

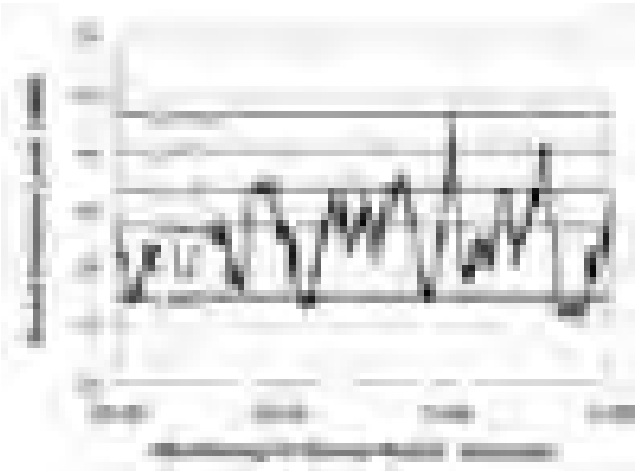
The Sound Power of a source is the rate at which it emits acoustic energy. As with Sound Pressure Levels, Sound Power Levels are expressed in decibel units (dB or dBA), but may be identified by the symbols SWL or LW, or by the reference unit 10^{-12} W.

The relationship between Sound Power and Sound Pressure is similar to the effect of an electric radiator, which is characterised by a power rating but has an effect on the surrounding environment that can be measured in terms of a different parameter, temperature.

4. Statistical Noise Levels

Sounds that vary in level over time, such as road traffic noise and most community noise, are commonly described in terms of the statistical exceedance levels LAN, where LAN is the A-weighted sound pressure level exceeded for N% of a given measurement period. For example, the LA1 is the noise level exceeded for 1% of the time, LA10 the noise exceeded for 10% of the time, and so on.

The following figure presents a hypothetical 15 minute noise survey, illustrating various common statistical indices of interest.



Of particular relevance, are:

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

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

LA90 The noise level exceeded for 90% of the sample period. This noise level is described as the average minimum background sound level (in the absence of the source under consideration), or simply the background level.

LAeq The A-weighted equivalent noise level (basically, the average noise level). It is defined as the steady sound level that contains the same amount of acoustical energy as the corresponding time-varying sound.

5. Frequency Analysis

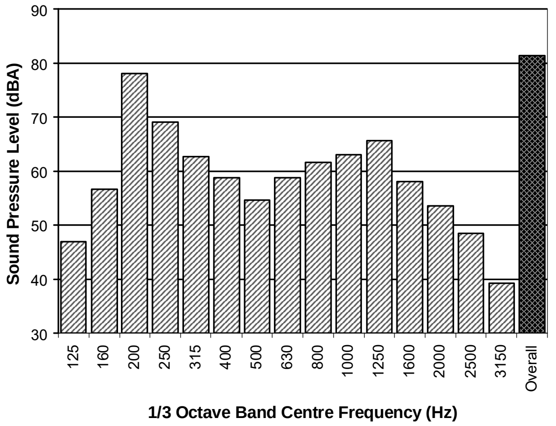
Frequency analysis is the process used to examine the tones (or frequency components) which make up the overall noise or vibration signal.

The units for frequency are Hertz (Hz), which represent the number of cycles per second.

Frequency analysis can be in:

- Octave bands (where the centre frequency and width of each band is double the previous band)
- 1/3 octave bands (three bands in each octave band)
- Narrow band (where the spectrum is divided into 400 or more bands of equal width)

The following figure shows a 1/3 octave band frequency analysis where the noise is dominated by the 200 Hz band. Note that the indicated level of each individual band is less than the overall level, which is the logarithmic sum of the bands.



6. Annoying Noise (Special Audible Characteristics)

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

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

7. Vibration

Vibration may be defined as cyclic or transient motion. This motion can be measured in terms of its displacement, velocity or acceleration. Most assessments of human response to vibration or the risk of damage to buildings use measurements of vibration velocity. These may be expressed in terms of ‘peak’ velocity or ‘rms’ velocity.

The former is the maximum instantaneous velocity, without any averaging, and is sometimes referred to as ‘peak particle velocity’, or PPV. The latter incorporates ‘root mean squared’ averaging over some defined time period.

Vibration measurements may be carried out in a single axis or alternatively as triaxial measurements (ie vertical, longitudinal and transverse).

The common units for velocity are millimetres per second (mm/s). As with noise, decibel units can also be used, in which case the reference level should always be stated. A vibration level V, expressed in mm/s can be converted to decibels by the formula 20 log (V/Vo), where Vo is the reference level (10^{-9} m/s). Care is required in this regard, as other reference levels may be used.

8. Human Perception of Vibration

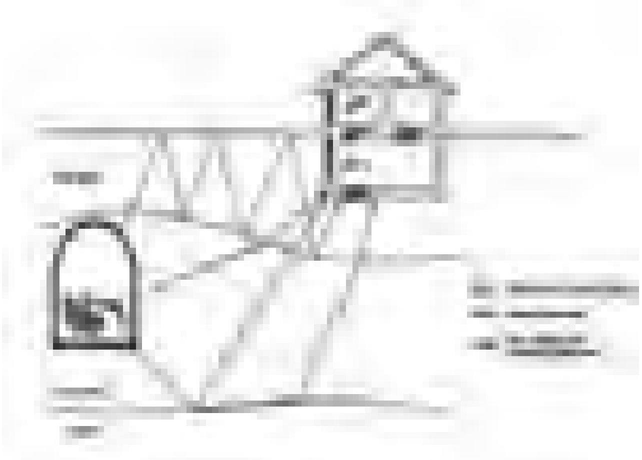
People are able to ‘feel’ vibration at levels lower than those required to cause even superficial damage to the most susceptible classes of building (even though they may not be disturbed by the motion). An individual's perception of motion or response to vibration depends very strongly on previous experience and expectations, and on other connotations associated with the perceived source of the vibration. For example, the vibration that a person responds to as ‘normal’ in a car, bus or train is considerably higher than what is perceived as ‘normal’ in a shop, office or dwelling.

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

Noise that propagates through a structure as vibration and is radiated by vibrating wall and floor surfaces is termed ‘structure-borne noise’, ‘ground-borne noise’ or ‘regenerated noise’. This noise originates as vibration and propagates between the source and receiver through the ground and/or building structural elements, rather than through the air.

Typical sources of ground-borne or structure-borne noise include tunnelling works, underground railways, excavation plant (eg rockbreakers), and building services plant (eg fans, compressors and generators).

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



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

APPENDIX B

Noise Monitoring Locations

D:\Quick Jobs\Martin Davenport\Donaldson\SLR630010530\1200_AB_MonitoringLocations_01.mxd

10 KINGS ROAD
NEW LAMBTON
NEW SOUTH WALES 2305
AUSTRALIA
T: 61 2 4037 3200
F: 61 2 4037 3201
www.slrconsulting.com

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Project No.:	630.01053.01200
Date:	11/01/2018
Drawn by:	NT
Scale:	1:45,000
Sheet Size:	A4
Projection:	GDA 1994 MGA Zone 56

LEGEND

Noise Monitoring Locations

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0 500 1,000 1,500 2,000
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Donaldson Coal

Noise Monitoring

Noise Monitoring Locations

APPENDIX B

APPENDIX C

Calibration Certificates

CERTIFICATE OF CALIBRATION

CERTIFICATE NO.: SLM 25532 & FILT 5408

Equipment Description: Sound Level Meter

Manufacturer: B & K

Model No: 2270 **Serial No:** 2679354

Microphone Type: 4189 **Serial No:** 2695417

Preamplifier Type: ZC0032 **Serial No:** 12254

Filter Type: 1/3 Octave **Serial No:** 2679354

Comments: All tests passed for class 1.
(See over for details)

Owner: SLR Consulting Australia Pty Ltd
Level 2, 2 Lincoln Street
Lane Cove, NSW 2066

Ambient Pressure: 998 hPa ±1.5 hPa

Temperature: 23 °C ±2° C **Relative Humidity:** 26% ±5%

Date of Calibration: 09/09/2019 **Issue Date:** 09/09/2019

Acu-Vib Test Procedure: AVP10 (SLM) & AVP06 (Filters)

CHECKED BY: NB **AUTHORISED SIGNATURE:** .... Jack Kielt

Accredited for compliance with ISO/IEC 17025 - Calibration
The results of the tests, calibration and/or measurements included in this document are traceable to Australian/national standards.

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web site: www.acu-vib.com.au

Accredited Lab. No. 9262
Acoustic and Vibration Measurements

CERTIFICATE NO.: SLM 25532 & FILT 5408

The performance characteristics listed below were tested. The tests are based on the relevant clauses of IEC 61672-3:2013

Tests Performed:	*Clause*	*Result*
Absolute Calibration	10	Pass
Acoustical Frequency Weighting	12	Pass
Self Generated Noise	11.1	Entered
Electrical Noise	11.2	Entered
Long Term Stability	15	Pass
Electrical Frequency Weightings	13	Pass
Frequency and Time Weightings	14	Pass
Reference Level Linearity	16	Pass
Range Level Linearity	17	NA
Toneburst	18	Pass
Peak C Sound Level	19	Pass
Overload Indicator	20	Pass
High Level Stability	21	Pass

Statement of Compliance: The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2013, for the environmental conditions under which the tests were performed. As public evidence was available, from an independent organization responsible for approving the results of pattern evaluation tests performed in accordance with IEC 61672-2:2013, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2013, the sound level meter submitted for testing conforms to the class 1 requirements of IEC61672-1:2013.
A full technical report is available if required.

This Sound Level Meter included an Octave Filter Set. Tests were based on IEC 1260: 1995 and AS/NZS 4476 - 1997 and were conducted to test the following performance characteristics:

1. Relative attenuation clause 5.3

Date of Calibration: 09/09/2019 **Issue Date:** 09/09/2019

Checked by: KB

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CERTIFICATE OF CALIBRATION

CERTIFICATE NO: 25534

EQUIPMENT TESTED: 1/2" Microphone
Manufacturer: B & K
Type No: 4197 **Serial No:** 3077697 (Part 2)
Owner: SLR Consulting Australia Pty Ltd
Level 2, 2 Lincoln Street
Lane Cove, NSW 2066
Tests Performed: Acoustic Microphone Frequency Response with Inverse A Weighting

CONDITION OF TEST:

Ambient Pressure: 997 hPa ±1.5 hPa **Relative Humidity:** 24% ±5%
Temperature: 23 °C ±2° C
Date of Calibration: 09/09/2019 **Issue Date** 09/09/2019
Acu-Vib Test Procedure: AVP05 (Microphone Acoustic Frequency Response)

CHECKED BY: VKB **AUTHORISED SIGNATURE:** ....

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Acoustic Tests, Microphone response

Job No: 13678 Test No: 255334

Microphone type: B&K 4197 Serial No,: 3077697 (Part 2)

Preamplifier type: 2683 Serial No. : 2792513

SLM body (if appropriate): SVAN 912 AE Serial No: 4396

Ambient Temperature: 23C ±2° C, Relative Humidity: 997 RH ±5% RH,

Ambient Pressure: 24 hPa ±1.5 hPa

Frequency Hz	Deviation re 1 kHz	Type 2 Tol.	Type 1 Tol.	U95 dB	P/F
31.5 Hz	0.11dB	± 3.0 dB	± 1.5 dB dB	0.12	P
63 Hz	-0.01dB	± 2.0 dB	± 1.5 dB dB	0.10	P
125 Hz	-0.08dB	± 1.5 dB	± 1.0 dB dB	0.09	P
250 Hz	-0.15dB	± 1.5 dB	± 1.0 dB dB	0.09	P
500 Hz	-0.14dB	± 1.5 dB	± 1.0 dB dB	0.09	P
1 kHz Ref	0.00dB	± 1.5 dB	± 1.0 dB dB	0.09	P
2 kHz	0.05dB	± 2.0 dB	± 1.0 dB dB	0.07	P
4 kHz	-0.25dB	± 3.0 dB	± 1.0 dB dB	0.13	P
8 kHz	-0.21dB	± 5.0 dB	+1.5;-3.0 dB	0.13	P
12.5 kHz	-0.10dB	+ 5.0; - ∞ dB	+3.0;-6.0 dB	0.19	P
16 kHz	0.61dB	+ 5.0; - ∞ dB	+ 3.0; - ∞ dB	0.30	P

Tolerances from AS1259-1990 part 1, (IEC 60651).

Notes:

Signed (Testing Officer) ______________ Date:09/09/2019

Checked by: VKB ______________ Date:09/09/2019

Acoustic test WS 1 results

CERTIFICATE OF CALIBRATION

CERTIFICATE NO: 25533

EQUIPMENT TESTED: 1/2" Microphone

Manufacturer: B & K

Type No: 4197 **Serial No:** 3077697 (Part 1)

Owner: SLR Consulting Australia Pty Ltd
Level 2, 2 Lincoln Street
Lane Cove, NSW 2066

Tests Performed: Acoustic Microphone Frequency Response with Inverse A Weighting

CONDITION OF TEST:

Ambient Pressure: 997 hPa ±1.5 hPa **Relative Humidity:** 24 % ±5%

Temperature: 23 °C ±2° C

Date of Calibration: 09/09/2019 **Issue Date** 09/09/2019

Acu-Vib Test Procedure: AVP05 (Microphone Acoustic Frequency Response)

CHECKED BY: KB **AUTHORISED SIGNATURE:** ....

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Acoustic Tests, Microphone response

Job No: 13678 Test No: 25533

Microphone type: B&K 4197 Serial No,: 3077697 (Part 1)

Preamplifier type: 2683 Serial No. : 2792513

SLM body (if appropriate): SVAN 912 AE Serial No: 4396

Ambient Temperature: 23C ±2° C, Relative Humidity: 997 RH ±5% RH,

Ambient Pressure: 24 hPa ±1.5 hPa

Frequency Hz	Deviation re 1 kHz	Type 2 Tol.	Type 1 Tol.	U95 dB	P/F
31.5 Hz	0.11dB	± 3.0 dB	± 1.5 dB dB	0.12	P
63 Hz	-0.11dB	± 2.0 dB	± 1.5 dB dB	0.10	P
125 Hz	-0.18dB	± 1.5 dB	± 1.0 dB dB	0.09	P
250 Hz	-0.25dB	± 1.5 dB	± 1.0 dB dB	0.09	P
500 Hz	-0.24dB	± 1.5 dB	± 1.0 dB dB	0.09	P
1 kHz Ref	0.00dB	± 1.5 dB	± 1.0 dB dB	0.09	P
2 kHz	0.05dB	± 2.0 dB	± 1.0 dB dB	0.07	P
4 kHz	-0.25dB	± 3.0 dB	+ 1.0 dB dB	0.13	P
8 kHz	-0.31dB	± 5.0 dB	+1.5;-3.0 dB	0.13	P
12.5 kHz	-0.20dB	+ 5.0; - ∞ dB	+3.0;-6.0 dB	0.19	P
16 kHz	0.51dB	+ 5.0; - ∞ dB	+ 3.0; - ∞ dB	0.30	P

Tolerances from AS1259-1990 part 1, (IEC 60651).

Notes:

Signed (Testing Officer) Date:09/09/2019

Checked by: /KB Date:09/09/2019

Acoustic test WS 1 results

CERTIFICATE OF CALIBRATION

CERTIFICATE NO.: SLM 42109

Equipment Description:	Noise Logger		
Manufacturer:	ARL		
Model No:	EL-316	**Serial No:**	16-207-050
Microphone Type:	UC-53A	**Serial No:**	318219
Preamplifier Type:	NA	**Serial No:**	NA

Comments: All tests passed for type 1.
(See over for details)

Owner: SLR Consulting Australia Pty Ltd
Level 2, 2 Lincoln Street
Lane Cove, NSW 2066

Ambient Pressure: 1019 hPa ±1.5 hPa

Temperature: 23 °C ±2° C **Relative Humidity:** 53 % ±5%

Date of Calibration: 27/06/2019 **Issue Date:** 27/06/2019

Acu-Vib Test Procedure: AVP05 (SLM)

CHECKED BY: .... **AUTHORISED SIGNATURE:** ....

Jack Kielt

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CERTIFICATE NO.: **SLM 42109**

The performance characteristics listed below were tested. The tests are based on the relevant clauses of A.S. 1259.1 and A.S. 1259.2 - 1990

1. RMS Performance	clause 10.4.5
2. Time Weighting Response, F&S	clause 10.4.2
3. Time Weighting I	clause 10.4.3 NA
4. Time Weighting P	clause 10.4.4 NA
5. Input Attenuator Accuracy	clause 10.3.3
6. Detector & Differential Linearity	clause 10.4.1
7. Weighting Networks & Linearity	clause 10.2.3
8. Overload Indication	clause 10.3.2
9. AC Output & Weighted Noise Level	clause 11. (c). (ii) 10.3.4
10. Time Averaging	clause 9.3.2
11. Absolute Sensitivity	clause 10.2.2

Note: Absolute Sensitivity as found was 95.8 dB and adjusted to 94.0 dB
Uncertainty: ±0.13dB (at 95% c.l.) k=2

Date of Calibration: 27/06/2019 **Issue Date:** 27/06/2019

Checked by:

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web site: www.acu-vib.com.au

CERTIFICATE OF CALIBRATION

CERTIFICATE NO.: **SLM 42108**

Equipment Description:	Noise Logger		
Manufacturer:	ARL		
Model No:	EL-316	**Serial No:**	16-207-044
Microphone Type:	UC-53A	**Serial No:**	321979
Preamplifier Type:	NA	**Serial No:**	NA

Comments: All tests passed for type 1.
(See over for details)

Owner: SLR Consulting Australia Pty Ltd
Level 2, 2 Lincoln Street
Lane Cove, NSW 2066

Ambient Pressure: 1019 hPa ±1.5 hPa

Temperature: 23 °C ±2° C **Relative Humidity:** 53 % ±5%

Date of Calibration: 27/06/2019 **Issue Date:** 27/06/2019

Acu-Vib Test Procedure: AVP05 (SLM)

CHECKED BY: ...... **AUTHORISED SIGNATURE:** ....

Jack Kielt

Accredited for compliance with ISO/IEC 17025 - Calibration
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CERTIFICATE NO.: SLM 42108

The performance characteristics listed below were tested. The tests are based on the relevant clauses of A.S. 1259.1 and A.S. 1259.2 - 1990

1. RMS Performance	clause 10.4.5
2. Time Weighting Response, F&S	clause 10.4.2
3. Time Weighting I	clause 10.4.3 NA
4. Time Weighting P	clause 10.4.4 NA
5. Input Attenuator Accuracy	clause 10.3.3
6. Detector & Differential Linearity	clause 10.4.1
7. Weighting Networks & Linearity	clause 10.2.3
8. Overload Indication	clause 10.3.2
9. AC Output & Weighted Noise Level	clause 11. (c). (ii) 10.3.4
10. Time Averaging	clause 9.3.2
11. Absolute Sensitivity	clause 10.2.2

Note: Absolute Sensitivity as found was 88.1 dB and adjusted to 94.0 dB
Uncertainty: ±0.13dB (at 95% c.l.) k=2

Date of Calibration: 27/06/2019 **Issue Date:** 27/06/2019

Checked by:

Accredited for compliance with ISO/IEC 17025 - Calibration
The results of the tests, calibration and/or measurements included in this document are traceable to Australian/national standards.
The uncertainties quoted are calculated in accordance with the methods of the ISO Guide to the Uncertainty of Measurement and quoted at a coverage factor of 2 with a confidence interval of approximately 95%.

NATA
WORLD RECOGNISED ACCREDITATION
Accredited Lab. No. 9262
Acoustic and Vibration Measurements

ACU-VIB
ELECTRONICS
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Level 7 Building 2 423 Pennant Hills Rd
Pennant Hills NSW AUSTRALIA 2120
Ph: +61 2 9484 0800 A.B.N. 65 160 399 119
www.acousticresearch.com.au

Sound Level Meter
AS 1259.1:1990 - AS 1259.2:1990
Calibration Certificate

Calibration Number C17217

Client Details SLR Consulting Australia Pty Ltd
2 Lincoln Street
Lane Cove NSW 2066

Equipment Tested/ Model Number : ARL [illegible]
Instrument Serial Number : 16-203-[illegible]
Microphone Serial Number : [illegible]080
Pre-amplifier Serial Number : [illegible]089

Atmospheric Conditions
Ambient Temperature : 24.9°C
Relative Humidity : 46.4%
Barometric Pressure : 100.27kPa

Calibration Technician : Vicky [illegible] **Secondary Check:** Riley Couper
Calibration Date : 09/0[illegible]/2017 **Report Issue Date :** 13/06/2017

Approved Signatory : Ken Williams

Clause and Characteristic Tested	Result	Clause and Characteristic Tested	Result
10.2[illegible]: Absolute sensitivity	*Pass*	10.[illegible]: Inherent system noise level	*Pass*
10.[illegible]: Frequency weighting	*Pass*	10.[illegible]: Time weighting characteristic F and S	*Pass*
10.[illegible]: Overload indications	*Pass*	10.[illegible]: Time weighting characteristic I	*Pass*
10.3.3: Accuracy of level range control	*Pass*	10.4.5: R.M.S performance	*Pass*
8.9: Detector-indicator linearity	*Pass*	9.3.2: Time averaging	*Pass*
8.10: Differential level linearity	*Pass*	9.3.5: Overload indication	*Pass*

Least Uncertainties of Measurement

Acoustic Tests		Environmental Conditions	
31.5 Hz to 8kHz	*±0.16dB*	*Temperature*	*±0.[illegible]*
12.5kHz	*±0.[illegible]dB*	*Relative Humidity*	*[illegible]*
16kHz	*±0.[illegible]dB*	*Barometric Pressure*	*±0.01kPa*
Electrical Tests			
31.5 Hz to [illegible]kHz	*±0.12dB*		

All uncertainties are derived at the [illegible] confidence level with a coverage factor of [illegible]

The sound level meter under test has been shown to conform to the type 1 requirements for periodic testing as described in AS 1259.1:1990 and AS 1259.2:1990 for the tests stated above.

This calibration certificate is to be read in conjunction with the calibration test report.

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Accredited for compliance with ISO/IEC 17025.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration and inspection reports.

Acoustic Research Labs Pty Ltd
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Pennant Hills NSW AUSTRALIA [illegible]
Ph: [illegible] A.B.N [illegible]
www.acousticresearch.com.au

Sound Level Meter
AS 1259.1:1990 - AS 1259.2:1990
Calibration Certificate

Calibration Number C18314

Client Details	SLR Consulting [illegible] [illegible]
Equipment Tested/ Model Number :	ARL EL-316
Instrument Serial Number :	16-207-[illegible]
Microphone Serial Number :	319922
Pre-amplifier Serial Number :	23454

Atmospheric Conditions

Ambient Temperature :	21.7°C
Relative Humidity :	45.3%
Barometric Pressure :	99.36kPa

Calibration Technician :	Lucky Jaswal	**Secondary Check:**	[illegible]
Calibration Date :	14 Jun 2018	**Report Issue Date :**	14 Jun 2018

Approved Signatory : Ken Williams

Clause and Characteristic Tested	Result	Clause and Characteristic Tested	Result
10.2.2: Absolute sensitivity	*Pass*	10.3.4: Inherent system noise level	*Pass*
10.2.3: Frequency weighting	*Pass*	10.4.2: Time weighting characteristic F and S	*Pass*
10.3.2: Overload indication	*Pass*	10.4.3: Time weighting characteristic I	*Pass*
10.3.3: Accuracy of level range control	*Pass*	10.4.5: R.M.S performance	*Pass*
8.9: Detector-indicator linearity	*Pass*	9.3.2: Time averaging	*Pass*
8.10: Differential level linearity	*Pass*	9.3.5: Overload indication	*Pass*

Least Uncertainties of Measurement

Acoustic Tests		Environmental Conditions	
31.5 Hz to 8kHz	*±0.1[illegible]dB*	*Temperature*	*[illegible]*
12.5kHz	*[illegible]dB*	*Relative Humidity*	*[illegible]*
16kHz	*±0.29dB*	*Barometric Pressure*	*[illegible]*
Electrical Tests			
31.5 Hz to 20kHz	*±0.13dB*		

All uncertainties are derived at the 95% confidence level with a coverage factor of 2.

The sound level meter under test has been shown to conform to the type 1 requirements for periodic testing described in AS 1259.1:1990 and AS 1259.2:1990 for the tests stated above.

Acoustic Research Labs Pty Ltd

Level 7 Building 2 423 Pennant Hills Rd
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Ph: +61 [illegible]
www.acousticresearch.com.au

Sound Level Meter

AS 1259.1:1990 - AS 1259.2:1990

Calibration Certificate

Calibration Number [illegible]

Client Details	SLR Consulting Suite [illegible] Domville Avenue Hawthorn Vic 3122
Equipment Tested/ Model Number :	ARL [illegible] 316
Instrument Serial Number :	16-103-294
Microphone Serial Number :	317[illegible]50
Pre-amplifier Serial Number :	280[illegible]

Atmospheric Conditions

Ambient Temperature :	[illegible] °C
Relative Humidity :	42 %
Barometric Pressure :	99.[illegible] kPa

Calibration Technician :	Lucky Jaswal	Secondary Check:	Lewis [illegible]
Calibration Date :	14 Jun 2018	Report Issue Date :	14 Jun 2018

Approved Signatory : Ken Williams

Clause and Characteristic Tested	Result	Clause and Characteristic Tested	Result
10.2.1: Absolute sensitivity	Pass	[illegible]	Pass
10.2.2: Frequency weighting	Pass	10.4.2: Time weighting characteristic F and S	Pass
10.3.2: Overload indication	Pass	10.4.3: Time weighting characteristic I	Pass
10.3.3: Accuracy of level range control	Pass	10.4.4: R.M.S performance	Pass
8.[illegible]: Detector-indicator linearity	Pass	9.3.2: Time averaging	Pass
[illegible] 10: Differential level linearity	Pass	9.3.4: Overload indication	Pass

Least Uncertainties of Measurement -

Acoustic Tests		Environmental Conditions	
[illegible] kHz	±0.15dB	Temperature	±[illegible] °C
[illegible]	±0.2[illegible]dB	Relative Humidity	±[illegible]%
[illegible]	±[illegible]dB	Barometric Pressure	±0.0[illegible] kPa
Electrical Tests			
[illegible] 20 kHz	±0.[illegible]0dB		

All uncertainties are derived at the 95% confidence level with a coverage factor of 2.

The sound level meter under test has been shown to conform to the test requirements for [illegible] AS 1259.1:1990 and AS 1259.2:1990 for the tests stated above.

This calibration certificate is to be read in conjunction with the [illegible]

Acoustic Research Labs Pty Ltd is NATA Accredited Laboratory Number 14172. Accredited for compliance with ISO/IEC 17025 - calibration

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

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SVANTEK

ISO9001 certified

FACTORY CALIBRATION DATA OF THE SVAN 977A No. 69756

with preamplifier SVANTEK type SV12L and microphone ACO PACIFIC type 7052E

SOUND LEVEL METER

1. CALIBRATION

2. CALIBRATION

3. LINEARITY TEST

4. TONE BURST RESPONSE

ENVIRONMENTAL CONDITIONS

Temperature	Relative humidity	Ambient pressure
[illegible]	[illegible]	[illegible]

TEST EQUIPMENT

Item	Manufacturer	Model	Serial no.	Description
1	SVANTEK	[illegible]	[illegible]	[illegible]
2	SVANTEK	[illegible]	[illegible]	[illegible]
3	[illegible]	[illegible]	[illegible]	[illegible]
4	SVANTEK	[illegible]	[illegible]	[illegible]
5	SVANTEK	[illegible]	[illegible]	[illegible]
6	SVANTEK	[illegible]	[illegible]	[illegible]

CONFORMITY & TEST DECLARATION

Calibration specialist: Krzysztof [illegible]

Test date: [illegible]

Range	Dynamic	Dynamic (ms)									
[illegible]	Fast	Indication (dB)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		Error (dB)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Slow	Indication (dB)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		Error (dB)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		Indication (dB)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		Error (dB)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Range	Detector	Duration (ms)			
[illegible]	Fast	Indication (dB)	[illegible]	[illegible]	[illegible]
		Error (dB)	[illegible]	[illegible]	[illegible]
	Slow	Indication (dB)	[illegible]	[illegible]	[illegible]
		Error (dB)	[illegible]	[illegible]	[illegible]
[illegible]		Indication (dB)	[illegible]	[illegible]	[illegible]
		Error (dB)	[illegible]	[illegible]	[illegible]

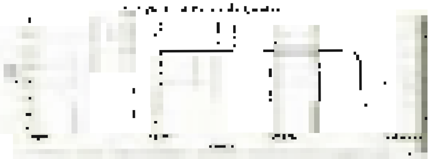
Range	Dynamic	Duration (ms)										
[illegible]	Fast	Indication (dB)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		Error (dB)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Slow	Indication (dB)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		Error (dB)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		Indication (dB)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		Error (dB)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Range	Detector	Duration (ms)				
[illegible]	Fast	Indication (dB)	[illegible]	[illegible]	[illegible]	[illegible]
		Error (dB)	[illegible]	[illegible]	[illegible]	[illegible]
	Slow	Indication (dB)	[illegible]	[illegible]	[illegible]	[illegible]
		Error (dB)	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		Indication (dB)	[illegible]	[illegible]	[illegible]	[illegible]
		Error (dB)	[illegible]	[illegible]	[illegible]	[illegible]

Range	Detector	Duration (ms)			
[illegible]	Fast	Indication (dB)	[illegible]	[illegible]	[illegible]
		Error (dB)	[illegible]	[illegible]	[illegible]
	Slow	Indication (dB)	[illegible]	[illegible]	[illegible]
		Error (dB)	[illegible]	[illegible]	[illegible]
[illegible]		Indication (dB)	[illegible]	[illegible]	[illegible]
		Error (dB)	[illegible]	[illegible]	[illegible]

5. FREQUENCY RESPONSE – BAND AUDIO

6. FREQUENCY RESPONSE – BAND ULTRA



7. INTERNAL NOISE LEVEL

	Characteristic	[illegible]	[illegible]	[illegible]
Range Low	Level (dB)	[illegible]	[illegible]	[illegible]
Range High	Level (dB)	[illegible]	[illegible]	[illegible]

8. INTERNAL NOISE LEVEL

Range	Low	High
Indication (dB)	[illegible]	[illegible]

VIBRATION LEVEL METER

1. CALIBRATION

Range	Low	High
Indication (dB)	[illegible]	[illegible]
Error (dB)	[illegible]	[illegible]

2. CALIBRATION

Characteristic	Reference Frequency (Hz)	Correct value (dB)	Indication (dB)	Error (dB)
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

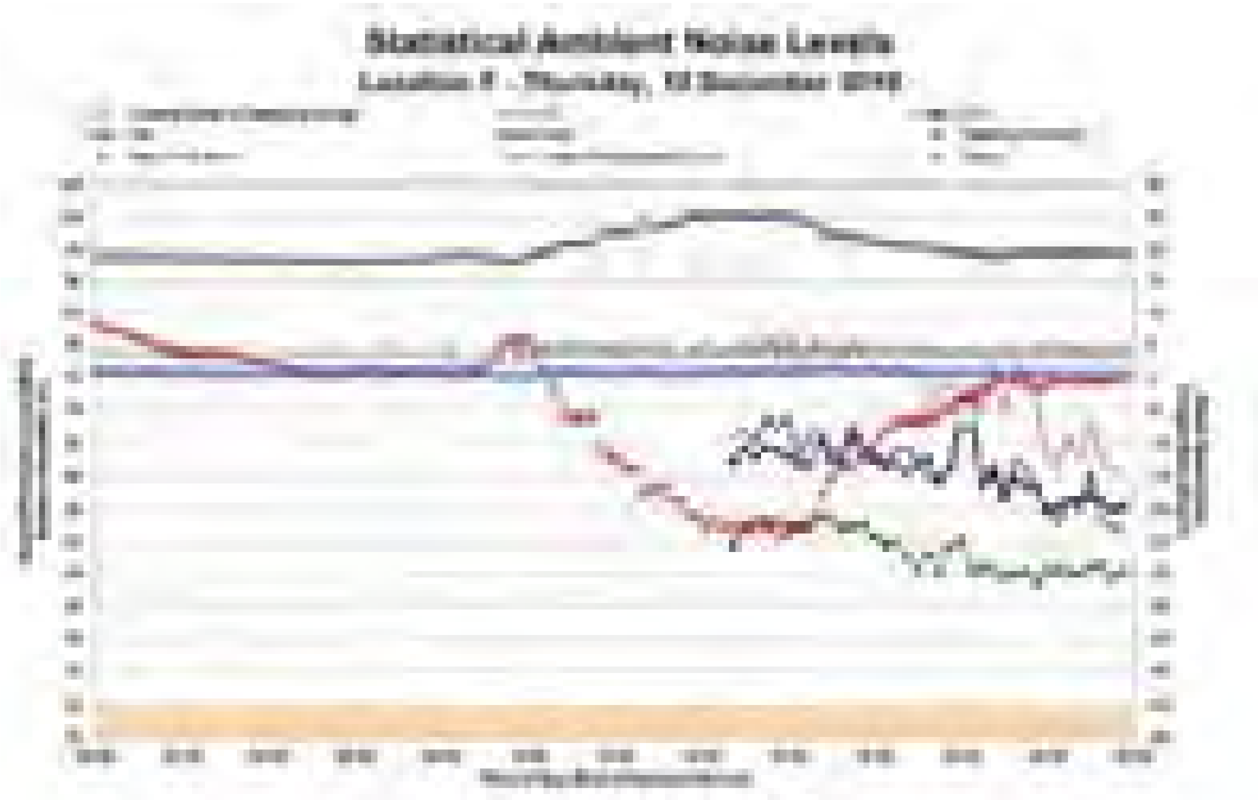
3. FREQUENCY RESPONSE

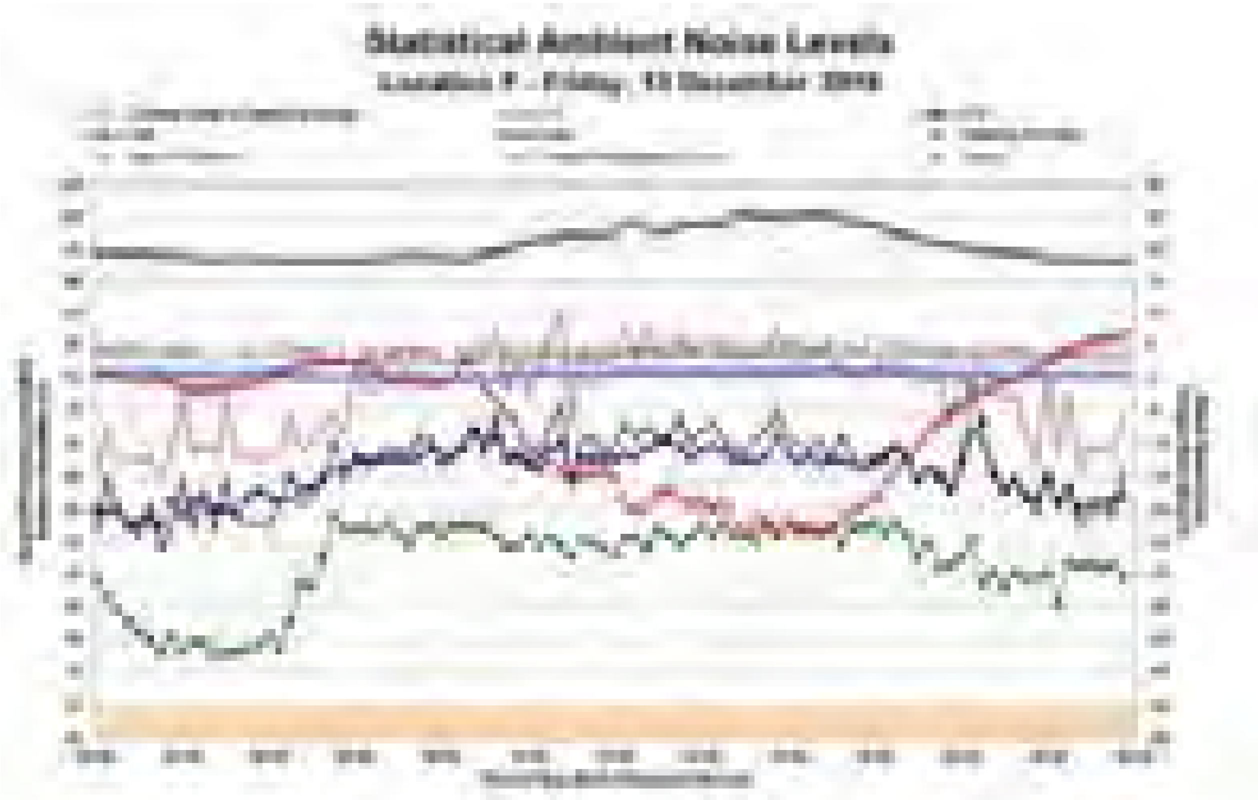
4. INTERNAL NOISE LEVEL

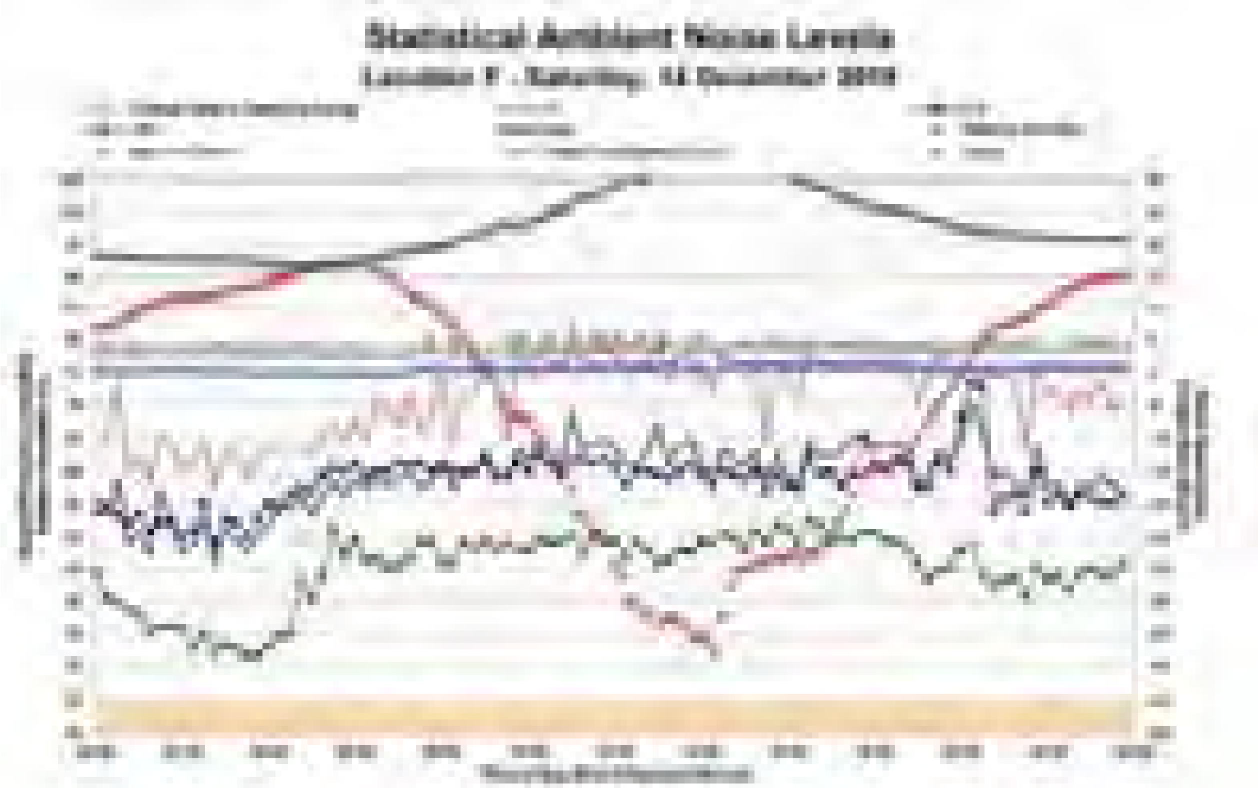
Characteristic	[illegible]
Indication (dB)	[illegible]

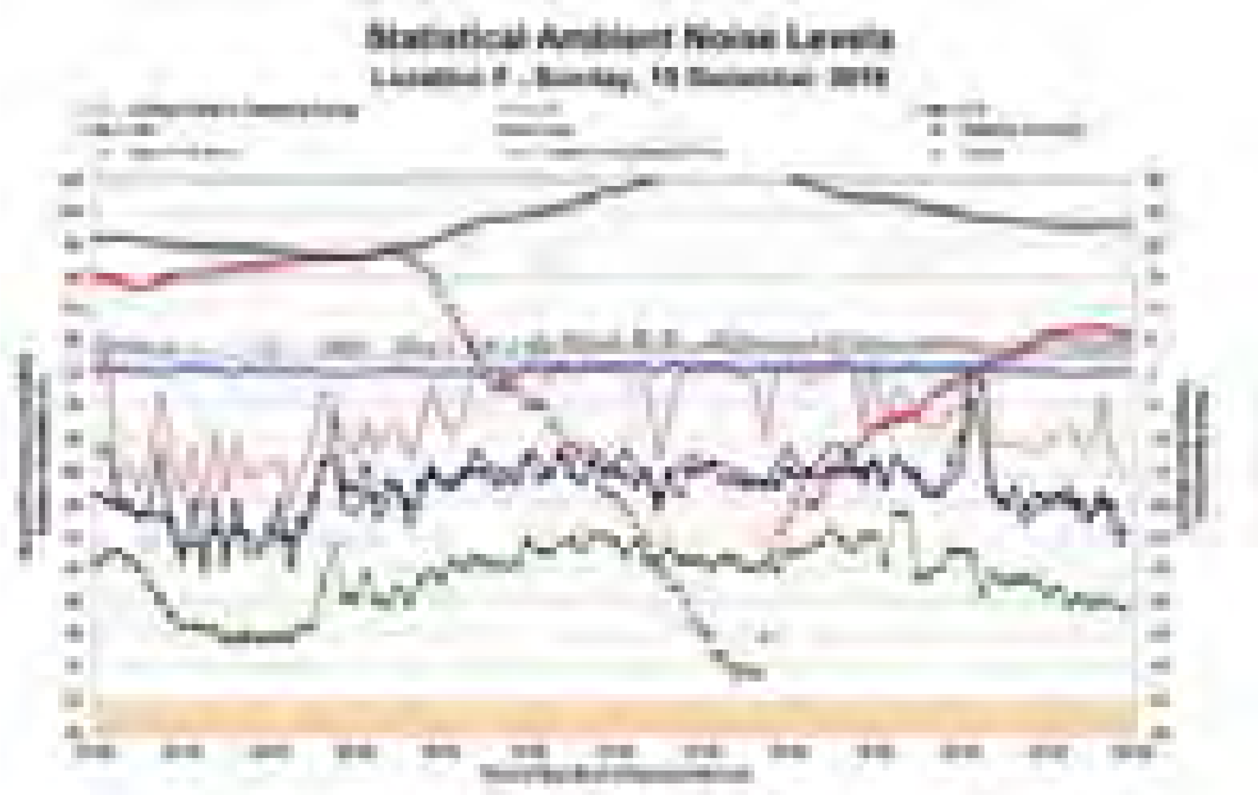
APPENDIX D

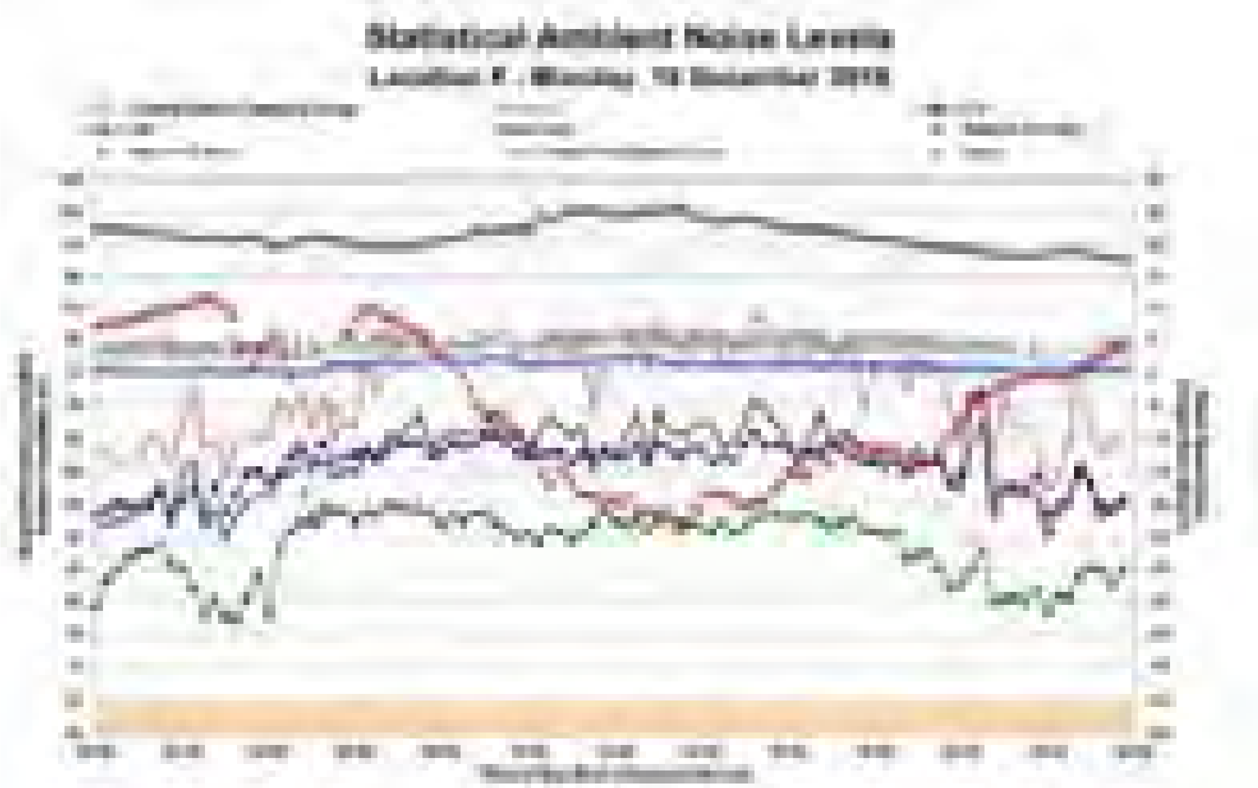
Statistical Ambient Noise Levels

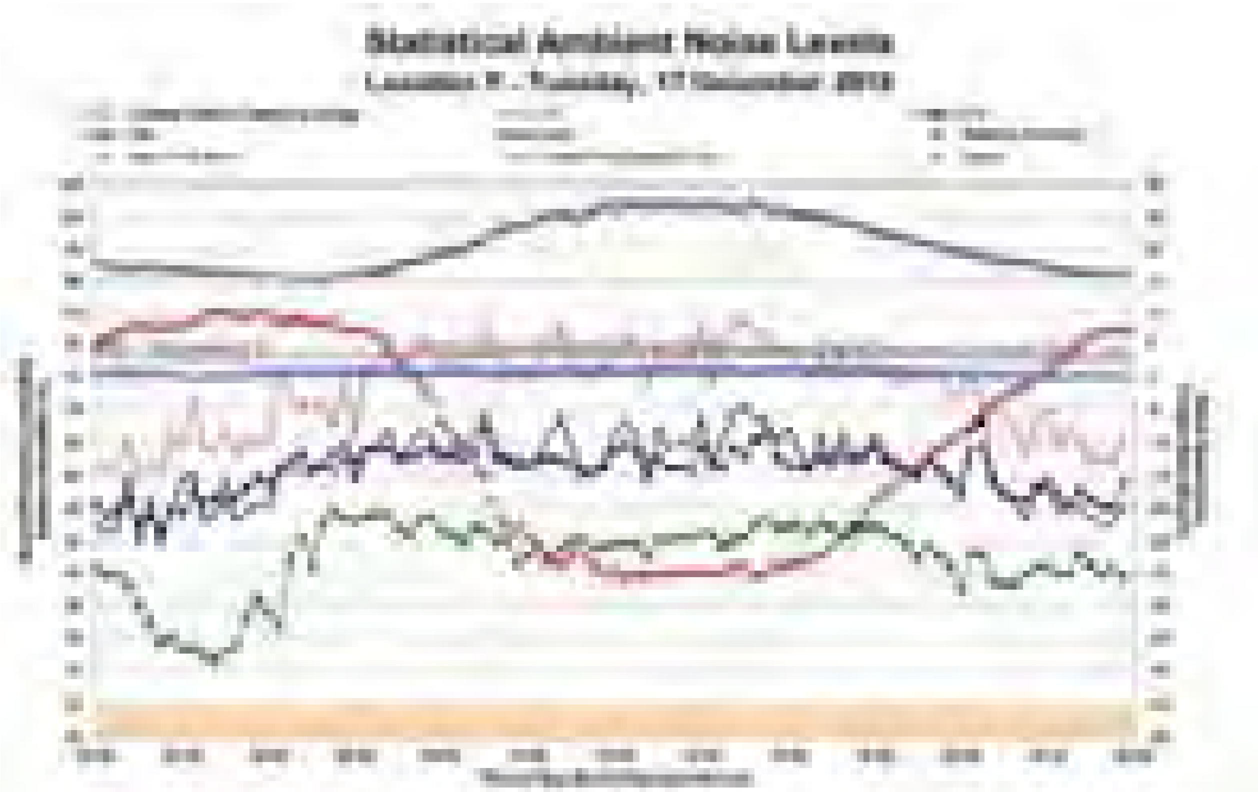

Statistical Ambient Noise Levels
Location F - Thursday, 12 December 2019

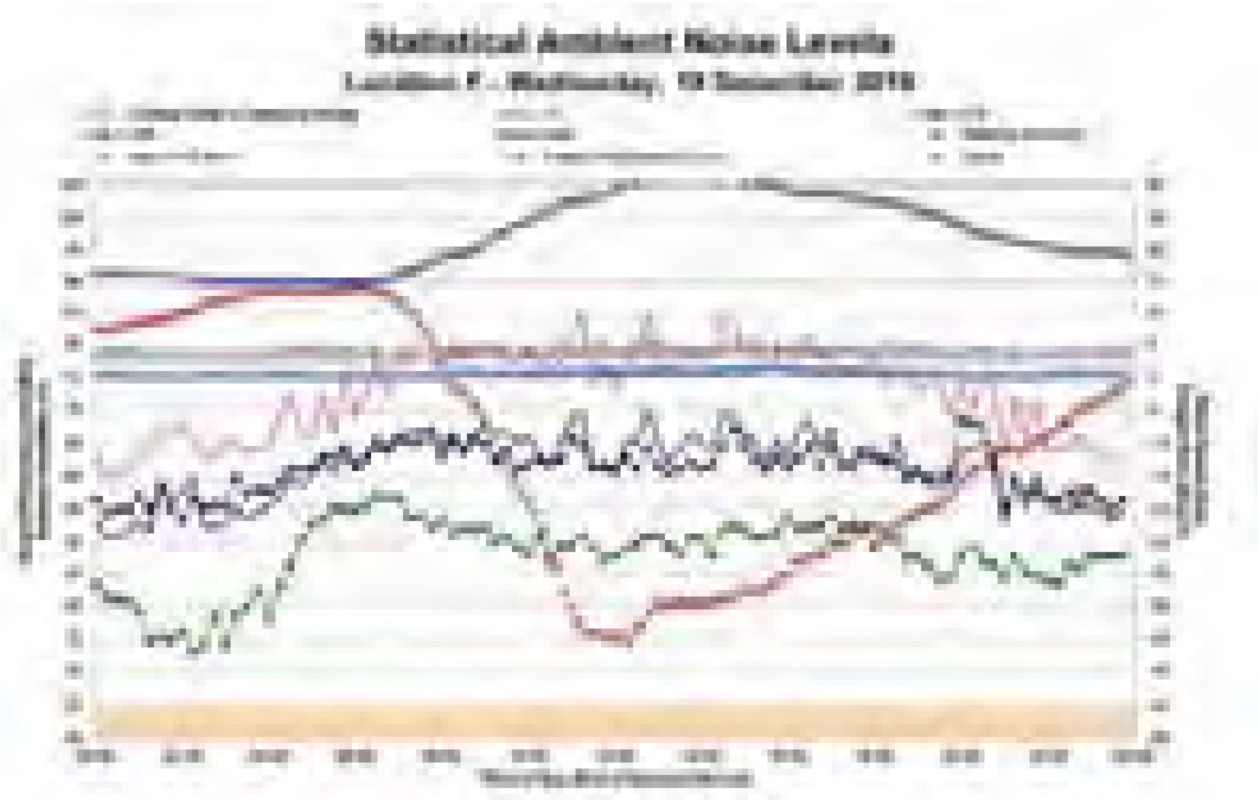

Statistical Ambient Noise Levels
Location F - Friday, 13 December 2019

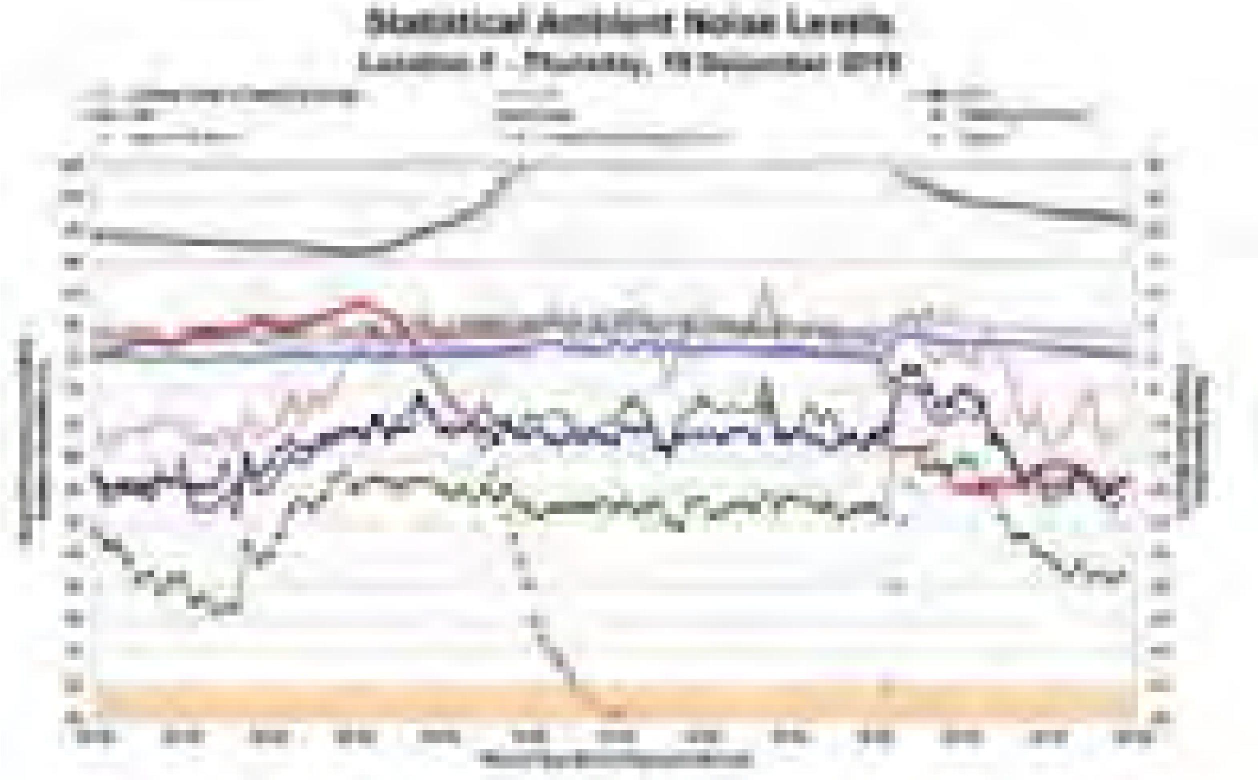

Statistical Ambient Noise Levels
Location F - Saturday, 14 December 2019

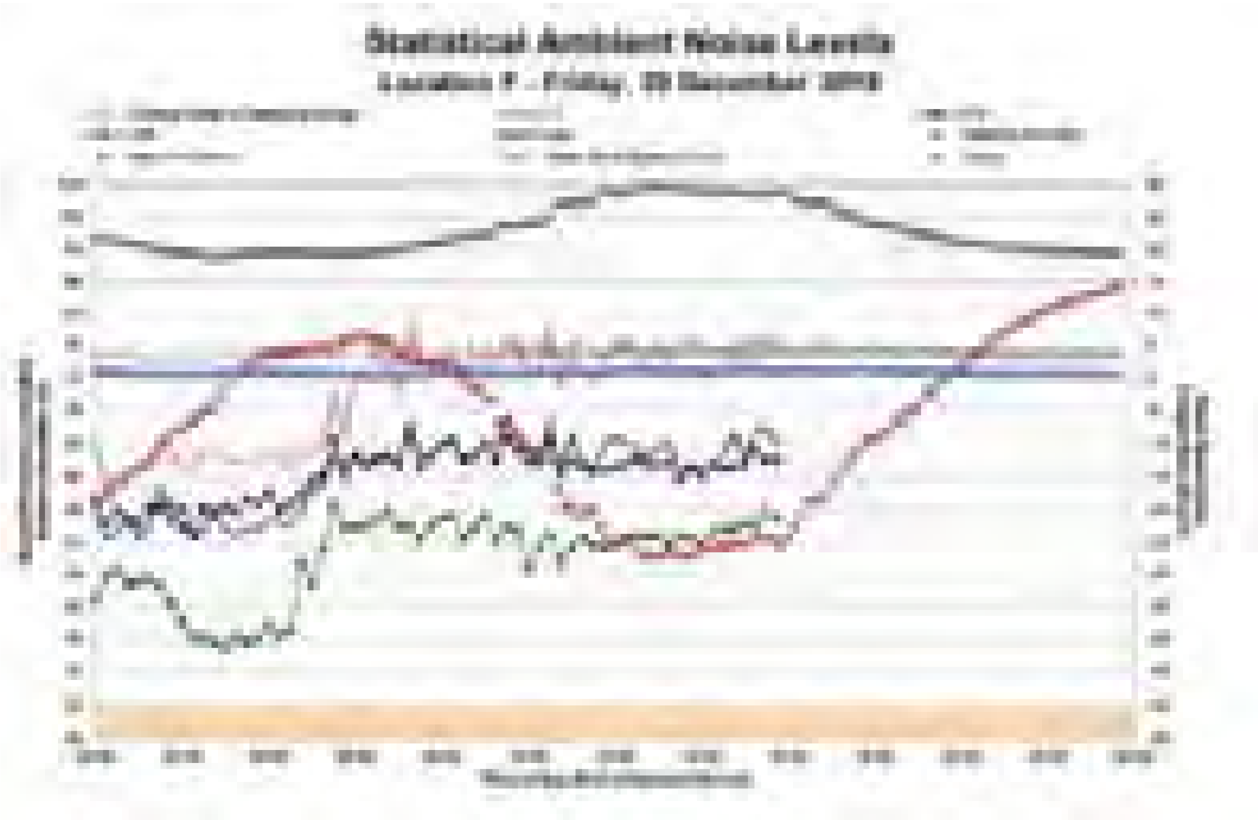

Statistical Ambient Noise Levels
Location F - Sunday, 15 December 2019

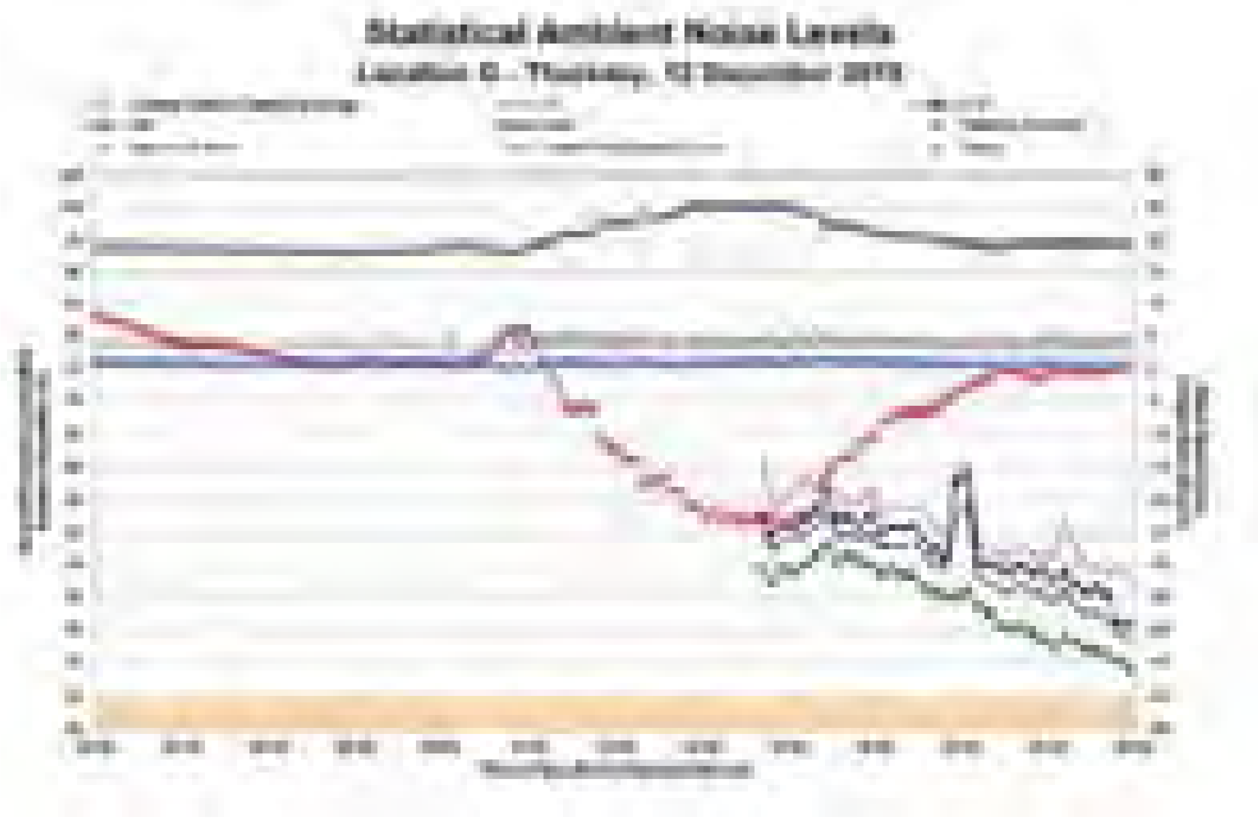

Statistical Ambient Noise Levels
Location F - Monday, 16 December 2013

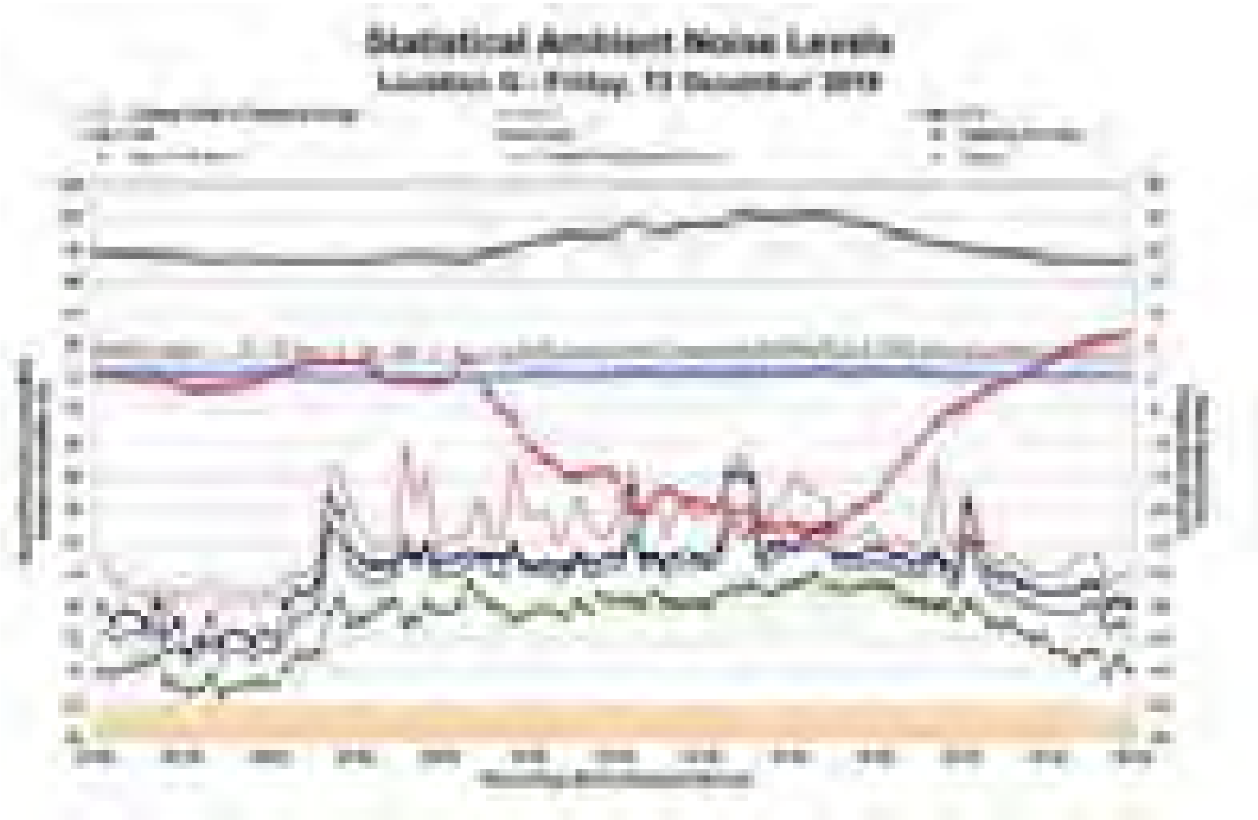

Statistical Ambient Noise Levels
Location F - Tuesday, 17 December 2013

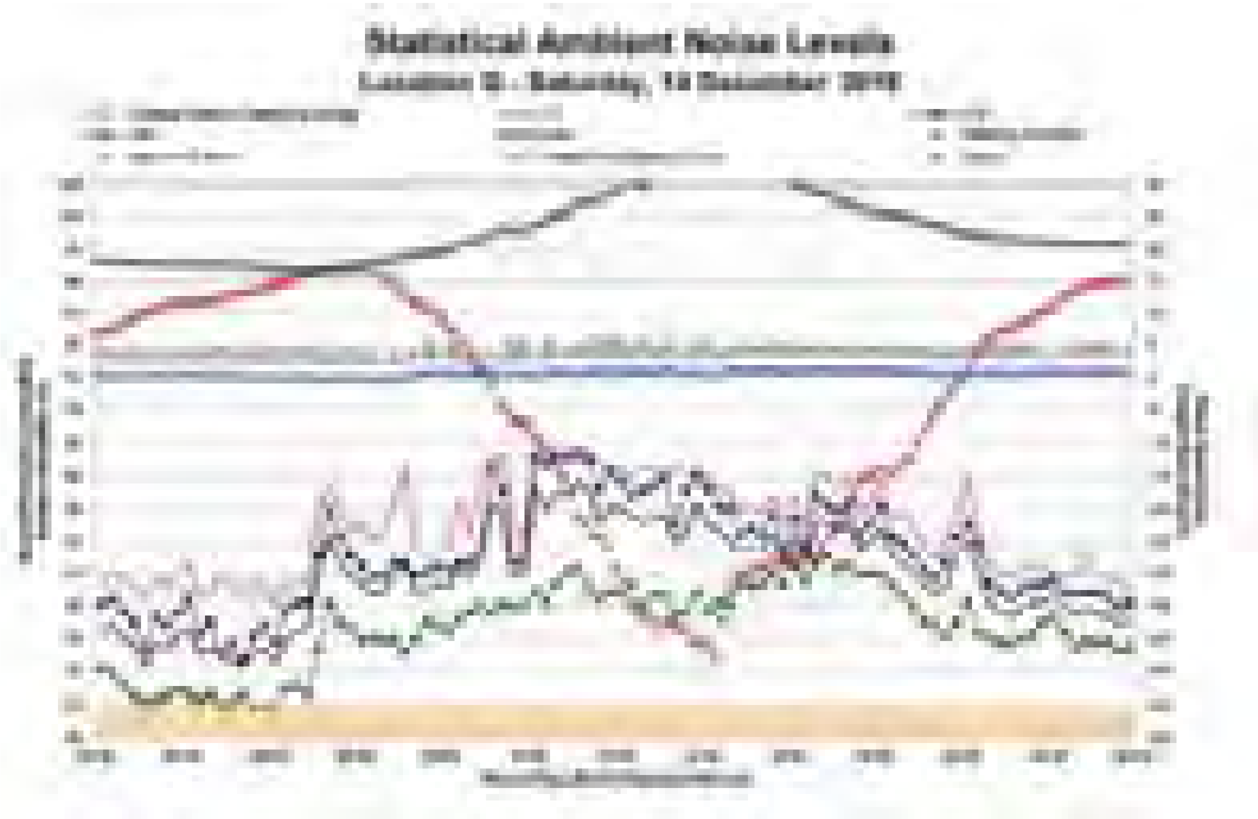

Statistical Ambient Noise Levels
Location F - Wednesday, 18 December 2019

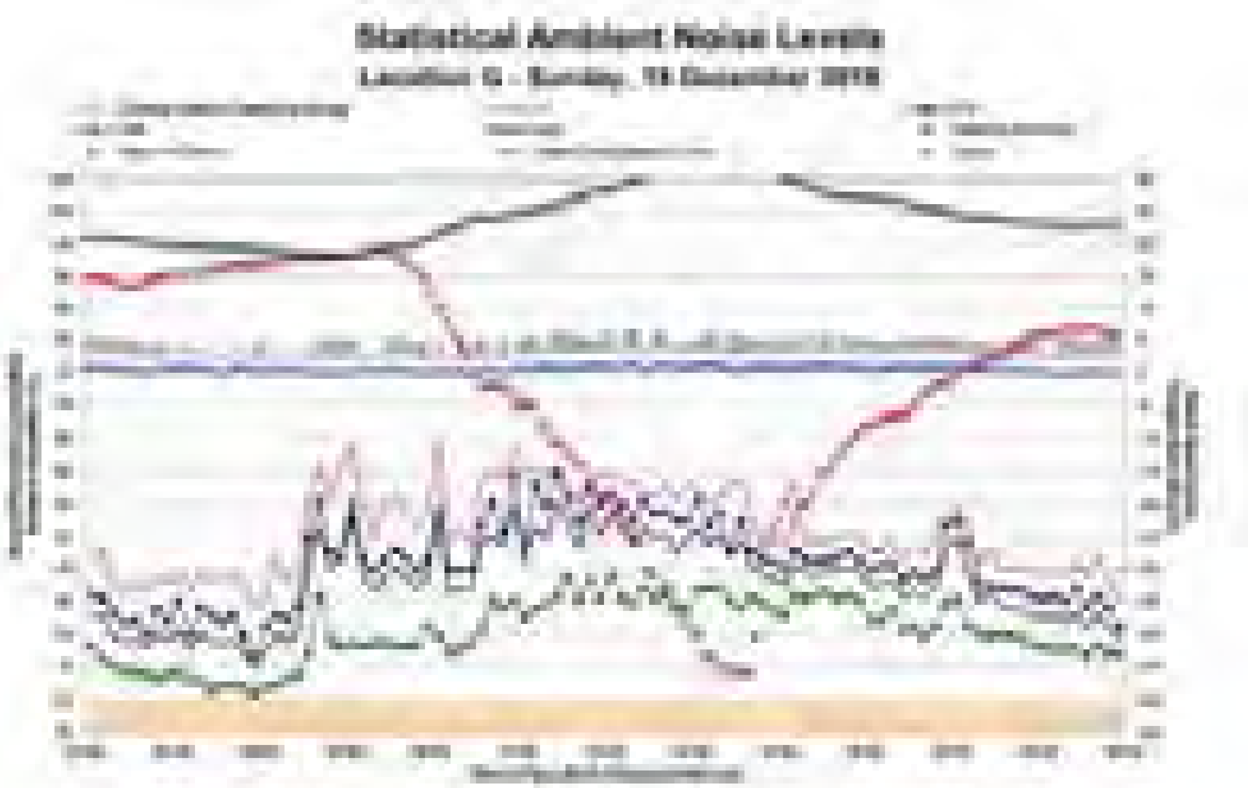

Statistical Ambient Noise Levels
Location F - Thursday, 19 December 2019

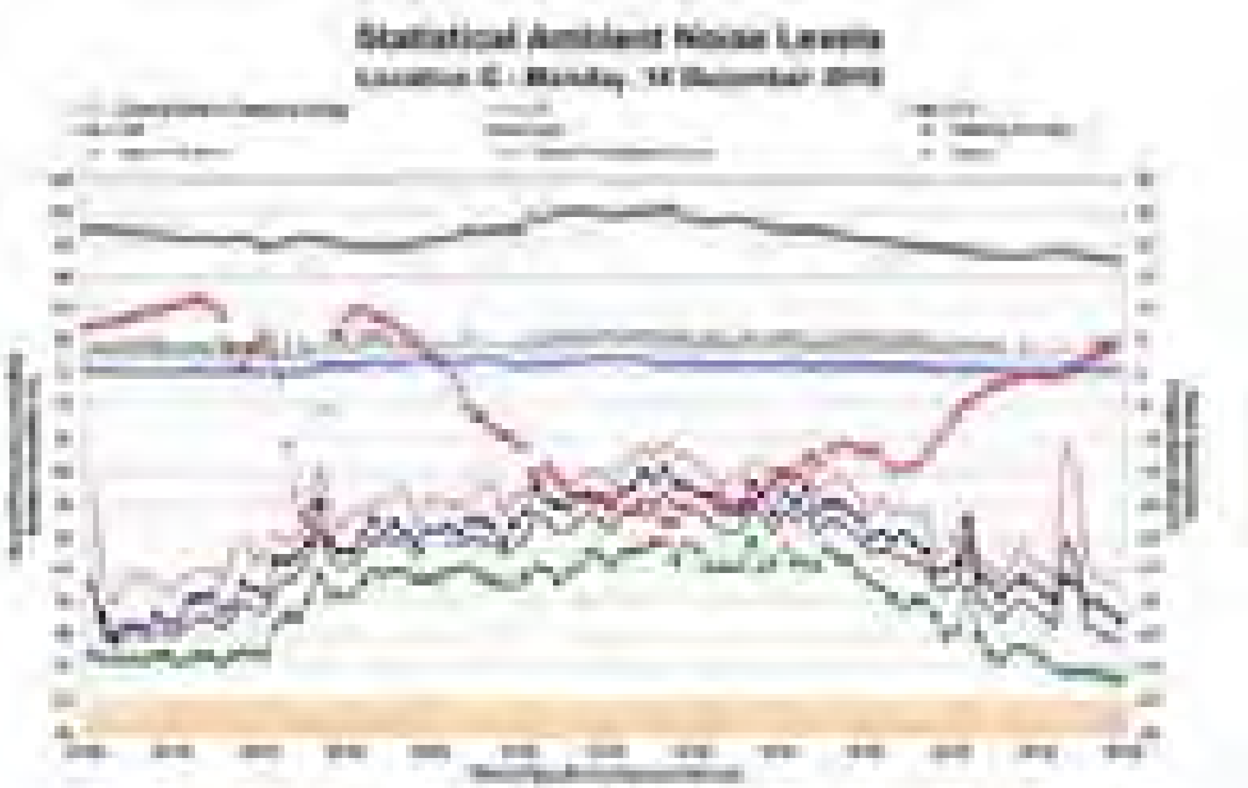

Statistical Ambient Noise Levels

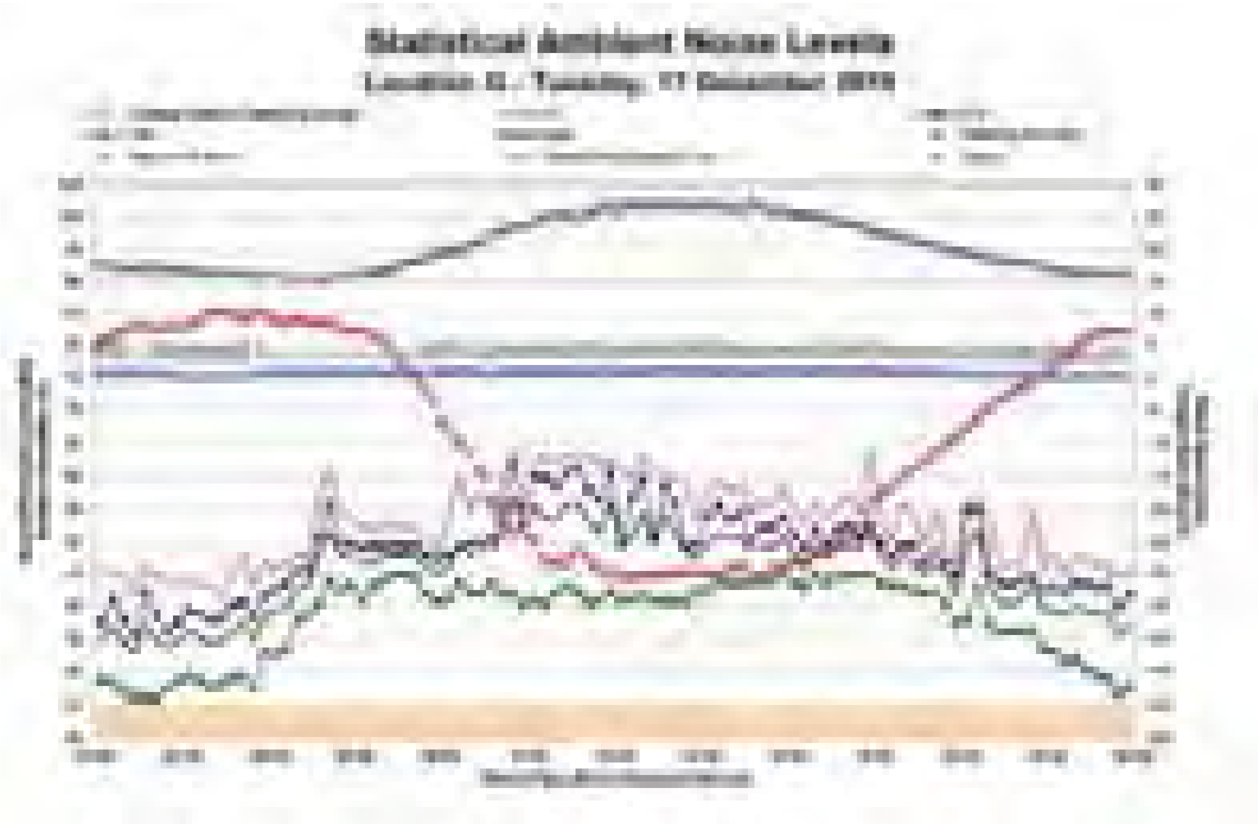

Statistical Ambient Noise Levels

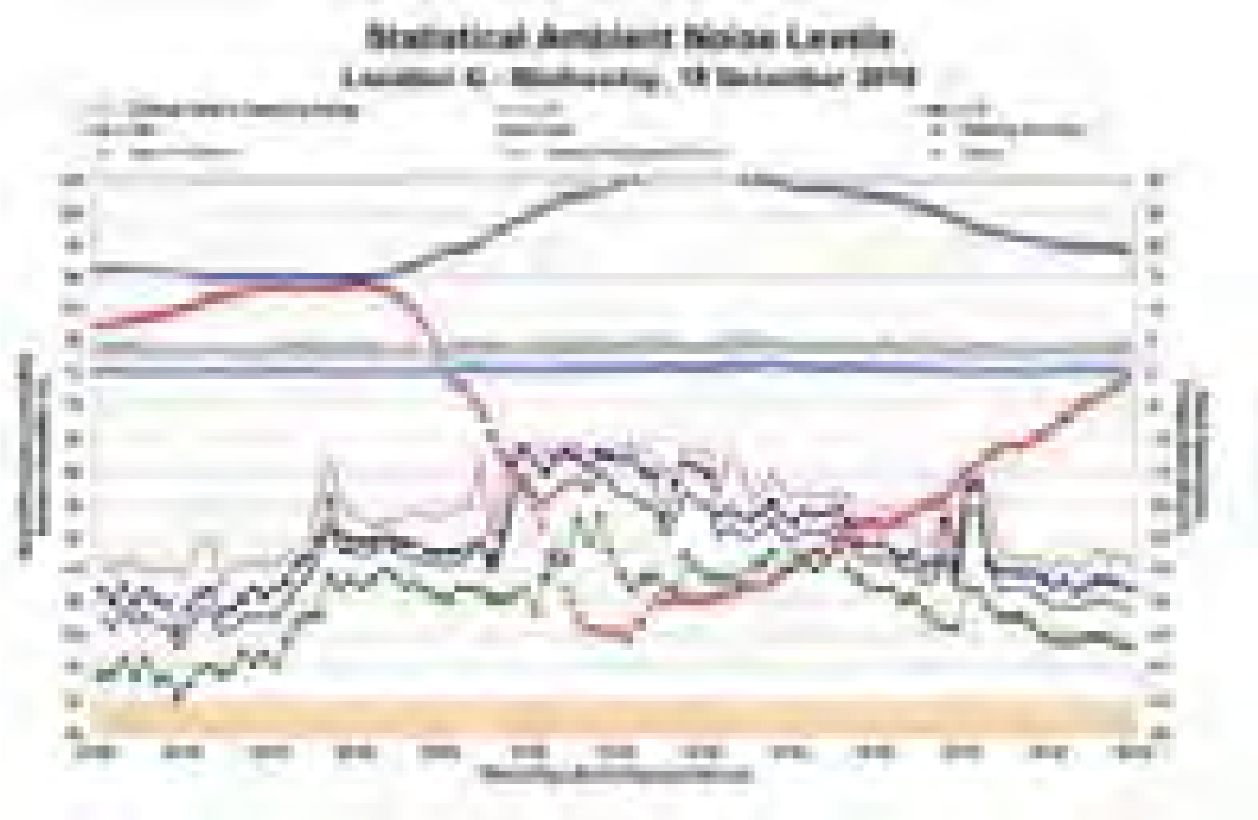

Statistical Ambient Noise Levels
Location G - Friday, 13 December 2019

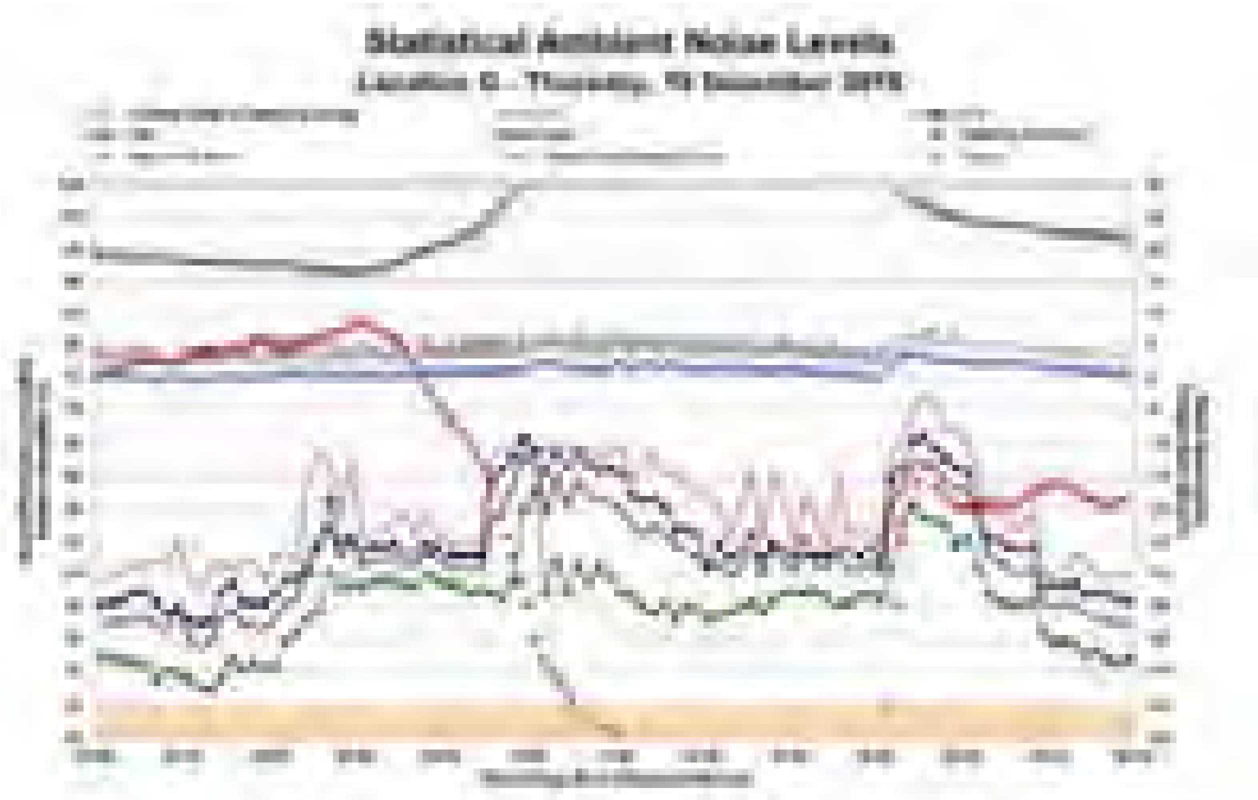

Statistical Ambient Noise Levels
Location G - Saturday, 14 December 2019

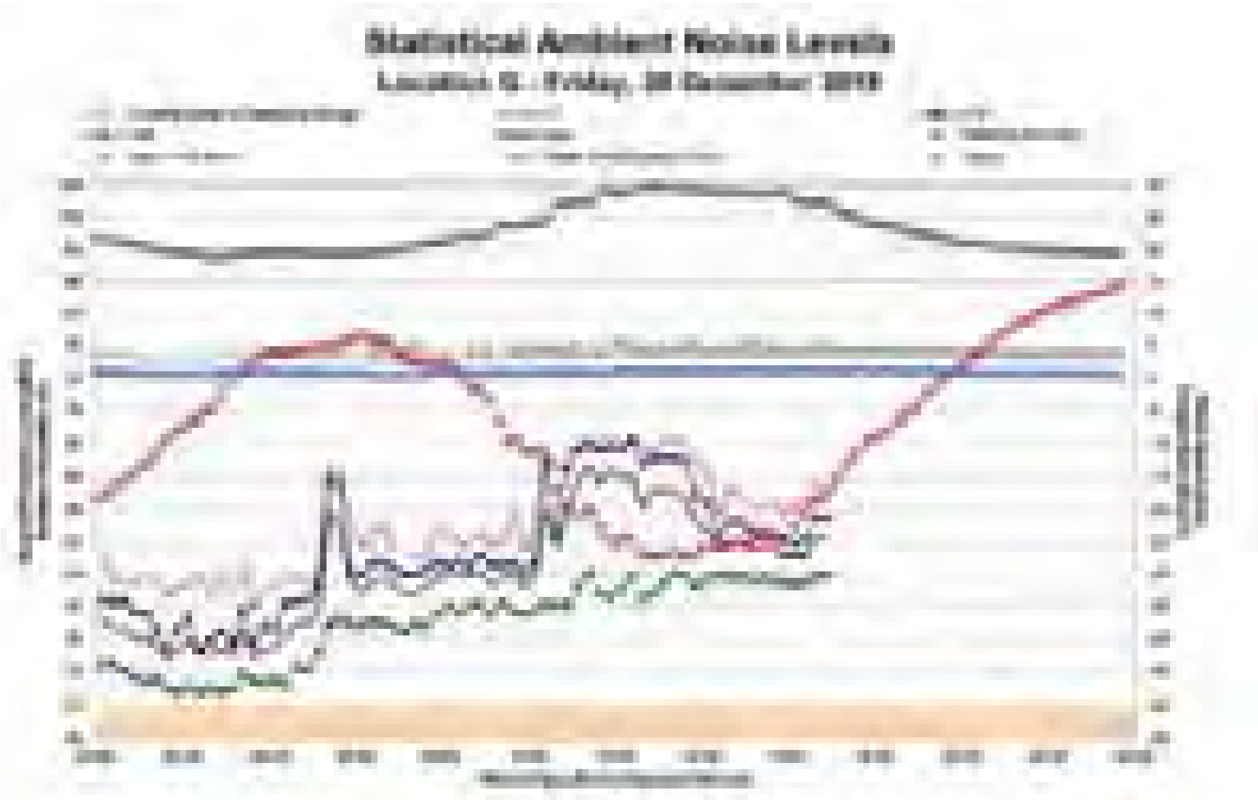

Statistical Ambient Noise Levels

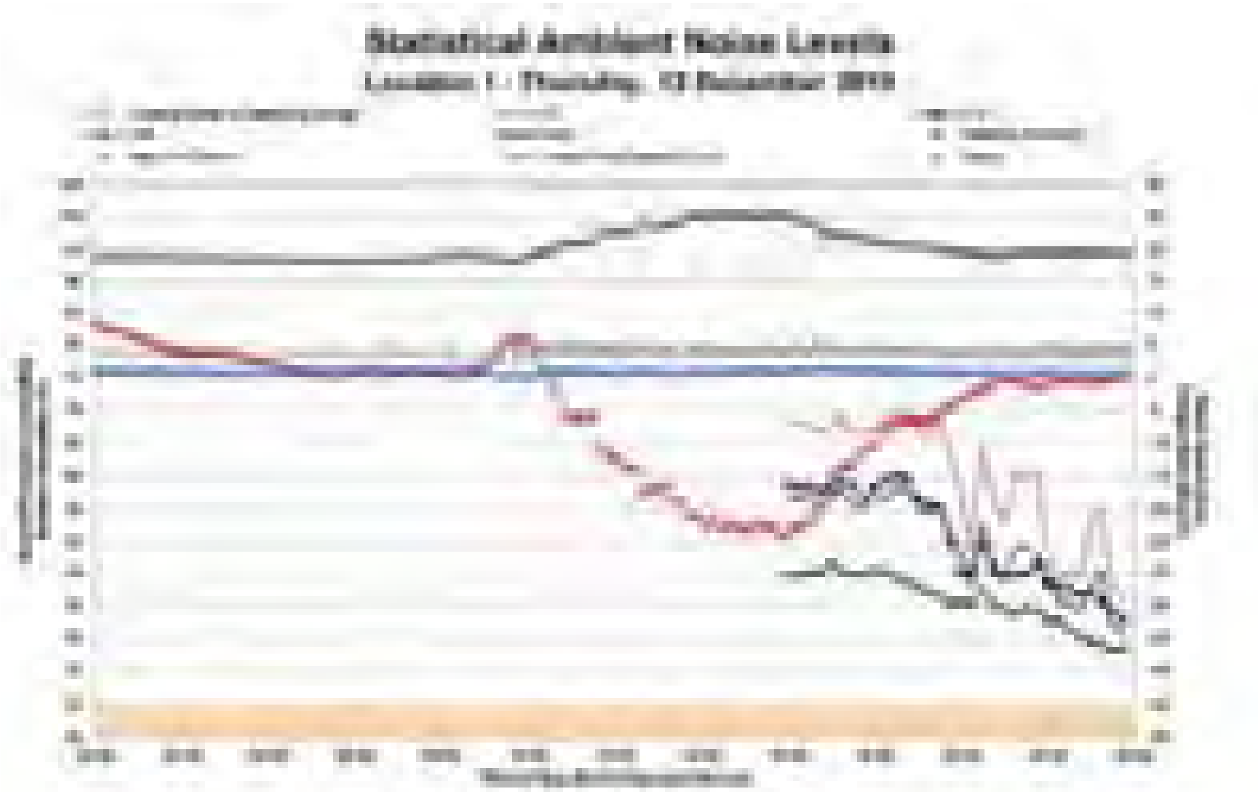

Statistical Ambient Noise Levels

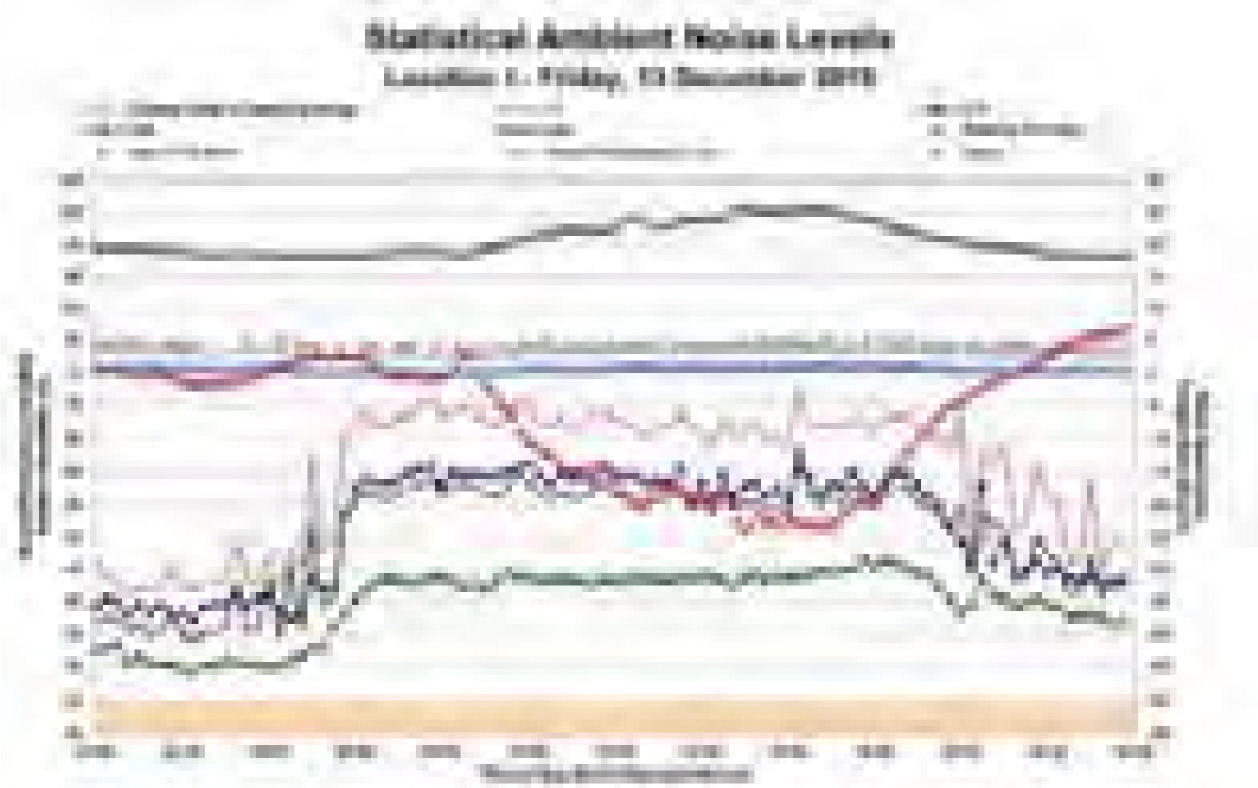


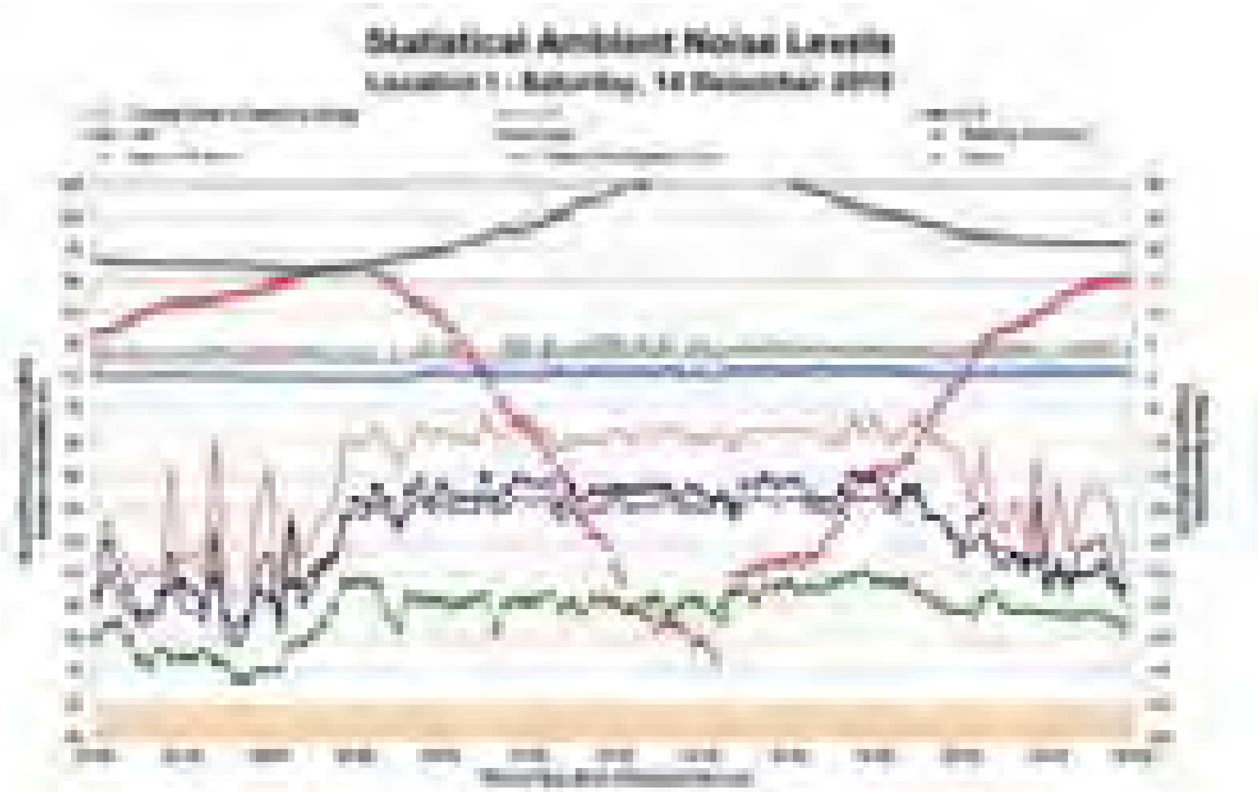


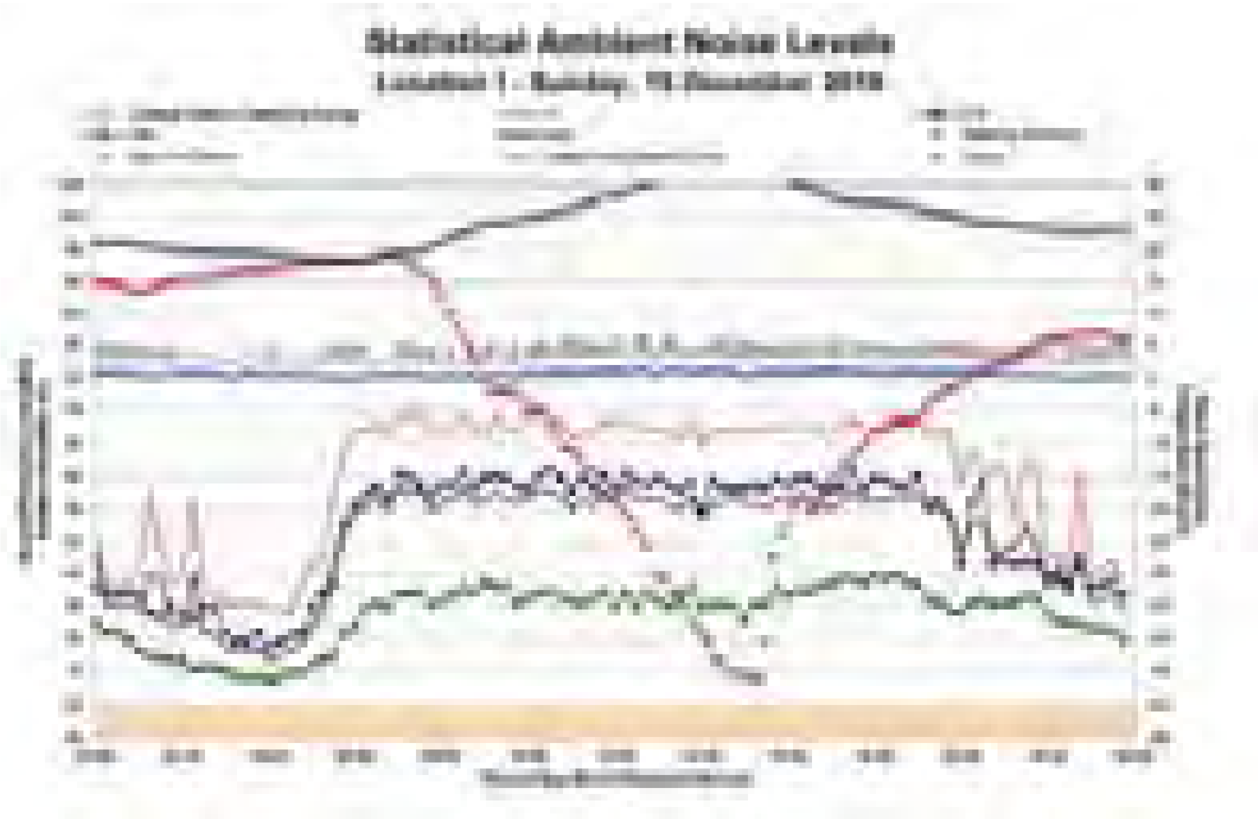

Statistical Ambient Noise Levels

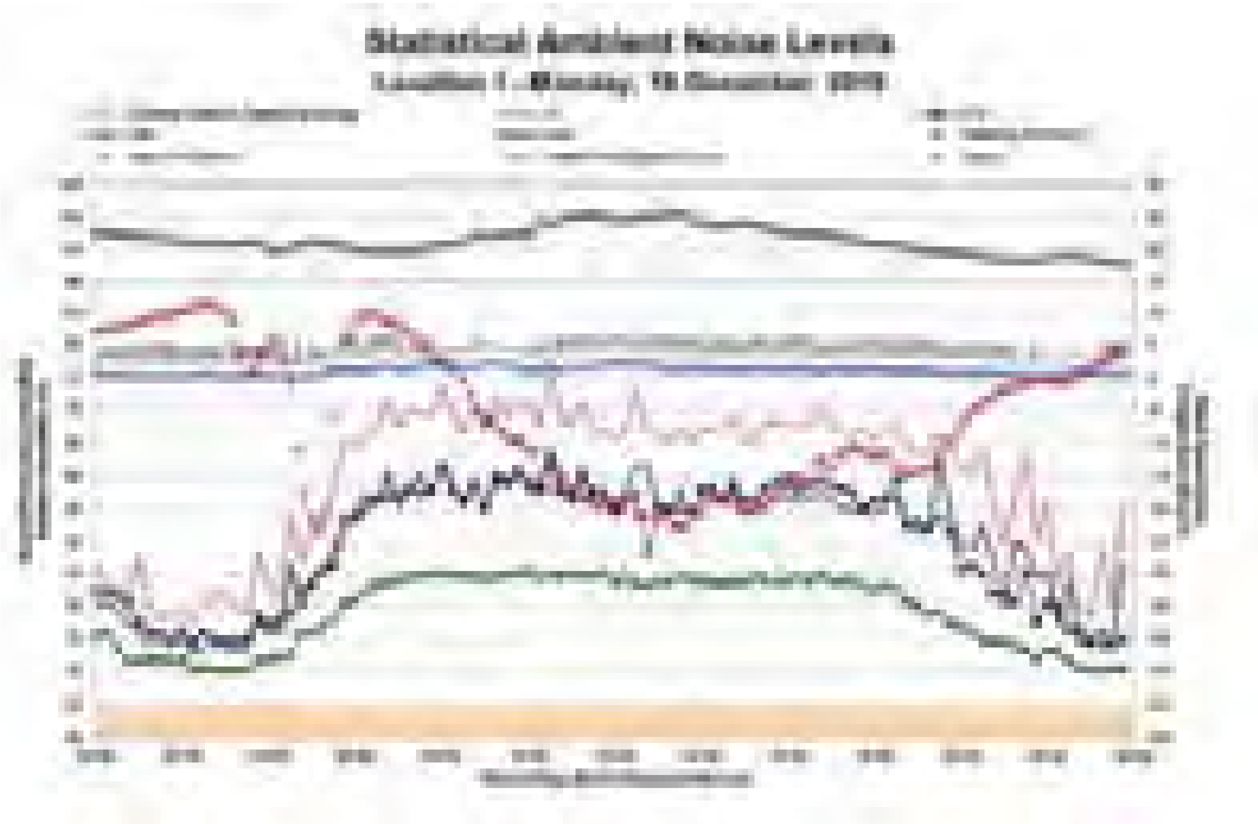

Statistical Ambient Noise Levels

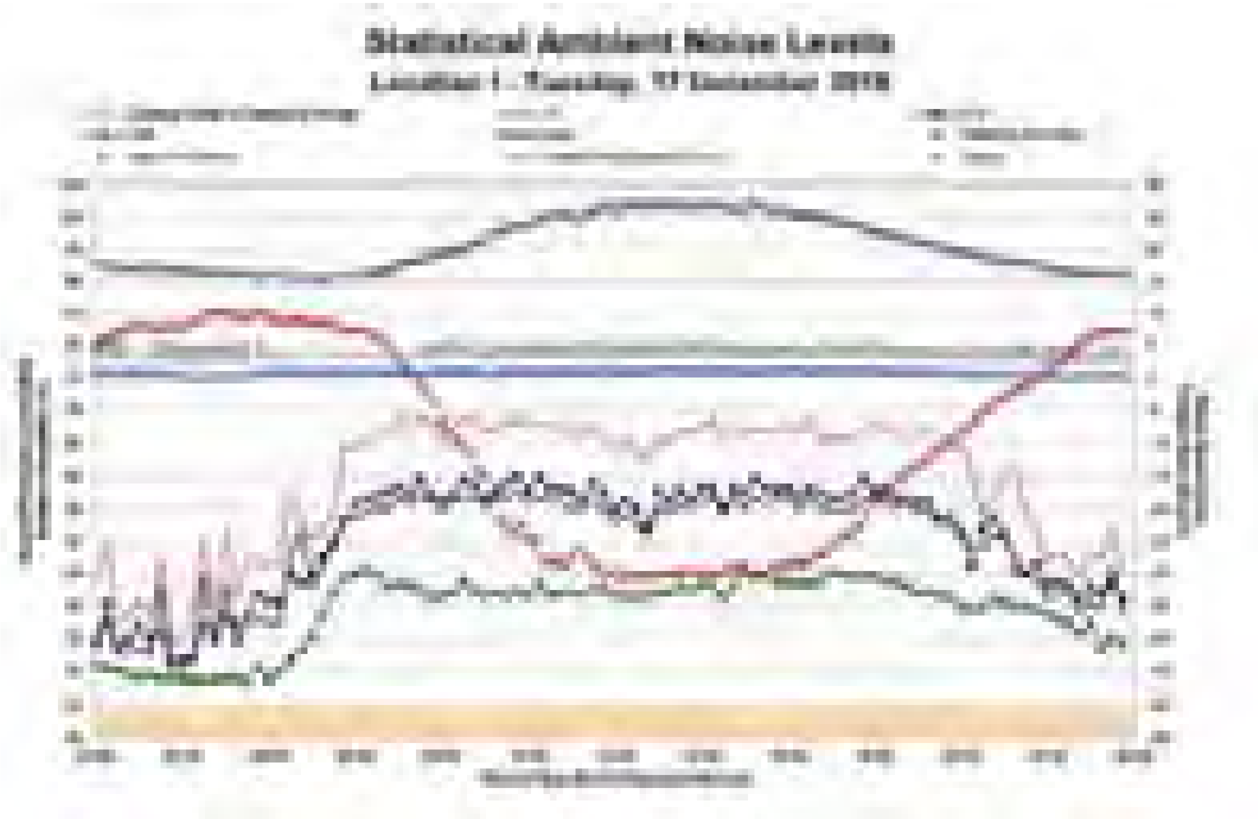

Statistical Ambient Noise Levels

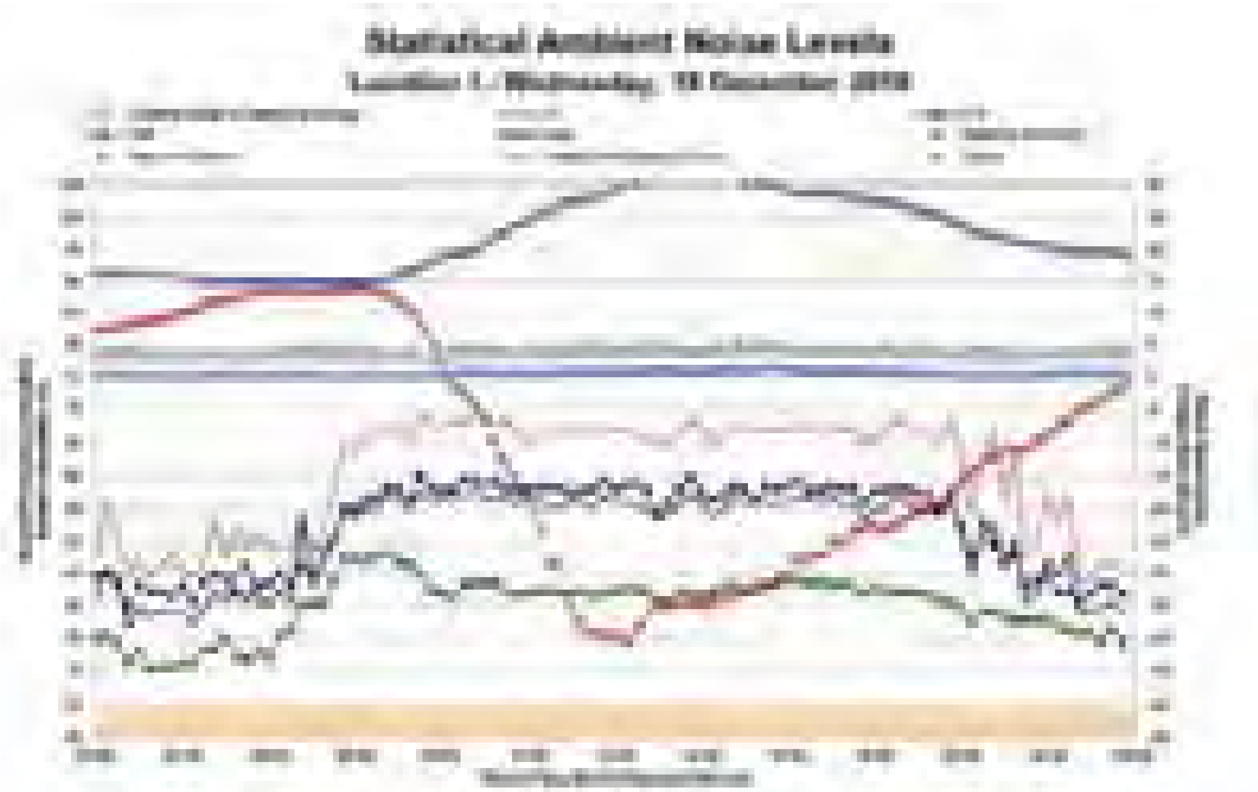

Statistical Ambient Noise Levels

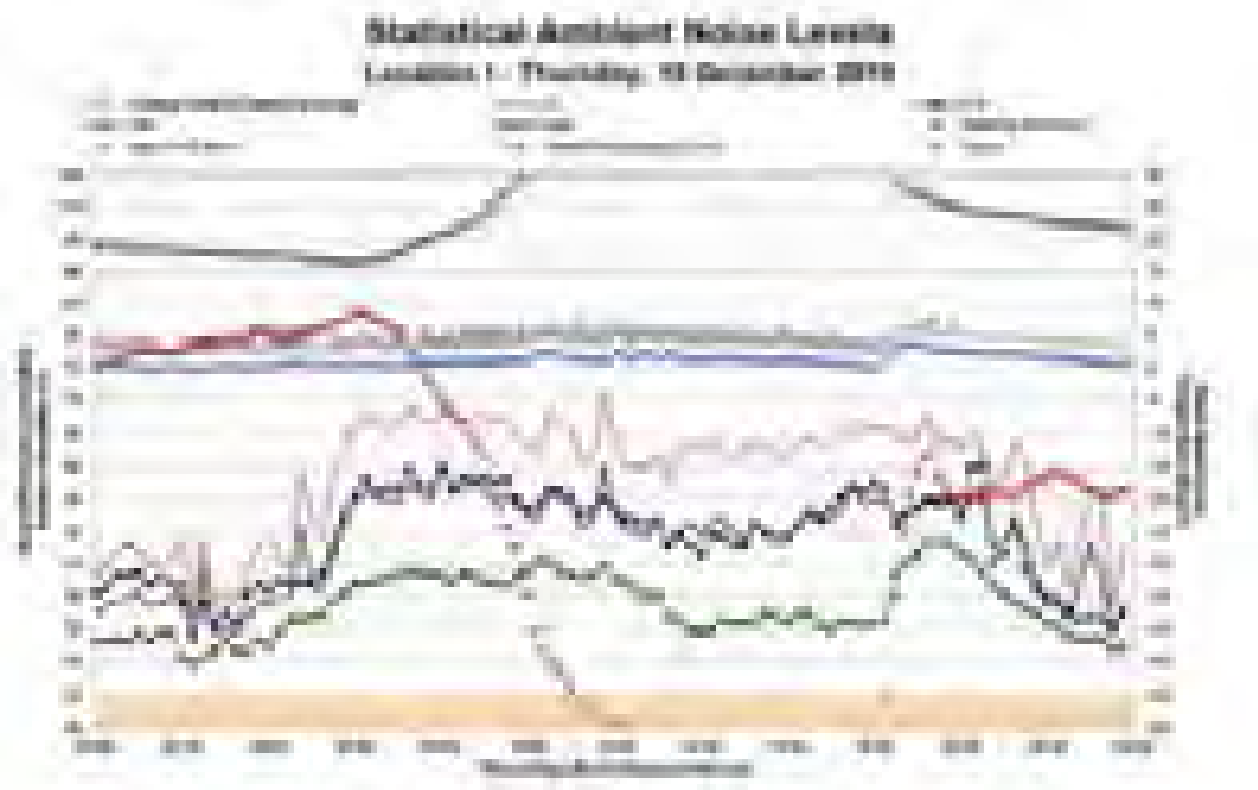

Statistical Ambient Noise Levels
Location 1 - Saturday, 14 December 2019

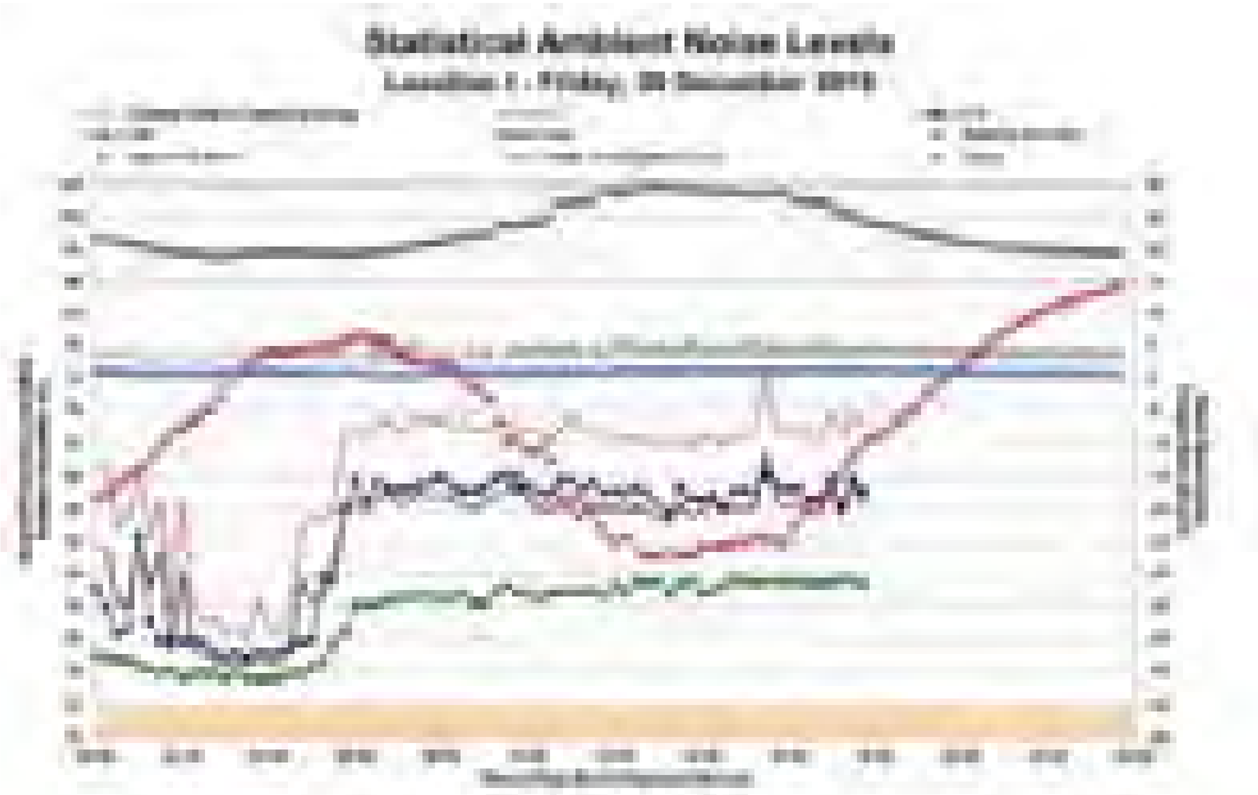

Statistical Ambient Noise Levels
Location 1 - Sunday, 15 December 2019

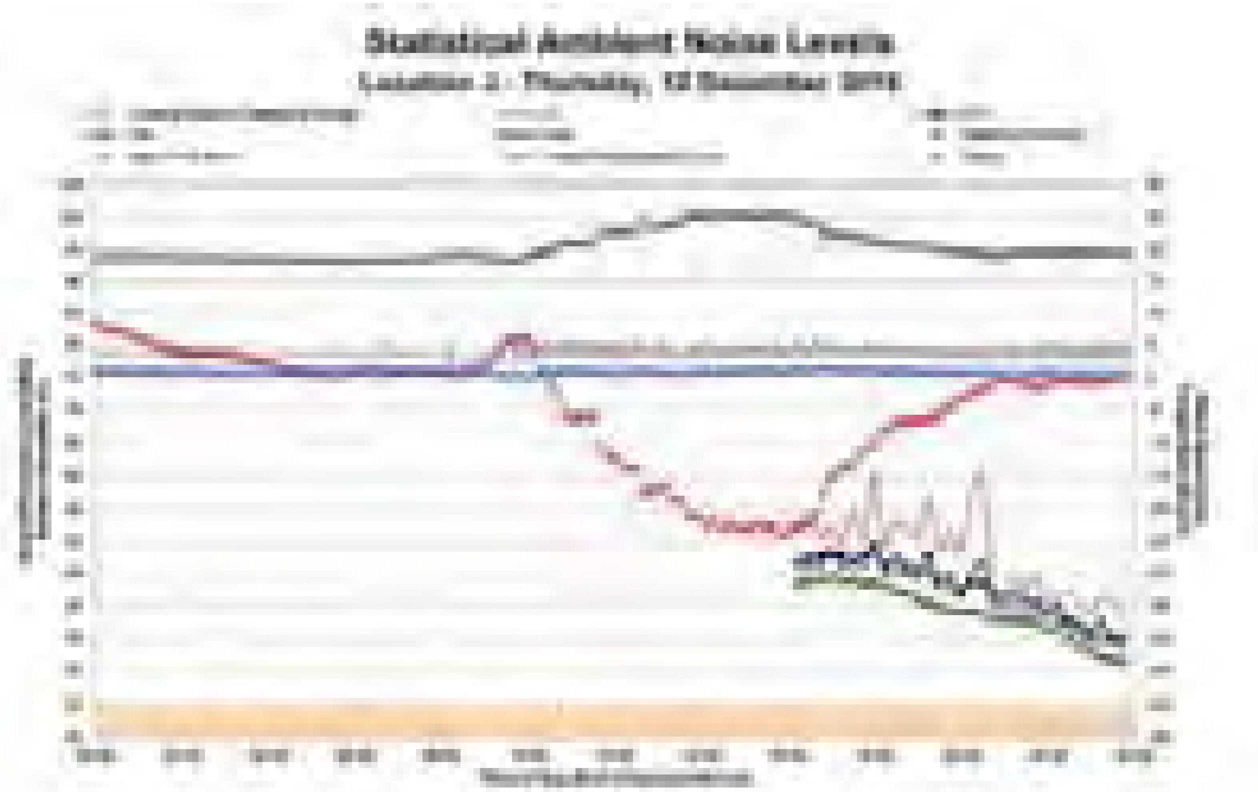

Statistical Ambient Noise Levels

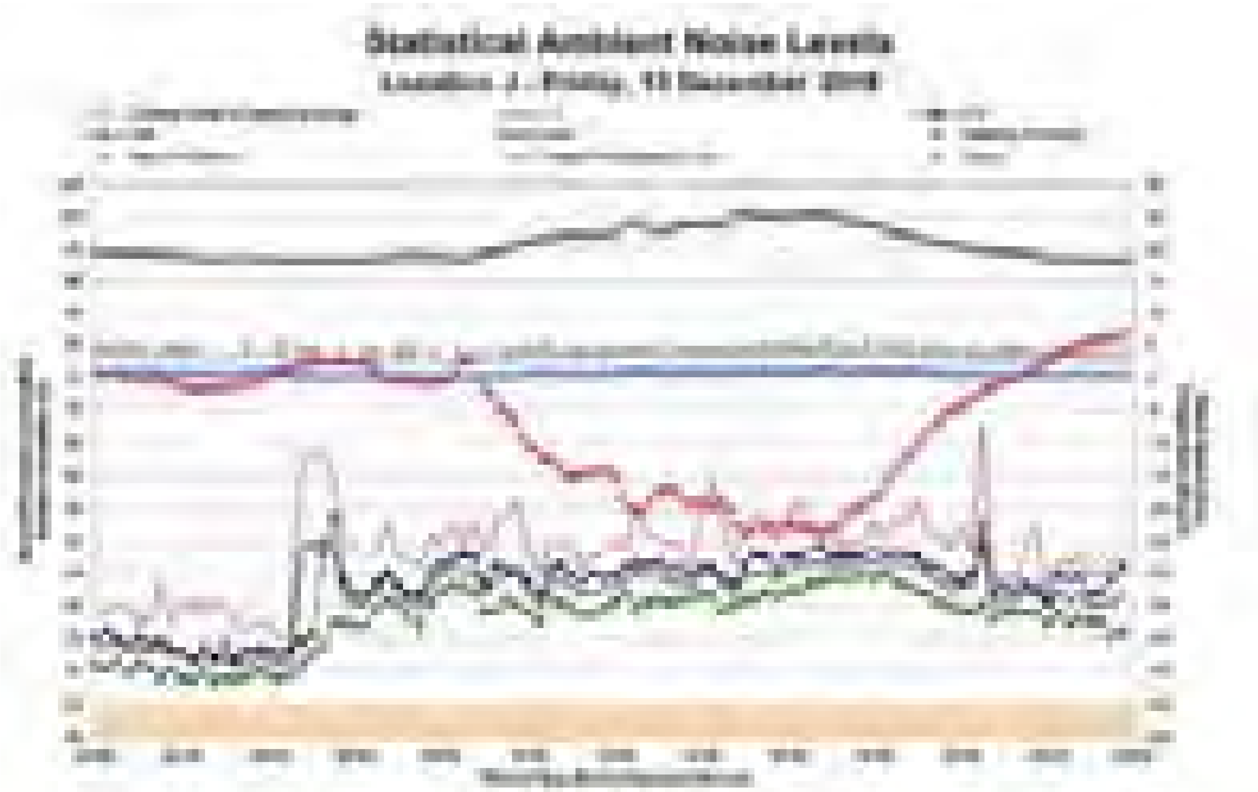

Statistical Ambient Noise Levels


Statistical Ambient Noise Levels


Statistical Ambient Noise Levels


Statistical Ambient Noise Levels


Statistical Ambient Noise Levels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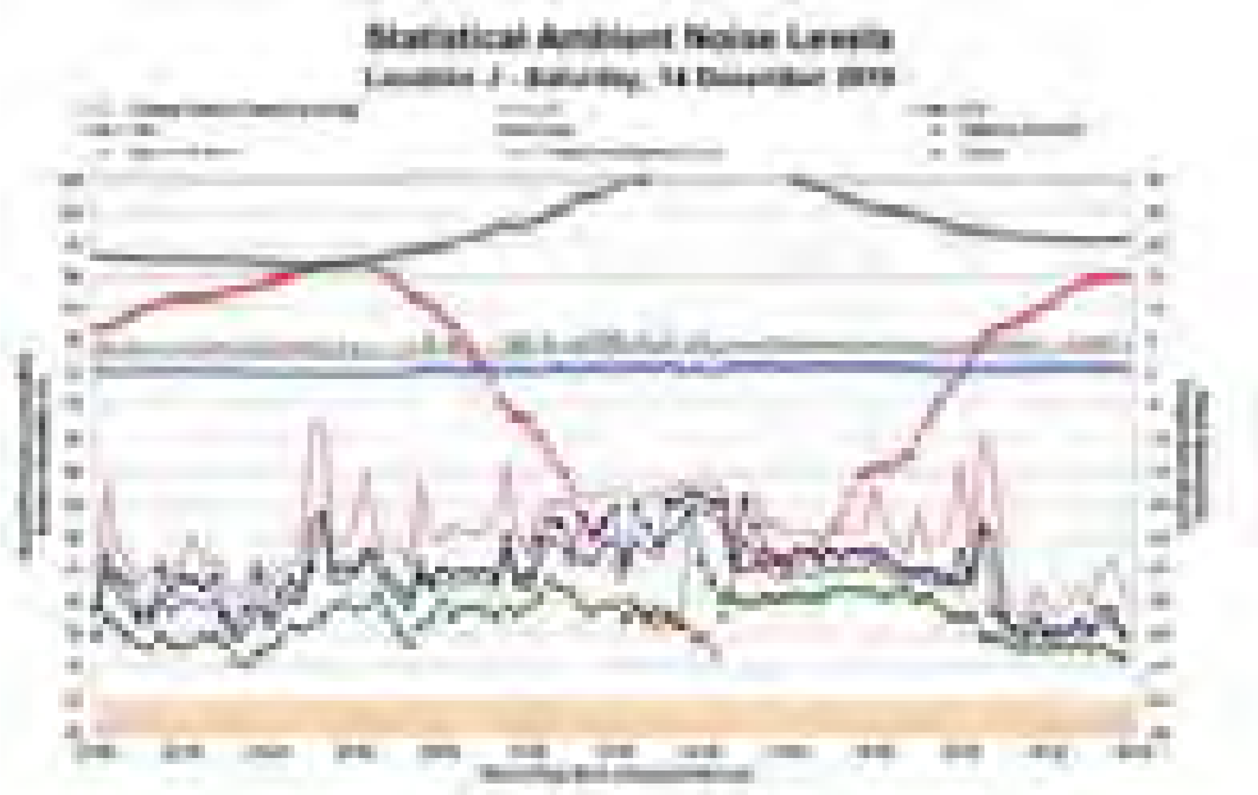
Location J - Friday, 13 December 2019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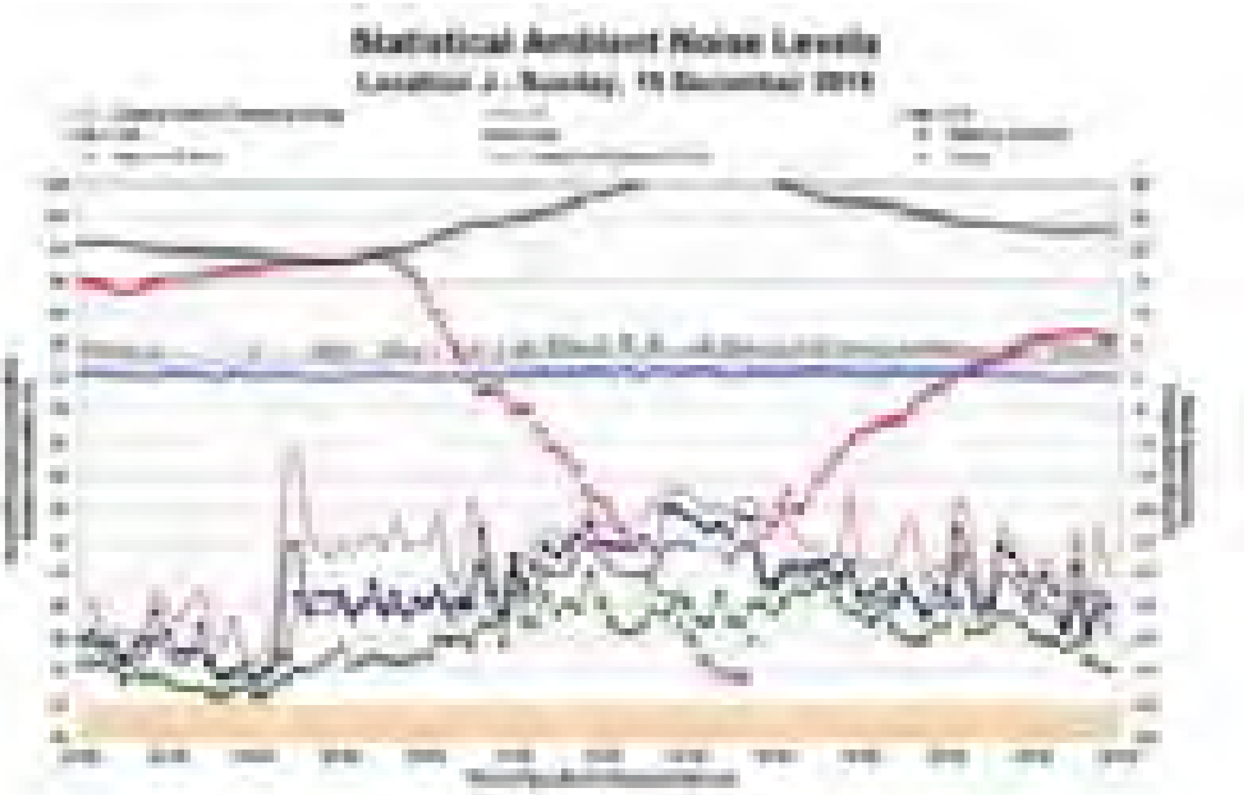
Location J - Saturday, 14 December 2019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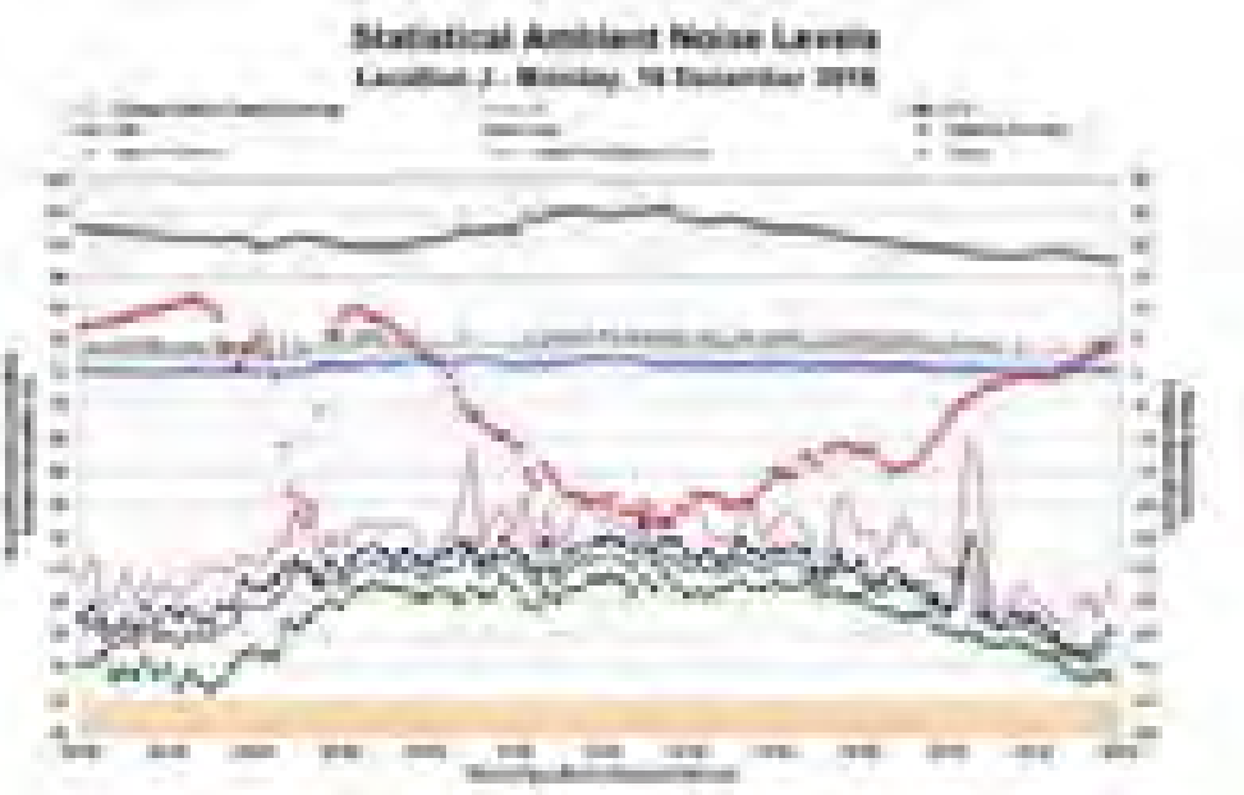
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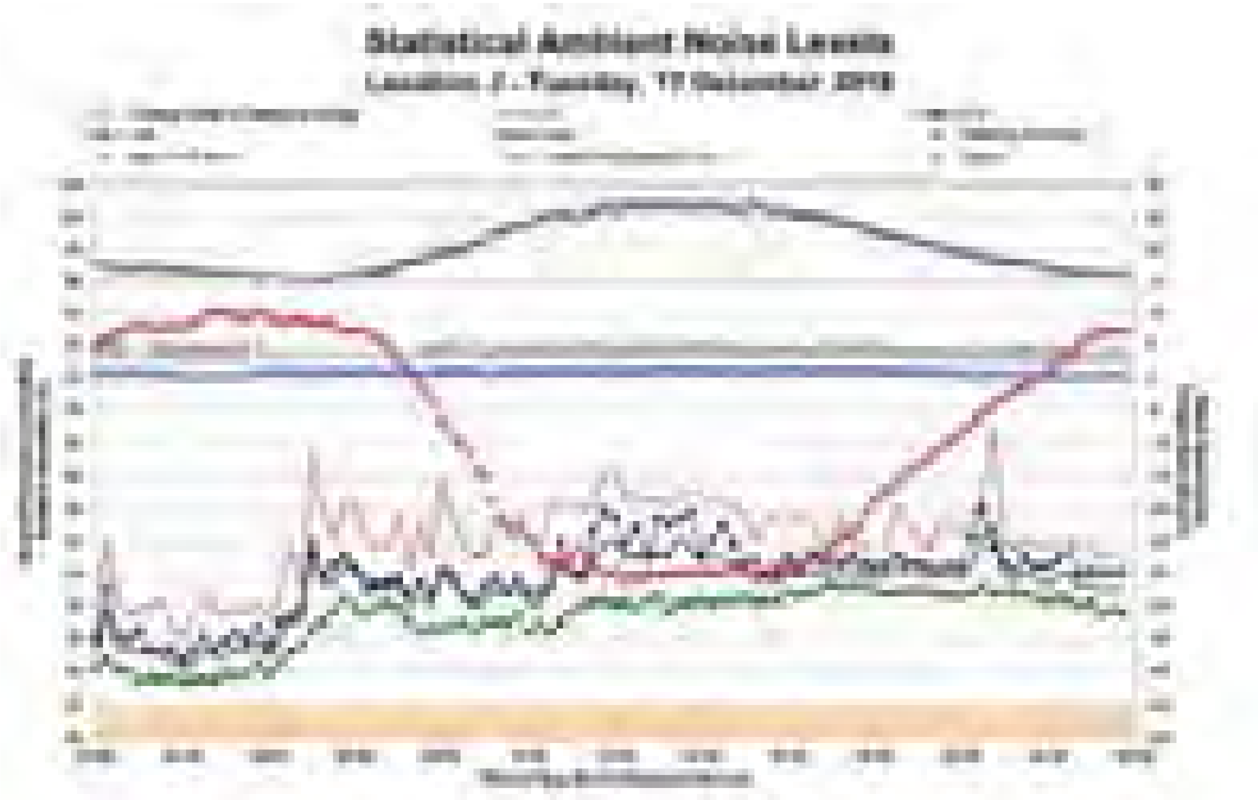
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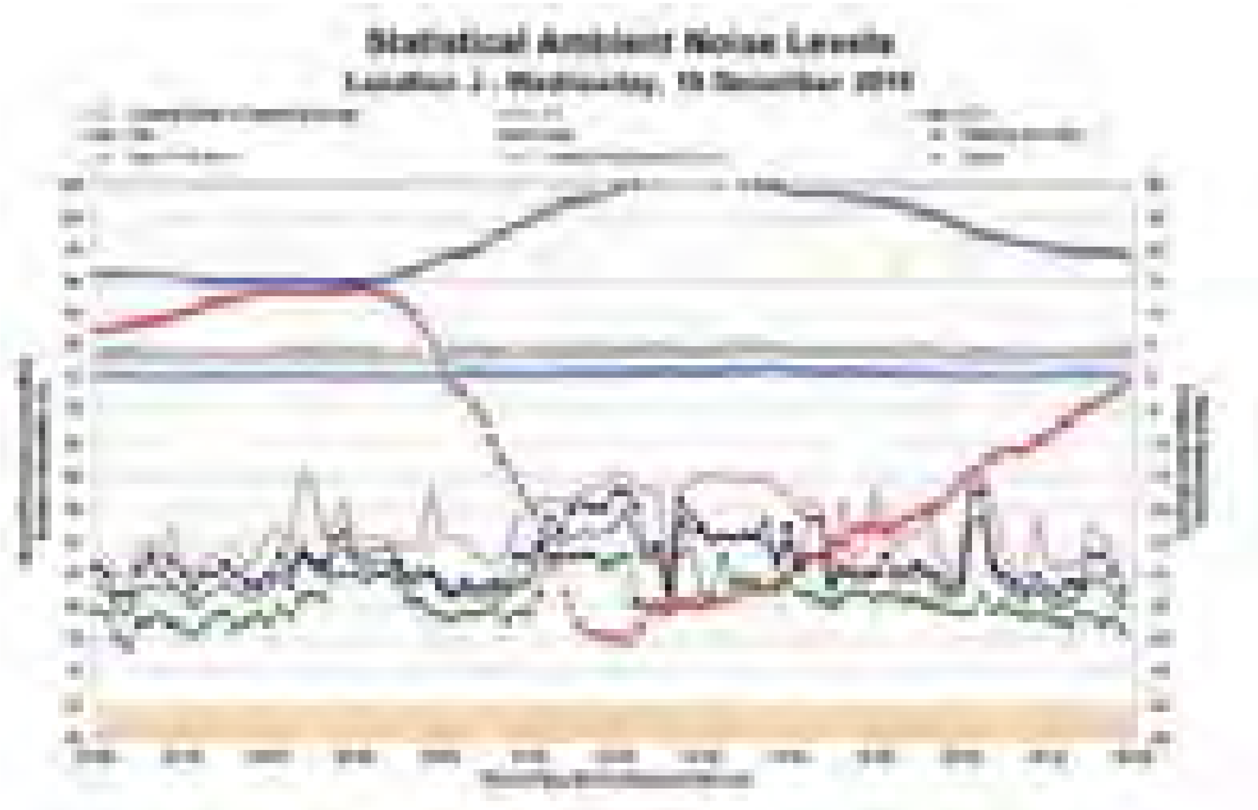
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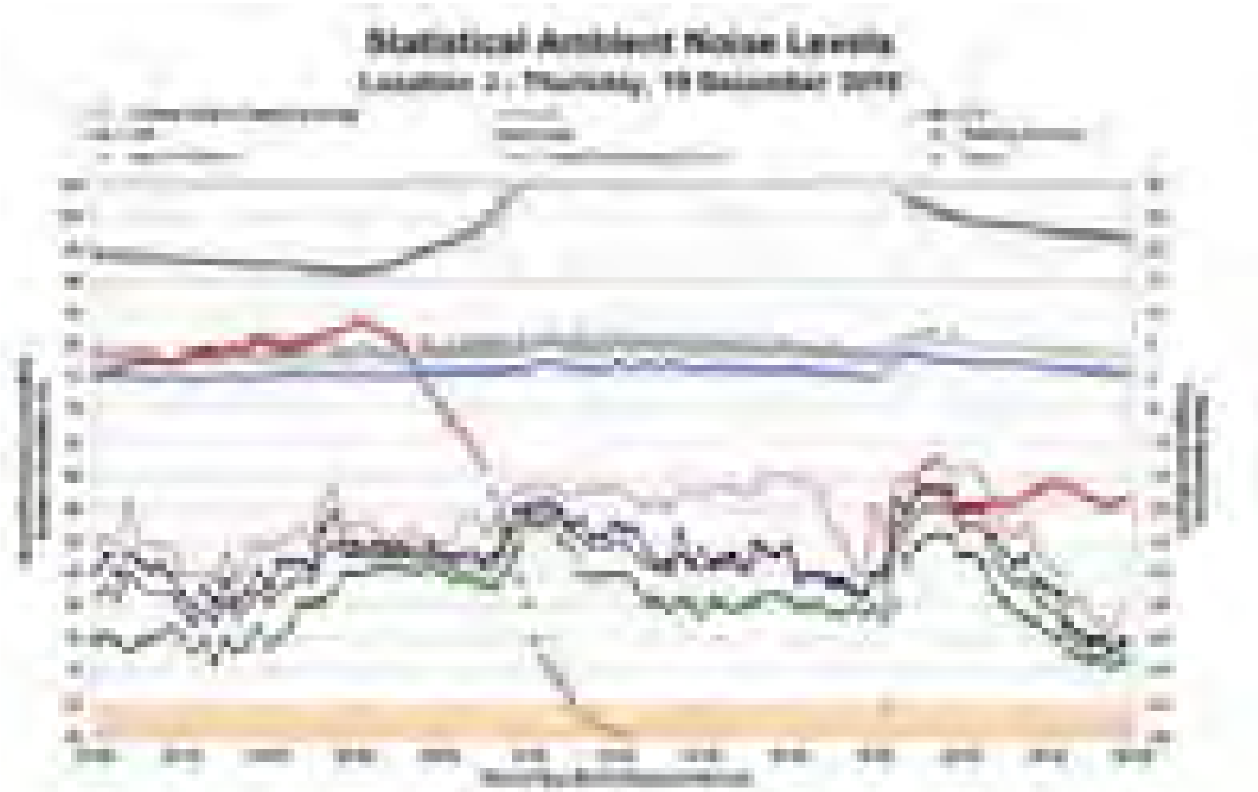
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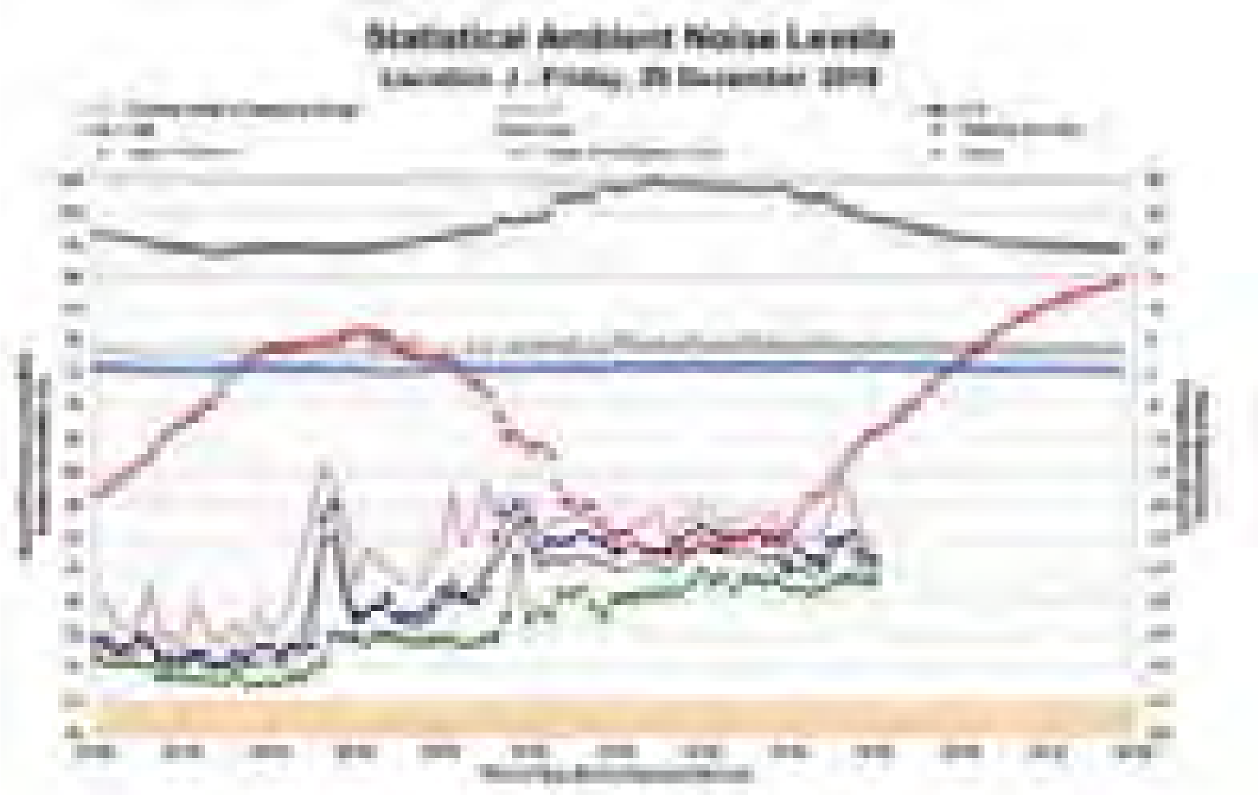
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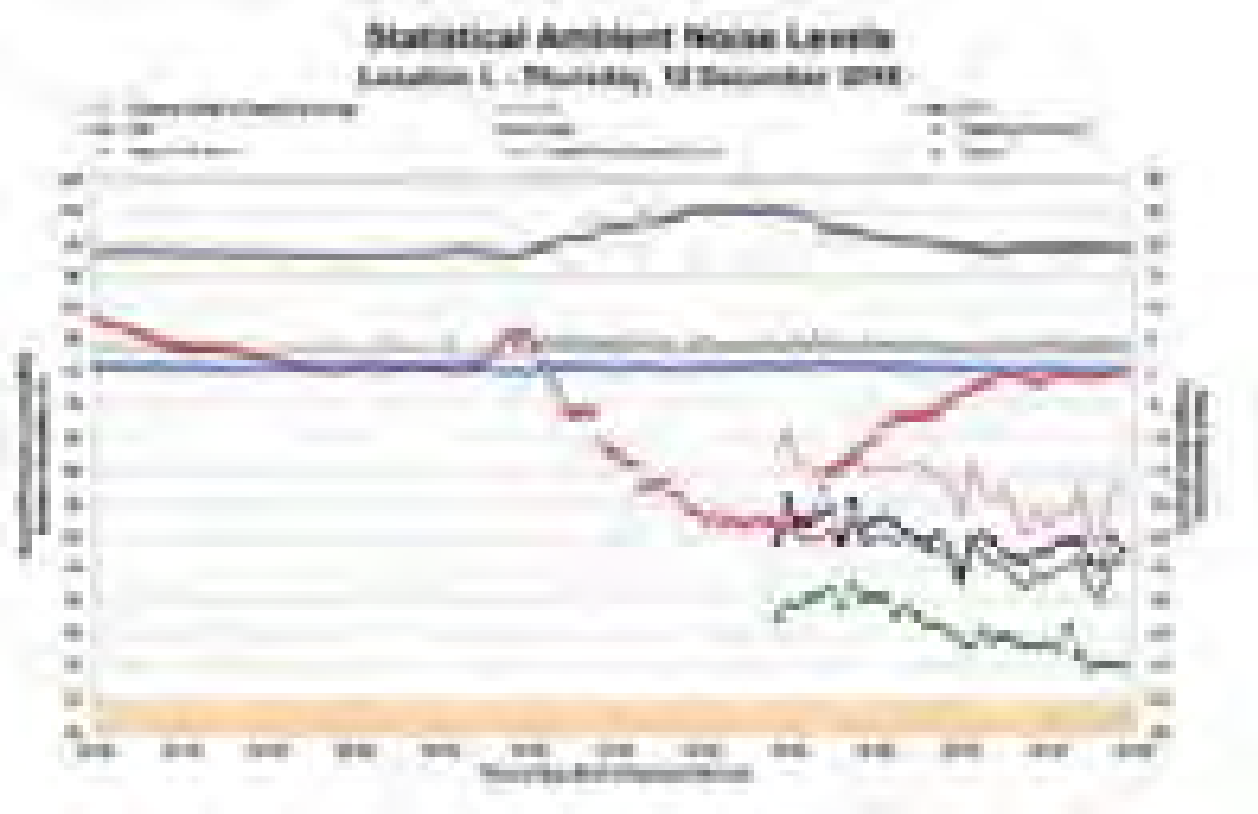
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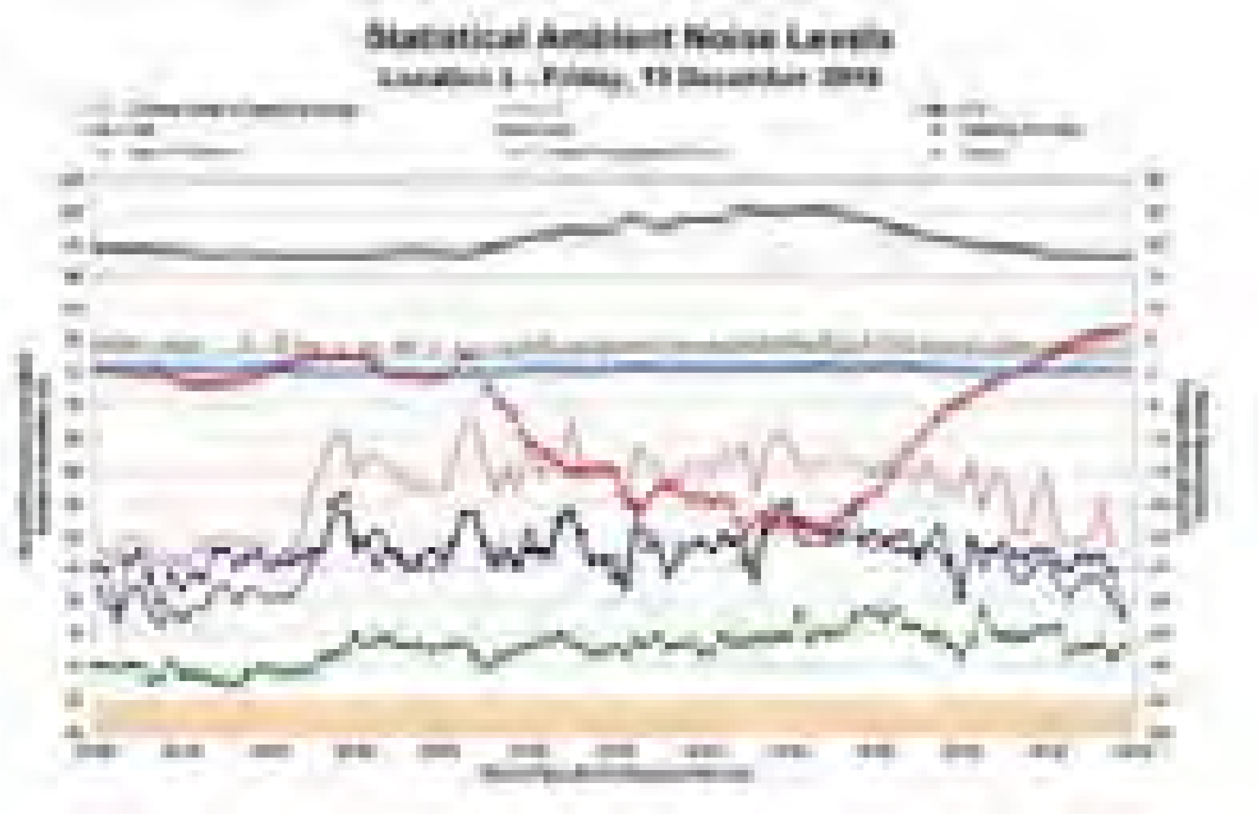
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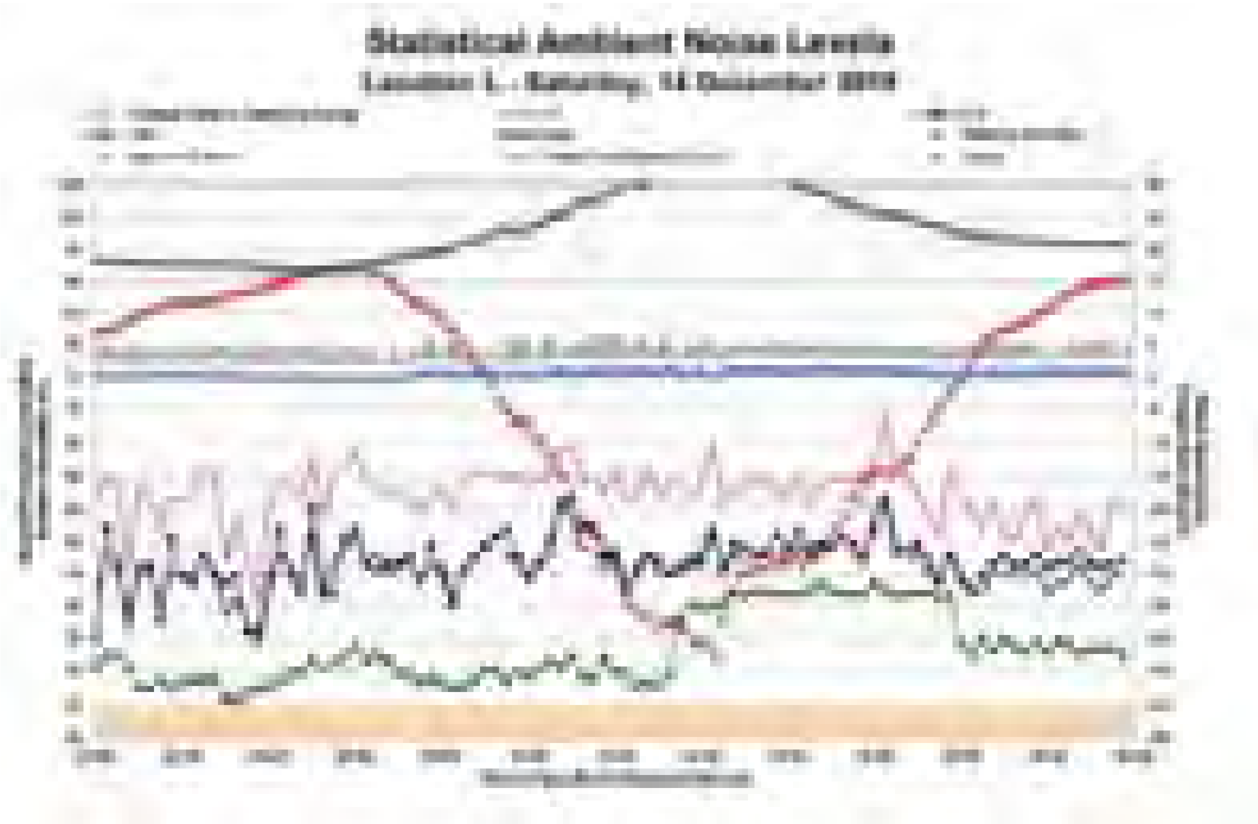
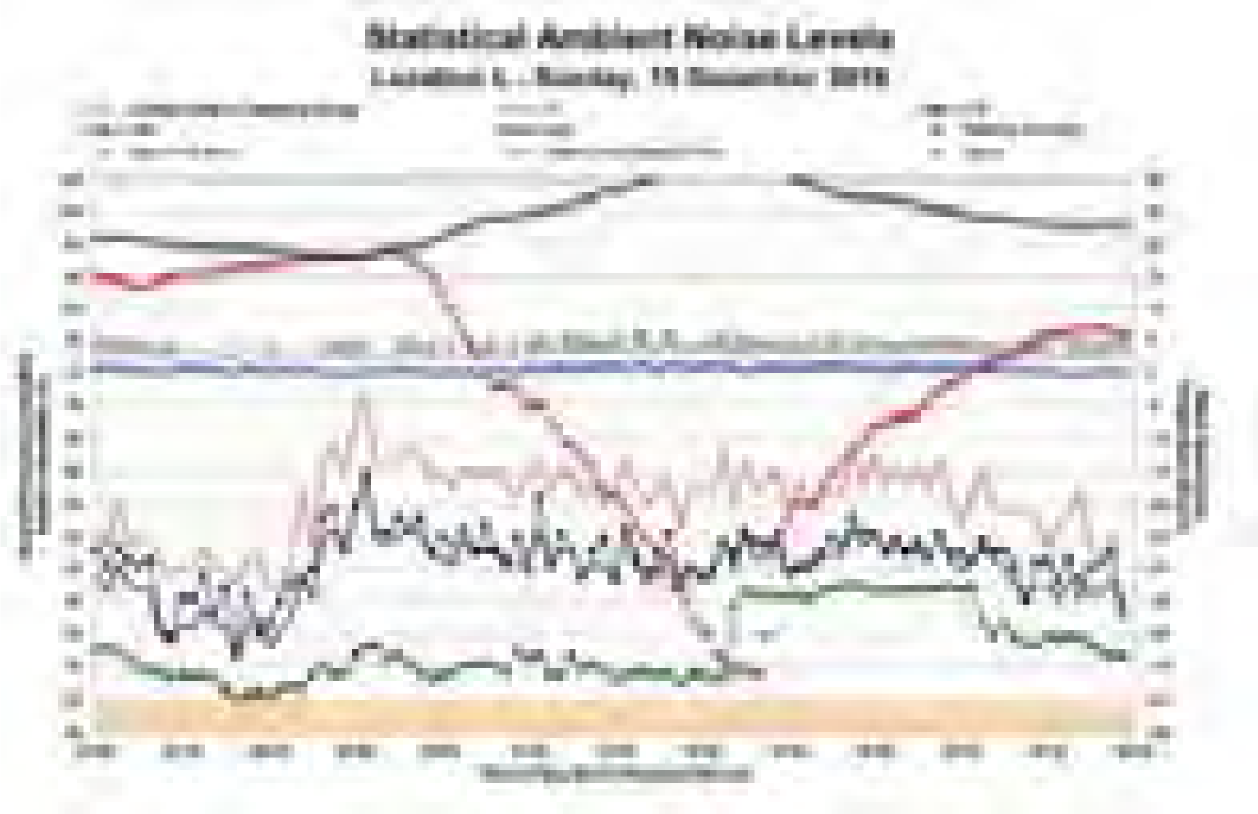
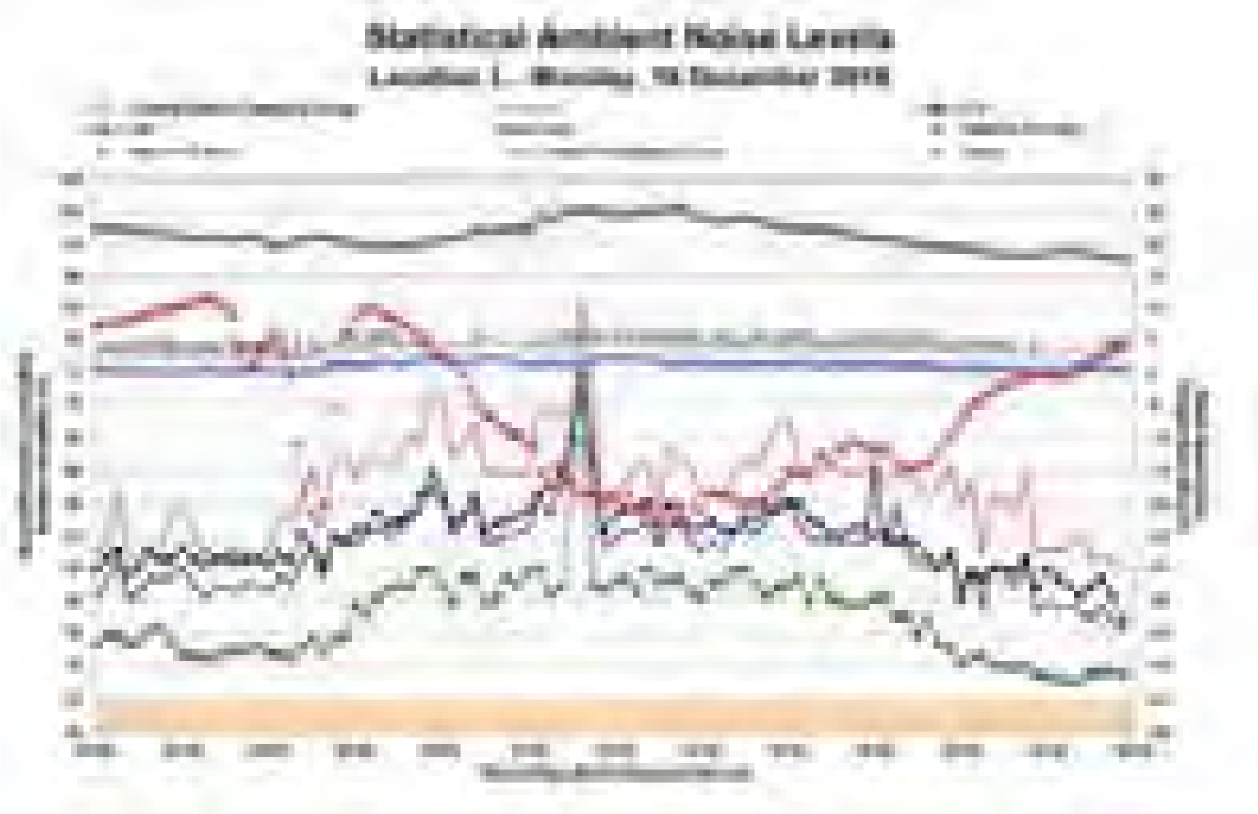

Statistical Ambient Noise Levels
Location L - Saturday, 14 December 2019


Statistical Ambient Noise Levels
Location L - Sunday, 15 December 2019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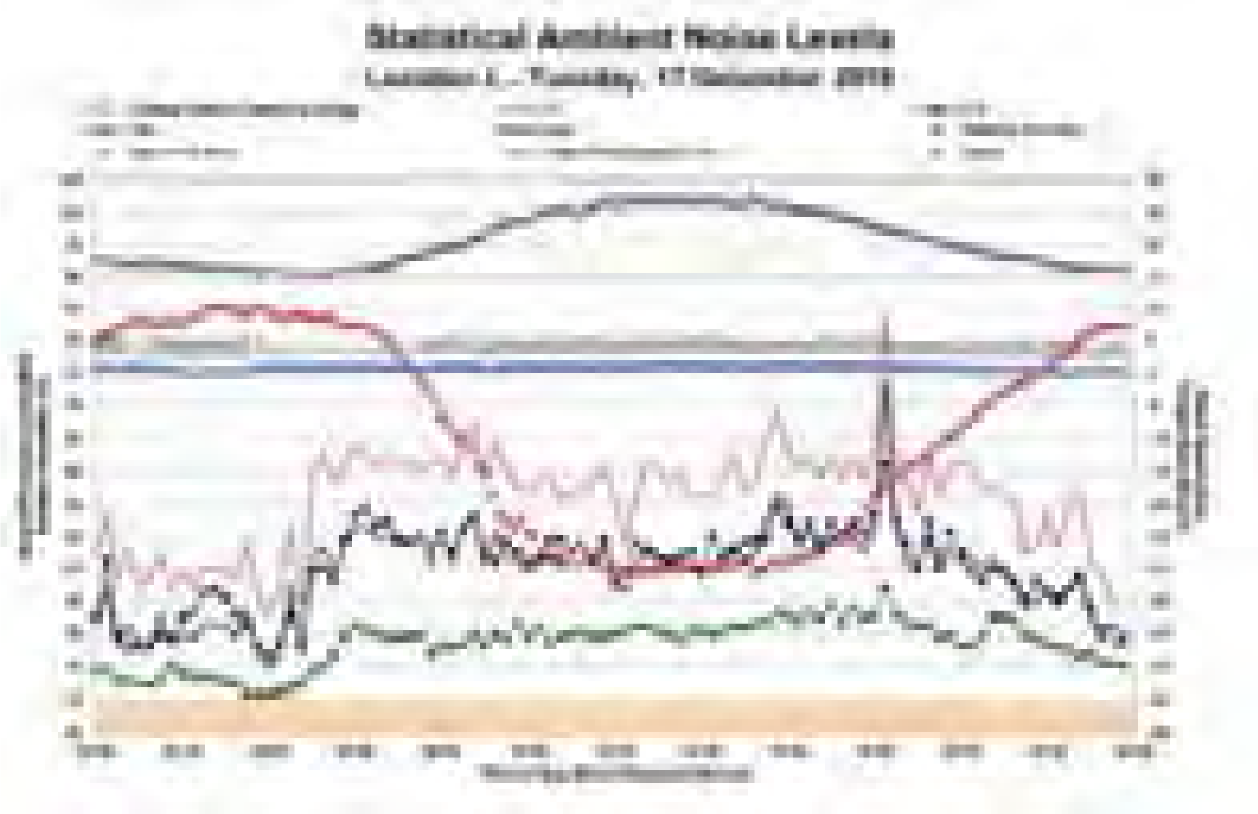
Location L – Monday, 16 December 2019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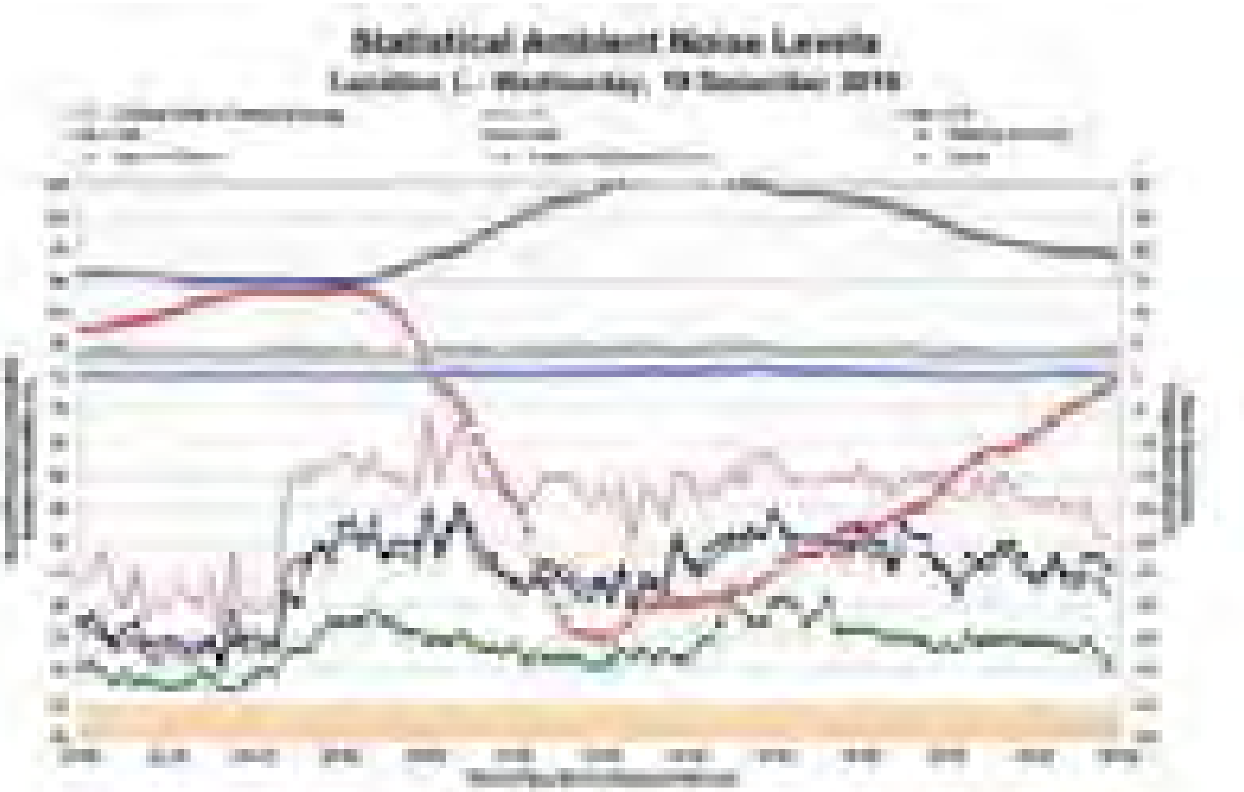
Location L – Tuesday, 17 December 2019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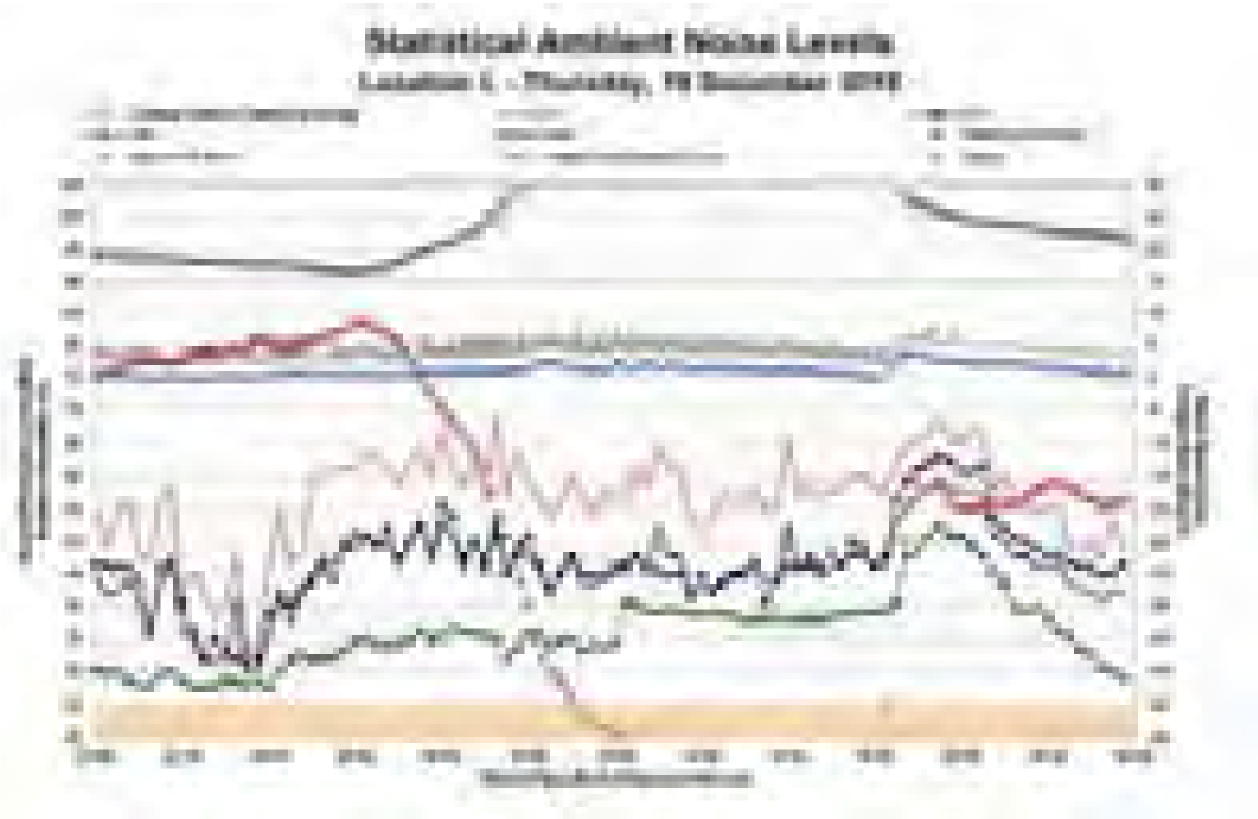
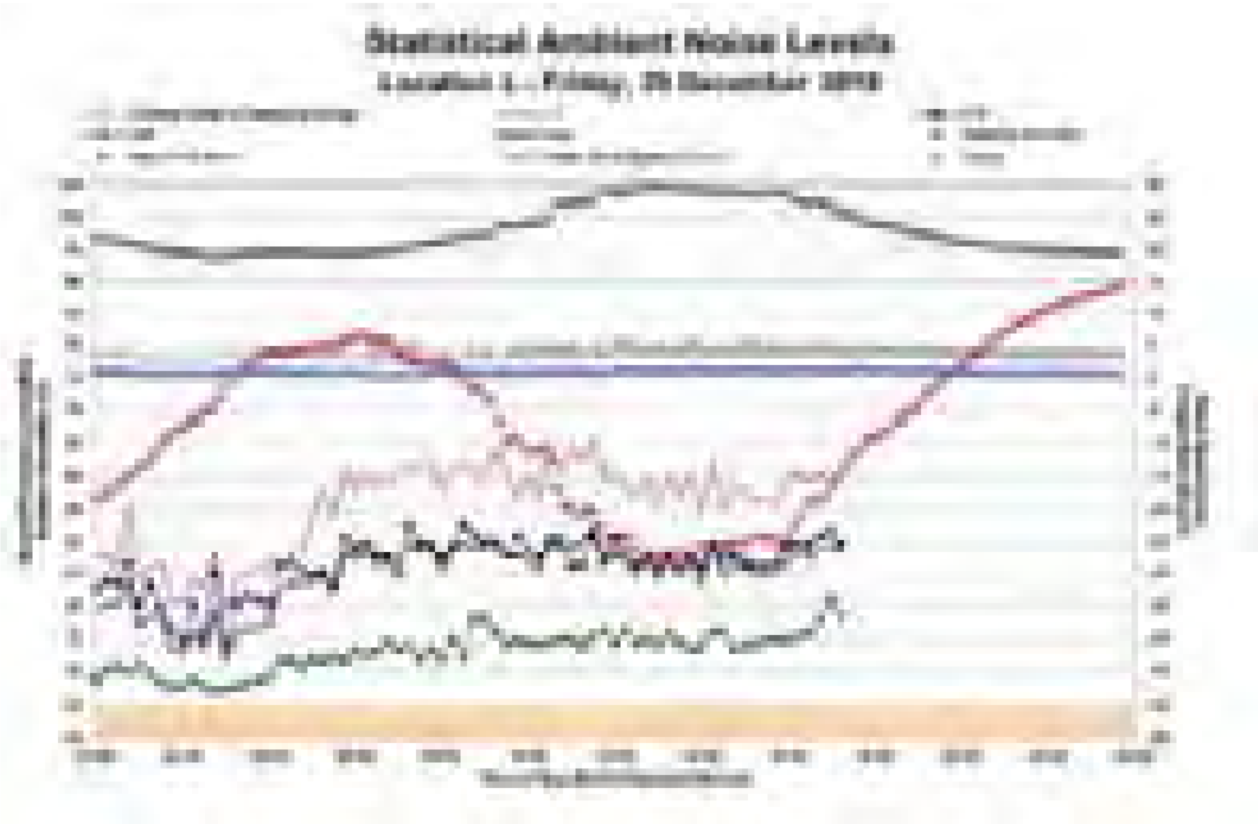

Statistical Ambient Noise Levels


Statistical Ambient Noise Levels

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Appendix 2

Air and Water Monitoring Results

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Deposited Dust 2008 to 2019

Month	D1			D2			D3		
	Insoluble Matter	Rolling Annual Average	Ash	Insoluble Matter	Rolling Annual Average	Ash	Insoluble Matter	Rolling Annual Average	Ash
Jan-08	0.4	1.4	0.01	0.1	0.6	<0.1	14	2.6	4.1
Feb-08	4.5	1.6	2.8	0.6	0.6	0.3	9.2	3.2	3.6
Mar-08	0.4	1.6	0.1	0.4	0.6	0.1	0.8	3.1	0.3
Apr-08	1.1	1.6	0.6	2.4	0.7	1.1	0.9	3.1	0.5
May-08	0.2	1.6	<0.1	0.4	0.7	<0.1	0.1	3.1	<0.1
Jun-08	0.4	1.6	0.3	0.7	0.7	0.4	1.3	3.1	0.6
Jul-08	1	1.5	0.6	0.5	0.7	0.3	0.7	3.1	0.4
Aug-08	0.6	1.5	0.3	1	0.8	0.4	1.3	3.1	0.7
Sep-08	1	1.2	0.6	5	1.1	<0.1	1	3.1	0.6
Oct-08	0.8	1.2	0.4	1.4	1.2	0.8	2.7	3.2	1
Nov-08	1.2	1.2	0.8	1.2	1.2	0.8	1.7	3.1	1.1
Dec-08	1.1	1.1	0.8	3	1.4	1.1	1.6	2.9	0.9
Jan-09	0.4	1.1	<0.1	4.4	1.8	0.7	1.5	1.9	0.9
Feb-09	2.8	0.9	2.1	5.8	2.2	2.8	2.7	1.4	2
Mar-09	2	1.1	1.2	0.8	2.2	0.3	0.8	1.4	0.4
Apr-09	0.6	1.0	0.5	1.6	2.2	0.7	0.8	1.4	0.5
May-09	0.4	1.0	<0.1	1.3	2.2	0.4	0.8	1.4	0.4
Jun-09	0.2	1.0	<0.1	1	2.3	0.3	0.6	1.4	0.3
Jul-09	0.8	1.0	0.5	3.6	2.5	0.8	0.8	1.4	0.5
Aug-09	1	1.0	0.7	18	3.9	9.6	1.8	1.4	1.1
Sep-09	4.3	1.3	3.6	9	4.3	4.6	5.2	1.8	4.3
Oct-09	0.8	1.3	0.5	1.7	4.3	0.6	1.4	1.6	0.9
Nov-09	1.4	1.3	1.1	4	4.5	2	1.6	1.6	1.1
Dec-09	0.6	1.3	0.3	0.8	4.3	0.4	5.6	2.0	4.8
Jan-10	1.9	1.4	0.9	**11.3	4.3	1.5	1.9	2.0	1.1
Feb-10	0.6	1.2	0.2	0.6	3.9	<0.1	3.2	2.0	1.5
Mar-10	0.8	1.1	0.2	1.8	3.9	0.4	2.4	2.2	1.8
Apr-10	0.8	1.1	0.3	4.9	4.2	1.8	3	2.4	2.1
May-10	0.3	1.1	<0.1	2.2	4.3	0.8	3	2.5	2.2
Jun-10	0.6	1.2	0.2	1.1	4.3	0.4	0.7	2.6	0.3
Jul-10	0.4	1.1	<0.1	0.5	4.1	0.2	1.9	2.6	1.1
Aug-10	0.6	1.1	0.3	2.6	2.7	0.4	1.6	2.6	1.2
Sep-10	0.9	0.8	0.3	1.6	2.0	0.2	0.9	2.3	0.5
Oct-10	0.9	0.8	0.3	3.5	2.1	1.5	0.9	2.2	0.4
Nov-10	1	0.8	0.2	0.7	1.8	0.2	0.9	2.2	0.3
Dec-10	1	0.8	0.5	0.7	1.8	0.3	1.8	1.9	1.1
Jan-11	0.7	0.7	0.3	4.1	2.0	0.9	0.9	1.8	0.5
Feb-11	0.5	0.7	0.2	2.9	2.2	0.7		1.6	
Mar-11	0.7	0.7	0.2	0.6	2.1	0.3	4.9	1.9	3.8
Apr-11	0.4	0.7	0.1	1.1	1.8	0.5	5.4	2.1	4.8
May-11	0.7	0.7	0.3	1.1	1.7	0.4	1.7	2.0	1.1
Jun-11	0.6	0.7	0.1	0.5	1.7	0.2	1.6	2.0	1
Jul-11	0.4	0.7	0.1	0.1	1.6	<0.1	0.6	1.9	0.3
Aug-11	1.3	0.8	0.8	0.4	1.4	0.2	0.8	1.9	0.5
Sep-11	1	0.8	0.5	1.2	1.4	0.5	0.6	1.8	0.3

Deposited Dust 2008 to 2019

Month	D1			D2			D3		
	Insoluble Matter	Rolling Annual Average	Ash	Insoluble Matter	Rolling Annual Average	Ash	Insoluble Matter	Rolling Annual Average	Ash
Oct-11	0.5	0.7	0.3	1	1.2	0.8	0.8	1.8	0.4
Nov-11	1.1	0.7	0.4	1.2	1.2	0.4	2	1.9	0.8
Dec-11	0.9	0.7	0.3	0.6	1.2	0.2	0.4	1.8	0.3
Jan-12	0.7	0.7	0.1	0.4	0.9	<0.1	0.4	1.7	0.1
Feb-12	0.8	0.8	<0.1	0.3	0.7	<0.1	0.7	1.7	<0.1
Mar-12	1.3	0.8	0.3	1.1	0.8	0.3	1	1.3	0.4
Apr-12	0.9	0.9	0.2	1.3	0.8	0.4	1.2	1.0	0.4
May-12	0.5	0.8	0.3	0.6	0.7	0.2	2.8	1.1	1
Jun-12	0.6	0.8	0.2	4.1	1.0	1.5	1.1	1.0	0.4
Jul-12	0.4	0.8	0.1	0.9	1.1	0.3	0.4	1.0	0.2
Aug-12	1	0.8	0.5	0.8	1.1	0.4	1.3	1.1	0.6
Sep-12	1.3	0.8	0.5		1.1		0.8	1.1	0.5
Oct-12	0.7	0.9	0.3	0.5	1.1	0.3	1.1	1.1	0.5
Nov-12	1	0.8	0.4	1.3	1.1	0.5	1.5	1.1	0.9
Dec-12	1.6	0.9	0.9	3.9	1.4	2.1	1.3	1.1	0.3
Jan-13	0.8	0.9	0.4	0.6	1.4	0.2	0.9	1.2	0.4
Feb-13	0.6	0.9	0.2	1	1.5	0.4	1	1.2	0.4
Mar-13	0.7	0.8	0.2	1.1	1.5	0.4	4.7	1.5	1
Apr-13	0.5	0.8	0.1	3.5	1.7	0.6	1.9	1.6	0.8
May-13	0.3	0.8	0.1	0.8	1.7	0.3	1	1.4	0.5
Jun-13	0.4	0.8	0.2	0.5	1.4	0.4	0.5	1.4	0.4
Jul-13	0.2	0.8	0.2	0.3	1.3	0.2	0.5	1.4	0.3
Aug-13	0.5	0.7	0.3	0.7	1.3	0.4	1.2	1.4	1
Sep-13	0.8	0.7	0.5	0.8	1.3	0.5	1.5	1.4	0.9
Oct-13	0.8	0.7	0.7	0.9	1.3	0.8	3.6	1.6	1.7
Nov-13	1.0	0.7	0.5	0.8	1.2	0.6	4.0	1.8	2.4
Dec-13	0.7	0.6	0.5	0.8	1.0	0.5	3.3	2.0	2.3
Jan-14	0.6	0.6	0.3	0.6	1.0	0.3	2.2	2.1	1.6
Feb-14	0.9	0.6	0.6	0.2	0.9	0.2	2	2.2	1.5
Mar-14	1.0	0.6	0.5	3.2	1.1	1	3.2	2.1	1.1
Apr-14	0.4	0.6	0.1	0.5	0.8	0.1	2.3	2.1	1.4
May-14	0.5	0.7	0.5	5.6	1.2	1.8	2.5	2.2	1.5
Jun-14	0.5	0.7	0.5	0.4	1.2	0.2	2.4	2.4	2
Jul-14	0.8	0.7	0.3	0.7	1.3	0.3	1.3	2.5	0.7
Aug-14	0.2	0.7	0.2	0.2	1.2	0.2	0.6	2.4	0.5
Sep-14	0.4	0.7	0.1	0.6	1.2	0.1	0.6	2.3	0.1
Oct-14	0.6	0.6	0.3	1.3	1.2	0.8	1.1	2.1	0.6
Nov-14	1.4	0.7	0.9	1.6	1.3	0.9	6.2	2.3	3.1
Dec-14	0.3	0.6	0.3	0.7	1.3	0.5	3.8	2.4	2.9
Jan-15	*16.2	0.6	13.1	0.8	1.3	0.4	2.2	2.4	1.2
Feb-15	0.6	0.6	0.4	6.5	1.8	1.9	3.2	2.5	1.5
Mar-15	0.5	0.6	0.5	0.5	1.6	0.3	0.9	2.3	0.6
Apr-15	0.7	0.6	0.3	0.8	1.6	0.3	5	2.5	3.5
May-15	0.2	0.6	0.2	1.5	1.3	0.9	2.9	2.5	2.2
Jun-15	0.2	0.5	0.1	0.2	1.3	0.2	1.8	2.5	1.2
Jul-15	0.2	0.5	0.2	0.3	1.3	0.2	1.8	2.5	1.4

Deposited Dust 2008 to 2019

Month	D1			D2			D3		
	Insoluble Matter	Rolling Annual Average	Ash	Insoluble Matter	Rolling Annual Average	Ash	Insoluble Matter	Rolling Annual Average	Ash
Aug-15	0.8	0.5	0.5	0.5	1.3	0.4	3	2.7	2.8
Sep-15	0.5	0.5	0.2	0.8	1.3	0.5	1.6	2.8	1.2
Oct-15	1	0.6	0.6	0.7	1.2	0.4	1.5	2.8	1.1
Nov-15	0.8	0.5	0.4	0.8	1.2	0.3	1.0	2.4	0.7
Dec-15	2.0	0.7	0.9	1.1	1.2	0.6	3.0	2.3	2.5
Jan-16	0.9	0.7	0.7	0.5	1.2	0.3	0.6	2.2	0.3
Feb-16	0.5	0.7	0.3	0.5	0.7	0.3	0.7	2.0	0.5
Mar-16	0.3	0.7	0.3	0.4	0.7	0.4	1.0	2.0	1
Apr-16	0.4	0.7	0.2	0.5	0.7	0.4	1.4	1.7	0.7
May-16	0.4	0.7	0.3	0.4	0.6	0.3	0.6	1.5	0.3
Jun-16	0.3	0.7	0.2	0.5	0.6	0.4	0.8	1.4	0.5
Jul-16	0.3	0.7	0.1	0.2	0.6	0.1	0.9	1.3	0.6
Aug-16	0.5	0.7	0.2	0.5	0.6	0.3	4.2	1.4	2.2
Sep-16	0.4	0.7	0.2	0.4	0.5	0.2	1.1	1.4	0.7
Oct-16	0.5	0.6	0.4	0.6	0.5	0.3	0.8	1.3	0.4
Nov-16	0.6	0.6	0.5	0.5	0.5	0.3	2.9	1.5	1.2
Dec-16	1.0	0.5	0.7	1.3	0.5	0.8	3.6	1.6	1.7
Jan-17	0.4	0.5	0.3	0.7	0.5	0.4	1	1.6	0.6
Feb-17	0.6	0.5	0.6	11	1.4	9	1.6	1.7	1.1
Mar-17	0.5	0.5	0.2	0.8	1.5	0.5	2.3	1.8	1.3
Apr-17	0.2	0.5	0.1	4.1	1.8	1.1	0.6	1.7	0.3
May-17	0.2	0.5	0.1	0.4	1.8	0.2	0.4	1.7	0.4
Jun-17	0.4	0.5	0.2	4.4	2.1	2.1	0.9	1.7	0.5
Jul-17	0.4	0.5	0.2	0.5	2.1	0.2	1.1	1.7	0.5
Aug-17	0.3	0.5	0.3	0.5	2.1	0.3	0.6	1.4	0.4
Sep-17	0.5	0.5	0.3	0.6	2.1	0.4	1.1	1.4	0.7
Oct-17	0.7	0.5	0.4	0.7	2.1	0.4	1	1.4	0.8
Nov-17	0.8	0.5	0.4	1.8	2.2	0.8	1.1	1.3	0.7
Dec-17	0.7	0.5	0.4	0.7	2.2	0.4	0.8	1.0	0.5
Jan-18	0.8	0.5	0.5	1.6	2.3	0.9	1.8	1.1	1.1
Feb-18	0.5	0.5	0.4	0.8	1.4	0.5	1.2	1.1	0.8
Mar-18	0.4	0.5	0.4	0.6	1.4	0.5	5.1	1.3	1.2
Apr-18	0.5	0.5	0.3	1	1.1	0.7	3.9	1.6	3.1
May-18	0.3	0.5	0.2	0.8	1.2	0.5	0.8	1.6	0.5
Jun-18	0.7	0.6	0.3	3.1	1.1	0.8	1	1.6	0.5
Jul-18	0.3	0.5	0.2	0.5	1.1	0.4	0.3	1.6	0.3
Aug-18	0.5	0.6	0.4	0.5	1.1	0.4	0.6	1.6	0.5
Sep-18	0.7	0.6	0.4	0.7	1.1	0.4	0.8	1.5	0.5
Oct-18	0.3	0.5	0.2	0.5	1.1	0.4	0.7	1.5	0.5
Nov-18	0.6	0.5	0.4	2.0	1.1	1.1	3.0	1.7	2.3
Dec-18	1.1	0.6	0.8	2.0	1.2	1.1	2.9	1.8	2
Jan-19	1.2	0.6	1	1.7	1.2	1.1	1.5	1.8	1.1
Feb-19	0.7	0.6	0.6	1.6	1.3	1.1	1.3	1.8	1
Mar-19	1.3	0.7	0.9	1.8	1.4	1.5	2	1.6	1.5
Apr-19	0.3	0.7	0.3	0.8	1.3	0.7	0.9	1.3	0.9

Deposited Dust 2008 to 2019

Month	D1			D2			D3		
	Insoluble Matter	Rolling Annual Average	Ash	Insoluble Matter	Rolling Annual Average	Ash	Insoluble Matter	Rolling Annual Average	Ash
May-19	0.4	0.7	0.2	0.9	1.3	0.5	0.8	1.3	0.5
Jun-19	0.5	0.7	0.3	1.7	1.2	0.8	0.7	1.3	0.5
Jul-19	0.3	0.7	0.2	0.4	1.2	0.3	0.4	1.3	0.3
Aug-19	0.4	0.7	0.2	0.5	1.2	0.4	0.7	1.3	0.4
Sep-19	0.5	0.6	0.3	0.6	1.2	0.5	0.6	1.3	0.4
Oct-19	1	0.7	0.6	2.9	1.4	1.3	1.5	1.4	1.1
Nov-19	0.4	0.7	0.2	0.9	1.3	0.5	0.8	1.3	0.5
Dec-19	0.5	0.7	0.3	1.7	1.2	0.8	0.7	1.3	0.5
Average*	***0.7***	***0.8***	***0.4***	***1.5***	***1.5***	***0.8***	***1.8***	***1.8***	***1.1***
Stnd Dev*	***0.6***	***0.3***	***0.4***	***2.1***	***1.0***	***1.2***	***1.7***	***0.5***	***1.0***
Min*	***0.2***	***0.5***	***0.0***	***0.1***	***0.5***	***0.1***	***0.1***	***1.0***	***0.1***
Max*	***4.5***	***1.6***	***3.6***	***18.0***	***4.5***	***9.6***	***14.0***	***3.2***	***4.8***

* Since 2008

** Contaminated sample (e.g. bird droppings)

Surface Water 2008 to 2019

Surface Water Quality Monitoring Results – 2008/2009

Sample Site	Date	pH	EC (µS/cm)	TSS (mg/L)	Flow	Sample Site	Date	pH	EC (µS/cm)	TSS (mg/L)	Flow
1	Jun-08	6.6	940	2	N	1	Dec-08	7.0	1210	6	N
8	Jun-08	7.1	810	7	N	8	Dec-08	7.3	980	16	N
9	Jun-08	7.7	740	4	L	9	Dec-08	6.8	1040	2	L
10	Jun-08	7.6	1230	5	L	10	Dec-08	7.2	1390	2	N
11	Jun-08	7.1	1840	2	N	11	Dec-08	6.8	1610	15	N
FMCU	Jun-08	6.9	620	11	VL	FMCU	Dec-08	7.0	450	2	N
FMCD	Jun-08	7.2	300	6	N	FMCD	Dec-08	6.8	160	4	L
1	Jul-08	6.8	1160	6	L	1	Jan-09	6.8	1130	39	N
8	Jul-08	7.2	1100	4	L	8	Jan-09	6.8	870	22	N
9	Jul-08	7.6	1060	3	L	9	Jan-09	7.0	1180	7	L
10	Jul-08	7.3	1400	4	M	10	Jan-09	7.3	1350	7	L
11	Jul-08	6.8	2060	7	L	11	Jan-09	6.8	1330	12	N
FMCU	Jul-08	7.4	820	10	N	FMCU	Jan-09	7.0	230	9	N
FMCD	Jul-08	7.4	190	2	VL	FMCD	Jan-09	7.3	150	27	M
1	Aug-08	6.9	1220	2	N	1	Feb-09	6.8	680	7	N
8	Aug-08	7.4	1140	4	L	8	Feb-09	7.0	590	3	L
9	Aug-08	7.7	1090	7	M	9	Feb-09	7.3	540	7	L
10	Aug-08	7.5	1410	5	N	10	Feb-09	7.1	1270	3	L
11	Aug-08	7.0	2220	4	N	11	Feb-09	6.8	910	11	N
FMCU	Aug-08	8.3	730	14	N	FMCU	Feb-09	6.8	350	13	N
FMCD	Aug-08	7.8	170	3	L	FMCD	Feb-09	7.4	260	11	M
1	Sep-08	7.1	890	9	N	1	Mar-09	6.8	650	4	N
8	Sep-08	7.5	820	2	L	8	Mar-09	7.2	700	3	N
9	Sep-08	7.8	650	5	M	9	Mar-09	7.5	820	2	M
10	Sep-08	7.9	1250	8	M	10	Mar-09	7.4	1230	6	M
11	Sep-08	7.3	1330	14	N	11	Mar-09	7.3	1060	7	N
FMCU	Sep-08	7.3	460	96	L	FMCU	Mar-09	7.3	420	9	N
FMCD	Sep-08	7.3	320	11	N	FMCD	Mar-09	7.6	150	7	M
1	Oct-08	6.7	970	3	N	1	Apr-09	7.0	740	4	N
8	Oct-08	7.7	1150	2	L	8	Apr-09	7.4	500	4	N
9	Oct-08	7.5	910	2	M	9	Apr-09	7.5	1030	9	M
10	Oct-08	7.1	1200	2	N	10	Apr-09	7.3	1050	10	M
11	Oct-08	6.8	1930	2	N	11	Apr-09	7.7	1020	11	N
FMCU	Oct-08	6.8	540	15	N	FMCU	Apr-09	6.7	340	17	M
FMCD	Oct-08	7.1	200	31	M	FMCD	Apr-09	7.3	200	51	H
1	Nov-08	7.1	1130	4	N	1	May-09	7.4	810	10	N
8	Nov-08	7.7	940	15	N	8	May-09	7.5	660	44	M
9	Nov-08	7.4	1050	3	H	9	May-09	7.9	610	41	M
10	Nov-08	7.4	510	2	L	10	May-09	7.7	1070	5	M
11	Nov-08	7.2	2020	6	N	11	May-09	7.3	940	3	N
FMCU	Nov-08	7.0	570	11	N	FMCU	May-09	6.9	540	10	N
FMCD	Nov-08	7.9	160	2	M	FMCD	May-09	8.0	180	2	M

N - Nil Flow, L - Low Flow, M - Medium Flow, H - High Flow

Surface Water Quality Monitoring Results – 2009/2010

Sample Site	Date	pH	EC (uS/cm)	TSS (mg/L)	Flow
1	Jun-09	6.8	510	15	N
8	Jun-09	7.4	630	<2	M
9	Jun-09	7.7	390	22	H
10	Jun-09	7.4	680	23	M
11	Jun-09	7.1	560	8	N
FMCU	Jun-09	7.6	280	12	H
FMCD	Jun-09	7.2	240	20	H
1	Jul-09	7.8	880	9	N
8	Jul-09	7.6	820	<2	L
9	Jul-09	7.9	870	19	L
10	Jul-09	7.6	1290	9	L
11	Jul-09	NS	NS	NS	-
FMCU	Jul-09	6.6	510	23	L
FMCD	Jul-09	7.5	150	69	L
1	Aug-09	7.2	990	15	L
8	Aug-09	7.3	840	11	L
9	Aug-09	7.6	1180	25	L
10	Aug-09	7.3	1640	16	L
11	Aug-09	7.3	1720	18	L
FMCU	Aug-09	7.4	700	21	N
FMCD	Aug-09	7.8	140	2	L
1	Sep-09	7.8	1050	5	N
8	Sep-09	6.4	730	10	N
9	Sep-09	7.6	1770	14	N
10	Sep-09	7.5	1820	8	L
11	Sep-09	6.2	1680	10	N
FMCU	Sep-09	NS	NS	NS	N
FMCD	Sep-09	NS	NS	NS	N
1	Oct-09	8.6	1050	10	N
8	Oct-09	NS	NS	NS	N
9	Oct-09	8.4	1500	186	L
10	Oct-09	8.5	1770	3	L
11	Oct-09	8.3	1480	7	N
FMCU	Oct-09	NS	NS	NS	N
FMCD	Oct-09	NS	NS	NS	N
1	Nov-09	8.8	1580	22	L
8	Nov-09	NS	NS	NS	N
9	Nov-09	NS	NS	NS	N
10	Nov-09	8.5	2610	10	L
11	Nov-09	8.8	2230	26	L
FMCU	Nov-09	NS	NS	NS	N
FMCD	Nov-09	NS	NS	NS	N

Sample Site	Date	pH	EC (uS/cm)	TSS (mg/L)	Flow
1	Dec-09	NS	NS	NS	N
8	Dec-09	NS	NS	NS	N
9	Dec-09	NS	NS	NS	N
10	Dec-09	NS	NS	NS	N
11	Dec-09	7.4	1590	18	N
FMCU	Dec-09	NS	NS	NS	N
FMCD	Dec-09	NS	NS	NS	N
1	Jan-10	NS	NS	NS	N
8	Jan-10	NS	NS	NS	N
9	Jan-10	NS	NS	NS	N
10	Jan-10	NS	NS	NS	N
11	Jan-10	7.1	2220	37	L
FMCU	Jan-10	NS	NS	NS	N
FMCD	Jan-10	NS	NS	NS	N
1	Feb-10	NS	NS	NS	N
8	Feb-10	NS	NS	NS	N
9	Feb-10	NS	NS	NS	N
10	Feb-10	NS	NS	NS	N
11	Feb-10	7.1	1820	17	N
FMCU	Feb-10	NS	NS	NS	N
FMCD	Feb-10	NS	NS	NS	N
1	Mar-10	NS	NS	NS	N
8	Mar-10	NS	NS	NS	N
9	Mar-10	NS	NS	NS	N
10	Mar-10	NS	NS	NS	N
11	Mar-10	7.5	1500	8	L
FMCU	Mar-10	NS	NS	NS	N
FMCD	Mar-10	NS	NS	NS	N
1	Apr-10	NS	NS	NS	N
8	Apr-10	NS	NS	NS	N
9	Apr-10	NS	NS	NS	N
10	Apr-10	NS	NS	NS	N
11	Apr-10	7.2	1620	72	-
FMCU	Apr-10	NS	NS	NS	N
FMCD	Apr-10	NS	NS	NS	N
1	May-10	NS	NS	NS	N
8	May-10	NS	NS	NS	N
9	May-10	NS	NS	NS	N
10	May-10	NS	NS	NS	N
11	May-10	NS	NS	NS	N
FMCU	May-10	7.5	322.0	14.0	-
FMCD	May-10	7.9	165	360	-

D - Dry, N - Nil Flow, L - Low Flow, M - Medium Flow, H - High Flow NS - Sample Unobtainable

Surface Water Quality Monitoring Results – 2010/2011

Sample Site	Date	pH	EC (uS/cm)	TSS (mg/L)	Flow	Sample Site	Date	pH	EC (uS/cm)	TSS (mg/L)	Flow
1	Jun-10	7.9	460	19	NS	1	Dec-10	6.7	436.0	28.0	Still
8	Jun-10	NS	NS	NS	Dry	8	Dec-10	7.16	732	6	Still
9	Jun-10	NS	NS	NS	Dry	9	Dec-10	7.32	1070	32	Still
10	Jun-10	7.3	880	8	NS	10	Dec-10	7.17	1410	10	Trickle
11	Jun-10	7.5	690	20	NS	11	Dec-10	6.85	493	36	Still
FMCU	Jun-10	6.9	388	NS	NS	FMCU	Dec-10	6.8	465.0	7.0	Trickle
FMCD	Jun-10	0	0	0	0	FMCD	Dec-10	7.21	1580	<5	Slow
1	Jul-10	6.22	504	18	Pond	1	Jan-11	6.9	536.0	36.0	Still
8	Jul-10	7.16	1110	2	Pond	8	Jan-11	7.19	943	<5	Trickle
9	Jul-10	7.2	1300	27	Trickle	9	Jan-11	NS	NS	NS	-
10	Jul-10	7.12	1350	8	Trickle	10	Jan-11	7.41	1680	5	Still
11	Jul-10	7.06	865	13	Pond	11	Jan-11	7.05	568	18	Slow
FMCU	Jul-10	7.9	590	8	Trickle	FMCU	Jan-11	6.7	528.0	14.0	Still
FMCD	Jul-10	7.99	128	1	Steady	FMCD	Jan-11	6.79	138	6	Slow
1	Aug-10	6.55	492	12	Slow	1	Feb-11	6.7	424.0	100	Still
8	Aug-10	6.75	988	1	Trickle	8	Feb-11	7.25	624	49	Still
9	Aug-10	6.92	516	44	Trickle	9	Feb-11	NS	NS	NS	-
10	Aug-10	6.67	1220	10	Trickle	10	Feb-11	7.16	519	31	Still
11	Aug-10	6.89	602	13	Slow	11	Feb-11	7.44	1570	20	Still
FMCU	Aug-10	7.31	543	7	Still	FMCU	Feb-11	6.7	488.0	16.0	Still
FMCD	Aug-10	7.38	130	2	Steady	FMCD	Feb-11	6.85	139	<5	Slow
1	Sep-09	7.05	464	4	Still	1	Mar-11	NS	NS	NS	Dry
8	Sep-10	7.14	947	3	Trickle	8	Mar-11	7.29	151	20	Still
9	Sep-10	7.23	1410	6	Trickle	9	Mar-11	NS	NS	NS	-
10	Sep-10	7.25	1700	2	Trickle	10	Mar-11	NS	NS	NS	Dry
11	Sep-10	7	671	14	Still	11	Mar-11	7.13	578	16	Still
FMCU	Sep-10	7.29	534	4	Pond	FMCU	Mar-11	NS	NS	NS	Dry
FMCD	Sep-10	7.44	121	1	Steady	FMCD	Mar-11	6.73	122	<5	Steady
1	Oct-10	7.19	484	5	Still	1	Apr-11	NS	NS	NS	Dry
8	Oct-10	7.29	1010	2	Still	8	Apr-11	7.27	650	9	Still
9	Oct-10	7.74	1570	7	Trickle	9	Apr-11	NS	NS	NS	-
10	Oct-10	7.59	1840	6	Trickle	10	Apr-11	7.12	487	230	Trickle
11	Oct-10	7.22	734	16	Still	11	Apr-11	6.82	577	48	Still
FMCU	Oct-10	7.07	456	7	Still	FMCU	Apr-11	7.1	292.0	20.0	Still
FMCD	Oct-10	6.93	121	1	Steady	FMCD	Apr-11	7.26	133	<5	Steady
1	Nov-10	6.89	402	12	Still	1	May-11	NS	NS	NS	Dry
8	Nov-10	7.13	461	2	Still	8	May-11	7.22	717	5	Still
9	Nov-10	7.1	307	45	Trickle	9	May-11	NS	NS	NS	-
10	Nov-10	7.09	751	32	Trickle	10	May-11	6.99	1203	5	Still
11	Nov-10	6.95	340	6	Still	11	May-11	6.87	320	22	Still
FMCU	Nov-10	6.94	509	16	Trickle	FMCU	May-11	6.5	278.0	12.0	Still
FMCD	Nov-10	7.14	294	23	Steady	FMCD	May-11	6.78	120	6	Steady

NS - Sample Unobtainable

Surface Water Quality Monitoring Results – 2011/2012

Sample Site	Date	pH	EC (uS/cm)	TSS (mg/L)	Flow
1	Jun-11	6.55	607	25	Slow
8	Jun-11	6.63	771	20	Steady
9	Jun-11	NS	NS	NS	NS
10	Jun-11	6.69	854	25	Steady
11	Jun-11	6.56	757	14	Still
FMCU	Jun-11	7	460	8	Slow
FMCD	Jun-11	7.48	138	8	Steady
1	Jul-11	6.59	227	38	Steady
8	Jul-11	6.6	255	16	Fast
9	Jul-11	NS	NS	NS	NS
10	Jul-11	6.65	248	74	Fast
11	Jul-11	6.54	200	91	Steady
FMCU	Jul-11	6.87	639	5	Trickle
FMCD	Jul-11	7.03	146	16	Steady
1	Aug-11	6.93	527	24	Slow
8	Aug-11	6.81	301	14	Slow
9	Aug-11	NS	NS	NS	NS
10	Aug-11	7.11	821	102	Slow
11	Aug-11	6.93	1060	29	Slow
FMCU	Aug-11	7.74	611	NS	Trickle
FMCD	Aug-11	6.95	180	5	Steady
1	Sep-11	6.78	674	8	Trickle
8	Sep-11	6.81	770	7	Slow
9	Sep-11	NS	NS	NS	NS
10	Sep-11	7.18	1410	5	0
11	Sep-11	6.97	866	26	Trickle
FMCU	Sep-11	6.81	502	10	Still
FMCD	Sep-11	7.08	200	10	Steady
1	Oct-11	6.96	781	5	Trickle
8	Oct-11	7.09	932	5	Trickle
9	Oct-11	NS	NS	NS	NS
10	Oct-11	7.08	1150	6	Slow
11	Oct-11	7.13	606	624	Trickle
FMCU	Oct-11	6.78	597	12	Slow
FMCD	Oct-11	6.98	180	11	Steady
1	Nov-11	7.05	455	173	Slow
8	Nov-11	6.97	217	18	Fast
9	Nov-11	NS	NS	NS	NS
10	Nov-11	7.23	285	342	Fast
11	Nov-11	7.22	1180	16	Steady
FMCU	Nov-11	7.1	270	51	Still
FMCD	Nov-11	7.17	133	132	Steady
1	Dec-11	7.0	545.0	30.0	Slow
8	Dec-11	7.49	615	10	Steady
9	Dec-11	NS	NS	NS	NS
10	Dec-11	7.32	752	24	Slow
11	Dec-11	7.31	526	49	Slow
FMCU	Dec-11	7.2	452.0	8.0	Trickle
FMCD	Dec-11	7.33	248	5	Steady
1	Jan-12	7.2	673.0	14.0	Still
8	Jan-12	7.33	296	60	Steady
9	Jan-12	NS	NS	NS	NS
10	Jan-12	7.36	1440	33	Steady
11	Jan-12	7.56	494	85	Still
FMCU	Jan-12	7.4	511.0	18.0	Still
FMCD	Jan-12	7.51	147	10	Still
1	Feb-12	7.3	388.0	44.0	Slow
8	Feb-12	7.5	480	20	Slow
9	Feb-12	NS	NS	NS	NS
10	Feb-12	7.47	618	30	Slow
11	Feb-12	7.4	393	25	Slow
FMCU	Feb-12	7.1	384.0	16.0	Slow
FMCD	Feb-12	7.49	253	55	Steady
1	Mar-12	7.0	687.0	16.0	Trickle
8	Mar-12	7.64	668	16	Slow
9	Mar-12	NS	NS	NS	NS
10	Mar-12	7.51	850	18	Slow
11	Mar-12	7.31	767	8	Slow
FMCU	Mar-12	6.9	199.0	21.0	Fast
FMCD	Mar-12	6.96	186	42	Fast
1	Apr-12	7.0	579.0	36.0	Slow
8	Apr-12	7.44	448	12	Steady
9	Apr-12	NS	NS	NS	NS
10	Apr-12	7.5	753	24	Steady
11	Apr-12	7.25	510	16	Slow
FMCU	Apr-12	7.3	432.0	26.0	Steady
FMCD	Apr-12	7.52	196	228	Fast
1	May-12	7.0	1190.0	37.0	Still
8	May-12	7.36	634	5	Slow
9	May-12	NS	NS	NS	NS
10	May-12	7.54	1440	22	Slow
11	May-12	7.35	1010	78	Still
FMCU	May-12	7.4	491.0	15.0	Slow
FMCD	May-12	7.59	192	33	Fast

D - Dry, N - Nil Flow, L - Low Flow, M - Medium Flow, H - High Flow NS - Sample Unobtainable

Surface Water Quality Monitoring Results – 2012/2013

Sample Site	Date	pH	EC (uS/cm)	TSS (mg/L)	Flow	Sample Site	Date	pH	EC (uS/cm)	TSS (mg/L)	Flow
1	Jun-12	6.97	699	22	-	1	Dec-12	0.0	0.0	0.0	Dry
8	Jun-12	7.35	841	<5	-	8	Dec-12	0	0	0	NS
9	Jun-12	NS	NS	NS	NS	9	Dec-12	NS	NS	NS	NS
10	Jun-12	7.41	825	22	-	10	Dec-12	0	0	0	NS
11	Jun-12	7.1	822	19	-	11	Dec-12	0	0	0	NS
FMCU	Jun-12	7.03	228	29	-	FMCU	Dec-12	7.4	427.0	16.0	-
FMCD	Jun-12	7.13	215	26	-	FMCD	Dec-12	7.69	142	5	-
1	Jul-12	6.97	906	<5	-	1	Jan-13	0.0	0.0	0.0	Dry
8	Jul-12	7.3	431	32	-	8	Jan-13	0	0	0	NS
9	Jul-12	NS	NS	NS	NS	9	Jan-13	NS	NS	NS	NS
10	Jul-12	7.66	1020	12	-	10	Jan-13	0	0	0	NS
11	Jul-12	0	0	0	NS	11	Jan-13	0	0	0	NS
FMCU	Jul-12	7.35	624	22	-	FMCU	Jan-13	7.7	461.0	20.0	-
FMCD	Jul-12	7.52	230	40	-	FMCD	Jan-13	7.77	157	<5	-
1	Aug-12	7.13	1330	17	-	1	Feb-13	6.9	483.0	28.0	-
8	Aug-12	7.36	717	174	-	8	Feb-13	0	0	0	NS
9	Aug-12	NS	NS	NS	NS	9	Feb-13	NS	NS	NS	NS
10	Aug-12	7.67	1520	9	-	10	Feb-13	7.08	724	18	-
11	Aug-12	7.43	1070	25	-	11	Feb-13	6.72	391	23	-
FMCU	Aug-12	7.32	477	6	-	FMCU	Feb-13	6.7	325.0	5.0	-
FMCD	Aug-12	7.52	235	6	-	FMCD	Feb-13	7.21	257	6	-
1	Sep-12	7.18	1590	17	-	1	Mar-13	7.0	922.0	24.0	-
8	Sep-12	0	0	0	NS	8	Mar-13	0	0	0	NS
9	Sep-12	NS	NS	NS	NS	9	Mar-13	NS	NS	NS	NS
10	Sep-12	7.62	1720	106	-	10	Mar-13	7.47	1210	6	-
11	Sep-12	7.4	1290	95	-	11	Mar-13	6.98	595	13	-
FMCU	Sep-12	7.21	500	7	-	FMCU	Mar-13	7.1	284.0	26.0	-
FMCD	Sep-12	7.57	206	<5	-	FMCD	Mar-13	7.19	300	<5	-
1	Oct-12	7.24	1760	18	-	1	Apr-13	7.1	1030.0	8.0	-
8	Oct-12	0	0	0	NS	8	Apr-13	0	0	0	NS
9	Oct-12	NS	NS	NS	NS	9	Apr-13	NS	NS	NS	NS
10	Oct-12	7.67	1750	12	-	10	Apr-13	7.42	1490	6	-
11	Oct-12	7.62	1650	57	-	11	Apr-13	7.1	675	10	-
FMCU	Oct-12	7.37	453	16	-	FMCU	Apr-13	7.1	269.0	25.0	-
FMCD	Oct-12	7.65	171	8	-	FMCD	Apr-13	7.37	172	82	-
1	Nov-12	0	0	0	Dry	1	May-13	7.0	648.0	22.0	-
8	Nov-12	0	0	0	NS	8	May-13	0	0	0	NS
9	Nov-12	NS	NS	NS	NS	9	May-13	NS	NS	NS	NS
10	Nov-12	0	0	0	NS	10	May-13	7.55	1070	38	-
11	Nov-12	7.67	2550	108	-	11	May-13	7.16	603	15	-
FMCU	Nov-12	7.11	549	36	-	FMCU	May-13	0.0	0.0	0.0	NS
FMCD	Nov-12	7.44	149	43	-	FMCD	May-13	0	0	0	NS

D - Dry, N - Nil Flow, L - Low Flow, M - Medium Flow, H - High Flow NS - Sample Unobtainable

Surface Water Quality Monitoring Results – 2013/2014

Sample Site	Date	pH	EC (uS/cm)	TSS (mg/L)	Flow	Sample Site	Date	pH	EC (uS/cm)	TSS (mg/L)	Flow
1	Jun-13	6.97	702	<5	-	1	Dec-13	6.7	706.0	9.0	-
8	Jun-13	NF	NF	NF	NF	8	Dec-13	NF	NF	NF	NF
9	Jun-13	NS	NS	NS	NS	9	Dec-13	NS	NS	NS	NS
10	Jun-13	7.54	1240	<5	-	10	Dec-13	7.02	1130	13	-
11	Jun-13	7.09	799	5	-	11	Dec-13	6.85	542	30	-
FMCU	Jun-13	7.17	306	83	Low	FMCU	Dec-13	6.6	337.0	6.0	Pond
FMCD	Jun-13	7.55	140	<5	Low	FMCD	Dec-13	7.27	187	<5	Mod
1	Jul-13	6.59	593	7	-	1	Jan-14	6.9	740.0	84.0	-
8	Jul-13	NF	NF	NF	NF	8	Jan-14	NF	NF	NF	NF
9	Jul-13	NS	NS	NS	NS	9	Jan-14	NS	NS	NS	NS
10	Jul-13	6.98	787	12	-	10	Jan-14	7.42	1270	6	-
11	Jul-13	6.84	392	5	-	11	Jan-14	7.32	896	66	-
FMCU	Jul-13	7.16	334	24	Low	FMCU	Jan-14	6.9	353.0	7.0	Pond
FMCD	Jul-13	7.6	142	<5	Low	FMCD	Jan-14	7.19	140	<5	Mod
1	Aug-13	6.81	955	9	-	1	Feb-14	7.3	865.0	10.0	-
8	Aug-13	NF	NF	NF	NF	8	Feb-14	NF	NF	NF	NF
9	Aug-13	NS	NS	NS	NS	9	Feb-14	NS	NS	NS	NS
10	Aug-13	7.44	1350	<5	-	10	Feb-14	7.66	1690	<5	-
11	Aug-13	7.16	569	31	-	11	Feb-14	0	0	0	Dry
FMCU	Aug-13	7	354	<5	Pond	FMCU	Feb-14	7.5	460.0	25.0	Pond
FMCD	Aug-13	7.5	132	<5	Mod	FMCD	Feb-14	7.65	146	<5	Low
1	Sep-13	7.32	1120	18	-	1	Mar-14	7.0	276.0	32.0	-
8	Sep-13	NF	NF	NF	NF	8	Mar-14	NF	NF	NF	NF
9	Sep-13	NS	NS	NS	NS	9	Mar-14	NS	NS	NS	NS
10	Sep-13	7.81	1500	9	-	10	Mar-14	7.4	815	14	-
11	Sep-13	7.74	1040	14	-	11	Mar-14	6.85	532	20	-
FMCU	Sep-13	7.21	377	<5	Pond	FMCU	Mar-14	6.9	169.0	18.0	Pond
FMCD	Sep-13	7.52	128	<5	Low	FMCD	Mar-14	7.23	139	11	Low
1	Oct-13	7.28	1090	9	-	1	Apr-14	6.9	166.0	24.0	-
8	Oct-13	NF	NF	NF	NF	8	Apr-14	NF	NF	NF	NF
9	Oct-13	NS	NS	NS	NS	9	Apr-14	NS	NS	NS	NS
10	Oct-13	7.64	1920	<5	-	10	Apr-14	7.32	533	28	-
11	Oct-13	8.03	1260	126	-	11	Apr-14	7.03	531	27	-
FMCU	Oct-13	7.31	428	12	Pond	FMCU	Apr-14	6.6	140.0	11.0	Pond
FMCD	Oct-13	7.33	132	<5	Low	FMCD	Apr-14	7.18	134	21	Mod
1	Nov-13	7.21	1060	5	-	1	May-14	6.7	502.0	6.0	-
8	Nov-13	NF	NF	NF	NF	8	May-14	NF	NF	NF	NF
9	Nov-13	NS	NS	NS	NS	9	May-14	NS	NS	NS	NS
10	Nov-13	7.6	2060	34	-	10	May-14	7.16	730	<5	-
11	Nov-13	7.05	585	16	-	11	May-14	6.77	513	<5	-
FMCU	Nov-13	6.85	202	6	Pond	FMCU	May-14	6.8	209.0	9.0	Pond
FMCD	Nov-13	6.88	274	5	Mod	FMCD	May-14	7.44	131	<5	Mod

D - Dry, N - Nil Flow, L - Low Flow, M - Medium Flow, H - High Flow NS - Sample Unobtainable

Surface Water Quality Monitoring Results – 2014

Sample Site	Date	pH	EC (uS/cm)	TSS (mg/L)	Flow
1	Jun-14	7.11	481	10	Low
8	Jun-14	0	0	0	Dry
9	Jun-14	0	0	0	Not
10	Jun-14	0	936	8	Low
11	Jun-14	6.99	352	290	Low
FMCU	Jun-14	7.05	185	7	Low
FMCD	Jun-14	7.19	119	25	Mod
1	Jul-14	7.01	530	<5	0
8	Jul-14	0	0	0	Dry
9	Jul-14	0	0	0	Not
10	Jul-14	0	1490	<5	Low
11	Jul-14	7.07	756	<5	0
FMCU	Jul-14	7.35	223	6	Poole
FMCD	Jul-14	7.74	129	<5	Low
1	Aug-14	6.73	200	26	No
8	Aug-14	0	0	0	Dry
9	Aug-14	0	0	0	No
10	Aug-14	0	931	40	Low
11	Aug-14	6.8	860	8	Low
FMCU	Aug-14	6.8	151	<5	Low
FMCD	Aug-14	7.09	140	<5	Low
1	Sep-14	7.03	497	<5	Low
8	Sep-14	0	0	0	Dry
9	Sep-14	0	0	0	0
10	Sep-14	0	1120	<5	Low
11	Sep-14	7.1	512	<5	Low
FMCU	Sep-14	0	0	0	No
FMCD	Sep-14	7.53	144	<5	Low
1	Oct-14	7.01	420	18	Low
8	Oct-14	0	0	0	No
9	Oct-14	0	0	0	0
10	Oct-14	0	1410	22	Low
11	Oct-14	7.29	585	24	Low
FMCU	Oct-14	0	0	0	No
FMCD	Oct-14	7.54	127	<5	Low
1	Nov-14	0	0	0	No
8	Nov-14	0	0	0	No
9	Nov-14	0	0	0	0
10	Nov-14	0	1120	7	Low
11	Nov-14	6.9	670	87	Low
FMCU	Nov-14	0	0	0	No
FMCD	Nov-14	7.42	203	<5	Low

Sample Site	Date	pH	EC (uS/cm)	TSS (mg/L)	Flow
1	Dec-14	0.0	0.0	0.0	No
8	Dec-14	0	0	0	0
9	Dec-14	0	0	0	0
10	Dec-14	0	0	0	No
11	Dec-14	0	0	0	No
FMCU	Dec-14	0.0	0.0	0.0	No
FMCD	Dec-14	7.43	189	<5	Low

D - Dry, N - Nil Flow, L - Low Flow, M - Medium Flow, H - High Flow NS - Sample Unobtainable

Surface Water Quality Monitoring Results – 2015

Sample Site	Date	pH	EC (uS/cm)	TSS (mg/L)	Flow
1	Jan-15	6.52	218	64	Low
8	Jan-15	5.55	116.3	17	Low
9	Jan-15	NS	NS	NS	NS
10	Jan-15	7.02	673	104	Mod
11	Jan-15	6.17	229	51	Mod
FMCU	Jan-15	6.49	204	13	
FMCD	Jan-15	6.97	201	10	
1	Feb-15	6.44	2910	14	Low
8	Feb-15	NS	NS	NS	No
9	Feb-15	NS	NS	NS	NS
10	Feb-15	6.95	766	<5	Low
11	Feb-15	6.75	545	19	Low
FMCU	Feb-15	NS	NS	NS	N
FMCD	Feb-15	7.12	164.5	<5	Low
1	Mar-15	NS	NS	NS	N
8	Mar-15	NS	NS	NS	N
9	Mar-15	NS	NS	NS	NS
10	Mar-15	6.89	1107	<5	Low
11	Mar-15	NS	NS	NS	N
FMCU	Mar-15	NS	NS	NS	N
FMCD	Mar-15	7.53	170	<5	Low
1	Apr-15	6.67	382	22	Low
8	Apr-15	6.45	506	<5	Low
9	Apr-15	NS	NS	NS	NS
10	Apr-15	6.69	803	<5	Low
11	Apr-15	6.62	1334	53	Low
FMCU	Apr-15	7.11	307	14	Low
FMCD	Apr-15	6.13	372	9	Low
1	May-15	6.28	838	6	Low
8	May-15	6.15	478	<5	Low
9	May-15	NS	NS	NS	NS
10	May-15	6.46	977	<5	Low
11	May-15	6.23	1140	23	Low
FMCU	May-15	7.04	214	13	Mod
FMCD	May-15	6.71	217	9	Mod
1	Jun-15	6.02	599	<5	Low
8	Jun-15	5.97	482	<5	Low
9	Jun-15	NS	NS	NS	NS
10	Jun-15	6.35	834	<5	Low
11	Jun-15	6.15	1426	<5	Low
FMCU	Jun-15	6.33	202	6	Low
FMCD	Jun-15	6.08	200	<5	Mod

Sample Site	Date	pH	EC (uS/cm)	TSS (mg/L)	Flow
1	Jul-15	7.0	872.0	<5	Low
8	Jul-15	6.56	642	<5	Low
9	Jul-15	NS	NS	NS	NS
10	Jul-15	7.03	1364	<5	Low
11	Jul-15	7.22	1492	<5	Low
FMCU	Jul-15	NS	NS	NS	N
FMCD	Jul-15	7.27	223	<5	Low
1	Aug-15	5.8	762.0	<5	Low
8	Aug-15	7.62	533	7	N
9	Aug-15	NS	NS	NS	NS
10	Aug-15	7.52	1315	<5	Low
11	Aug-15	7.67	1072	7	N
FMCU	Aug-15	7.9	267.0	<5	N
FMCD	Aug-15	7.92	145.7	17	Low
1	Sep-15	7.3	698.0	15.0	No
8	Sep-15	7.25	499	<5	No
9	Sep-15	NS	NS	NS	NS
10	Sep-15	7.7	1237	<5	Low
11	Sep-15	6.72	714	8	N
FMCU	Sep-15	7.2	252.0	8.0	N
FMCD	Sep-15	8	135.4	<5	Low
1	Oct-15	7.0	578.0	13.0	N
8	Oct-15	7.04	459	9	N
9	Oct-15	NS	NS	NS	NS
10	Oct-15	7.57	1332	8	Low
11	Oct-15	6.92	822	18	No
FMCU	Oct-15	7.0	226.9	<5	No
FMCD	Oct-15	7.6	134.9	<5	Low
1	Nov-15	7.3	442.0	<5	Low
8	Nov-15	6.99	452	<5	N
9	Nov-15	NS	NS	NS	NS
10	Nov-15	7.38	1022	<5	Low
11	Nov-15	7.13	1945	40	Low
FMCU	Nov-15	7.5	232.5	<5	N
FMCD	Nov-15	7.4	148.9	<5	Low
1	Dec-15	7.1	286.0	30.0	N
8	Dec-15	7.07	294	<5	Low
9	Dec-15	NS	NS	NS	NS
10	Dec-15	7.28	901	6	Low
11	Dec-15	7.08	626	10	N
FMCU	Dec-15	7.2	208.3	14.0	N
FMCD	Dec-15	7.58	175.1	<5	Low

D - Dry, N - Nil Flow, L - Low Flow, M - Medium Flow, H - High Flow NS - Sample Unobtainable

Surface Water Quality Monitoring Results – 2016

Sample Site	Date	pH	EC (uS/cm)	TSS (mg/L)	Flow
1	Jan-16	6.85	765	6	N
8	Jan-16	7.22	545	5	N
9	Jan-16	NS	NS	NS	NS
10	Jan-16	7.2	1215	6	N
11	Jan-16	6.87	828	6	L
FMCU	Jan-16	6.65	200.9	5	
FMCD	Jan-16	7.08	208.2	5	
1	Feb-16	7.09	1004	5	N
8	Feb-16	7.04	541	5	L
9	Feb-16	NS	NS	NS	NS
10	Feb-16	7.24	1230	<5	N
11	Feb-16	7.07	1091	16	L
FMCU	Feb-16	7.19	259	5	N
FMCD	Feb-16	7.3	193.6	5	N
1	Mar-16	7.4	1060	5	N
8	Mar-16	7.34	556	5	N
9	Mar-16	NS	NS	NS	NS
10	Mar-16	7.5	1421	5	L
11	Mar-16	7.39	1388	16	N
FMCU	Mar-16	7.17	289	18	N
FMCD	Mar-16	7.8	183.2	5	N
1	Apr-16	7.81	498	151	N
8	Apr-16	7.34	270	10	N
9	Apr-16	NS	NS	NS	NS
10	Apr-16	7.42	1484	6	L
11	Apr-16	7.69	1105	15	N
FMCU	Apr-16	7.36	229.5	5	N
FMCD	Apr-16	8.07	133.8	5	N
1	May-16	7.35	487	22	N
8	May-16	7.3	479	5	N
9	May-16	NS	NS	NS	NS
10	May-16	7.35	1701	<5	M
11	May-16	7.53	1421	22	N
FMCU	May-16	6.97	226	5	
FMCD	May-16	7.65	133.6	5	
1	Jun-16	7.19	226	32	N
8	Jun-16	6.92	437	5	N
9	Jun-16	NS	NS	NS	NS
10	Jun-16	7.23	1044	<5	L
11	Jun-16	7	901	6	N
FMCU	Jun-16	6.8	176.3	5	
FMCD	Jun-16	7.6	142.9	18	

Sample Site	Date	pH	EC (uS/cm)	TSS (mg/L)	Flow
1	Jul-16	7.4	238.0	12.0	N
8	Jul-16	6.96	427	5	N
9	Jul-16	NS	NS	NS	NS
10	Jul-16	7.34	1267	<5	L
11	Jul-16	7.08	1245	14	N
FMCU	Jul-16	7.3	169.7	5.0	
FMCD	Jul-16	7.67	158.1	10	
1	Aug-16	7.1	432.0	5.0	N
8	Aug-16	6.95	408	5	N
9	Aug-16	NS	NS	NS	NS
10	Aug-16	7.22	1569	<5	L
11	Aug-16	7.34	972	7	N
FMCU	Aug-16	7.5	173.2	5.0	
FMCD	Aug-16	8.06	148.8	5	
1	Sep-16	7.3	374.0	10.0	N
8	Sep-16	6.91	374	5	N
9	Sep-16	NS	NS	NS	NS
10	Sep-16	7.27	1303	<5	N
11	Sep-16	7.07	321	8	N
FMCU	Sep-16	7.3	197.4	5.0	
FMCD	Sep-16	0	134.5	17	
1	Oct-16	7.3	400.0	10.0	N
8	Oct-16	7.21	394	7	N
9	Oct-16	NS	NS	NS	NS
10	Oct-16	7.39	1653	8	N
11	Oct-16	7.29	152.1	10	N
FMCU	Oct-16	7.4	194.9	5.0	N
FMCD	Oct-16	7.8	172.8	5	N
1	Nov-16	7.3	403.0	10.0	N
8	Nov-16	7.13	398	5	N
9	Nov-16	NS	NS	NS	NS
10	Nov-16	7.18	1893	11	N
11	Nov-16	7.16	154.2	5	N
FMCU	Nov-16	7.2	175.1	8.0	
FMCD	Nov-16	7.62	145.2	5	
1	Dec-16	7.0	378.0	63.0	N
8	Dec-16	6.86	328	11	N
9	Dec-16	NS	NS	NS	NS
10	Dec-16	7.28	1946	12	N
11	Dec-16	0	0	0	N
FMCU	Dec-16	7.1	213.9	30.0	N
FMCD	Dec-16	7.29	176.6	5	N

D - Dry, N - Nil Flow, L - Low Flow, M - Medium Flow, H - High Flow NS - Sample Unobtainable

Surface Water Quality Monitoring Results – 2017

Sample Site	Date	pH	EC (uS/cm)	TSS (mg/L)	Flow
1	Jan-17	6.91	259	113	NF
8	Jan-17	NS	NS	NS	NF
9	Jan-17	NS	NS	NS	
10	Jan-17	NS	NS	NS	NF
11	Jan-17	6.51	142.1	9	NF
FMCU	Jan-17	7.05	181.7	22	
FMCD	Jan-17	7.19	164.4	9	
1	Feb-17	6.93	443	16	NF
8	Feb-17	NS	NS	NS	NF
9	Feb-17	NS	NS	NS	
10	Feb-17	NS	NS	NS	NF
11	Feb-17	6.6	171.9	22	NF
FMCU	Feb-17	6.98	198.3	23	
FMCD	Feb-17	7.49	173.2	5	
1	Mar-17	6.34	404	5	LF
8	Mar-17	5.89	580	<5	LF
9	Mar-17	NS	NS	NS	
10	Mar-17	6.76	1092	9	LF
11	Mar-17	6.5	904	10	NF
FMCU	Mar-17	6.09	252.9	8	
FMCD	Mar-17	7.45	241	9	
1	Apr-17	6.92	592	11	NF
8	Apr-17	6.33	521	<5	LF
9	Apr-17	NS	NS	NS	
10	Apr-17	6.85	1044	<5	LF
11	Apr-17	6.94	978	10	NF
FMCU	Apr-17	6.55	289	6	
FMCD	Apr-17	7.29	186.6	<5	
1	May-17	6.93	603	17	NF
8	May-17	6.7	685	16	NF
9	May-17	NS	NS	NS	
10	May-17	7.34	1493	30	NF
11	May-17	5.88	348	14	NF
FMCU	May-17	7.48	291	<5	
FMCD	May-17	6.94	168.6	<5	
1	Jun-17	6.67	450	6	LF
8	Jun-17	6.67	455	<5	NF
9	Jun-17	NS	NS	NS	
10	Jun-17	6.68	811	8	NF
11	Jun-17	6.75	1278	15	NF
FMCU	Jun-17	7.38	267	8	
FMCD	Jun-17	8.24	186	5	

Sample Site	Date	pH	EC (uS/cm)	TSS (mg/L)	Flow
1	Jul-17	7.8	565.0	5.0	NF
8	Jul-17	7.04	506	<5	NF
9	Jul-17	NS	NS	NS	
10	Jul-17	7	1438	<5	NF
11	Jul-17	7.37	387	14	NF
FMCU	Jul-17	7.5	298.0	14.0	Light brown
FMCD	Jul-17	8.15	110.1	<5	
1	Aug-17	8.1	494.0	5.0	NF
8	Aug-17	7.33	536	<5	NF
9	Aug-17	NS	NS	NS	
10	Aug-17	7.27	1361	<5	NF
11	Aug-17	7.31	476	176	NF
FMCU	Aug-17	6.7	303.0	122.0	
FMCD	Aug-17	6.83	110.8	86	
1	Sep-17	7.4	586.0	37.0	NF
8	Sep-17	7.21	581	28	NF
9	Sep-17	NS	NS	NS	
10	Sep-17	6.89	2071	30	NF
11	Sep-17	7.64	222	24	NF
FMCU	Sep-17	7.4	340.0	<5	
FMCD	Sep-17	7.22	202.3	<5	
1	Oct-17	NS	NS	NS	NF
8	Oct-17	NS	NS	NS	NF
9	Oct-17	NS	NS	NS	
10	Oct-17	7.07	2240	111	NF
11	Oct-17	NS	NS	NS	NF
FMCU	Oct-17	6.2	468.0	23.0	Pooled
FMCD	Oct-17	8.15	225	<5	
1	Nov-17	7.3	202.1	33.0	NF
8	Nov-17	6.28	348	<5	NF
9	Nov-17	NS	NS	NS	
10	Nov-17	7	456	21	NF
11	Nov-17	NS	NS	NS	NF
FMCU	Nov-17	6.5	163.5	10.0	
FMCD	Nov-17	7.53	149.2	5	
1	Dec-17	6.4	242.0	24.0	NF
8	Dec-17	NS	NS	NS	NF
9	Dec-17	NS	NS	NS	
10	Dec-17	6.43	1185	41	NF
11	Dec-17	NS	NS	NS	NF
FMCU	Dec-17	6.5	190.8	16.0	
FMCD	Dec-17	7.75	170.9	<5	

D - Dry, N - Nil Flow, L - Low Flow, M - Medium Flow, H - High Flow NS - Sample Unobtainable

Surface Water Quality Monitoring Results – 2018

Sample Site	Date	pH	EC (uS/cm)	TSS (mg/L)	Flow
1	Jan-18	NS	NS	NS	N
8	Jan-18	NS	NS	NS	N
9	Jan-18	NS	NS	NS	N
10	Jan-18	NS	NS	NS	
11	Jan-18	6.69	178.2	16	
FMCU	Jan-18	NS	NS	NS	L
FMCD	Jan-18	7.2	190.9	5	
1	Feb-18	NS	NS	NS	N
8	Feb-18	NS	NS	NS	N
9	Feb-18	NS	NS	NS	N
10	Feb-18	NS	NS	NS	
11	Feb-18	6.59	158.9	13	
FMCU	Feb-18	5.42	313	16	
FMCD	Feb-18	7.98	208.2	10	
1	Mar-18	NS	NS	NS	N
8	Mar-18	6.87	389	7	
9	Mar-18	NS	NS	NS	
10	Mar-18	6.91	1071	235	
11	Mar-18	7.03	275	5	
FMCU	Mar-18	6.67	245	6	
FMCD	Mar-18	7.89	151.8	8	
1	Apr-18	7.14	580	10	
8	Apr-18	6.85	583	8	
9	Apr-18	NS	NS	NS	
10	Apr-18	6.82	1121	16	
11	Apr-18	7.4	311	5	
FMCU	Apr-18	6.06	291	7	
FMCD	Apr-18	7.12	157.1	5	
1	May-18	7.08	625	10	
8	May-18	6.8	650	9	
9	May-18	NS	NS	NS	
10	May-18	7.35	1436	5	
11	May-18	7.2	182.8	5	
FMCU	May-18	7.11	288	6	
FMCD	May-18	8.44	154.8	5	
1	Jun-18	6.96	302	9	
8	Jun-18	6.15	410	5	
9	Jun-18	NS	NS	NS	
10	Jun-18	6.96	1157	8	
11	Jun-18	6.85	359	5	
FMCU	Jun-18	6.63	193.9	5	
FMCD	Jun-18	7.8	147.7	26	

Sample Site	Date	pH	EC (uS/cm)	TSS (mg/L)	Flow
1	Jul-18	NS	NS	NS	N
8	Jul-18	7.13	630	24	
9	Jul-18	NS	NS	NS	
10	Jul-18	7.19	1776	11	
11	Jul-18	7	276	5	
FMCU	Jul-18	6.8	210.0	5.0	
FMCD	Jul-18	8.02	255	5	
1	Aug-18	7.3	253.0	31.0	
8	Aug-18	NS	NS	NS	N
9	Aug-18	NS	NS	NS	
10	Aug-18	7.25	1343	5	
11	Aug-18	6.95	134.4	5	
FMCU	Aug-18	6.3	239.0	13.0	
FMCD	Aug-18	7.35	149.5	7	
1	Sep-18	6.9	225.6	57.0	
8	Sep-18	NS	NS	NS	N
9	Sep-18	NS	NS	NS	
10	Sep-18	6.9	1469	5	
11	Sep-18	6.85	139.9	5	
FMCU	Sep-18	6.8	193.9	10.0	
FMCD	Sep-18	7.76	126.6	6	
1	Oct-18	6.7	486.0	5.0	
8	Oct-18	6.58	367	5	
9	Oct-18	NS	NS	NS	
10	Oct-18	6.98	1077	5	
11	Oct-18	6.74	272	5	
FMCU	Oct-18	6.5	434.0	10.0	
FMCD	Oct-18	8.03	148.4	11	
1	Nov-18	6.7	324.0	10.0	
8	Nov-18	6.89	441	12	
9	Nov-18	NS	NS	NS	
10	Nov-18	6.94	1437	12	
11	Nov-18	6.74	182.9	22	
FMCU	Nov-18	6.9	440.0	15.0	
FMCD	Nov-18	8.08	166.9	5	
1	Dec-18	6.4	294.0	15.0	
8	Dec-18	6.32	326	6	
9	Dec-18	NS	NS	NS	
10	Dec-18	6.95	523	23	
11	Dec-18	6.65	204	14	
FMCU	Dec-18	6.9	239.0	5.0	
FMCD	Dec-18	7.24	240	26	

D - Dry, N - Nil Flow, L - Low Flow, M - Medium Flow, H - High Flow NS - Sample Unobtainable

Surface Water Quality Monitoring Results – 2019

Sample Site	Date	pH	EC (uS/cm)	TSS (mg/L)	Flow	Sample Site	Date	pH	EC (uS/cm)	TSS (mg/L)	Flow
1	Jan-19	6.92	350	15	N	1	Jul-19	7.0	296.6	15.0	N
8	Jan-19	NS	NS	NS	N	8	Jul-19	7.2	451.3	11	N
9	Jan-19	NS	NS	NS	N	9	Jul-19	NS	NS	NS	N
10	Jan-19	6.78	1676	9	N	10	Jul-19	7.36	751.6	5	N
11	Jan-19	7.26	163.5	5	N	11	Jul-19	7.37	183.9	5	N
FMCU	Jan-19	6.95	314	28	N	FMCU	Jul-19	6.7	219.3	5.0	N
FMCD	Jan-19	7.44	190.3	5	M	FMCD	Jul-19	7.69	237	5	L
1	Feb-19	6.98	443	26	N	1	Aug-19	NS	NS	NS	N
8	Feb-19	NS	NS	NS	N	8	Aug-19	NS	NS	NS	N
9	Feb-19	NS	NS	NS	N	9	Aug-19	NS	NS	NS	N
10	Feb-19	NS	NS	NS	N	10	Aug-19	7.19	1004	9	N
11	Feb-19	7.26	196.6	10	N	11	Aug-19	7.47	257	5	L
FMCU	Feb-19	NS	NS	NS	N	FMCU	Aug-19	NS	NS	NS	N
FMCD	Feb-19	7.84	147.9	5	M	FMCD	Aug-19	7.88	256	5	L
1	Mar-19	6.55	193.9	50	N	1	Sep-19	6.8	315.0	20.0	N
8	Mar-19	6.41	498	26	N	8	Sep-19	NS	NS	NS	N
9	Mar-19	NS	NS	NS	N	9	Sep-19	NS	NS	NS	N
10	Mar-19	6.54	410	28	N	10	Sep-19	7	666	10	N
11	Mar-19	6.94	214	5	N	11	Sep-19	7.27	588	10	N
FMCU	Mar-19	7.09	163	10	N	FMCU	Sep-19	6.9	162.9	18.0	N
FMCD	Mar-19	7.64	224	26	L	FMCD	Sep-19	7.57	225	5	L
1	Apr-19	5.73	329	27	N	1	Oct-19	7.1	341.0	5.0	N
8	Apr-19	6.3	275.2	10	N	8	Oct-19	NS	NS	NS	N
9	Apr-19	NS	NS	NS	N	9	Oct-19	NS	NS	NS	N
10	Apr-19	6.64	673.7	22	N	10	Oct-19	7.7	931	8	N
11	Apr-19	7.25	241	5	N	11	Oct-19	7.68	160.3	5	N
FMCU	Apr-19	6.87	189	5	N	FMCU	Oct-19	6.9	210.6	21.0	N
FMCD	Apr-19	7.45	283	5	L	FMCD	Oct-19	7.68	232.7	5	L
1	May-19	6.83	330	48	N	1	Nov-19	6.7	369.0	44.0	N
8	May-19	NS	NS	NS	N	8	Nov-19	NS	NS	NS	N
9	May-19	NS	NS	NS	N	9	Nov-19	NS	NS	NS	N
10	May-19	6.85	961	10	N	10	Nov-19	7.28	1100	6	N
11	May-19	6.94	249	5	N	11	Nov-19	6.65	314	24	N
FMCU	May-19	7	178.9	12	N	FMCU	Nov-19	NS	NS	NS	D
FMCD	May-19	8.07	241	5	L	FMCD	Nov-19	7.86	274	10	L
1	Jun-19	7.1	294	NS	N	1	Dec-19	NS	NS	NS	N
8	Jun-19	NS	NS	NS	N	8	Dec-19	NS	NS	NS	N
9	Jun-19	NS	NS	NS	N	9	Dec-19	NS	NS	NS	N
10	Jun-19	6.82	1027	NS	N	10	Dec-19	7.23	1285	12	N
11	Jun-19	7.09	238	NS	N	11	Dec-19	6.65	366	38	N
FMCU	Jun-19	7.22	151.8	10	N	FMCU	Dec-19	NS	NS	NS	D
FMCD	Jun-19	8.1	219	6	L	FMCD	Dec-19	7.79	332	68	N

D - Dry, N - Nil Flow, L - Low Flow, M - Medium Flow, H - High Flow NS - Sample Unobtainable

Groundwater 2008 to 2019

Groundwater Quality Monitoring Results – 2008/2009

Sample Site	Date	pH	EC (uS/cm)	TSS (mg/L)
6	Jun-08	6.1	3740	362
7	Jun-08	6.8	2200	1130
12	Jun-08	6.1	4640	148
13	Jun-08	6.8	12830	32
JRD1	Jun-08	7	2660	132
JRD2	Jun-08	6.7	600	130
6	Jul-08	6.1	3970	174
7	Jul-08	7.1	2590	616
12	Jul-08	6.7	6720	121
13	Jul-08	6.7	14710	6
JRD1	Jul-08	6.8	3210	28
JRD2	Jul-08	7	3040	15
6	Aug-08	6.1	3930	804
7	Aug-08	6.7	2350	98
12	Aug-08	6.8	10130	216
13	Aug-08	7	13610	15
JRD1	Aug-08	7.0	3220	35
JRD2	Aug-08	7.2	2980	57
6	Sep-08	6.2	2860	261
7	Sep-08	6.9	2300	130
12	Sep-08	6.6	1630	152
13	Sep-08	6.8	13580	30
JRD1	Sep-08	7.3	3230	71
JRD2	Sep-08	6.5	220	78
6	Oct-08	6.4	3950	14
7	Oct-08	6.6	2260	878
12	Oct-08	6.8	11530	407
13	Oct-08	6.8	13910	9
JRD1	Oct-08	6.8	3650	28
JRD2	Oct-08	6	220	125
6	Nov-08	6	3750	550
7	Nov-08	6.9	2250	670
12	Nov-08	6.7	8880	182
13	Nov-08	7	13180	3
JRD1	Nov-08	6.7	3830	12
JRD2	Nov-08	6.9	240	178

Sample Site	Date	pH	EC (uS/cm)	TSS (mg/L)
6	Dec-08	6.1	3750	356
7	Dec-08	6.8	2490	416
12	Dec-08	6.9	11300	173
13	Dec-08	7	13280	11
JRD1	Dec-08	6.9	3800	28
JRD2	Dec-08	6.4	410	180
6	Jan-09	6.6	4260	1160
7	Jan-09	6.5	2250	160
12	Jan-09	6.8	12440	1550
13	Jan-09	6.8	14450	7
JRD1	Jan-09	6.8	3830	13
JRD2	Jan-09	7.1	3080	16
6	Feb-09	6.3	3090	165
7	Feb-09	6.6	2070	177
12	Feb-09			
13	Feb-09	6.9	13090	18
JRD1	Feb-09	6.9	3790	59
JRD2	Feb-09	6.7	500	63
6	Mar-09	6.3	3820	204
7	Mar-09	6.5	2090	534
12	Mar-09	6.3	2390	106
13	Mar-09	7	13250	9
JRD1	Mar-09	6.8	3870	14
JRD2	Mar-09	6.7	490	27
6	Apr-09	6.7	3340	192
7	Apr-09	6.3	2060	196
12	Apr-09	6.8	7970	727
13	Apr-09	6.8	14680	2
JRD1	Apr-09	6.6	3770	11
JRD2	Apr-09	7	2620	15
6	May-09	6.8	4250	136
7	May-09	7	2530	264
12	May-09	6.7	11550	454
13	May-09	6.9	13410	18
JRD1	May-09	6.7	3260	23
JRD2	May-09	6.9	560	25

Groundwater Quality Monitoring Results – 2009/2010

Sample Site	Date	pH	EC (uS/cm)	TSS (mg/L)
6	Jun-09	6.5	4460	459
7	Jun-09	6.5	2140	551
12	Jun-09	NS	NS	NS
13	Jun-09	7.1	11920	15
JRD1	Jun-09	6.8	2250	29
JRD2	Jun-09	7.4	730	91
6	Jul-09	6.6	4290	945
7	Jul-09	6.8	2260	103
12	Jul-09	6.7	5330	1380
13	Jul-09	6.8	14850	25
JRD1	Jul-09	6.6	3720	21
JRD2	Jul-09	7	2660	15
6	Aug-09	6.7	4580	807
7	Aug-09	6.8	2380	16
12	Aug-09	6.9	8730	15
13	Aug-09	7.1	12600	20
JRD1	Aug-09	6.8	3090.0	52.0
JRD2	Aug-09	7	1160	97
6	Sep-09	6.6	4380	119
7	Sep-09	6.6	2460	12
12	Sep-09	NS	NS	NS
13	Sep-09	6.6	13490	14
JRD1	Sep-09	6.8	3130	66
JRD2	Sep-09	7.9	1230	61
6	Oct-09	6.9	3940	51
7	Oct-09	6.8	2000	147
12	Oct-09	NS	NS	NS
13	Oct-09	7.2	11610	12
JRD1	Oct-09	7.1	3250	106
JRD2	Oct-09	7.6	1770	61
6	Nov-09	7.2	8400	266
7	Nov-09	6.8	3590	246
12	Nov-09	NS	NS	NS
13	Nov-09	7.3	260	14
JRD1	Nov-09	6.9	10230	47
JRD2	Nov-09	7.1	350.0	47.0

Sample Site	Date	pH	EC (uS/cm)	TSS (mg/L)
6	Dec-09	6.9	4270.0	193.0
7	Dec-09	6.9	2390	14
12	Dec-09	NS	NS	NS
13	Dec-09	7	12390	26
JRD1	Dec-09	6.7	3650	63
JRD2	Dec-09	7.3	1920.0	87.0
6	Jan-10	6.7	5310	173
7	Jan-10	NS	NS	NS
12	Jan-10	6.7	13200.0	37.0
13	Jan-10	6.5	12990	31
JRD1	Jan-10	6.8	3580	22
JRD2	Jan-10	7.3	2050.0	44.0
6	Feb-10	6.9	4570	193
7	Feb-10	NS	NS	NS
12	Feb-10	6.9	12280	46
13	Feb-10	7.1	11560	28
JRD1	Feb-10	6.9	3750	40
JRD2	Feb-10	7.3	960	139
6	Mar-10	6.7	4180	394
7	Mar-10	NS	NS	NS
12	Mar-10	6.5	6880	30
13	Mar-10	7	11430	32
JRD1	Mar-10	6.8	4040	38
JRD2	Mar-10	7.4	1220	100
6	Apr-10	6.4	3900.0	397.0
7	Apr-10	NS	NS	NS
12	Apr-10	8.2	8440	67
13	Apr-10	7	11430	32
JRD1	Apr-10	6.7	3930	52
JRD2	Apr-10	6.3	1990	101
6	May-10	6.89	1590	268
7	May-10	NS	NS	NS
12	May-10	6.75	8310	34
13	May-10	NS	NS	NS
JRD1	May-10	6.73	3780	23
JRD2	May-10	7.41	1590	136

Groundwater Quality Monitoring Results – 2010/2011

Sample Site	Date	pH	EC (uS/cm)	TSS (mg/L)
6	Jun-10	6.9	3320	206
7	Jun-10	NS	NS	NS
12	Jun-10	7.3	3200	63
13	Jun-10	7.6	10300	12
JRD1	Jun-10	7.5	3780	43
JRD2	Jun-10	7.2	315	14
6	Jul-10	7.23	3920	194
7	Jul-10	6.81	2630	22
12	Jul-10	6.41	7790	50
13	Jul-10	6.64	13100	6
JRD1	Jul-10	6.65	3520	22
JRD2	Jul-10	7.1	338	52
6	Aug-10	6.37	4020	234
7	Aug-10	6.8	2680	62
12	Aug-10	6.85	7840	12
13	Aug-10	6.65	13400	16
JRD1	Aug-10	7.2	3960.0	22.0
JRD2	Aug-10	7.2	2380	48
6	Sep-10	7.05	3700	412
7	Sep-10	4.76	2580	36
12	Sep-10	6.78	7800	22
13	Sep-10	6.78	11800	5
JRD1	Sep-10	8.03	3840	16
JRD2	Sep-10	7.05	2460	34
6	Oct-10	6.58	2320	152
7	Oct-10	7.03	2660	86
12	Oct-10	6.6	10800	17
13	Oct-10	6.99	12000	9
JRD1	Oct-10	8.05	4380	76
JRD2	Oct-10	7.27	2500	17
6	Nov-10	6.64	1090	141
7	Nov-10	7.21	2870	65
12	Nov-10	6.44	3260	30
13	Nov-10	6.97	13100	10
JRD1	Nov-10	8.34	4720	57
JRD2	Nov-10	7.2	2520.0	58.0

Sample Site	Date	pH	EC (uS/cm)	TSS (mg/L)
6	Dec-10	6.5	1410.0	244.0
7	Dec-10	7.01	2670	232
12	Dec-10	6.31	2390	71
13	Dec-10	6.84	11000	5
JRD1	Dec-10	8.31	4460	229
JRD2	Dec-10	7.0	1120.0	99.0
6	Jan-11	6.51	3020	708
7	Jan-11	6.92	2800	68
12	Jan-11	6.4	7560.0	40.0
13	Jan-11	6.86	12400	30
JRD1	Jan-11	7.87	4990	51
JRD2	Jan-11	7.2	2110.0	222.0
6	Feb-11	6.47	2850	173
7	Feb-11	6.8	2760.0	147.0
12	Feb-11	6.35	7480	94
13	Feb-11	6.6	12400	25
JRD1	Feb-11	7.93	4660	69
JRD2	Feb-11	7.03	2500	62
6	Mar-11	6.68	2590	380
7	Mar-11	7.04	2560	39
12	Mar-11	6.58	13800	12
13	Mar-11	6.86	12200	24
JRD1	Mar-11	8.23	4710	32
JRD2	Mar-11	7.68	2080	69
6	Apr-11	7.4	3950.0	287.0
7	Apr-11	7.69	2780	150
12	Apr-11	7.46	14200	82
13	Apr-11	6.86	12200	24
JRD1	Apr-11	8.38	4840	24
JRD2	Apr-11	7.77	2520	50
6	May-11	6.7	4140	84
7	May-11	7.01	2860	18
12	May-11	6.5	9230	24
13	May-11	6.88	12600	42
JRD1	May-11	8.2	4970	76
JRD2	May-11	7.15	2080	70

Groundwater Quality Monitoring Results – 2011/2012

Sample Site	Date	pH	EC (uS/cm)	TSS (mg/L)	Sample Site	Date	pH	EC (uS/cm)	TSS (mg/L)
6	Jun-11	6.72	4020	143	6	Dec-11	7.0	2680.0	262.0
7	Jun-11	6.84	2720	18	7	Dec-11	6.78	2050	142
12	Jun-11	6.46	6820	18	12	Dec-11	6.18	2720	80
13	Jun-11	6.99	8970	16	13	Dec-11	7.28	9180	66
JRD1	Jun-11	8.18	4750	26	JRD1	Dec-11	NS	NS	NS
JRD2	Jun-11	7.08	2280	94	JRD2	Dec-11	6.8	313.0	76.0
6	Jul-11	7.17	4120	123	6	Jan-12	7.08	2740	542
7	Jul-11	7.2	2380	40	7	Jan-12	7.18	2190	240
12	Jul-11	6.7	1840	210	12	Jan-12	6.4	9120.0	22.0
13	Jul-11	7.37	11000	14	13	Jan-12	7.24	11000	21
JRD1	Jul-11	8.18	4720	18	JRD1	Jan-12	8.17	4120	36
JRD2	Jul-11	6.32	441	32	JRD2	Jan-12	7.1	389.0	28.0
6	Aug-11	6.78	3530	-	6	Feb-12	7.1	3260	66
7	Aug-11	6.47	2160	258	7	Feb-12	7.2	2180.0	40.0
12	Aug-11	7.33	1540	-	12	Feb-12	6.12	1460	27
13	Aug-11	6.98	3770	-	13	Feb-12	7.21	8210	22
JRD1	Aug-11	8.3	4640.0	-	JRD1	Feb-12	8.26	4260	14
JRD2	Aug-11	7.04	337	-	JRD2	Feb-12	8.06	471	18
6	Sep-11	6.77	3890	144	6	Mar-12	7.11	3140	35
7	Sep-11	6.56	2190	154	7	Mar-12	7.04	2190	124
12	Sep-11	6.29	4560	40	12	Mar-12	6.17	517	46
13	Sep-11	6.89	11000	17	13	Mar-12	7.03	3710	14
JRD1	Sep-11	NS	NS	NS	JRD1	Mar-12	8.05	4170	40
JRD2	Sep-11	6.25	351	48	JRD2	Mar-12	7.26	390	48
6	Oct-11	6.69	2370	94	6	Apr-12	7.3	3120.0	222.0
7	Oct-11	6.31	1540	113	7	Apr-12	7.55	2740	105
12	Oct-11	6.01	1080	108	12	Apr-12	6.5	2170	161
13	Oct-11	6.88	10200	36	13	Apr-12	7.03	3710	14
JRD1	Oct-11	NS	NS	NS	JRD1	Apr-12	8.18	4500	57
JRD2	Oct-11	6.21	408	45	JRD2	Apr-12	8	506	50
6	Nov-11	7.28	3730	194	6	May-12	7.16	3170	174
7	Nov-11	7.06	2010	15	7	May-12	7.49	2720	106
12	Nov-11	6.83	4290	101	12	May-12	6.37	1250	130
13	Nov-11	7.34	11400	15	13	May-12	7.34	11200	80
JRD1	Nov-11	8.25	4620	52	JRD1	May-12	8.17	4380	26
JRD2	Nov-11	7.1	386.0	54.0	JRD2	May-12	6.57	315	69

Groundwater Quality Monitoring Results – 2012/2013

Sample Site	Date	pH	EC (uS/cm)	TSS (mg/L)	Sample Site	Date	pH	EC (uS/cm)	TSS (mg/L)
6	Jun-12	7.04	662	6400	6	Dec-12	NS	NS	NS
7	Jun-12	7.14	2340	78	7	Dec-12	7.1	1190	90
12	Jun-12	6.28	452	40	12	Dec-12	7.42	4340	93
13	Jun-12	7.3	7560	87	13	Dec-12	7.56	11600	66
JRD1	Jun-12	8.36	4280	40	JRD1	Dec-12	8.41	4480	22
JRD2	Jun-12	6.78	256	88	JRD2	Dec-12	8.0	474.0	50.0
6	Jul-12	7.15	3320	384	6	Jan-13	NS	NS	NS
7	Jul-12	7.47	2750	94	7	Jan-13	6.78	2170	34
12	Jul-12	6.44	1980	84	12	Jan-13	7.0	5770.0	130.0
13	Jul-12	7.25	11200	57	13	Jan-13	7.45	12100	158
JRD1	Jul-12	8.63	4590	54	JRD1	Jan-13	8.3	4590	22
JRD2	Jul-12	6.9	317	72	JRD2	Jan-13	7.6	483.0	25.0
6	Aug-12	0	NS	NS	6	Feb-13	NS	NS	NS
7	Aug-12	7.41	2760	78	7	Feb-13	7.4	2760.0	16.0
12	Aug-12	6.39	1030	63	12	Feb-13	6.45	1010	27
13	Aug-12	7.48	9580	63	13	Feb-13	7.4	8840	69
JRD1	Aug-12	8.4	4530.0	17.0	JRD1	Feb-13	8.26	4810	31
JRD2	Aug-12	6.93	336	118	JRD2	Feb-13	6.66	351	28
6	Sep-12	NS	NS	NS	6	Mar-13	NS	NS	NS
7	Sep-12	7.53	2820	166	7	Mar-13	7.19	2550	18
12	Sep-12	6.57	1400	99	12	Mar-13	6.31	636	73
13	Sep-12	7.37	11500	19	13	Mar-13	7.26	6050	328
JRD1	Sep-12	8.42	4550	22	JRD1	Mar-13	8.33	4460	38
JRD2	Sep-12	7.22	421	53	JRD2	Mar-13	6.66	242	120
6	Oct-12	NS	NS	NS	6	Apr-13	NS	NS	NS
7	Oct-12	7.08	2410	61	7	Apr-13	6.79	1280	72
12	Oct-12	6.59	1910	118	12	Apr-13	6.73	1800	61
13	Oct-12	7.29	12400	11	13	Apr-13	7.26	6050	328
JRD1	Oct-12	8.44	4660	12	JRD1	Apr-13	8.31	4540	32
JRD2	Oct-12	7.24	404	37	JRD2	Apr-13	6.77	255	67
6	Nov-12	NS	NS	NS	6	May-13	NS	NS	NS
7	Nov-12	7.07	2490	232	7	May-13	7.12	2160	136
12	Nov-12	6.78	3060	96	12	May-13	6.78	2520	81
13	Nov-12	7.09	12400	44	13	May-13	7.46	6660	130
JRD1	Nov-12	8.31	4730	8	JRD1	May-13	8.37	4610	37
JRD2	Nov-12	7.0	434.0	25.0	JRD2	May-13	7.31	407	656

Groundwater Quality Monitoring Results – 2013/2014

Sample Site	Date	pH	EC (uS/cm)	TSS (mg/L)	Sample Site	Date	pH	EC (uS/cm)	TSS (mg/L)
6	Jun-13	NS	NS	NS	6	Dec-13	6.8	967	44.0
7	Jun-13	6.98	2910	<5	7	Dec-13	NS	NS	NS
12	Jun-13	6.92	3750	664	12	Dec-13	6.07	1940	14
13	Jun-13	7.62	6280	136	13	Dec-13	7.42	5670	118
JRD1	Jun-13	8.28	4560	94	JRD1	Dec-13	NS	NS	NS
JRD2	Jun-13	7.16	372	201	JRD2	Dec-13	6.2	282	<5
6	Jul-13	6.45	807	11600	6	Jan-14	6.86	2260	655
7	Jul-13	7.26	2530	1620	7	Jan-14	NS	NS	NS
12	Jul-13	6.85	4200	3530	12	Jan-14	6.7	8240	120.0
13	Jul-13	7.2	6910	1520	13	Jan-14	7.28	6170	135
JRD1	Jul-13	8.46	4350	68	JRD1	Jan-14	8.39	4440	45
JRD2	Jul-13	7.22	1870	795	JRD2	Jan-14	7.4	2140	371.0
6	Aug-13	6.86	2590	6840	6	Feb-14	7.12	2350	1950
7	Aug-13	NS	NS	NS	7	Feb-14	NS	NS	NS
12	Aug-13	7.02	5310	3070	12	Feb-14	NS	NS	NS
13	Aug-13	7.82	10200	820	13	Feb-14	7.51	6430	78
JRD1	Aug-13	8.3	4320	150.0	JRD1	Feb-14	8.35	4520	28
JRD2	Aug-13	7.43	2500	402	JRD2	Feb-14	7.48	2390	497
6	Sep-13	7.04	2410	4800	6	Mar-14	6.98	2240	512
7	Sep-13	NS	NS	NS	7	Mar-14	NS	NS	NS
12	Sep-13	6.9	6590	892	12	Mar-14	NS	NS	NS
13	Sep-13	7.42	5950	180	13	Mar-14	7.47	5480	133
JRD1	Sep-13	8.04	4390	30	JRD1	Mar-14	8.35	4220	70
JRD2	Sep-13	7.55	2350	178	JRD2	Mar-14	7.4	1800	932
6	Oct-13	6.69	2350	2560	6	Apr-14	7.2	2400	790.0
7	Oct-13	NS	NS	NS	7	Apr-14	NS	NS	NS
12	Oct-13	7.12	9590	157	12	Apr-14	NS	NS	NS
13	Oct-13	7.49	5320	43	13	Apr-14	7.47	5480	133
JRD1	Oct-13	8.31	4350	9	JRD1	Apr-14	8.36	4330	121
JRD2	Oct-13	7.54	2400	271	JRD2	Apr-14	7.4	2150	364
6	Nov-13	7.06	2300	207	6	May-14	7.04	2350	3590
7	Nov-13	NS	NS	NS	7	May-14	NS	NS	NS
12	Nov-13	6.94	11100	332	12	May-14	NS	NS	NS
13	Nov-13	7.64	5950	22	13	May-14	7.3	5260	36
JRD1	Nov-13	8.39	4560	18	JRD1	May-14	8.35	4200	57
JRD2	Nov-13	7.5	2530	100.0	JRD2	May-14	7.55	1440	230

Groundwater Quality Monitoring Results – 2014

Sample Site	Date	pH	EC (uS/cm)	TSS (mg/L)
6	Jun-14	0	0	0
7	Jun-14	0	0	0
12	Jun-14	0	0	0
13	Jun-14	0	0	0
JRD1	Jun-14	0	0	0
JRD2	Jun-14	0	0	0
6	Jul-14	7.04	2110	872
7	Jul-14	0	0	0
12	Jul-14	0	0	0
13	Jul-14	7.43	5380	415
JRD1	Jul-14	8.35	4100	18
JRD2	Jul-14	7.36	2380	242
6	Aug-14	6.64	174	2220
7	Aug-14	0	0	0
12	Aug-14	0	0	0
13	Aug-14	6.48	4350	0
JRD1	Aug-14	8.5	3990	6.3
JRD2	Aug-14	7.8	2280	693
6	Sep-14	7.29	2370	1300
7	Sep-14	0	0	0
12	Sep-14	0	0	0
13	Sep-14	0	0	0
JRD1	Sep-14	0	0	0
JRD2	Sep-14	7.67	2290	71
6	Oct-14	7.58	2400	342
7	Oct-14	0	0	0
12	Oct-14	0	0	0
13	Oct-14	7.33	5280	22
JRD1	Oct-14	0	0	0
JRD2	Oct-14	7.36	690	92
6	Nov-14	7.29	2500	63
7	Nov-14	0	0	0
12	Nov-14	0	0	0
13	Nov-14	7.35	6130	88
JRD1	Nov-14	0	0	0
JRD2	Nov-14	7.4	2160	93.0

Sample Site	Date	pH	EC (uS/cm)	TSS (mg/L)
6	Dec-14	6.8	2280	234.0
7	Dec-14	0	0	0
12	Dec-14	0	0	0
13	Dec-14	7.15	4910	75
JRD1	Dec-14	0	0	0
JRD2	Dec-14	6.6	439	102.0

Groundwater Quality Monitoring Results – 2015

Sample Site	Date	pH	EC (uS/cm)	TSS (mg/L)
6	Jan-15	6.64	2190	550
7	Jan-15	0	0	0
12	Jan-15	0	0	0
13	Jan-15	7.06	5490	75
JRD1	Jan-15	NS	NS	NS
JRD2	Jan-15	6.6	1784	171
6	Feb-15	6.74	2310	38
7	Feb-15	0	0	0
12	Feb-15	0	0	0
13	Feb-15	6.97	5480	40
JRD1	Feb-15	NS	NS	NS
JRD2	Feb-15	6.58	446	24
6	Mar-15	6.78	2350	424
7	Mar-15	0	0	0
12	Mar-15	0	0	0
13	Mar-15	6.91	5890	76
JRD1	Mar-15	NS	NS	NS
JRD2	Mar-15	6.68	788	110
6	Apr-15	6.45	2440	626
7	Apr-15	0	0	0
12	Apr-15	0	0	0
13	Apr-15	6.68	3220	86
JRD1	Apr-15	NS	NS	NS
JRD2	Apr-15	6.74	2080	130
6	May-15	6.53	2270	44
7	May-15	0	0	0
12	May-15	0	0	0
13	May-15	6.95	4030	27
JRD1	May-15	NS	NS	NS
JRD2	May-15	6.83	1910	41
6	Jun-15	6.47	2290	38
7	Jun-15	0	0	0
12	Jun-15	0	0	0
13	Jun-15	6.92	4250	71
JRD1	Jun-15	NS	NS	NS
JRD2	Jun-15	6.7	2030	37.0

Sample Site	Date	pH	EC (uS/cm)	TSS (mg/L)
6	Jul-15	6.9	2099	90.0
7	Jul-15	0	0	0
12	Jul-15	0	0	0
13	Jul-15	7.28	2540	94
JRD1	Jul-15	NS	NS	NS
JRD2	Jul-15	7.3	914	9.0
6	Aug-15	7.4	2260	62
7	Aug-15	0	0	0
12	Aug-15	0.0	0	0.0
13	Aug-15	7.45	4780	122
JRD1	Aug-15	NS	NS	NS
JRD2	Aug-15	7.7	2168	24.0
6	Sep-15	6.65	2399	31
7	Sep-15	0.0	0	0.0
12	Sep-15	0	0	0
13	Sep-15	7.1	4810	62
JRD1	Sep-15	NS	NS	NS
JRD2	Sep-15	6.94	2580	38
6	Oct-15	6.74	2267	68
7	Oct-15	0	0	0
12	Oct-15	0	0	0
13	Oct-15	7.01	4040	23
JRD1	Oct-15	NS	NS	NS
JRD2	Oct-15	7.13	1961	100
6	Nov-15	6.8	2450	103.0
7	Nov-15	0	0	0
12	Nov-15	0	0	0
13	Nov-15	7.01	4040	23
JRD1	Nov-15	NS	NS	NS
JRD2	Nov-15	7.12	2335	196
6	Dec-15	6.81	2417	342
7	Dec-15	0	0	0
12	Dec-15	0	0	0
13	Dec-15	7.15	5290	30
JRD1	Dec-15	NS	NS	NS
JRD2	Dec-15	7.13	2160	108

Groundwater Quality Monitoring Results – 2016

Sample Site	Date	pH	EC (uS/cm)	TSS (mg/L)
6	Jan-16	6.72	2425	128
12	Jan-16	0	0	0
13	Jan-16	7.03	3060	584
JRD1	Jan-16	NS	NS	NS
JRD2	Jan-16	6.29	527	142
6	Feb-16	6.64	2580	63
12	Feb-16	0	0	0
13	Feb-16	6.89	3670	20
JRD1	Feb-16	NS	NS	NS
JRD2	Feb-16	6.96	2113	15
6	Mar-16	6.67	2650	25
12	Mar-16	0	0	0
13	Mar-16	6.99	4410	33
JRD1	Mar-16	NS	NS	NS
JRD2	Mar-16	7.05	2436	38
6	Apr-16	6.72	2194	50
12	Apr-16	0	0	0
13	Apr-16	7.13	4240	31
JRD1	Apr-16	NS	NS	NS
JRD2	Apr-16	7.14	2360	36
6	May-16	6.8	2550	154
12	May-16	0	0	0
13	May-16	6.99	4840	45
JRD1	May-16	NS	NS	NS
JRD2	May-16	7.12	2650	21
6	Jun-16	6.7	2230	148
12	Jun-16	0	0	0
13	Jun-16	6.99	4540	19
JRD1	Jun-16	NS	NS	NS
JRD2	Jun-16	7.1	2470	24.0

Sample Site	Date	pH	EC (uS/cm)	TSS (mg/L)
6	Jul-16	6.7	2390	47.0
12	Jul-16	0	0	0
13	Jul-16	7.09	5310	146
JRD1	Jul-16	NS	NS	NS
JRD2	Jul-16	7.1	2660	75.0
6	Aug-16	6.68	2560	10
12	Aug-16	0.0	0	0.0
13	Aug-16	6.98	4200	9
JRD1	Aug-16	NS	NS	NS
JRD2	Aug-16	7.0	2120	106.0
6	Sep-16	6.73	2480	65
12	Sep-16	0	0	0
13	Sep-16	7.06	4040	10
JRD1	Sep-16	NS	NS	NS
JRD2	Sep-16	7.04	2330	12
6	Oct-16	6.9	2560	148
12	Oct-16	0	0	0
13	Oct-16	7.06	4240	18
JRD1	Oct-16	NS	NS	NS
JRD2	Oct-16	6.98	2550	28
6	Nov-16	6.8	2550	160.0
12	Nov-16	0	0	0
13	Nov-16	7.06	4240	18
JRD1	Nov-16	NS	NS	NS
JRD2	Nov-16	6.91	1015	42
6	Dec-16	6.57	2502	47
12	Dec-16	0	0	0
13	Dec-16	6.98	4520	30
JRD1	Dec-16	NS	NS	NS
JRD2	Dec-16	6.96	2515	30

Groundwater Quality Monitoring Results – 2017

Sample Site	Date	pH	EC (uS/cm)	TSS (mg/L)	Sample Site	Date	pH	EC (uS/cm)	TSS (mg/L)
6	Jan-17	6.93	2469	152	6	Jul-17	6.5	2230	92.0
13	Jan-17	NS	NS	NS	13	Jul-17	NS	NS	NS
JRD2	Jan-17	7.05	2522	32	JRD2	Jul-17	6.9	1661	62.0
6	Feb-17	6.68	2163	89	6	Aug-17	6.75	2130	611
13	Feb-17	NS	NS	NS	13	Aug-17	NS	NS	NS
JRD2	Feb-17	6.81	2202	44	JRD2	Aug-17	7.1	1533	28.0
6	Mar-17	6.62	2470	100	6	Sep-17	6.63	2250	183
13	Mar-17	NS	NS	NS	13	Sep-17	NS	NS	NS
JRD2	Mar-17	5.99	304	252	JRD2	Sep-17	6.85	2410	11
6	Apr-17	6.6	2219	104	6	Oct-17	6.51	2340	55
13	Apr-17	NS	NS	NS	13	Oct-17	NS	NS	NS
JRD2	Apr-17	6.26	506	33	JRD2	Oct-17	6.98	2480	27
6	May-17	6.69	2350	98	6	Nov-17	5.4	363	658.0
13	May-17	NS	NS	NS	13	Nov-17	NS	NS	NS
JRD2	May-17	7.26	583	32	JRD2	Nov-17	6.6	425	146
6	Jun-17	6.54	1720	30	6	Dec-17	5.93	1875	378
13	Jun-17	NS	NS	NS	13	Dec-17	NS	NS	NS
JRD2	Jun-17	5.8	330	152.0	JRD2	Dec-17	6.41	1330	28

Groundwater Quality Monitoring Results – 2018

Sample Site	Date	pH	EC (uS/cm)	TSS (mg/L)	Sample Site	Date	pH	EC (uS/cm)	TSS (mg/L)
6	Jan-18	NS	NS	NS	6	Jul-18	6.7	2310	34.0
13	Jan-18	NS	NS	NS	13	Jul-18	NS	NS	NS
JRD2	Jan-18	7.11	1432	51	JRD2	Jul-18	6.7	1252	29.0
6	Feb-18	5.87	203	190	6	Aug-18	6.26	2036	161
13	Feb-18	NS	NS	NS	13	Aug-18	NS	NS	NS
JRD2	Feb-18	6.81	1373	98	JRD2	Aug-18	6.4	1770	44.0
6	Mar-18	5.98	171	27	6	Sep-18	6.64	2280	37
13	Mar-18	NS	NS	NS	13	Sep-18	NS	NS	NS
JRD2	Mar-18	6.91	1100	12	JRD2	Sep-18	7.24	1182	78
6	Apr-18	6.59	2220	114	6	Oct-18	6.63	2240	72
13	Apr-18	NS	NS	NS	13	Oct-18	NS	NS	NS
JRD2	Apr-18	6.79	2230	5	JRD2	Oct-18	6.86	1198	81
6	May-18	6.8	2180	108	6	Nov-18	6.8	2360	27.0
13	May-18	NS	NS	NS	13	Nov-18	NS	NS	NS
JRD2	May-18	7.02	2060	60	JRD2	Nov-18	6.97	961	52
6	Jun-18	6.67	2400	38	6	Dec-18	6.26	1177	616
13	Jun-18	NS	NS	NS	13	Dec-18	NS	NS	NS
JRD2	Jun-18	7.0	2350	18.0	JRD2	Dec-18	5.88	178	158

Groundwater Quality Monitoring Results – 2019

Sample Site	Date	pH	EC (uS/cm)	TSS (mg/L)	Sample Site	Date	pH	EC (uS/cm)	TSS (mg/L)
6	Jan-19	6.59	2420	77	6	Jul-19	6.8	1997	90.0
13	Jan-19	NS	NS	NS	13	Jul-19	NS	NS	NS
JRD2	Jan-19	6.27	146	68	JRD2	Jul-19	7.1	2540	6.0
6	Feb-19	6.82	2310	60	6	Aug-19	6.88	2350	26
13	Feb-19	NS	NS	NS	13	Aug-19	NS	NS	NS
JRD2	Feb-19	6.66	1103	119	JRD2	Aug-19	7.1	2500	28.0
6	Mar-19	6.65	2170	134	6	Sep-19	6.66	2080	26
13	Mar-19	NS	NS	NS	13	Sep-19	NS	NS	NS
JRD2	Mar-19	6.87	2290	98	JRD2	Sep-19	6.68	2100	136
6	Apr-19	6.7	2340	74	6	Oct-19	6.89	2404	23
13	Apr-19	NS	NS	NS	13	Oct-19	NS	NS	NS
JRD2	Apr-19	7.19	2550	34	JRD2	Oct-19	7.16	2548	24
6	May-19	6.84	2360	55	6	Nov-19	7.0	2370	28.0
13	May-19	NS	NS	NS	13	Nov-19	NS	NS	NS
JRD2	May-19	7.03	2460	5	JRD2	Nov-19	7.28	2490	13
6	Jun-19	6.7	1960	28	6	Dec-19	6.93	2410	18
13	Jun-19	NS	NS	NS	13	Dec-19	NS	NS	NS
JRD2	Jun-19	7.1	2410	27.0	JRD2	Dec-19	7.22	2470	5

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Appendix 3

2018/2019 Annual Monitoring Report

Pambalong Nature Reserve

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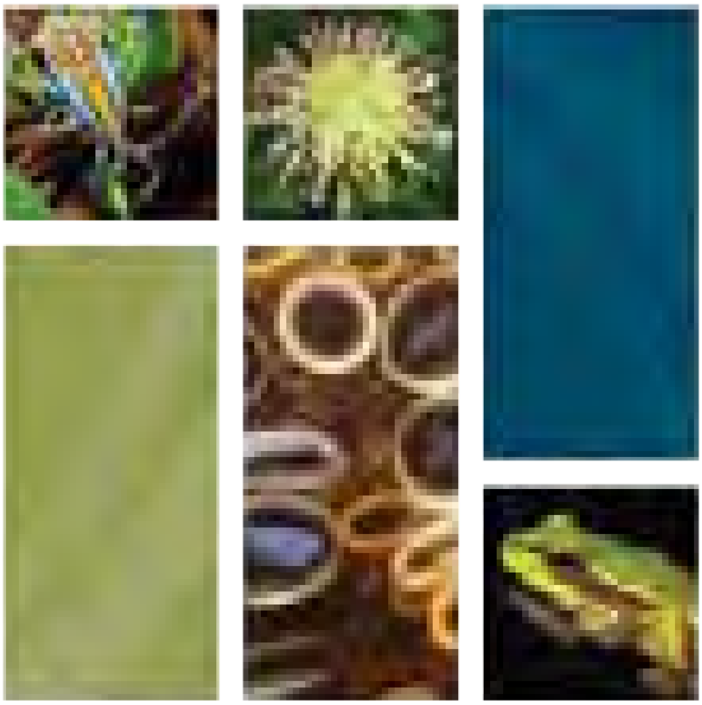
2018 / 19 Annual Monitoring Report



Yancoal Australia Pty Ltd

Pambalong Nature Reserve

Abel Underground Coal Mine, Beresfield NSW

03 February 2020

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2018 / 19 Annual Monitoring Report

Pambalong Nature Reserve

Abel Underground Coal Mine, Beresfield NSW

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EXECUTIVE SUMMARY

Donaldson Coal Pty Ltd commenced operations at Abel Underground Coalmine at Beresfield in the lower Hunter Valley, New South Wales in 2008. A Flora and Fauna Management Plan, prepared by Kleinfelder (ecobiological 2007) in accordance with consent conditions, identified the need for ecological monitoring at Pambalong Nature Reserve, a 34 ha freshwater wetland located between the eastern extent of the Abel coal mine lease and the M1 Pacific Motorway.

Pambalong Nature Reserve provides critical habitat for wader and water bird species and is part of a chain of protected wetlands in the lower Hunter floodplains and estuary. The wetland at Pambalong depends on fresh water from Blue Gum Creek to maintain and replenish aquatic and terrestrial habitats in the reserve. Consequently, any changes to the quantity and quality of water delivered from the Blue Gum Creek catchment arising from mining activities or subsidence would compromise the ecological integrity of the wetland (ecobiological 2007).

A decline in the quantity of water could result in a reduction in the area of wetland and a subsequent loss of aquatic and terrestrial flora and fauna habitat. Increased sediment loads in Blue Gum Creek could affect macroinvertebrate numbers and change the depth of waterbodies within the wetland. Other related impacts to the wetland could also occur such as weed and/or feral animal invasion (ecobiological 2007).

The mine is currently in a state of care and maintenance and has not extended to the Blue Gum Creek catchment. Nevertheless, ecological monitoring has contributed to a robust dataset on baseline conditions at the wetland. It is important that data is collected over as many years as possible to determine what constitutes normal variation and enable valid comparisons with post-mining conditions.

This document reports on results of the 11th annual monitoring event at Pambalong Nature Reserve. Detected during this survey were 109 flora species; and, 104 fauna species comprising six frog, two reptile, 17 mammal (12 bat) and 79 bird species. Threatened species recorded included three bat and three bird species. Twenty-two flora species were recorded this survey that were not recorded in the 2017 survey (nine exotic species and 13 native species). No significant changes to the spatial extent of vegetation communities were observed. Two exotic weed species, Lantana camara and Ambrosia tenufolia were recorded as having increased in extent.

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1. INTRODUCTION

Donaldson Coal Pty Ltd (now owned by Yancoal Australia Pty Ltd) commenced mining at an underground coal mine (known as Abel Underground Coal Mine) in 2008, located approximately 23 kilometres north-west of Newcastle. The mine is currently in a state of care and maintenance, with no coal extraction at this time. Should the mine re-open in the future, the seams that would be mined are located under the rural residential and forested areas at Black Hill. Mine access and associated surface infrastructure is located within the existing open cut void at Beresfield, with transfer of coal to the existing Bloomfield Coal Handling and Preparation Plant (CHPP) immediately to the north for coal washing and rail transport to the Port of Newcastle.

Underground coal mining can cause land subsidence which may result in adverse environmental impacts such as loss of productive land, damage to underground pipelines and above-ground structures, decreased stability of slopes and escarpments, contamination of groundwater by acid drainage and dewatering of streams and groundwater supplies (Bell *et al*. 2000, Sidle *et al*. 2000). The main ecological concern arising from the Abel mine is the effect of subsidence on local and regional hydrology. Surface and sub-surface cracking associated with mining subsidence can alter and create preferential flow paths, causing dewatering and rerouting of surface water and groundwater (Sidle *et al*. 2000). Alterations in channel and drainage morphology may also affect channel erosion, sediment delivery, and routing in streams and riparian habitat.

Development approval for the Abel coal mine was granted with a number of conditions, including a requirement to prepare a Flora and Fauna Management Plan (F&FMP) (ecobiological 2007). The F&FMP is part of a comprehensive Environmental Management System (EMS) for Abel mine and sets out a strategy to monitor the effectiveness of the conservation measures identified in the Environmental Assessment (EA) Statement of Commitments. A Surface Ecological Monitoring Plan (SEMP) produced as part of the strategy focused monitoring effort on three discrete habitat areas:

1. Farm dams that form a belt across the mine site;
2. Subtropical rainforest areas of Long Gully Creek; and
3. Pambalong Nature Reserve.

Baseline and subsequent monitoring data are to be gathered in each of these areas to inform management and future change analysis. Results from the current period continue to contribute to a dataset that documents baseline ecological conditions at Pambalong Nature Reserve and contributes to the overall SEMP.

1.1 LOCATION

The Abel Underground Mine is located within Newcastle, Cessnock and Maitland Local Government Areas (LGAs). The majority of the underground mine and surface infrastructure area is within the Cessnock LGA. The seams to be mined, if mining is to recommence, are located under the Black Hill rural residential and adjoining forested areas. Mine access and associated surface infrastructure is located within the existing Donaldson Coal mine open cut void at Black Hill, with transfer of coal to the existing Bloomfield Coal Handling and Preparation Plant (CHPP) immediately to the north for coal washing and rail transport to the Port of Newcastle **(Figure 1)**

The Abel underground mine covers an area of approximately 2,750 ha that consists of low undulating forested hills with patches of cleared land supporting 110 rural/residential properties. A ridgeline associated with Black Hill runs east-west through the proposed underground mine area. Tributaries of Buttai Creek, Viney Creek, Weakley's Flat Creek and Four Mile Creek drain northwards from this ridgeline. A wide catchment containing Long Gully and Blue Gum Creek drains from the ridgeline providing water to the wet swamp at Pambalong Nature Reserve. Some cliff-lines and steeper gullies are located along sections of the Black Hill ridge.

The underground mine area is bounded on the eastern side by Pambalong Nature Reserve and the M1 Pacific Motorway; the western and southern sides by a tract of forest that extends south to the Central Coast and beyond to Hornsby, and the northern side by existing open cut coal mining activities within the Donaldson and Bloomfield mine leases (**Figure 2**).

Pambalong Nature Reserve consists of 34 ha of predominantly freshwater wetland on the western side of the M1 Pacific Motorway, approximately 20 km north-west of Newcastle (**Figure 2**). The reserve was gazetted in December 2000 over former farmland acquired by the Roads and Traffic Authority during construction of the M1 Pacific Motorway (former F3 Freeway) (DEC 2006).

Figure 1 - Locality Map

Legend

- Waterways
- Abel Underground Coalmine Boundary
- Extent of Underground Mine
- Pambalong Nature Reserve

Project Ref:	20192319
Plot Date:	2/20/2019 16:32
Revision:	001 (THawkins)

Map Projection:

GDA 1994 MGA Zone 56

Data Sources:
LPI - 2017
Nearmap - 2018

Disclaimer: This is not an official or a legal map but is for informational use only. All data was compiled from the best sources available. All boundaries, scale and geographic points are approximate.

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Figure 2: Pambalong Nature Reserve

Legend

- Pambalong Nature Reserve
- Abel Underground Coalmine Boundary

Map Projection:

GDA 1994 MGA Zone 56

Data Sources:

LPI - 2017
Nearmap - 2018

Project Ref:	20192319
Plot Date:	2/20/2019 16:33
Revision:	001 (THawkins)

Disclaimer: This is not an official or a legal map but is for informational use only. All data was compiled from the best sources available. All boundaries, scale and geographic points are approximate.

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2. METHODOLOGY

2.1 FLORA

Flora survey and vegetation mapping has been undertaken in accordance with the requirements of the F&FMP. The location of flora survey activities is shown in **Figure 3**.

A base vegetation map of the wetland was prepared for the 2008 annual monitoring report using a combination of aerial photograph interpretation and ground-truthing to delineate community boundaries. Communities were defined based on the type of habitat they formed as well as floristic content and structure. Vegetation community boundaries are monitored and mapped each year to identify any variation in extent.

Two standard 0.04 ha (20 m x 20 m) floristic quadrats (Q1 & Q3), two 0.1024 ha (32 m x 32m) floristic quadrats (Q2 & Q4) and a 50 m long x 2 m wide transect were established in representative areas of identifiable vegetation structure. Data collected in these quadrats each year include total floristic content and the cover abundance index for each species in the plots using the Braun-Blanquet scale (Poore 1995).

Targeted searches for threatened flora species (*Tetratheca juncea*, *Maundia triglochinoides*, *Persicaria elatior* and *Zannichellia palustris*) are also conducted each year in appropriate communities through random meandering. The location of any threatened flora species detected is recorded using a GPS.

Annual surveys also record the presence and distribution of weed species across the subject site. The dominant weed species, outbreak areas and recently treated areas are mapped.

Floristic identification and nomenclature is based on Harden (1992, 1993, 2000 and 2002) with subsequent revisions as published on PlantNET (http://plantnet.rbgsyd.nsw.gov.au). Plants listed under the ROTAP scheme (Briggs and Leigh 1995) were also considered in this assessment along with species and vegetation deemed to be of local conservation significance.

Figure 3: Flora & Fauna Survey Effort

Legend

- Pambalong Nature Reserve
- Water Bird Survey Locations
- Flora Quadrats
- Flora Quadrats 2008
- Owl Call Playback
- HarpTrap
- Anabat
- AmphibianTransect
- Flora Transect 50m
- Bird Survey Transect
- TrappingTransect
- Flora Meander
- Frog Call Playback

Project Ref:	20192319
Plot Date:	2/20/2019 16:38
Revision:	001 (THawkins)

Map Projection:

GDA 1994 MGA Zone 56

Data Sources:
LPI - 2016
Nearmap - 2017
Kleinfelder - 2017
OEH -2012

Disclaimer:This is not an official or a legal map but is for informational use only. All data was compiled from the best sources available. All boundaries, scale and geographic points are approximate.

2.2 FAUNA

The position of observation points and transects has been recorded to ensure that sampling occurs at the same location each year. Systematic fauna monitoring is centred on two transects, one situated in the Spotted Gum – Ironbark open forest fringing the South Swamp and the other situated in the Melaleuca Swamp Forest fringing the Main Swamp.

Table 1 depicts trapping effort at transects, while **Table 2** details other fauna survey effort across the subject site. The location of fauna survey activities is shown in **Figure 3**.

Table 1: Trapping effort for the subject site

Trap type	Traps	Nights	Trap nights
Elliott A	40	4	160
Elliott B Tree	3	4	12
Elliott B Ground	6	4	24
Cage Trap	4	4	16
Harp Trap	2	4	8
Hair Tubes	8	4	32

Table 2: Fauna survey effort for the subject site

Survey method	Days/nights	Locations
Anabat recording	2	4
Spotlighting	2	2
Owl call playback	2	3
Frog transect survey	2	3
Bird transect survey	2	2
Bird water body survey	8	3
Roosting bird abundance estimate	2	1
Opportunistic fauna observations	15	Across entire site

2.2.1 Arboreal Mammals

Three Elliott B traps and eight hair tubes were placed in trees at heights of 3 m or above, along transects and baited with a mixture of rolled oats, honey, peanut butter and treacle. The trunks of trees containing the traps were sprayed with a mixture of honey and water. Traps were checked daily for arboreal species. After 4 nights the sticky wafers from hair tubes were collected and checked for the presence of hair samples. Hair identification methods follow those of Brunner *et al.* (2002). If any hair sample was from a vulnerable or endangered species, the sample was sent to an expert in hair identification for confirmation. Spotlighting was undertaken along each transect for one hour per night on two separate nights.

2.2.2 Terrestrial Mammals

Forty Elliott A, six Elliott B and four cage traps were placed along two transects at regular intervals to capture terrestrial mammal species. Traps were baited with a mix of rolled oats, honey, peanut butter and treacle and set for four consecutive nights with checks for captures occurring each morning.

Opportunistic daytime observations of the signs of recent terrestrial mammal activity such as diggings, droppings or scratch marks were noted.

2.2.3 Bats

Two harp traps were erected on transects at South Swamp and Main Swamp. To increase the likelihood of captures traps were positioned in potential bat ‘flyways’ such as on tracks or in natural forest openings. Traps were set in position for four consecutive nights and checked each morning. Captured bats were identified in the field and placed in ‘soft release’ boxes tethered to nearby trees to enable the bats to shelter during the day and exit at nightfall.

Anabat™ bat-call detectors were used passively to record the calls of passing Microchiropteran bats. Two units were set up at dusk and recording occurred for one hour on two separate nights (four hours total). Nocturnal searches of blossoming trees were also undertaken during spotlighting to detect Megachiropteran bats.

2.2.4 Birds

Surveys to detect birds were conducted at two transects in native vegetation fringing wetlands, and three permanent monitoring points overlooking the North, South and Main waterbodies (**Figure 3**).

Transects were surveyed for a period of 20 minutes on two separate days. Species were identified visually with the aid of binoculars or aurally from call identification. Bird surveys were conducted in the morning or late afternoon when bird activity is maximised (Bibby *et al.* 2000). After dark the calls of threatened owl species (Powerful, Masked, Sooty, Barking and Grass Owls) were broadcast over a megaphone at transects on two separate nights in an attempt to encourage a call back response.

Water bird surveys were conducted at permanent monitoring points in spring and autumn. During one season monitoring points are surveyed four times, at dawn and dusk in one week and again approximately 1 week later. All birds detected within a viewing arc overlooking open water bodies in a 20-minute period were recorded. Birds were identified by sight, with the aid of binoculars or a spotting scope, and by their calls.

At the completion of one of the dusk surveys, a count of birds roosting in the Melaleuca Swamp Forest within the Main Swamp was undertaken. This method is repeated at approximately the same time (on nightfall) each year to enable comparison of the composition and abundance of bird species using the roost.

2.2.5 Amphibians

Amphibian surveys were carried out at each of the three main water bodies over four days and nights. Diurnal surveys involved dip netting and visual searches to detect tadpoles in water bodies. Nocturnal surveys involved aural detection of characteristic calls or visual detection of animals with a spotlight or head torch. Call playback for the endangered Green and Golden Bell Frog was carried out due to the species' historical occurrence at the site and the presence of suitable habitat.

Adult frogs encountered were identified by visual confirmation or by their distinct advertisement calls. Tadpoles were identified using diagnostic features including mouthparts (tooth rows, jaw sheaths and papillae), pigmentation, body size, tail structure (musculature, fin depth, fin shape, tip shape), eye direction and spacing, pupil pigmentation, nare shape and spacing, spiracle height and direction, vent length and direction, and tadpole behaviour according to Anstis (2002).

2.2.6 Introduced Fauna

Introduced species detected during annual field surveys are reported to the NSW National Parks and Wildlife Service to assist with their management.

3. RESULTS

3.1 WEATHER CONDITIONS AND SURVEY ACTIVITIES

Prevailing weather conditions during the spring survey were warm to hot days and cool to mild nights with a light breeze, and clear to partly cloudy skies. Conditions during the autumn bird surveys were mild to warm, little to no breeze and some brief showers (**Table 3**).

Table 3: Weather conditions and survey activities undertaken during the sample period

Date	Min Temp (°C)	Max Temp (°C)	Rain (mm)	Flora survey methods		Fauna survey methods						
				Transect and plot surveys & vegetation mapping	Threatened species & weed search	Trapping	Amphibian survey	Nocturnal spotlighting, call playback, & Anabat	Bird survey (Transects)	Dawn Water Bird survey	Dusk Water Bird survey	Roosting Bird count
22/10/18	16.5	20.1	11.2			+						
23/10/18	12.7	32.0	0.2			+		+				
24/10/18	15.6	22.6	0.2			+		+				
25/10/18	15.5	23.8	0			+						
26/10/18	12.1	25.1	0			+						
14/11/18	15.0	25.6	0						+	+		
20/11/18	12.9	30.6	0	+			+				+	
27/11/18	11.2	27.6	0						+	+		
6/12/18	15.0	27.0	0				+				+	
7/12/18	12.5	29.8	0	+	+							
3/04/19	11.5	26.1	1.2							+	+	
10/04/19	13.4	21.7	0.8							+		
11/04/19	9.2	23.4	0								+	+

Source: Australian Government Bureau of Meteorology, Maitland Airport 061428.

3.2 GENERAL ENVIRONMENTAL MONITORING

Changes in species composition, abundance or distribution within the wetland can result from a variety of external factors not associated with mining. Rainfall, bushfire and nearby development are examples of such factors (ecobiological 2007). During 2018/19 there was no high intensity bushfire events or development activity in the vicinity of the wetland that would impact water flow or quality.

3.2.1 Historical Rainfall

Nearby Bureau of Meteorology (BoM) weather stations at East Maitland Bowling Club (1903 - 1994), and the Maitland Visitors Centre (1995-2015), Maitland Belmore Bridge (2016-2018) provide historical rainfall data for a 114 year period (1903 – 2017). Historical mean monthly rainfall (mm) from 1903 – 2007 and monthly rainfall (mm) from 2008 – 2019 are presented in **Table 4**. Monthly rainfall for the 2018/19 survey period compared to the historical monthly average (1903-2019) is presented in **Figure 4**.

Table 4: Monthly rainfall (mm) recorded at Maitland Visitors Centre (1995-2015) weather station (long term mean includes East Maitland Bowling Club 1903 to 1994) and at Maitland Belmore Bridge (Hunter River) (2016-19)

Year	J	F	M	A	M	J	J	A	S	O	N	D	Total
2008	182	174	45	224	7	123	42	22	183	76	89	74	1241
2009	12	267	53	125	73	75	24	2	24	67	44	58	824
2010	65	53	86	22	73	111	62	32	20	60	192	63	839
2011	36	37	47	140	91	162	86	57	75	104	141	67	1043
2012	84	174	102	79	12	125	45	14	22	7	46	45	753
2013	140	134	79	66	51	79	30	11	17	51	279	16	953
2014	21	113	66	81	30	45	22	111	31	50	22	164	756
2015	155	41	35	358	80	42	15	38	55	44	102	135	1100
2016	380.5	35	48	20.5	5.5	122.5	30	55.5	57.5	43	43	106.5	947.5
2017	58	60	216	75	22.2	94.6	0.6	7.0	10.6	93.2	28.4	29.4	695
2018	9.6	102.6	181.6	35.2	6	78.4	1.2	14.6	49.4	107.6	78.4	96.4	761
2019	9	31	149.5	22.5									
Mean 1903-2019	**88**	**97**	**95**	**89**	**67**	**86**	**56**	**49**	**54**	**63**	**66**	**79**	**877**

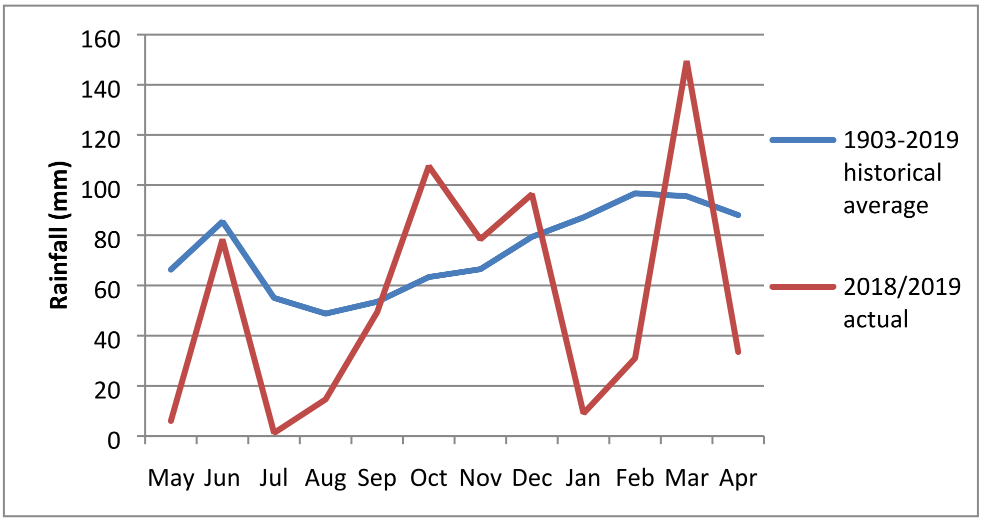

Figure 4: **Monthly rainfall for 2018/19 survey period compared to historical monthly average (1903-2017)**

Above average rainfall was recorded in October, November and December 2018 with the three months recording well below average rainfall. Above average rainfall was also observed in March 2019 which with 149.5 mm being recorded. However monthly totals were well below the average in May, July, August 2018 and January, February and April of 2019.

3.2.2 Water Quality and Water Level Monitoring

Funding was provided by the Donaldson Conservation Trust to The Tom Farrell Institute for the Environment for the installation of a water quality and water level monitoring station at Pambalong that records a range of data such as pH, electrical conductivity, temperature, dissolved oxygen, turbidity and water level within 15 minute intervals. Water quality monitoring in the Main Swamp commenced in October 2016, however, due to dry to very low water levels and access restrictions, no additional water quality data level is available (**Table 5**). Water level data is available for the period mid January 2017 – mid May 2018 (**Figure 5**). Data generated by this station will be immensely valuable in interpreting the results of future ecological monitoring.

Table 5: **Water quality monitoring data from Main Swamp during late 2016 – early 2017**

Date	Time	Temp.	pH	Electrical Conductivity	Dissolved Oxygen	Turbidity
		oC	-	µS/cm	mg/L	NTU
18-10-16	10:00	16.4	6.98	1380	8.84	7
25-10-16	10:30	19.8	6.95	1300	7.22	7
01-11-16	10:30	17.8	6.98	1470	1.2	9
08-11-16	11:15	20.9	7.29	1650	1.78	15
15-11-16	11:00	21.2	7.38	1840	2.68	50
22-11-16	10:05	23.7	7.32	1810	2.24	33
29-11-16	9:10	24.4	7.51	1960	6.9	41
04-03-17	9:30	23	7.24	790	7.4	11
04-04-17	10:30	23.1	7.11	815	6.8	9
09-05-17	10:10	22.3	6.94	850	6.4	6

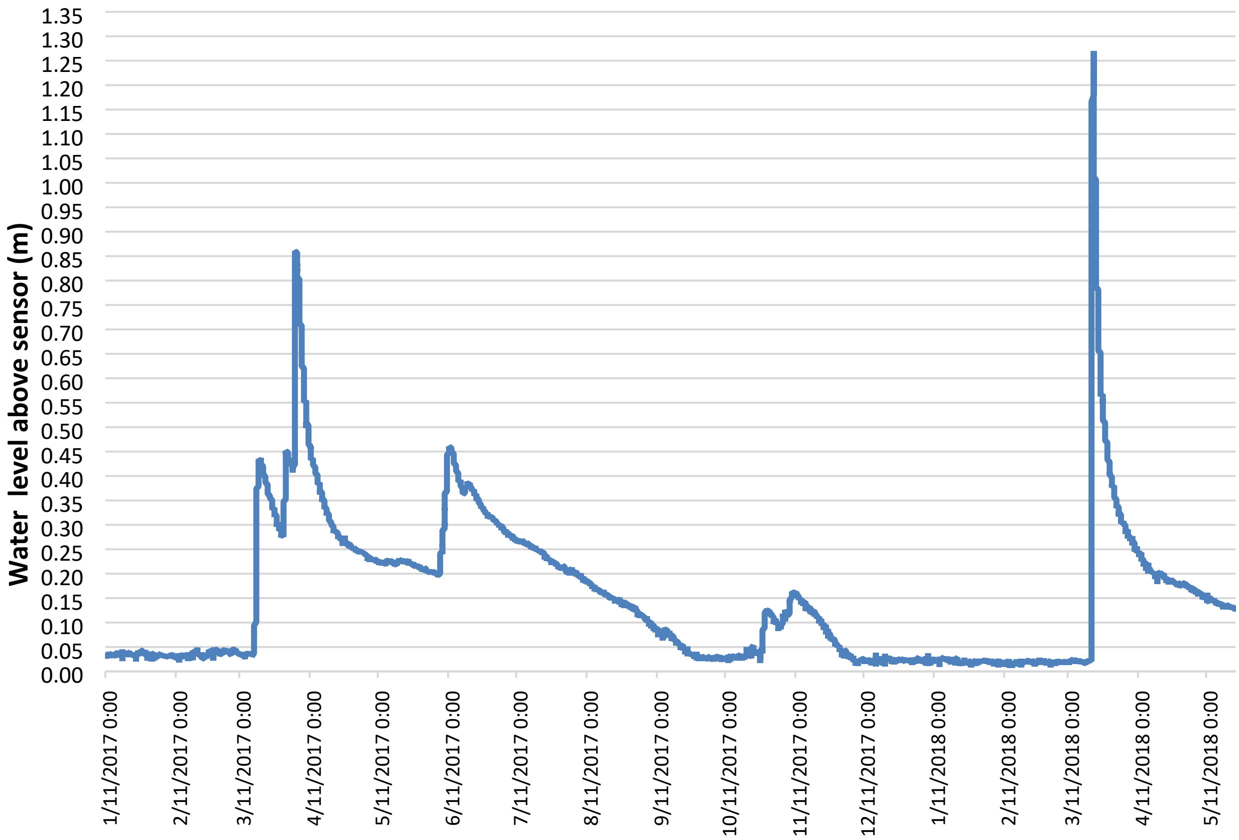

Figure 5: **Water levels at Pambalong recorded monthly from the Main Swamp in 2017/18**

The water level data reveals that considerable fluctuation occurs in the Main Swamp, with lows of between < 1 – 10 cm recorded during January to mid March 2017, with other extremely dry periods occurring from mid September 2017 through to mid March 2018 (consistent with field observations). Significant rainfall events in mid to late March 2017 resulted in water levels increasing to a high of 86.5 cm in early April, with the highest water level of 1.27 m recorded in late March 2018 after close to 100 mm of rain fell in a 24-hr period (22 and 23 March).

However, two other significant rainfall events (> 50 mm in one day) in late February and early March 2018 had no observable impact on water levels at Pambalong. After the extremely dry spring / summer period of 2017 / 2018 it is not surprising that sporadic rainfall prior to the late March 2018 deluge did not increase water levels as the larger catchment probably acted like a sponge. However, the > 100 mm on the 22nd/23rd March significantly increased water levels and very quickly. Water appears to flow through the Pambalong system after a large rainfall event as reflected in the dropping water levels post rainfall.

General field observations during 2019/2019 surveys indicate that water levels are particularly shallow within the Southern Swamp, generally less than 30cm as surveyors were able to walk through the centre of the waterbody with gumboots.

Analysis and discussion of water quality monitoring data will be included in future reports when a more complete dataset is available.

3.3 FLORA RESULTS

Flora surveys were conducted during December 2018. A total of 109 species were detected in 2018, compared to 90 species in 2017. A total of 200 species have been identified on the site since monitoring surveys commenced in 2008, an increase of four (196) since the last survey (**Appendix 1**). Twenty-two species were recorded in 2018 that were not recorded in 2017 (nine exotic and 13 native species), whereas three species were not recorded in 2018 that were recorded in the previous year's survey - all natives.

No threatened flora species were recorded during the field surveys. Three species considered as regionally significant by Eco Logical (2003) have been detected during the surveys since monitoring began; *Cyperus odoratus, Melaleuca linariifolia* and *Enydra fluctuans*.

Coastal Foothills Spotted Gum - Ironbark Forest (Q1)

The Coastal Foothills Spotted Gum - Ironbark Forest quadrat (Q1) has contained the highest species diversity of the four flora plots surveyed in the Reserve (**Plate 1**) during the annual spring surveys since 2008. The 2018 results were consistent with this trend (66 species recorded).

Flora diversity in this quadrat has recovered in 2018 to be near the peak diversity of 67 species recorded in 2014, albeit six of those are exotic species (**Figure 6**). *Corymbia maculata* (Spotted Gum), *Eucalyptus siderophloia* (Grey Ironbark), *Entolasia stricta* (Wiry Panic Grass) and *Aristida vagans* (Three-awned Spear Grass) and *Themeda triandra* (Kangaroo Grass) dominate the Coastal Foothills Spotted Gum - Ironbark Forest community (**Appendix 1**). A total of 13 species (12 native and one exotic) were recorded from the 2018 survey that were not observed in the 2017 survey. These species were entirely in the ground cover and forb layers and their presence or absence can depend on current environmental conditions.

During the 2018 survey, six exotic species were recorded within Quadrat 1; *Bidens pilosa* (Cobblers Peg), *Senecio madagascariensis* (Fireweed), *Sida rhombifolia* (Paddy's Lucerne), *Ehrharta erecta* (Panic Veldtgrass), *Lantana camara* (Lantana) and *Paspalum dilatatum* (Paspalum) - a new species recorded this survey. Five of these species were observed to comprise less than 5% coverage with Lantana increasing to a coverage score of 3 (5-<25%) – a considerable increase from the previous survey.

The vegetation community appears to be in good overall health evident by the increase in species diversity. This could be due to natural fluctuations and/or climatic conditions. However, the increase in Lantana requires control action.

Plate 1: Flora quadrat 1 (Q1) located in Coastal Foothills Spotted Gum - Ironbark Forest (Photograph taken in 2018)

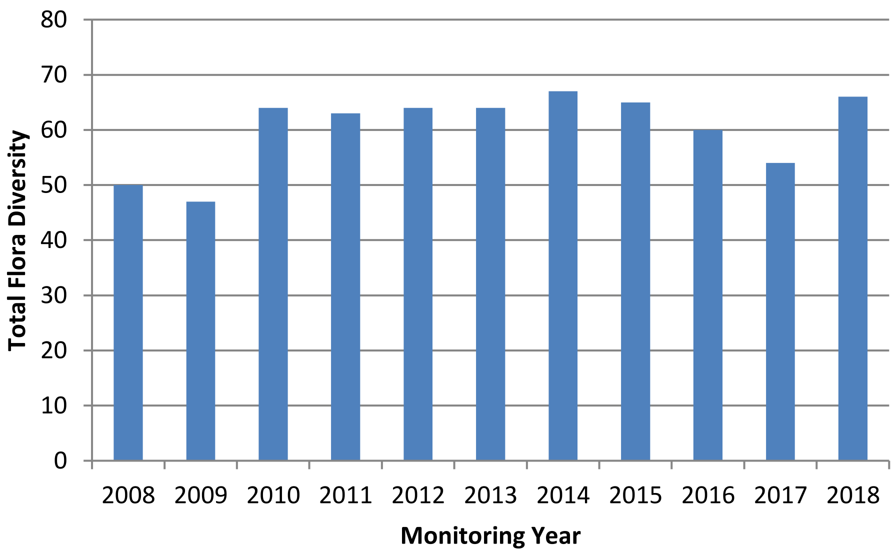

Figure 6: Flora species richness within Q1 from 2008 to 2018

Freshwater Wetland Complex (Q2)

The number of species recorded in the Freshwater Wetland Complex (Q2) since 2009 has fluctuated with a minimum of 18 and a maximum of 26 species recorded. The 2018 survey recorded 25 species, an increase on the previous year's 19 species (**Plate 2**, **Figure 7**). This quadrat was relocated in 2009 following an OEH recommendation. It was thought that the new location would provide data more relevant to the scope of the survey.

One native species, *Triglochin procerum* were not recorded from the quadrat in 2018.

A total of 12 exotic species were recorded in the 2018 survey, an increase of seven from the 2017 survey. The five species recorded from 2017: *Atriplex prostrata, Cassia pendula* subsp. *glabrata, Vicia sativa, Cenchrus clandestinus* (formerly *Pennisetum clandestinum* [Kikuyu]) and *Rumex conglomeratus* were recorded again during the 2018 survey. *Ageratina adenophora* (Crofton Weed), *Cyclospermum leptophyllum* (Slender Celery), *Lantana camara* (Lantana), *Phytolacca octandra* (Inkweed), *Senecio madagascariensis* (Fireweed), *Solanum nigrum* (Blackberry Nightshade) and *Verbena bonariensis* (Purpletop) were the new weed species recorded in 2018.

All but Kikuyu (increased to between 5% - <25%) were recorded at less than 5 percent coverage. The increase in the exotic species diversity, and the appearance of Crofton Weed indicate that the weeds are beginning to encroach in to the wetland. Whether this trend will be reversed with an increase in water levels following increased rainfall will be determined by subsequent years' monitoring. The weeds have most likely been sourced from the adjacent road side.

Overall, the wetland appears to still be in good health with native species dominating the wettest areas (*Typha orientalis, Schoenoplectus subulatus, Bolboschoenus caldwellii* and *Eleocharis equisetina*).

Plate 2: **Flora quadrat 2 (Q2) located in Freshwater Wetland Complex dominated by Typha (Photograph taken in 2018)**

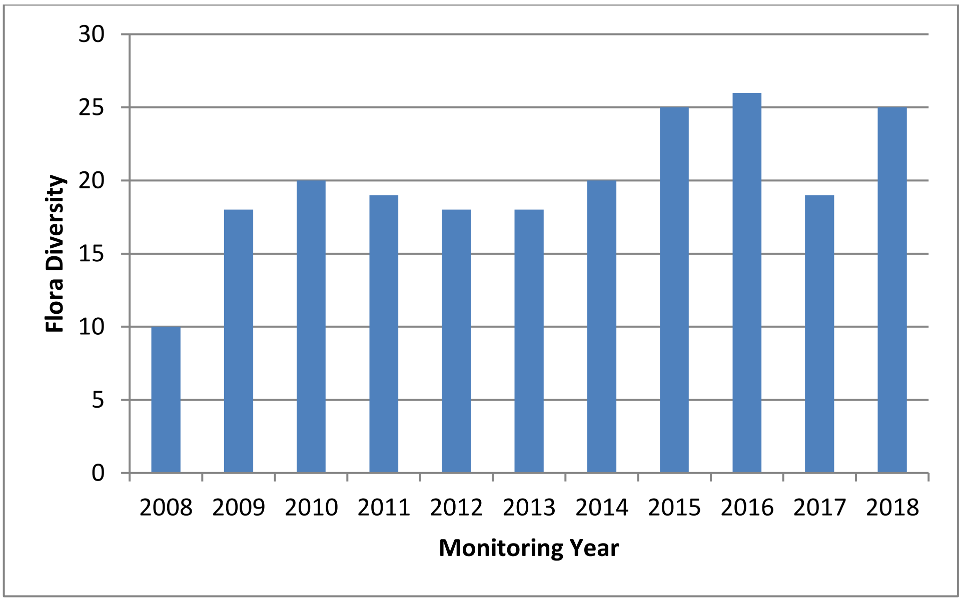

Figure 7: **Flora species richness within Q2 from 2008 to 2017**

Paperbark Swamp Forest (Q3)

Flora species richness in the Paperbark Swamp Forest (Q3) (**Plate 3**) has remained relatively constant throughout the survey period (between 15-19 species), with two years of high species abundance being 2010 and 2016 (**Figure 8**). This year's survey recorded 23 species, with the increase wholly attributable to exotic species.

Twenty-three species were recorded in the 2018 survey; of these, 12 were exotic. Exotic species recorded this survey (but not 2017) were *Brassica juncea*, *Bidens pilosa* (Cobblers Pegs), *Cirsium vulgare* (Black Thistle), *Conyza spp.* (Fleabane), *Phytolacca octandra* (Inkweed) and *Solanum nigrum* (Blackberry Nightshade). The 2017 survey noted that the exotic species *Atriplex prostrata* (Hastate Orache) had increased dramatically over the previous three surveys. This survey recorded a substantial decrease in cover from 5 (50 - <75%) to 2 (<5%, but many individuals). *Cenchrus clandestinus* (Kikuyu) and *Rubus fruticosus* (Blackberry) remain abundant adjacent to Q3 in the north-east corner of the reserve. One exotic species *Aster subulatus* (Wild Aster) was not recorded this survey.

Native species richness and their cover remain largely unchanged between surveys at Q3.

Plate 3: **Flora quadrat 3 (Q3) located in Paperbark Swamp Forest (Photograph taken in 2018)**

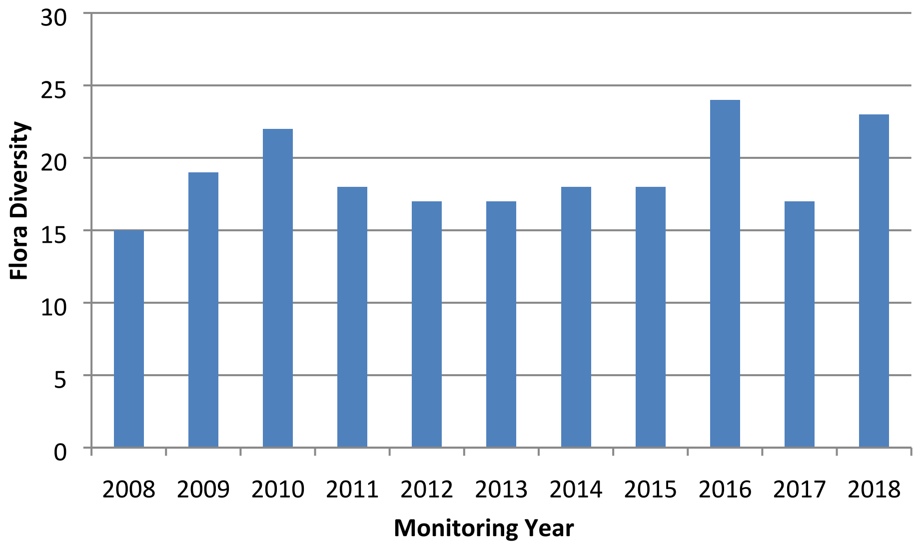

Figure 8: Flora species richness within Q3 from 2008 to 2018

Paperbark Swamp Forest (Q4)

A total of 12 species were recorded in the Paperbark Swamp Forest (Q4) in 2008 (**Figure 9**, **Plate 4**). This quadrat was relocated in 2009 in response to a request by OEH, as the new location was thought likely to produce more informative seasonal data. There has been a gradual decrease in the number of flora species recorded from 2009 to 2012 with the number of species remaining stable from 2012 to 2015. In 2016 species richness rose slightly to the highest since the 2011 survey before falling again by one species to a total of 14 during the 2017 survey, while in the 2018 survey 16 species were recorded (**Figure 9**). This is likely to be due to natural seasonal variation. Native species richness increased slightly by one species with *Schoenoplectus subulatus* recorded this survey.

The environmental weed *Alternanthera philoxeroides* (Alligator Weed) was first recorded in 2011. The abundance of this weed has fallen somewhat to a cover of two (<5%, many individuals).

Plate 4: **Flora quadrat 4 located in Paperbark Swamp Forest (Photograph taken in 2017). Alligator Weed dominates in the foreground.**

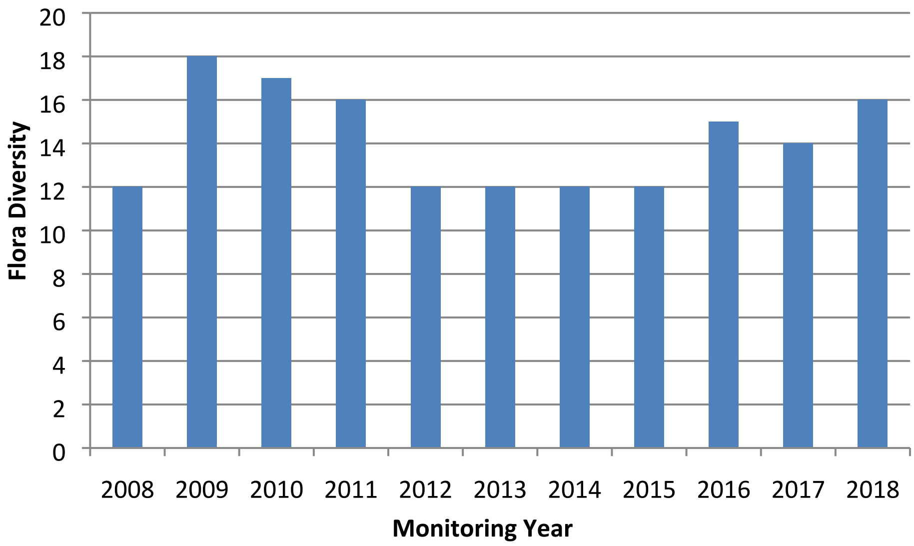

Figure 9: **Flora species richness within Q4 from 2008 to 2018**

Flora Transect

The flora transect samples a Freshwater Wetland Complex (**Plate 5**). Flora species richness has remained relatively stable since monitoring began (**Figure 10**). The 2018 survey recorded the same number of species as the 2017 survey but recorded a different suite of species. A total of six native and two exotic species were recorded in 2018, compared to seven native species and one exotic in 2017. The major change was the prevalence of open water this year (**Plate 5**), compared to the 2017 survey (**Plate 6**).

The exotic plant *Myriophyllum aquaticum* (Parrots Feather) was a new exotic recorded this survey, although its cover is only <5% (cover abundance of 2). Native species not recorded since 2017 were *Paspalum distichum* (Water Couch) and *Persicaria decipiens* (Slender Knotweed), while *Ludwigia peploides* (Water Primrose), *Spirodela punctata* (Duck Weed) and *Triglochin procerum*, all with substantial cover abundances were also not recorded this year. Water Hyacinth (*Eichhornia crassipes*) was recorded at high densities from 2008 to 2011, with a reduction in 2012 following control efforts. As found in the previous two years (2016 and 2017), only a small number of plants were observed in 2018, and these were located around the edges of the swamp.

Plate 5: **Flora transect located in Freshwater Wetland Complex (Photograph taken in 2018). Note the extent of open water.**

Plate 6: **Flora transect located in Freshwater Wetland Complex (Photograph taken in 2017). Note the absence of open water.**

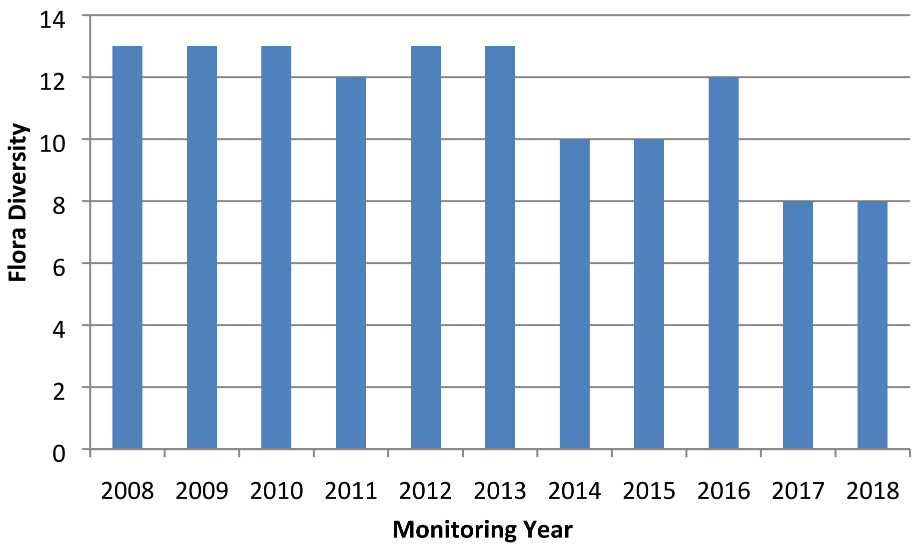

Figure 10: **Species richness within the flora transect from 2008 to 2018**

3.4 WEED SPECIES

The reserve has significant weed infestations across both disturbed areas and within the natural vegetation (**Figure 11**). The primary weeds at the time of survey were:

- *Eichhornia crassipes* (Water Hyacinth);
- *Alternanthera philoxeroides* (Alligator Weed);
- *Cenchrus clandestinus* (Kikuyu);
- *Rubus fruticosus* sp. aggregate (Blackberry); and
- *Lantana camara* (Lantana).

3.4.1 *Eichhornia crassipes* (Water Hyacinth)

Eichhornia crassipes (Water Hyacinth) can survive for extended periods of time and when conditions are favourable, can spread rapidly and cover large areas of open water. This rapid spread can choke out sunlight for natural inundated plant species and reduce open water access and usage for water birds. The life cycle of this plant means that it will continue to become established from both local and regional sources as it can float downstream and seeds can be delivered by itinerant birdlife.

- This weed dominated the water outlet from the Main Swamp to the North Swamp during the first monitoring event in 2008 (**Plate 7**). Prior to the 2009 monitoring event, some Water Hyacinth had been extracted from the open water and a grate installed to prevent this weed blocking the under-road culvert (**Plate 8**). Subsequent years can be observed in **Plates 9-17**.
- The 2018 monitoring event found that the coverage of *Eichhornia crassipes* on the North Swamp has increased since the previous year (2017). While areas of open water are present in 2018 (**Figure 11**), they are noticeably reduced in area. **Plate 16** shows the increase in weeds surrounding the installed grate when compared to 2016 (**Plate 15**) however this is predominantly *Alternanthera philoxeroides* (Alligator Weed). This is likely to be due to *Eichhornia crassipes* spraying by the Pambalong Nature Reserve Enhancement Project which caused significant reductions of the weed in 2012 (**Plate 11**) and 2013 (**Plate 12**), and appears to have had similar results in 2016.
- Aerial drone photography shows the extent of the Water Hyacinth in the north swamp (**Plate 18**).
- Water Hyacinth is an environmental weed that should be controlled under the General Biosecurity Duty of the *Biosecurity Act 2015* due to its potential biosecurity risk. The NPWS Hunter Region Pest Management Strategy (2002) has identified control of Water Hyacinth

at Pambalong Nature Reserve as a "high priority" and an active program has been operating in the reserve since 2002.

Plate 7: **Water Hyacinth at the Northern Swamp inlet in 2008**

Plate 8: **Water Hyacinth at the Northern Swamp inlet in 2009 showing the installation of a grate**

Plate 9: **Water Hyacinth at the Northern Swamp inlet in 2010**

Plate 10: **Water Hyacinth at the Northern Swamp inlet in 2011**

Plate 11: **Water Hyacinth at the Northern Swamp inlet in 2012**

Plate 12: **Water Hyacinth at the Northern Swamp inlet in 2013**

Plate 13: Water Hyacinth at the Northern Swamp inlet in 2014

Plate 14: Water Hyacinth and Alligator Weed at the Northern Swamp inlet in 2015

Plate 15: Water Hyacinth and Alligator Weed at the Northern Swamp inlet in 2016

Plate 16: Water Hyacinth and Alligator Weed at the Northern Swamp inlet in 2017

Plate 17: Alligator Weed (foreground) and Typha at the Northern Swamp inlet in 2018.

Plate 18: **Aerial photography showing the extent of the Water Hyacinth on the north swamp in 2018.**

3.4.2 *Alternanthera philoxeroides* (Alligator Weed)

Alternanthera philoxeroides (Alligator Weed) may infest both terrestrial and aquatic environments (**Plate 17**). The abundance of Alligator Weed in 2018 was found to be approximately the same as the 2017 survey, although this has not been quantifiably assessed. Alligator Weed has the potential to form more extensive infestations within the reserve and invade adjoining land. Alligator Weed is easily spread and once established it is virtually impossible to eradicate. Alligator Weed is an environmental weed that should be controlled under General Biosecurity Duty of the *Biosecurity Act 2015* due to its potential biosecurity risk The NPWS Hunter Region Pest Management Strategy (2002) identifies Alligator Weed as a “high priority” weed.

NSW National Parks and Wildlife have attempted in the past to control Alligator Weed at the site but after a 3-year treatment program, have not made any headway with controlling its spread. Upstream weed sources and the species’ long seed viability has made its control extremely difficult.

3.4.3 *Cenchrus clandestinus* (Kikuyu)

Cenchrus clandestinus (Kikuyu) forms dense, monoculture grassy thickets within disturbed areas of the subject site (**Plate 19**). The thickets are so dense in some areas that they are supressing native vegetation from regenerating.

- Kikuyu is a species listed under the Key Threatening Process (KTP) ‘Invasion of native vegetation communities by exotic perennial grasses’.
- The boundary of Kikuyu dominance is restricted by the hydrological regime, generally adjacent to the high water mark, and is unlikely to spread into the wetland areas.
- Kikuyu is particularly dense in the north-west and south-east corners of the subject site and along the majority of the roadsides (**Plate 20**).

Plate 19: ***Cenchrus clandestinus*** **(Kikuyu) in the north-west corner of the reserve**

Plate 20: **Aerial view of transition (from top to bottom) from open water to Typha to Kikuyu to woodland. Kikuyu excludes all other vegetation.**

3.4.4 *Rubus fruticosus* sp. aggregate. (Blackberry)

Rubus fruticosus sp. aggregate. (Blackberry) is found in areas of previous disturbance within the reserve, and forms a dense thicket to 1 m high, supressing natural regeneration. Blackberry thickets can restrict fauna access to the wetland areas and provide shelter for feral animals. Blackberry is listed as a prohibited matter under the *Biosecurity Act 2015* in Newcastle, Cessnock and Maitland local government areas and the growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority (the plant may not be imported into the state or sold).

- The NPWS Hunter Region Pest Management Strategy (2002) identifies Blackberry as a "high priority" weed. This species was initially treated by weed control efforts in 2008; however, it was still recorded at low densities on Transect 1 in 2013. Ongoing treatment is required to eradicate/suppress this species and prevent re-establishment as it is still present in patches in certain sections of the reserve (**Plate 21** and **Figure 11**).

Plate 21: ***Rubus fruticosus* (Blackberry) – background in the north-west corner of the reserve. *Ambrosia tenuifolia* (Lacy Ragweed) in the foreground.**

3.4.5 *Lantana camara* (Lantana)

Lantana camara (Lantana) is a primary weed of the dry sclerophyll woodland at the southern portion of the subject site. Efforts to control the weed in this area have been successful in previous years. As noted in Section 3.3, this weed has increased its cover in the Coastal Foothills Spotted Gum – Ironbark Forest community and requires control efforts.

This species can dominate the shrub and mid stratum if left untreated, effectively out-competing native species and can provide refuge for feral animals.

- The 'Invasion, establishment and spread of *Lantana camara'* is listed as a Key Threatening Process (KTP) under the NSW *Biodiversity Conservation Act 2016*.
- Lantana is a Weed of National Significance (WONS). The NPWS Hunter Region Pest Management Strategy (2002) identifies Lantana as a "high priority" weed. Significant efforts were made to control this weed in the southern part of the reserve in 2013 and 2016 with good results.

3.4.6 Environmental Weeds

An environmental weed is a plant species that is not a priority weed and / or WoNs but can still impact on the environment through the degradation of ecosystems by interfering with the growth and spread of other native flora species. Environmental weeds can also impact on native fauna by replacing their natural food sources, making wildlife corridors impenetrable, and/or degrading other important habitat features.

Other weeds found at the subject site are general weeds of disturbed areas, confined to the fringes of the reserve, roadsides and the former rail line and are generally outside the natural vegetation areas. Some naturally occurring species may also present a problem if they become too abundant.

3.4.6.1 *Typha orientalis (native)*

Typha orientalis (Typha) has increased in abundance over the past few years and has spread into areas of open water, restricting the available habitat of open water bird species, such as pelicans, ducks and swans. This is particularly evident in the north swamp inlet (**Plates 13-17**). The extent of Typha within the subject site should continue to be monitored to determine if this high abundance is temporary (e.g. in response to favourable climatic conditions) or relatively permanent (e.g. in response to changes in the catchment that have affected water levels within the swamp).

3.4.6.2 *Ambrosia tenuifolia*

Ambrosia tenuifolia (Lacy Ragweed) is an environmental weed that has colonised and spread rapidly in the north-west corner of the reserve in the area adjacent to Q3 in the Kikuyu Grassland and disturbed area (**Figure 11, Plate 21**). Under the NSW *Biosecurity Act 2015* this species is required to be managed to prevent, eliminate or minimise any risk it presents as far as is practicable.

Figure 11: Weed Species Mapping

Legend

- Pambalong Nature Reserve
- Blackberry
- Motorway
- Arterial Road
- Local Road
- Track- Vehicular
- Alligator Weed
- Alligator Weed - Scattered
- Blackberry Treated 2009
- Kikuyu Grassland, Blackberry and Lacy Ragweed
- Lantana (Scattered - 10% Cover)
- Scattered Weeds - Lantana, Moth Vine, Senna, Ground Asparagus, Blackberry
- Water Hyacinth
- Water Hyacinth - Scattered

Map Projection:

GDA 1994 MGA Zone 56

Data Sources:
NSW DFSI - 2017
Nearmap - 2019

Project Ref:	20192319
Plot Date:	5/03/2019 11:49
Revision:	001 (BDeane)

Disclaimer: This is not an official or a legal map but is for informational use only. All data was compiled from the best sources available. All boundaries, scale and geographic points are approximate.

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3.5 VEGETATION COMMUNITIES

Three natural vegetation communities and associated variations, and two altered vegetation types were mapped on the subject site in 2008 (**Figure 12**). The distribution of communities did not change in the 2018 surveys.

3.5.1 Coastal Foothills Spotted Gum – Ironbark Forest (Dry Sclerophyll Forest)

This community occurs as an open forest on the knoll at the southern portion of the subject site. The overall community shows significant past disturbance and subsequent weed infestation.

The community is dominated by *Corymbia maculata* and *Eucalyptus siderophloia* with some *Eucalyptus acmenoides* scattered throughout. The mid stratum has a high abundance of *Bursaria spinosa* and *Acacia maidenii*. The shrub layer is dominated by *Daviesia ulicifolia* and the ground cover is grassy with *Themeda australis*, *Dichelachne micrantha*, *Entolasia stricta*, *Echinopogon caespitosus* and *Aristida vagans* common.

This community is not dependent on the wetland and associated hydrology. *Coastal Foothills Spotted Gum – Ironbark Forest* is not listed as a Threatened Ecological Community.

3.5.2 Paperbark Swamp Forest (Swamp Sclerophyll Forest)

The Paperbark community is restricted to more elevated flats and areas bordering the freshwater wetland complex. Patches at the centre of the reserve are the most mature and consist of a scattered *Casuarina glauca* canopy over dense *Melaleuca* sub-canopy. Flora quadrat 3 is located in the northern portion, adjacent to the Water Couch-Triglochin Swamp Meadow community and flora quadrat 4 is located centrally in the core forested area.

The species composition within Q3 is typically dominated by the canopy species *Melaleuca linariifolia* and *M. styphelioides*. One juvenile *Ficus macrophylla* is also located in the quadrat. Some *Melaleuca ericifolia* is present within the quadrat indicating frequent inundation; however, this species is more common in permanent swamp areas at the ecotone between the Paperbark community and the freshwater wetlands. The mid stratum is sparse or absent.

The ground cover within the quadrat comprises *Bolboschoenus caldwellii, Eleocharis acuta, Atriplex prostrata* and *Lachnagrostis filiformis.*

Within Q4, floristic structure is similar to Q3; however, with the more permanent inundation, several other species are also present. These include *Enydra fluctuans, Juncus pallidus*, *Ludwigia peploides* subsp. *montevidensis*, *Typha orientalis* and *Casuarina glauca*. The exotic species *Alternanthera philoxeroides* also dominates the area with scattered Water hyacinth also present. Two epiphytic orchid species, *Dendrobium linguiforme* (Tongue Orchid) and *D. teretifolium* (Rat's Tail Orchid), occur on several *Casuarina glauca* trees.

The Paperbark Swamp Forest and Paperbark Woodland forms part of the NSW BC Act listed *Swamp Sclerophyll Forest on Coastal Floodplains EEC*.

3.5.3 Freshwater Wetland Complex (Freshwater Wetland)

The Freshwater Wetland Complex occurs in deeper depressions having a permanent or periodical inundation of fresh water, such that the species composition is comprised of water tolerant species. At the subject site the Freshwater Wetland Complex consists of three variations: Typha Reedland; Rushland Swamp/Open Water; and Water Couch-Triglochin Swamp Meadow.

Specifically, these mapped freshwater wetland variations range from open water bodies, with tall reeds and sedges, to a mixed reedland, rushland or swamp meadow integrating with the Paperbark Swamp Forest community. The integration is likely to be a dynamic and moving boundary, at the present time directed by seasonal and climatic conditions.

The Freshwater Wetland Complex forms part of the NSW BC Act listed *Freshwater Wetlands on Coastal Floodplains* EEC.

3.5.3.1 Typha Reedland

The Typha Reedland dominates deeper permanently inundated areas within the reserve. The Typha Reedland generally borders the lagoon areas. The extent of Typha relates to the seasons and water levels. Q2 is located within this community variant. The dominant species are *Typha orientalis* (Broadleaf Cumbungi), *Schoenoplectus validus, Paspalum distichum* (Water Couch), *Eleocharis equisetina* and *Bolboschoenus caldwellii.*

3.5.3.2 Rushland Swamp/Open Water

The Rushland Swamp is located in shallow semi-permanent and permanent water bodies. Transect 1 is located in this community in the South Swamp and the species diversity within this community is relatively low. The water level varies from deeper water to boggy substrate in the survey transect. The community is dominated by *Eleocharis sphacelata, Ludwigia peploides* subsp. *montevidensis*, *Spirodela punctata* and *Triglochin procera*, although these latter three species were recorded this year.

The open water areas occupy large portions of the Main Swamp and the North Swamp. This community is very variable due to seasonal and local climatic conditions and is related to the extent of the Typha Reedland and Rushland Swamp.

3.5.3.3 Water Couch-Triglochin Swamp Meadow

The Water Couch-Triglochin Swamp Meadow is found at the northern end of the Main Swamp. The presence of old fence lines indicates the previous land use of the site for grazing purposes. The composition and structure of flora are indicative of some disturbance. This community is dominated by *Paspalum distichum*, *Triglochin* sp. and *Persicaria* sp. The Swamp Meadow is also fringed on the deeper inundations by Typha Reedland.

3.5.4 Altered Vegetation - Swamp Oak Forest (planted)

Two isolated sections of the subject site contain *Casuarina glauca* stands that have been physically planted. These communities are not natural and their composition does not adequately represent a natural community. *Casuarina glauca* is also found naturally throughout the Paperbark Swamp Forest.

3.5.5 Altered Vegetation - Disturbed/Kikuyu Grassland

The Kikuyu dominated grasslands and disturbed areas have a monoculture of Kikuyu or a weed dominated composition. Kikuyu Grass dominates large areas adjacent to the south swamp and Coastal Foothills Spotted Gum – Ironbark Forest community and north from the main swamp. The rail line between the South Swamp and Main Swamp is infested by weeds; however, this is mainly restricted to the elevated area and is not impacting upon the swamp areas.

3.5.6 Endangered Ecological Communities

The vegetation mapping encompasses two Endangered Ecological Communities: *Freshwater Wetlands on Coastal Floodplains* EEC; and, *Swamp Sclerophyll Forest on Coastal Floodplains EEC*. The EECs occupy the majority of the reserve and their distribution is shown in **Figure 12**.

3.5.6.1 Freshwater Wetlands

Freshwater Wetlands are associated with coastal areas subject to periodic flooding and in which standing fresh water persists for at least part of the year in most years. Soils are typically silts, muds or humic loams in low-lying parts of floodplains, alluvial flats, depressions, drainage lines, back-swamps, lagoons and lakes but may also occur in back-barrier landforms where floodplains adjoin coastal sandplains (NSW Scientific Committee 2004).

The species composition of freshwater wetlands at the subject site is indicative of the EEC as they are dominated by herbaceous plants and have few woody species. The vegetation composition (grassland, open water or sedgeland vegetation) is known to vary both spatially and temporally depending on the water regime.

Hexham Swamp and Pambalong Nature Reserve are recognised as important reserves for freshwater wetlands.

3.5.6.2 Swamp Sclerophyll Forests

The Paperbark Swamp Forest is recognised as a Swamp Sclerophyll Forest EEC. The community is dominated by *Melaleuca linariifolia, M. ericifolia* and *M. styphelioides* (paperbarks) and scattered *Casuarina glauca.* This is indicative of a sclerophyllous community; however, it does lack a tree layer of eucalypts. Much of the subject site was inundated at the time of surveying; however, previous reports indicate these areas become dry land during extended dry periods.

The groundcover was composed of abundant sedges, ferns, forbs, and grasses which are indicative of the EEC. Within the Lower Hunter district, this community includes 'Swamp Mahogany-Paperbark Swamp Forest' (map unit 37), Riparian Melaleuca Swamp Woodland (map unit 42) and Melaleuca Scrub (map unit 42a) of NPWS (2000).

Figure 12: Vegetation Community Mapping

Legend

Pambalong Nature Reserve

Map Projection:	GDA 1994 MGA Zone 56
Data Sources:	LPI - 2016 Nearmap - 2017
Project Ref:	20192319
Plot Date:	2/20/2019 16:41
Revision:	001 (THawkins)

Disclaimer: This is not an official or a legal map but is for informational use only. All data was compiled from the best sources available. All boundaries, scale and geographic points are approximate.

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3.6 FAUNA

A total of 104 fauna species have been recorded during the 2018/19 monitoring period. Total fauna species richness recorded in each monitoring year is shown in **Figure 13**. Species recorded in 2018/19 comprised six frog, two reptile, two arboreal mammal, three terrestrial mammal, 12 bat and 79 bird species. Of these, five are listed as Vulnerable and one is listed as Endangered under the NSW BC Act (**Table 6**). Additionally, two species are listed under the Commonwealth EPBC Act. Total fauna species richness in 2018/19 has returned to similar number observed in 2015/16 after slightly fewer numbers of species were noted in 2016/17 and 2017/2018. Differences in recent years appears to be largely driven by the diversity of birds detected year to year.

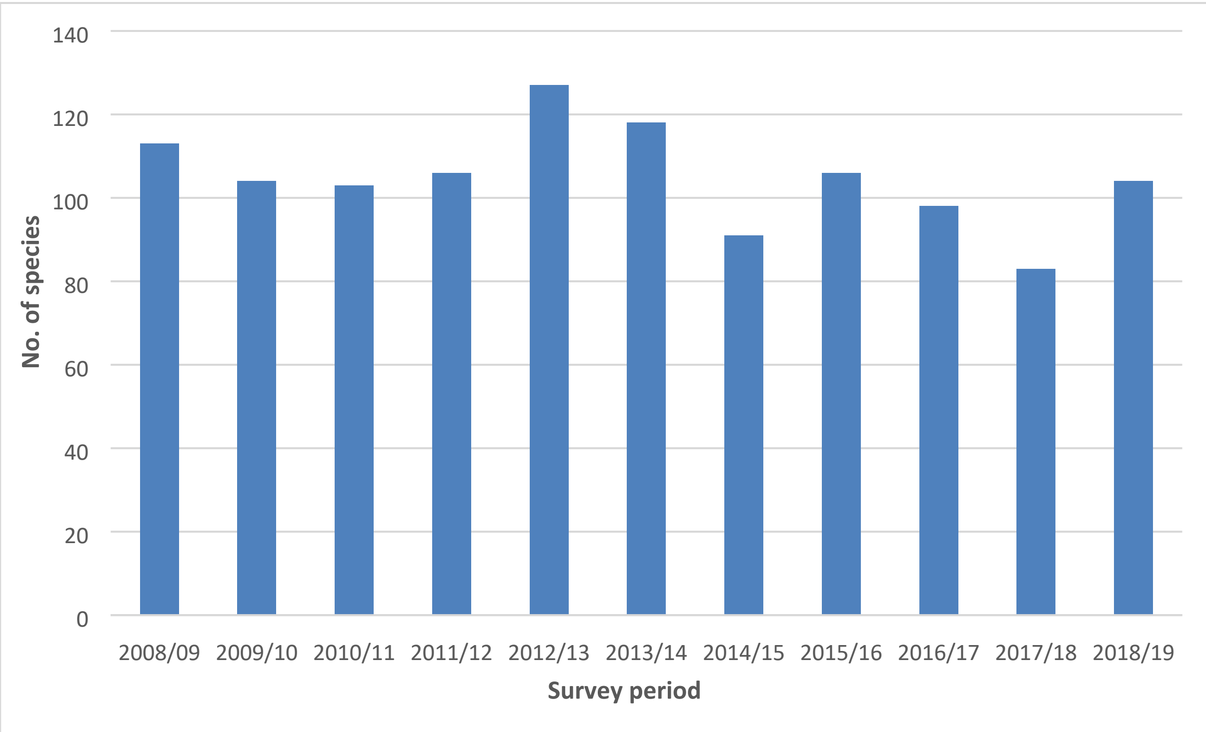

Figure 13: Fauna species richness recorded from 2008/09 to 2018/19.

Table 6: Threatened fauna species recorded in 2018/19

Scientific Name	Common Name	Legal status	Survey Method
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V – BC Act	Anabat recording (probable)
Haliaeetus leucogaster	White-bellied Sea-Eagle	V – BC Act	Bird survey
Miniopterus australis	Little Bentwing-bat	V – BC Act	Trapped and Anabat recording (confident)
Pteropus poliocephalus	Grey-headed Flying-fox	V – BC Act / V – EPBC Act	Spotlighting
Botaurus poiciloptilus	Australasian Bittern	E – BC Act / E – EPBC Act	Bird Survey
Glossopsitta pusilla	Little Lorikeet	V – BC Act	Bird Survey

NB: taxonomy for bats follows Churchill (2008). V = vulnerable.

The number of amphibian, reptile, and mammal species detected in each monitoring year is shown in **Figure 14**. The number of mammal and amphibian species recorded each year has remained relatively constant throughout the survey years; however, the number of reptile species detected has been found to fluctuate each year. Two reptile species were recorded in the 2018/19 survey period; Red-bellied Black Snake (*Pseudechis porphyriacus*) and Common Tree Snake (*Dendrelaphis punctulata*). Reptiles are not specifically targeted by the monitoring program.

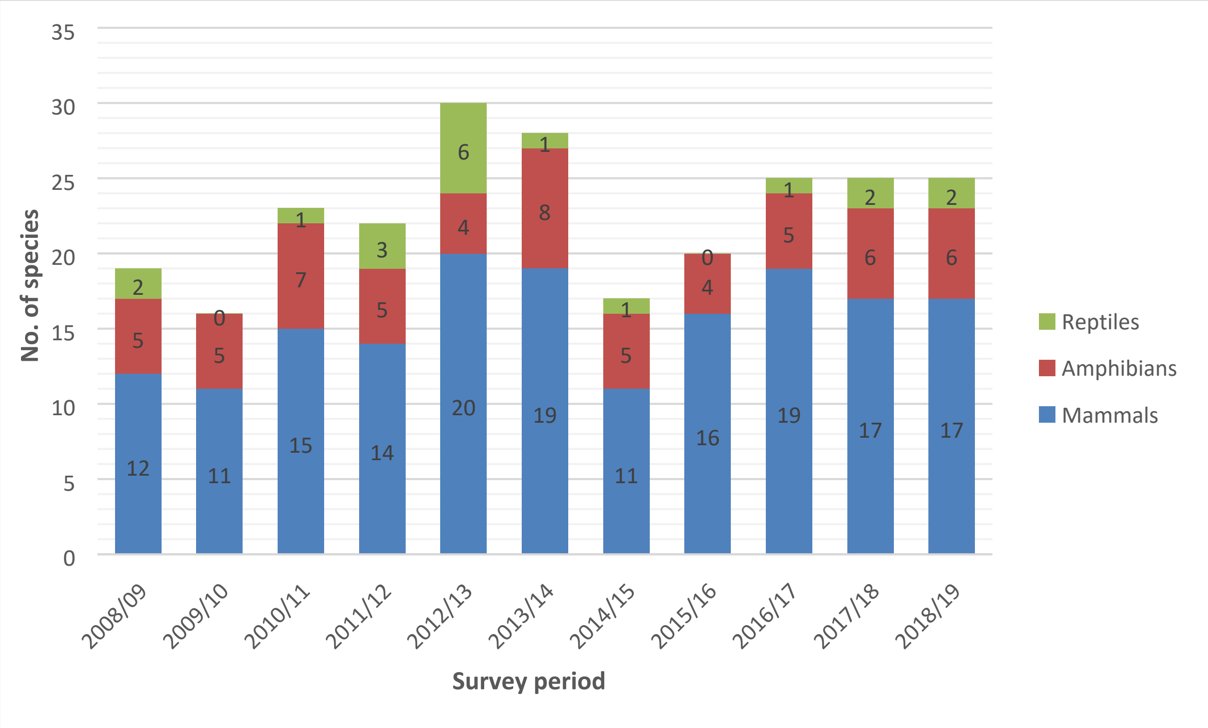

Figure 14: **Fauna species richness by taxon from 2008/09 to 2018/19 (excluding birds).**

3.6.1 Amphibians

Six species of amphibian were detected during the 2018 surveys. No threatened species were detected; neither were any new species or notable absences detected.

Selected photographs of each water body surveyed for birds and amphibians are provided in **Appendix 8**. Photographs from the Autumn 2012, 2014, 2015, 2017 and 2018 survey periods are provided to enable a visual comparison of the variability of water levels, areas of open water and aquatic vegetation occurring at each of the three water bodies.

3.6.2 Birds

Figure 15 shows changes in bird species richness at each of the five survey locations over time. A total of 79 bird species were recorded during the 2018/19 surveys, which is slightly less the yearly average over the 10 year survey period. The total number of species recorded during each survey period has remained relatively constant, with expected natural fluctuations, over the past 10 years of surveys. Bird numbers appear to rise and fall on a cyclical basis, every 2 years.

Three species not previously detected by Kleinfelder from the study area were detected in 2018/19 which brings the total number of bird species detected over the past 11 years to 137. A Brown Goshawk (*Accipiter fasciatus*) was detected foraging within the southern swamp which then proceed to perch within the woodland patch. One new threatened species were also detected during surveys, the Australasian Bittern - *Botaurus poiciloptilus* (listed as Endangered under both the BC and EPBC Act) was heard calling at dusk from within emergent vegetation within the northern portion of the Main Swamp (where the road dissects the Main and North Swamps). Detection of an Australasian Bittern is of significance as the species is highly cryptic, hiding amongst dense vegetation and is often missed during targeted searches. Calls of the species are distinct and are described as a deep “ooOOm, ooOOm”. The source of the individual may be from Hexham Swamp which is suspected to be a possible breeding ground.

Australasian Shovelers were once again detected during the 2018/2019 surveys after being periods of absence between 2009 and 2017. A total of 16 Shovelers were observed in the Main Swamp along with 33 Black Swan’s that were recorded during the roosting bird counts.

Twenty-seven species were detected at the North Transect in 2018 which is slightly below the yearly average of 32 species. A decline in species richness at this transect is evident (**Figure 15**) and has been gradually occurring since the Spring 2011 survey. Noticeable absences in the current survey at the North (and South) Transect included spring migrants such as the White-throated Gerygone and Cicadabird, several Cuckoo species, Tawny Grassbird, Pied Currawong and small passerines such as the Variegated Fairy-wren and Yellow Thornbill. Two species not previously detected at the North Transect were recorded in 2018; Brush Cuckoo and Rufous Fantail. A Pheasant Coucal was also observed in 2018 which has not been detected since 2012.

Similarly, slightly less species were observed in the Southern Transect than the yearly average. A total of 24 species were recorded in the Southern Transect which has fluctuated between 36 and 22 species over the past 11 years.

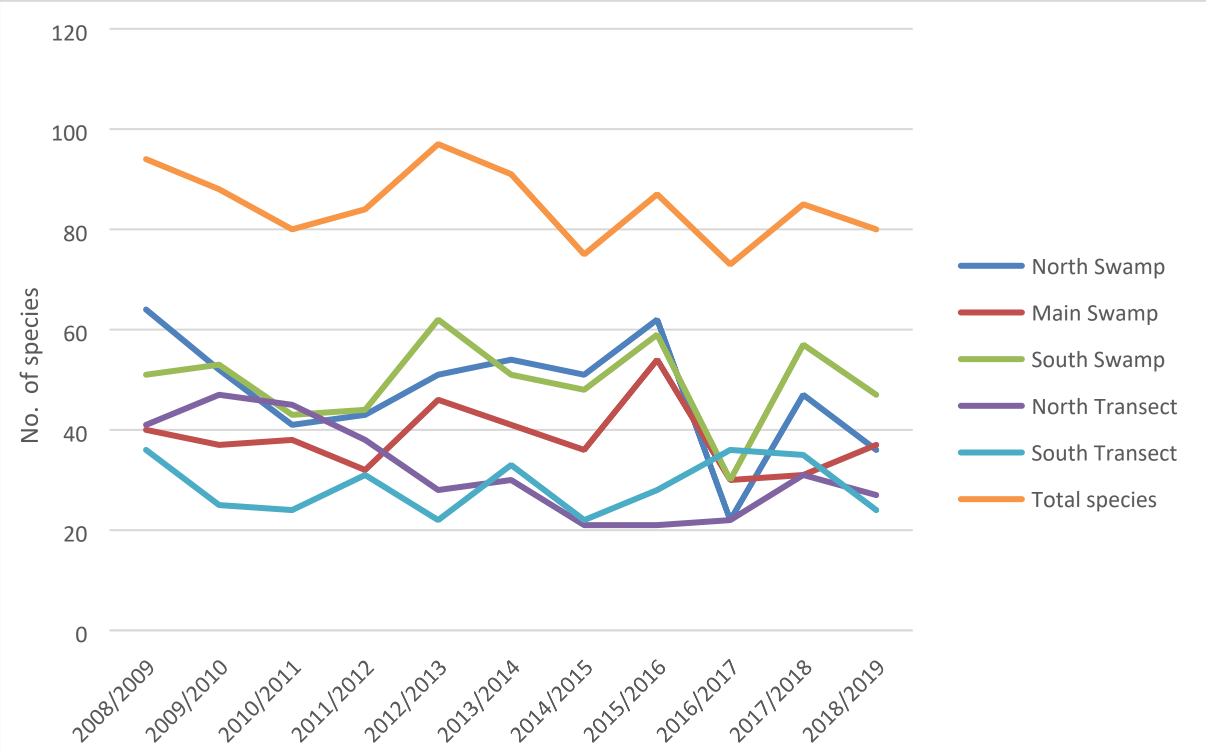

Figure 15: Bird species richness recorded at Pambalong Reserve from 2008 to 2019.

Wetland-specialist species were separated from the total species list for comparison over time. These species were then further separated into waterbirds, (ducks, cormorants and pelicans) and wading birds (ibises, egrets and herons, etc.) to determine if there has been any change in the occurrence of species within these guilds over time. As these groups use different habitat (open deep water versus shallow, vegetated edges), changing conditions at the reserve will affect each group differently.

The number of wetland-specialist bird species recorded during the monitoring events has fluctuated considerably over time (**Figure 16**). A total of 23 wetland-specialist species were detected at the Main Swamp in 2018/19 which is a substantial increase from 9 species detected in 2017/2018. While the waterbody survey location is increasingly becoming overgrown, limiting the field of view, birds that were recorded opportunistically along the northern reaches of the Main Swamp have also been included.

Large numbers of Straw-necked Ibis were detected within the Main Swamp following several years where the species has not been detected. Apart from Ibis, reasonable numbers of Australasian Shovelers and Black Swans were observed on multiple surveys within the Main Swamp. This is the first time Australasian Shovelers have been recorded in the Main Swamp.

The annual number of wetland species within the reserve has remaining relatively stable since the previous year's survey in 2017/2018. While the number of wetland birds detected in the South and North Swamp is lower than the previous year, significantly more species (23) were detected in the North Swamp after only nine species were observed the year previous.

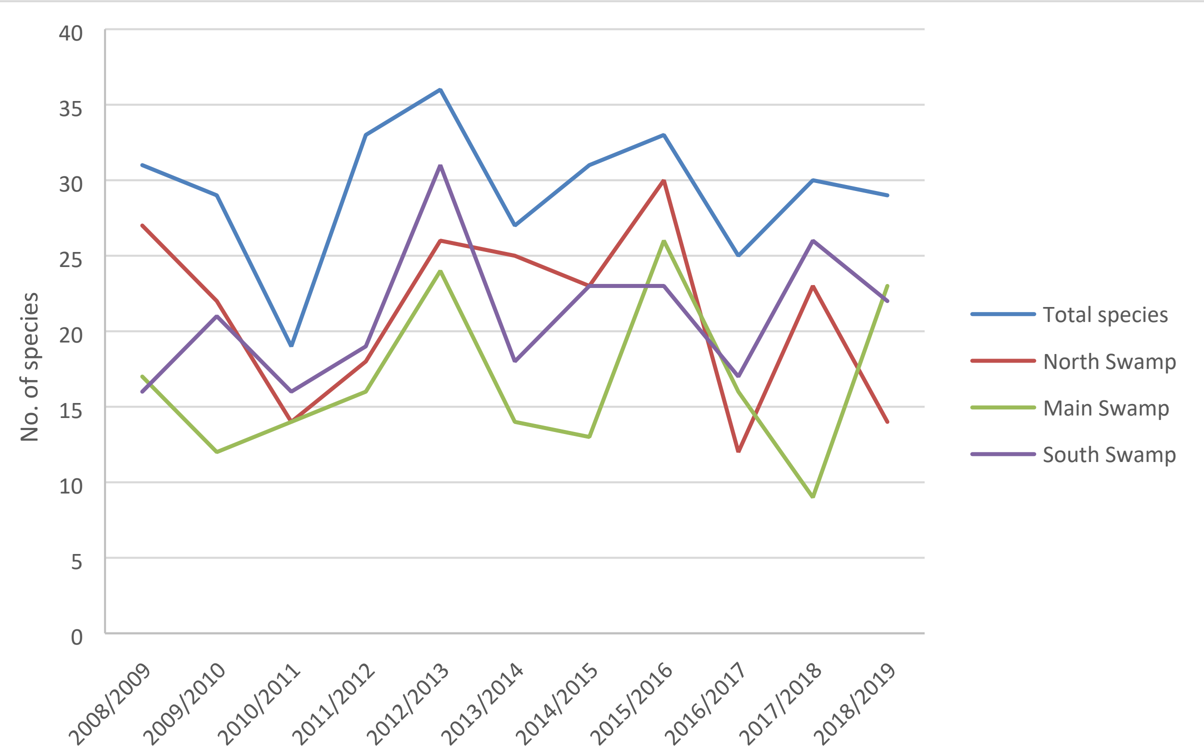

Figure 16: Wetland-specialist bird species recorded at Pambalong Reserve from 2008 to 2019.

The pattern of occurrence of waterbird species that rely on open water for foraging has fluctuated considerably across the three Swamps over the past four years (**Figure 17**). Overall, the number of waterbirds has rebounded to the highest diversity recorded since 2012/2013. Since then, lower than average waterbird species have generally been observed through the three Swamps. In particular, fewer birds have progressively been detected in the North Swamp which is likely to be the result of loss of open water habitat. While the South Swamp is experiencing similar levels of aquatic and riparian weed growth, the number of waterbirds has remained relatively constant. This may be explained by the persistence of an area of open water immediately adjacent to the waterbird survey point. However, closer inspection of the open area of water in the South Swamp during 2018/2019 surveys has revealed that the water level is very low (approximately 30cm) and is being encroached around the periphery by grasses. Loss of open water in future years may result in complete loss of water and wading birds in the South Swamp. Greater numbers of waterbirds and wading birds are being observed in the northern reaches of the Main Swamp may be due to the loss of open water in the North and South Swamp.

The total number of wading birds at Pambalong has varied over the recent years. Peaks and troughs in diversity appear to occur on alternate years with the 2018/2019 surveys returned slightly less numbers of species than the previous year. Across the three Swamps, the number of wading birds has experienced similar changes throughout the 11 year survey period. In 2017/2018 the greatest difference was observed between numbers of wading birds between Swamps, however, there difference is marginal in 2018/2019.

Lower than average annual rainfall conditions have been experienced throughout much of eastern Australia seaboard, particularly since 2016. This trend has also been observed in the Hunter with lower than average annual rainfall recorded at the closest weather station to Pambalong in 2017 and 2018. Previously during periods of low annual rainfall, greater numbers of species have been generally observed at Pambalong. This is suggested to be the result of inland areas drying up, leading to birds seeking water in coastal regions. In 2018/2019 surveys, reasonable rainfall events were recorded immediately prior to surveys in Nov/Dec 2018 and May 2019 in the lower Hunter. Above average rainfall events during these months may have allowed wetland birds to return to inland regions resulting in fewer birds being detected in the current survey year.

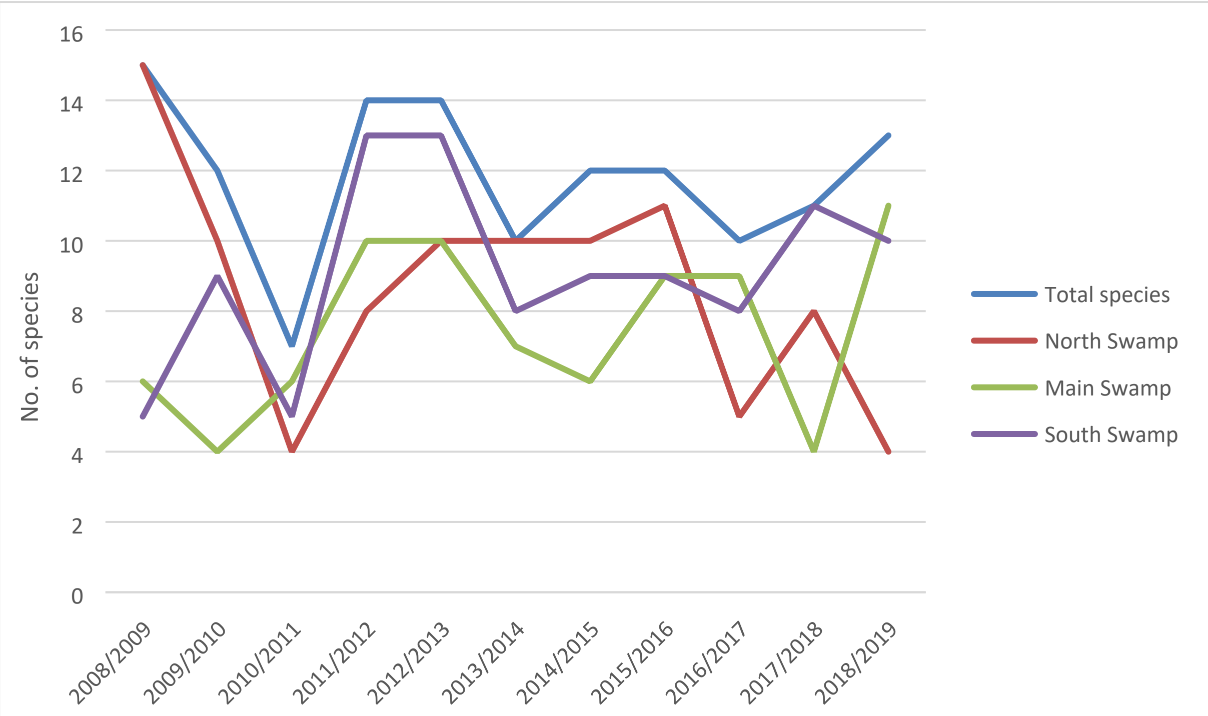

Figure 17: Waterbird species recorded at Pambalong Reserve from 2008 to 2019.

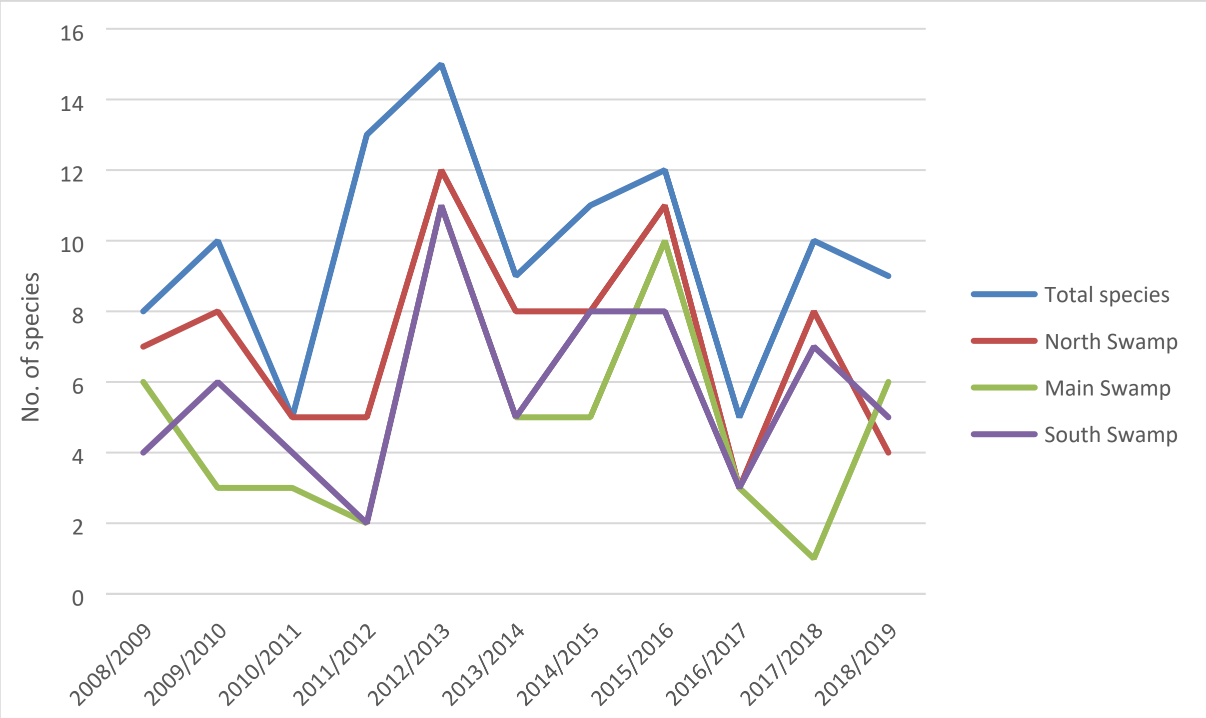

Figure 18: Wading bird species recorded at Pambalong Reserve from 2008 to 2019.

Roosting bird counts have largely reflected the presence of a small number of species that sometimes appear in large numbers. For example, three species (Australian White Ibis, Straw-necked Ibis and Cattle Egret) have contributed 91% of all 2705 individual roosting birds recorded since project initiation in 2008. The highest numbers of roosting birds were observed in 2015 (598 birds), while less than 100 birds have been reported in any survey since to 2015 to 2018. Reasonable numbers of Australian White Ibis (112 birds) were observed in the most recent survey (May 2019) indicating that the stand of Melaleucas and Casuarinas within the Main Swamp are still used as roosting habitats for waterbirds on an intermittent basis.

Other factors likely to affect bird species detection between years include seasonal variations (e.g. arrival times of migratory species), flowering times of foraging resources for nectarivorous species, climatic conditions and individual species ecology (e.g. some species have a large home range and may be absent from the study area during surveys or have cryptic traits which make them more difficult to detect).

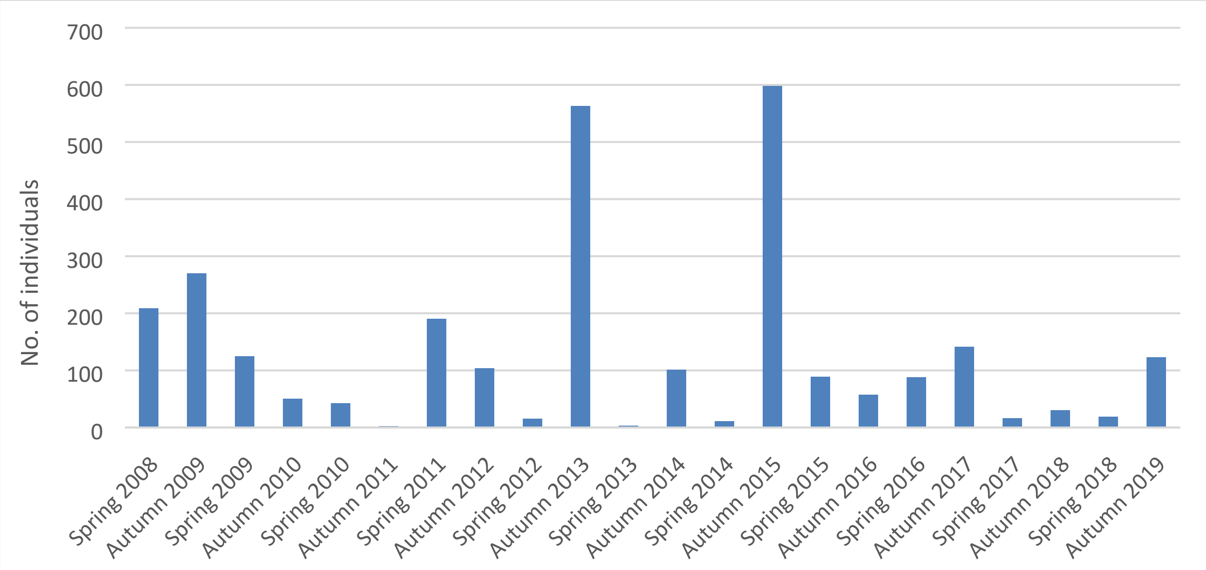

Figure 19: Number of birds recorded roosting in the Melaleuca Swamp Forest of the Main Swamp from 2008 to 2019.

3.6.2.1 Bird Data from Other Sources

Members of the Hunter Bird Observers Club (HBOC) and other similar interest groups make occasional visits to the Reserve. The HBOC was approached for their records of species during the in 2017, however, Kleinfelder was advised that Club records had been provided to Birdlife Australia's database https://birdata.birdlife.org.au. A search of records contained within the database from May 2018 to May 2019 returned a total of 99 species. A number of species that were not detected during Kleinfelder surveys within the Reserve include wetland species. These were Hoary-headed Grebe, Black-winged Stilt, Royal Spoonbill in addition to a number of woodland and predatory birds.

3.6.3 Mammals

Two arboreal mammals were detected in 2018/19 (Common Brushtail Possum and Brown Antechinus), both of which have been detected in previous surveys. Three terrestrial mammals were also detected, including two introduced species; European Rabbit (*Oryctolagus cuniculus*), and the Black Rat (*Rattus rattus*) which have been irregularly recorded over the 11 years of annual monitoring.

A total of 12 bat species, including three threatened species, were recorded in 2018/19, which is considered a high diversity for the local area.

The exotic Black Rat has been consistently recorded since 2008/09, with the exception of 2011/12 and 2016/17. This species is known to out-compete native rodent species. This could explain the intermittent detection of native rodents, such as the Swamp Rat, which was only detected in 2013/14 and the Bush Rat, which was detected in 2008/09, and again in 2015/16.

3.6.4 Reptiles

Two reptile species were detected during the 2018 surveys; Red-bellied Black Snake (*Pseudechis porphyriacus)* and the Common Tree Snake (*Dendrelaphis punctulata*). Reptiles are not specifically targeted by the monitoring program.

3.6.5 Introduced Fauna

Introduced species previously recorded in the reserve include: Black Rat, House Mouse, Rabbit, Fox, Wild Dog, Feral Cat, Common Myna, Spotted Dove, Northern Mallard, House Sparrow, Red-whiskered Bulbul and Common Starling (Hunter Bird Observers Club records 1990 – 2008; Straw 2000; White 2000; Kleinfelder 2008 - 2017).

Two introduced fauna species were recorded during the 2018/19 survey period, European Rabbit (*Oryctolagus cuniculus*) and Black Rat (*Rattus rattus*). The ecological condition of the reserve is negatively impacted by the presence of these species and their presence should be monitored and control measures implemented if deemed necessary.

4. CONCLUSION AND RECOMMENDATIONS

Monitoring of the Pambalong Nature Reserve has been undertaken in 2018/19 in accordance with the Flora and Fauna Management Plan for Abel Underground Coalmine (ecobiological 2007).

In total, there were 109 flora species (within the flora survey quadrats and transect) and 98 fauna species comprising six amphibian, two reptile, 17 mammal (12 bat) and 73 bird species recorded in 2018/19. The following threatened species were recorded during field surveys:

- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*);
- Grey-headed Flying-fox (*Pteropus poliocephalus*);
- Little Bentwing-bat (*Miniopterus australis);* and
- White-bellied Sea-Eagle (*Haliaeetus leucogaster*);

Two feral species were detected in 2018/19:

- European Rabbit (*Oryctolagus cuniculus*);
- Black Rat (*Rattus rattus*).

Control of the aquatic weeds Water Hyacinth and Alligator Weed throughout the reserve is recommended to improve the quality of the habitat for water birds and other native fauna (however, it is acknowledged that continued efforts will unlikely ever eradicate these weeds from the reserve without the cooperation from upstream landholders). Control of terrestrial weeds such as Lantana, Blackberry and Kikuyu should also be undertaken in combination with rubbish removal to make the habitat less suitable for feral fauna species and more suitable for native species.

The 2018/19 survey recorded four new flora species, three of which are native species (*Cheilanthes sieberi* subsp. *sieberi* Mulga Fern, *Desmodium gunnii* Slender Tick-treefoil, *Eremophila debilis* Winter Apple). The fourth new species was the exotic *Myriophyllum aquaticum* (Parrots Feather) at Transect 1, although its cover its still <5% (cover abundance of 2). Flora species richness has remained relatively constant between the monitoring events in Quadrats 1 – 4. Flora species richness at Transect 1 remained the same as in the previous year's survey. No significant changes to the vegetation community extents were recorded in the 2018 surveys.

Kikuyu grass, blackberry and other weeds continue to cover significant dry areas and any treatment of these areas would require follow up regeneration and rehabilitation. Planting with canopy species such as *Casuarina glauca* (Swamp Oak) or other 'forested wetland' species may provide sufficient shade to prevent reinfestation of these areas once the weeds have been eradicated by herbicidal spray.

In order to maintain the quality and usefulness of data collected on the health of Pambalong Reserve it is recommended that new methods be added where possible to the existing methodology. One evident change in the reserve is the continued encroachment of *Typha orientalis* into areas that were once open water (refer to **Section 3.4.6.1** for details). While *Typha orientalis* is a native species, infestations can interfere with waterflow (restricting access to water by wildlife), reduce water quality and limited establishment of other native emergent vegetation. This encroachment may be due to the lack of water movement throughout the swamps or gradual sedimentation of all swamps (Kathleen Straw, pers. comm.). Bird species, particularly wading species may be a good indicator that this sedimentation is occurring. While the proliferation of Typha is simply part of wetland dynamics and changing water levels, if the reserve continues to dry, many species that require areas of open water i.e. ducks, grebes etc. may be forced elsewhere and diversity as a whole will decline. As such, it is recommended that potential annual mapping of aquatic vegetation such as *Typha orientalis* be undertaken and then used in conjunction with data collected by the water quality monitoring station. Such data may provide explanations for changing numbers of waterbird diversity/abundance and need to manage the extent of *Typha* should natural water flows be impeded.

Fauna surveys in 2018/19 recorded 104 species which is marginally below the yearly average (n = 105 species). Mammal, amphibian and reptile diversity were similar to recent years. Bird diversity recorded in 2018/2019 was highest observed since 2015/2016. The total diversity of wetland bird species has fallen from the previous year's survey results, however, the trend appears to follow a rise and fall on alternate years. While the diversity of wading and waterbird species within the North and South Swamp are lower than average, diversity within the Main Swamp has increased. Increased in Alligator Weed and *Typha orientalis* within the wetland is clearly reducing open water availability and without targeted management is likely to continue to impact bird diversity.

Annual monitoring in 2018/19 has continued to contribute to a valuable long term data set on the composition, abundance and distribution of flora and fauna within Pambalong Nature Reserve. This information provides a sound basis for evaluating the potential ecological impacts of underground mining which may arise in the future, and the development of appropriate management responses.

5. REFERENCES

Anstis M 2002, *Tadpoles of South-Eastern Australia: A Guide with Keys,* Reed New Holland, Sydney.

Bell FG, Stacey TR & Genske DD 2000 'Mining subsidence and its effect on the environment: some differing examples' *Environmental Geology* 40(1-2), pp 135-152.

Bibby CJ, Burgess ND & Hill DA 2000, *Bird Census Techniques*, Academic Press Limited, London.

Briggs JD & Leigh JH 1995, *Rare or Threatened Australian Plants*, CSIRO, Canberra.

Brunner H, Triggs B & Ecobyte Pty Ltd 2002, H*air ID - An interactive tool for identifying Australia mammalian hair,* CSIRO Publishing, Collingwood.

Churchill S 2008, *Australian Bats 2nd Edition*, Allen & Unwin, Crows Nest.

Department of Environment and Conservation 2006, *Pambalong Nature Reserve Plan of Management*, DEC Hunter Region, May 2006.

ecobiological 2007, *Abel Underground Coalmine Flora and Fauna Management Plan*, prepared for Donaldson Coal Pty Ltd, October 2007.

Eco Logical Australia 2003, *An Investigation and Description of the Vegetation of the Pambalong Swamp (Pambalong Nature Reserve)*, NSW National Parks and Wildlife Service.

Harden GJ (ed) 1992, *Flora of New South Wales Volume 3*, NSW University Press, Sydney.

Harden GJ (ed) 1993, *Flora of New South Wales Volume 4*, NSW University Press, Sydney.

Harden GJ (ed) 2000 *Flora of New South Wales Volume 1*, NSW University Press, Sydney.

Harden GJ (ed) 2002 *Flora of New South Wales Volume 2,* NSW University Press, Sydney.

NPWS 2000, *Vegetation Survey, Classification and Mapping Lower Hunter and Central Coast Region Version 1.2,* A project undertaken for The Lower Hunter and Central Coast Regional Environment Management Strategy CRA Unit Sydney Zone, National Parks and Wildlife Service.

NPWS 2002, *Hunter Region Pest Management Strategy*, NSW National Parks and Wildlife Service, Shortland.

NSW Scientific Committee 2004, *Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions – Endangered Ecological Community Listing*, Office of Environment and Heritage Website, Updated 28 February 2011, Available:
http://www.environment.nsw.gov.au/determinations/FreshwaterWetlandsEndSpListing.htm

Poore, MED 1955 'The use of phytosociological methods in ecological investigations: The Braun-Blanquet system', *Journal of Ecology*, 43(1), pp 226-244.

Sidle RC, Kamil I, Sharma A & Yamashita S 2000, 'Stream response to subsidence from underground coal mining in central Utah', *Environmental Geology* 39(3-4), pp 279-291.

Straw P 2000, *Birds of Pambalong Nature Reserve – Management Strategy Avifauna,* Avifauna studies for NSW National Parks and Wildlife Service.

White A 2000, *Frog, Reptile and Mammal Survey Minmi Swamp Biosphere*, Environmental Consultants for NSW National Parks and Wildlife Service.

APPENDIX 1. FLORA SPECIES LIST

Table 7: Flora species identified from the 2018 survey

Family	Scientific Name	Common Name	Q1	Q2	Q3	Q4	T1
Acanthaceae	*Brunoniella australis*	Blue Trumpet	1				
Adiantaceae	*Cheilanthes distans*	Bristly Cloak Fern	2				
Adiantaceae	*Cheilanthes sieberi* subsp. *sieberi*	Mulga Fern	2				
Alismataceae	*Alisma plantago-aquatica*	Water Plantain					
Amaranthaceae	**Alternanthera philoxeroides*	Alligator Weed				2	
Amaranthaceae	*Alternanthera denticulata*	Lesser Joyweed		1	2		
Anthericaceae	*Arthropodium milleflorum*	Pale Vanilla-lily	2				
Apiaceae	*Cyclospermum leptophyllum*	Slender Celery		1			
Apiaceae	**Foeniculum vulgare*	Fennel					
Apiaceae	**Hydrocotyle bonariensis*	Pennywort					
Apiaceae	*Centella asiatica*	Indian Pennywort					
Apium	*Apium prostratum*						
Apocynaceae	**Araujia sericifera*	Moth Vine					
Apocynaceae	**Gomphocarpus fruticosus*	Wild Cotton					
Apocynaceae	*Parsonsia straminea*	Monkey Rope		1			
Asparagaceae	**Protasparagus aethiopicus*	Fern Asparagus					
Asteraceae	**Ageratina adenophora*	Crofton Weed		1			
Asteraceae	**Ambrosia psilostachya*						
Asteraceae	**Ambrosia tenuifolia*	Lacy Ragweed					
Asteraceae	**Aster subulatus*	Wild Aster				2	
Asteraceae	**Bidens pilosa*	Cobblers peg	2		2		

Family	Scientific Name	Common Name	Q1	Q2	Q3	Q4	T1
Asteraceae	**Cirsium vulgare*	Black Thistle			2		
Asteraceae	**Conyza canadensis* var. *canadensis*	Canadian Fleabane					
Asteraceae	**Conyza* sp.	Fleabane			2		
Asteraceae	**Conyza sumatrensis*	Tall Fleabane					
Asteraceae	**Crassocephalum crepidioides*	Thickhead					
Asteraceae	**Euchiton* sp.	Cudweed					
Asteraceae	**Hypochaeris radicata*	Catsear					
Asteraceae	**Hypochaeris radicata*	Catsear					
Asteraceae	**Senecio madagascariensis*	Fireweed	1	2	2		
Asteraceae	**Sonchus oleraceus*	Milk Thistle		1	2		
Asteraceae	**Tagetes minuta*	Stinking Roger					
Asteraceae	*Brachycome multifida* var. *dilatata*	Cut-leaf daisy					
Asteraceae	*Cotula coronopifolia*	Water Buttons					
Asteraceae	*Enydra fluctuans*					3	
Asteraceae	*Euchiton involucratus*	Star Cudweed					
Asteraceae	*Ozothamnus diosmifolius*	White dogwood	1				
Asteraceae	*Senecio pterophorus*						
Asteraceae	*Vernonia cinerea* var. *cinerea*		2				
Asteraceae	*Vittadinia cuneata* var. *cuneata*	Fuzzweed	2				
Azollaceae	*Azolla filiculoides*	Pacific Azolla				2	
Bignoniaceae	*Pandorea pandorana* subsp. *pandorana*	Wonga Wonga Vine	2				
Brassica	**Brassica juncea*				1		
Campanulaceae	*Wahlenbergia gracilis*	Native Bluebell					
Caryophyllaceae	**Stellaria media*	Chickweed					
Casuarinaceae	*Casuarina glauca*	Swamp Oak		2		4	
Celastraceae	*Denhamia silvestris*	Orange Bark	1				
Ceratophyllaceae	*Ceratophyllum demersum*	Hornwort					
Chenopodiaceae	**Atriplex prostrata*	Hastate Orache		1	2		

Family	Scientific Name	Common Name	Q1	Q2	Q3	Q4	T1
Chenopodiaceae	*Einadia hastata*	Berry Saltbush	1				
Commelinaceae	**Tradescantia albiflora*	Wandering Jew					
Commelinaceae	*Commelina cyanea*		1		2		
Convolvulaceae	**Ipomoea purpurea*	Common Morning Glory					
Convolvulaceae	*Dichondra repens*	Kidney weed	2				
Cyperaceae	**Cyperus difformis*						
Cyperaceae	*Bolboschoenus caldwellii*			3	4	3	
Cyperaceae	*Cyperus gracilis*	Slender Flat-sedge	2				
Cyperaceae	*Cyperus inversa*						
Cyperaceae	*Cyperus odoratus*						
Cyperaceae	*Eleocharis acuta*	Tall Spike-rush					
Cyperaceae	*Eleocharis equisetina*			3	3		2
Cyperaceae	*Eleocharis sphacelata*	Tall Spike-rush					2
Cyperaceae	*Fimbristylis dichotoma*	Common Fringe-sedge					
Cyperaceae	*Schoenoplectus subulatus*			5		2	1
Cyperaceae	*Schoenoplectus validus*			2			
Euphorbiaceae	**Ricinus communis*	Castor Oil Plant					
Fabaceae - Caesalpinioideae	**Senna pendula* subsp. *glabrata*	Cassia		1			
Fabaceae - Faboideae	**Trifolium dubium*	Yellow Suckling Clover					
Fabaceae - Faboideae	**Trifolium fragiferum*	Strawberry Clover					
Fabaceae - Faboideae	**Trifolium repens*	White Clover					
Fabaceae - Faboideae	**Vicia sativa*	Common Vetch		2			
Fabaceae - Faboideae	*Daviesia ulicifolia*	Gorse Bitter Pea	3				
Fabaceae - Faboideae	*Desmodium gunnii*	Slender Tick-trefoil	1				
Fabaceae - Faboideae	*Desmodium rhytidophyllum*	Tick-trefoil					
Fabaceae - Faboideae	*Desmodium varians*	Slender Tick-trefoil	1				
Fabaceae - Faboideae	*Glycine clandestina*	Twining Glycine	1				

Family	Scientific Name	Common Name	Q1	Q2	Q3	Q4	T1
Fabaceae - Faboideae	*Glycine tabacina*						
Fabaceae - Faboideae	*Hardenbergia violacea*	Purple Twining Pea	1				
Fabaceae - Faboideae	*Kennedia rubicunda*	Red Kennedy Pea					
Fabaceae - Mimosoideae	*Acacia falcata*	Sickle Wattle					
Fabaceae - Mimosoideae	*Acacia fimbriata*						
Fabaceae - Mimosoideae	*Acacia implexa*	Hickory					
Fabaceae - Mimosoideae	*Acacia irrorata subsp irrorata*						
Fabaceae - Mimosoideae	*Acacia maidenii*	Maidens Wattle	3				
Gentianaceae	**Centaurium erythraea*	Common Centaury					
Goodeniaceae	*Goodenia heterophylla*						
Haloragaceae	**Myriophyllum aquaticum*	Parrots Feather					2
Haloragaceae	*Myriophyllum variifolium*						
Iridaceae	**Freesia laxa*						
Juncaceae	*Juncus continuus*						
Juncaceae	*Juncus pallidus*	Pale Rush					
Juncaceae	*Juncus usitatus*	Common Juncus	2	2		1	
Juncaginaceae	*Triglochin procerum*					2	
Juncaginaceae	*Triglochin striata*	Streaked Arrowgrass					
Lamiaceae	*Plectranthus parviflorus*	Cockspur Flower	2				
Lemnaceae	*Lemna disperma*						
Lemnaceae	*Spirodela punctata*	Duck Weed				3	
Lobeliaceae	*Pratia purpurascens*	White root	2				
Lomandraceae	*Lomandra filiformis*	Wattle Matt Rush	1				
Lomandraceae	*Lomandra glauca*	Pale Mat-rush					
Lomandraceae	*Lomandra multiflora* subsp. *multiflora*	Iron Grass	2				
Loranthaceae	*Dendrophthoe vitellina*	Mistletoe	1				
Luzuriagaceae	*Eustrephus latifolius*	Wombat Berry	2				
Luzuriagaceae	*Geitonoplesium cymosum*	Scrambling Lily	2				

Family	Scientific Name	Common Name	Q1	Q2	Q3	Q4	T1
Malvaceae	**Sida rhombifolia*	Paddy's Lucerne	2				
Menispermaceae	*Stephania japonica* var. *discolor*	Snake Vine	2				
Moraceae	*Ficus macrophylla*	Moreton Bay Fig			1		
Myoporaceae	*Eremophila debilis*	Winter Apple	1				
Myrsinaceae	*Myrsine variabilis*		2				
Myrtaceae	*Corymbia maculata*	Spotted Gum	4				
Myrtaceae	*Eucalyptus acmenoides*	White mahogany	1				
Myrtaceae	*Eucalyptus siderophloia*	Grey Ironbark	4				
Myrtaceae	*Eucalyptus tereticornis*	Forest Redgum					
Myrtaceae	*Melaleuca ericifolia*				3	3	
Myrtaceae	*Melaleuca linariifolia*	Flax-leaved Paperbark			4	4	
Myrtaceae	*Melaleuca styphelioides*				4		
Oleaceae	*Notelaea longifolia*	Mock olive	3				
Onagraceae	**Oenothera stricta*	Evening Primrose					
Onagraceae	*Epilobium billardierianum* subsp. *billardierianum*						
Onagraceae	*Ludwigia peploides* subsp. *montevidensis*	Water Primrose				2	
Orchidaceae	*Dendrobium linguiforme*	Tongue Orchid					
Orchidaceae	*Dendrobium teretifolium*	Rat's Tail Orchid					
Oxalidaceae	*Oxalis perennans*		2				
Passifloraceae	**Passiflora edulis*	Common Passionfruit					
Phormiaceae	*Dianella caerulea*	Blue Flax-lily	3				
Phormiaceae	*Dianella revoluta* var. *revoluta*	Blueberry Lily	2				
Phyllanthaceae	*Breynia oblongifolia*	Coffee Bush	3				
Phyllanthaceae	*Phyllanthus hirtellus*	Thyme Spurge	2				
Phytolaccaceae	**Phytolacca octandra*	Inkweed			2		
Pittosporaceae	*Bursaria spinosa*	Box Thorn	3				
Pittosporaceae	*Pittosporum multiflorum*	Orange Thorn	1				
Pittosporaceae	*Pittosporum revolutum*	Wild Yellow Jasmine	2				

Family	Scientific Name	Common Name	Q1	Q2	Q3	Q4	T1
Plantaginaceae	**Plantago lanceolata*	Lambs Tongue					
Plantaginaceae	*Veronica plebeia*	Trailing Speedwell					
Poaceae	**Andropogon virginicus*	Whisky Grass					
Poaceae	**Axonopus fissifolius*	Narrow-leafed Carpet Grass					
Poaceae	**Briza maxima*	Quaking Grass					
Poaceae	**Bromus catharticus*	Prairie Grass			2		
Poaceae	**Cenchrus clandestinus*	Kikuyu		3			
Poaceae	**Chloris gayana*	Rhodes Grass					
Poaceae	**Cortaderia selloana*	Pampas Grass					
Poaceae	**Ehrharta erecta*	Panic Veldtgrass	2				
Poaceae	**Eragrostis curvula*	African Lovegrass					
Poaceae	**Hyparrhenia hirta*	Coolatai Grass					
Poaceae	**Lolium perenne*	Perennial Ryegrass					
Poaceae	**Melinis repens*	Red Natal Grass					
Poaceae	**Panicum maximum*	Guinea Grass					
Poaceae	**Paspalum dilatatum*	Paspalum					
Poaceae	**Paspalum urvillei*	Tall Paspalum					
Poaceae	**Polypogon monspeliensis*	Annual Beardgrass					
Poaceae	**Setaria pumila*	Pale Pigeon Grass					
Poaceae	**Setaria sphacelata*	South African Pigeon Grass					
Poaceae	**Setaria verticillata*	Whorled Pigeon Grass					
Poaceae	**Sporobolus africanus*	Parramatta Grass					
Poaceae	*Aristida ramosa*	Three-awned Spear Grass					
Poaceae	*Aristida vagans*	Three-awned Spear Grass	4				
Poaceae	*Austrostipa sp.*	Speargrass	2				
Poaceae	*Austrostipa spp*	Speargrass	2				
Poaceae	*Capillipedium parviflorum*	Scented-top Grass					
Poaceae	*Cymbopogon refractus*	Barbed Wire Grass	2				

Family	Scientific Name	Common Name	Q1	Q2	Q3	Q4	T1
Poaceae	*Cynodon dactylon*	Couch	2	4	3		2
Poaceae	*Dichelachne micrantha*	Shorthair Plumegrass	2				
Poaceae	*Digitaria ramularis*						
Poaceae	*Digitaria parviflora*	Small-flowered Finger Grass	2				
Poaceae	*Echinopogon caespitosus*	Tufted Hedgehog Grass					
Poaceae	*Entolasia stricta*	Wiry panic	4				
Poaceae	*Imperata cylindrica*	Bladey grass	2				
Poaceae	*Lachnagrostis filiformis*				3		
Poaceae	*Microlaena stipoides* var. *stipoides*	Weeping Grass	2				
Poaceae	*Oplismenus aemulus*	Basket Grass					
Poaceae	*Panicum simile*	Two Colour Panic					
Poaceae	*Paspalidium distans*		2				
Poaceae	*Paspalum dilatatum*	Paspalum	2				
Poaceae	*Paspalum distichum*	Water Couch				2	2
Poaceae	*Rytidosperma tenuius*	Wallaby Grass	2				
Poaceae	*Sporobolus creber*	Western Rat-tail Grass					
Poaceae	*Themeda triandra*	Kangaroo grass	5				
Polygonaceae	**Polygonum arenastrum*	Wireweed					
Polygonaceae	**Rumex conglomeratus*	Clustered Dock		2	2		
Polygonaceae	**Rumex crispus*	Dock			2		
Polygonaceae	*Persicaria attenuata* subsp. *attenuata*					2	
Polygonaceae	*Persicaria decipiens*	Slender Knotweed		1			2
Polygonaceae	*Persicaria hydropiper*	Water Pepper					
Pontederiaceae	**Eichhornia crassipes*	Water Hyacinth					2
Ranunculaceae	**Ranunculus plebeius*	Creeping Buttercup					
Ranunculaceae	*Clematis glycinoides*	Old Mans Beard					
Ranunculaceae	*Ranunculus inundatus*	River Buttercup		2			
Rhamnaceae	*Alphitonia excelsa*	Red Ash	1				

Family	Scientific Name	Common Name	Q1	Q2	Q3	Q4	T1
Rhamnaceae	*Polyscias sambucifolia*	Elderberry Panax	1				
Rosaceae	**Rubus fruticosus sp.agg*	Blackberry					
Rubiaceae	*Opercularia diphylla*		1				
Scrophulariaceae	*Bacopa monnieri*	Bacopa					
Solanaceae	**Solanum mauritianum*	Wild Tobacco					
Solanaceae	**Solanum nigrum*	Blackberry Nightshade		1	2		
Solanaceae	*Solanum brownii*	Violet Nightshade	3				
Solanaceae	*Solanum prinophyllum*	Forest Nightshade					
Typhaceae	*Typha orientalis*	Broadleaf Cumbungi		6	2	3	
Verbenaceae	**Lantana camara*	Lantana	3	1			
Verbenaceae	**Verbena bonariensis*	Purpletop		2			
Violaceae	*Viola hederacea*	Ivy-leaved Violet	2				
Vitaceae	*Cayratia clematidea*	Native Grape	1				
Total Species			**61**	**24**	**23**	**16**	**8**
Exotic			**15**	**14**	**11**	**7**	**3**
Native			**46**	**10**	**12**	**9**	**5**

* denotes an introduced species

APPENDIX 2. FAUNA SPECIES LISTS (EXCLUDING BIRDS)

Scientific Name	Common Name	White (2000)	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19
Amphibians													
Crinia signifera	Common Eastern Froglet		+		+	+	+	+	+		+	+	+
Limnodynastes peronii	Striped Marsh Frog		+	+	+	+	+	+		+	+	+	+
Limnodynastes tasmaniensis	Spotted Marsh Frog							+	+			+	+
Litoria fallax	Eastern Dwarf Tree Frog		+	+	+	+	+	+	+	+	+	+	+
Litoria freycineti	Freycinet's Frog	+											
Litoria latopalmata	Broad-palmed Frog	+			+			+					
Litoria peronii	Peron's Tree Frog		+	+	+	+		+	+	+	+	+	+
Litoria tyleri	Southern Laughing Tree Frog		+	+	+	+	+	+	+	+	+	+	+
Litoria verreauxii	Verreaux's Tree Frog			+				+					
Uperoleia laevigata	Smooth Toadlet				+								
Total		**2**	**5**	**5**	**7**	**5**	**4**	**8**	**5**	**4**	**5**	**6**	**6**

Scientific Name	Common Name	White (2000)	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19
Reptiles													
Amphibolurus muricatus	Jacky Lizard	+					+						
Chelodina longicollis	Eastern Long-necked Turtle	+				+		+					
Ctenotus robustus	Robust Ctenotus	+											
Dendrelaphis punctulata	Common Tree Snake												+
Eulamprus quoyii	Eastern Water Skink	+											
Hemiaspis signata	Marsh Snake										+		
Lampropholis delicata	Garden Skink	+					+						
Physignathus lesueurii lesueurii	Eastern Water Dragon		+				+						
Pseudechis porphyriacus	Red-bellied Black Snake	+	+		+	+	+					+	+
Pseudonaja textilis	Eastern Brown Snake					+	+						
Tiliqua scincoides	Eastern Blue-tongued Lizard						+						
Varanus varius	Lace Monitor								+				
Total		**6**	**2**	**0**	**1**	**3**	**6**	**1**	**1**	**0**	**1**	**1**	**2**

Scientific Name	Common Name	White (2000)	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19
Non-flying Mammals													
Acrobates pygmaeus	Feathertail Glider								+				
Antechinus stuartii	Brown Antechinus	+	+		+	+			+				+
Petaurus breviceps	Sugar Glider	+						+	+		+		
Pseudocheirus peregrinus	Common Ringtail Possum							+			+		
Trichosurus vulpecula	Common Brushtail Possum						+	+	+		+		+
Canis lupus	*Wild Dog						+				+		
Felis catus	*Domestic Cat				+								
Wallabia bicolor	Swamp Wallaby						+				+		
Mus domesticus	*House Mouse		+	+									
Oryctolagus cuniculus	*European Rabbit									+			+
Rattus fuscipes	Bush Rat		+							+			
Rattus lutreolus	Swamp Rat							+					
Rattus rattus	*Black Rat	+	+	+	+		+	+	+	+		+	+
Tachyglossus aculeatus	Short-beaked Echidna											+	+
Vulpes vulpes	*Red Fox	+				+	+	+			+	+	
Total Non-flying Mammals		**4**	**4**	**2**	**3**	**2**	**5**	**6**	**5**	**3**	**6**	**3**	**5**

* denotes an introduced species

Scientific Name	Common Name	White (2000)	2008 /09	2009 /10	2010 /11	2011 /12	2012 /13	2013 /14	2014 /15	2015 /16	2016 /17	2017 /18	2018 /19
Bats													
Chalinolobus dwyeri	# Large-eared Pied Bat										+		
Chalinolobus gouldii	Gould's Wattled Bat	+	+	+	+	+	+	+	+	+	+	+	+
Chalinolobus morio	Chocolate Wattled Bat			+	+		+	+	+	+		+	+
Falsistrellus tasmaniensis	# Eastern False Pipistrelle		+		+	+		+		+		+	+
Miniopterus australis	# Little Bentwing-bat	+	+	+	+	+	+	+		+	+	+	+
Miniopterus schreibersii oceanensis	# Eastern Bentwing-bat	+	+			+	+	+		+	+	+	
Mormopterus norfolkensis	# East-coast Freetail-bat	+	+	+		+	+	+		+	+	+	
Mormopterus ridei	Eastern Freetail-bat	+			+	+	+	+		+	+		+
Myotis macropus	# Southern Myotis					+	+			+	+		
Nyctophilus geoffroyi	Lesser Long-eared Bat					+	+	+		+	+	+	+
Nyctophilus gouldii	Gould's Long-eared Bat								+				
Nyctophilus sp.	Unidentified Long-eared Bat	+		+	+	+	+	+					+
Pteropus sp.	Flying-fox						+						
Pteropus poliocephalus	# Grey-headed Flying-fox	+	+					+	+		+		+
Rhinolopus megaphyllus	Eastern Horseshoe-bat				+					+		+	+
Saccolaimus flaviventris	# Yellow-bellied Sheathtail-bat			+								+	
Scoteanax rueppellii	# Greater Broad-nosed Bat	+					+			+			
Scotorepens orion	Eastern Broad-nosed Bat			+	+		+				+	+	+
Tadarida australis	White-striped Mastiff-bat				+	+	+	+	+		+		+
Vespadelus darlingtoni	Large Forest Bat									+			
Vespadelus pumilus	Eastern Forest Bat	+	+	+	+		+						
Vespadelus regulus	Southern Forest Bat										+		
Vespadelus troughtoni	# Eastern Cave Bat				+	+		+					
Vespadelus vulturnus	Little Forest Bat	+	+	+	+	+	+	+	+	+	+	+	+
Total Bats		**10**	**8**	**9**	**12**	**12**	**15**	**13**	**6**	**13**	**13**	**11**	**12**

* denotes an introduced species; # denotes a threatened species under the NSW BC Act 2016 and/or the Commonwealth EPBC Act 1999; NB: Taxonomy for bats follows Churchill (2008).

APPENDIX 3. BIRD SPECIES LIST - TRANSECTS

Family	Scientific Name	Common Name	Spring 2008		Spring 2009		Summer 2010		Spring 2011		Spring 2012		Spring 2013		Spring 2014		Spring 2015		Spring 2016		Spring 2017		Spring 2018	
			North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South
Acanthizidae	*Acanthiza lineata*	Striated Thornbill			+		+						+	+			+							
Acanthizidae	*Acanthiza nana*	Yellow Thornbill		+	+	+	+								+			+					+	+
Acanthizidae	*Acanthiza pusilla*	Brown Thornbill			+		+								+			+			+		+	
Acanthizidae	*Gerygone mouki*	Brown Gerygone	+		+		+	+	+	+	+				+		+		+	+	+			
Acanthizidae	*Gerygone olivacea*	White-throated Gerygone	+	+	+	+		+		+	+			+										
Acanthizidae	*Sericornis frontalis*	White-browed Scrubwren	+		+		+		+		+			+	+				+	+	+		+	
Accipitridae	*Accipiter novaehollandiae*	Grey Goshawk																		+				
Accipitridae	*Aquila audax*	Wedge-tailed Eagle	+	+										+										
Accipitridae	*Aviceda subcristata*	Pacific Baza	+	+	+	+	+				+		+	+						+				
Accipitridae	*Circus approximans*	Swamp Harrier			+		+							+			+							
Accipitridae	*Elanus axillaris*	Black-shouldered Kite																			+			
Accipitridae	*Haliastur sphenurus*	Whistling Kite			+		+											+	+	+				
Acrocephalidae	*Acrocephalus australis*	Australian Reed-Warbler			+		+		+	+	+	+			+		+						+	
Anatidae	*Anas superciliosa*	Pacific Black Duck	+		+		+		+															

Family	Scientific Name	Common Name	Spring 2008		Spring 2009		Summer 2010		Spring 2011		Spring 2012		Spring 2013		Spring 2014		Spring 2015		Spring 2016		Spring 2017		Spring 2018	
			North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South
Apodidae	*Hirundapus caudacutus*	White-throated Needletail												+								+		
Ardeidae	*Ardea ibis*	Cattle Egret	+										+	+							+			
Ardeidae	*Egretta novaehollandiae*	White-faced Heron	+																			+		
Artamidae	*Artamus leucorynchus*	White-breasted Woodswallow	+	+	+	+	+	+	+	+		+	+					+			+			
Artamidae	*Cracticus nigrogularis*	Pied Butcherbird	+												+				+		+		+	
Artamidae	*Cracticus tibicen*	Australian Magpie									+		+				+		+		+	+	+	
Artamidae	*Cracticus torquatus*	Grey Butcherbird	+	+	+	+	+		+	+		+	+			+								
Artamidae	*Strepera graculina*	Pied Currawong	+	+	+		+		+	+	+	+		+										
Cacatuidae	*Cacatua galerita*	Sulphur-crested Cockatoo								+		+	+	+				+		+		+		
Cacatuidae	*Cacatua sanguinea*	Little Corella	+		+													+						
Cacatuidae	*Eolophus roseicapillus*	Galah																		+				+
Campephagidae	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike	+	+	+	+	+	+	+	+	+				+	+	+	+	+	+	+	+	+	+
Campephagidae	*Coracina tenuirostris*	Cicadabird	+		+	+	+	+	+	+	+													
Charadriidae	*Vanellus miles*	Masked Lapwing			+		+		+								+	+		+				
Cisticolidae	*Cisticola exilis*	Golden-headed Cisticola								+		+			+									
Columbidae	*Geopelia humeralis*	Bar-shouldered Dove											+					+	+		+	+		
Columbidae	*Leucosarcia picata*	Wonga Pigeon	+		+															+				
Columbidae	*Lopholaimus antarcticus*	Topknot Pigeon																	+					

Family	Scientific Name	Common Name	Spring 2008		Spring 2009		Summer 2010		Spring 2011		Spring 2012		Spring 2013		Spring 2014		Spring 2015		Spring 2016		Spring 2017		Spring 2018	
			North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South
Columbidae	*Ocyphaps lophotes*	Crested Pigeon		+				+		+														
Columbidae	*Phaps chalcoptera*	Common Bronzewing																			+			
Coraciidae	*Eurystomus orientalis*	Dollarbird			+		+		+		+			+		+		+		+		+	+	
Corvidae	*Corvus coronoides*	Australian Raven		+												+				+	+	+	+	
Cuculidae	*Cacomantis flabelliformis*	Fan-tailed Cuckoo			+		+		+				+							+			+	
Cuculidae	*Cacomantis variolosus*	Brush Cuckoo		+										+									+	
Cuculidae	*Centropus phasianinus*	Pheasant Coucal	+	+	+	+	+	+	+	+		+											+	
Cuculidae	*Chalcites basalis*	Horsfield's Bronze-Cuckoo	+	+	+		+	+		+														
Cuculidae	*Chalcites lucidus*	Shining Bronze-Cuckoo	+	+	+	+	+	+	+	+	+	+			+									
Cuculidae	*Eudynamys orientalis*	Eastern Koel	+	+	+	+	+		+		+			+							+			+
Cuculidae	*Scythrops novaehollandiae*	Channel-billed Cuckoo	+	+	+	+	+	+	+	+		+	+				+	+		+	+	+		
Estrildidae	*Neochmia temporalis*	Red-browed Finch			+		+					+	+	+		+	+			+	+	+		
Estrildidae	*Taeniopygia bichenovii*	Double-barred Finch		+					+		+													
Falconidae	*Falco peregrinus*	Peregrine Falcon																			+			
Halcyonidae	*Dacelo novaeguineae*	Laughing Kookaburra	+	+	+	+	+	+	+		+						+				+	+		+
Halcyonidae	*Todiramphus sanctus*	Sacred Kingfisher		+			+		+					+	+	+	+	+		+	+	+	+	+
Hirundinidae	*Hirundo neoxena*	Welcome Swallow	+	+	+		+						+	+				+						
Maluridae	*Malurus cyaneus*	Superb Fairy-wren													+	+	+	+	+	+	+	+	+	+

Family	Scientific Name	Common Name	Spring 2008		Spring 2009		Summer 2010		Spring 2011		Spring 2012		Spring 2013		Spring 2014		Spring 2015		Spring 2016		Spring 2017		Spring 2018	
			North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South
Maluridae	*Malurus lamberti*	Variegated Fairy-wren	+		+	+	+	+		+						+	+		+				+	+
Megaluridae	*Megalurus gramineus*	Little Grassbird					+		+				+											
Megaluridae	*Megalurus timoriensis*	Tawny Grassbird	+	+	+	+	+	+	+	+			+	+					+				+	
Meliphagidae	*Acanthorhynchus tenuirostris*	Eastern Spinebill							+		+							+		+	+			
Meliphagidae	*Lichenostomus chrysops*	Yellow-faced Honeyeater	+							+		+	+		+	+		+	+	+	+	+		+
Meliphagidae	*Manorina melanocephala*	Noisy Miner	+	+	+	+			+		+		+	+		+		+						+
Meliphagidae	*Manorina melanophrys*	Bell Miner											+			+		+	+	+		+		+
Meliphagidae	*Meliphaga lewinii*	Lewin's Honeyeater	+		+		+	+	+	+	+	+				+	+		+	+	+	+	+	+
Meliphagidae	*Melithreptus brevirostris*	Brown-headed Honeyeater	+	+	+	+	+	+	+	+	+	+	+											
Meliphagidae	*Melithreptus lunatus*	White-naped Honeyeater									+		+	+						+		+		+
Meliphagidae	*Myzomela sanguinolenta*	Scarlet Honeyeater												+	+	+	+	+		+	+	+		
Meliphagidae	*Philemon corniculatus*	Noisy Friarbird	+	+	+	+	+	+	+	+	+	+	+	+				+				+		
Meliphagidae	*Phylidonyris niger*	White-cheeked Honeyeater												+						+		+		
Meliphagidae	*Plectorhyncha lanceolata*	Striped Honeyeater												+										
Meropidae	*Merops ornatus*	Rainbow Bee-eater		+		+		+	+	+	+													
Monarchidae	*Grallina cyanoleuca*	Magpie-lark	+	+	+	+	+	+	+	+	+	+	+	+					+			+	+	+
Monarchidae	*Monarcha melanopsis*	Black-faced Monarch											+											
Monarchidae	*Myiagra rubecula*	Leaden Flycatcher																		+				

Family	Scientific Name	Common Name	Spring 2008		Spring 2009		Summer 2010		Spring 2011		Spring 2012		Spring 2013		Spring 2014		Spring 2015		Spring 2016		Spring 2017		Spring 2018	
			North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South
Nectariniidae	*Dicaeum hirundinaceum*	Mistletoebird							+		+		+	+		+						+		
Neosittidae	*Daphoenositta chrysoptera*	# Varied Sittella	+	+	+	+	+	+		+		+	+	+				+				+		
Oriolidae	*Oriolus sagittatus*	Olive-backed Oriole	+	+	+	+	+		+		+				+	+					+	+		+
Oriolidae	*Sphecotheres vieilloti*	Australasian Figbird	+		+		+		+		+													
Pachycephalidae	*Colluricincla harmonica*	Grey Shrike-thrush	+	+	+		+		+					+								+		
Pachycephalidae	*Pachycephala pectoralis*	Golden Whistler	+		+		+	+		+					+	+					+	+	+	+
Pachycephalidae	*Pachycephala rufiventris*	Rufous Whistler												+	+	+	+	+	+	+		+	+	+
Pardalotidae	*Pardalotus punctatus*	Spotted Pardalote	+		+		+		+				+	+										
Petroicidae	*Eopsaltria australis*	Eastern Yellow Robin	+	+				+		+		+			+		+		+		+			
Phasianidae	*Coturnix ypsilophora*	Brown Quail																		+				
Psittacidae	*Alisterus scapularis*	Australian King-Parrot																		+		+		+
Psittacidae	*Glossopsitta pusilla*	# Little Lorikeet																		+				+
Psittacidae	*Platycercus eximius*	Eastern Rosella	+	+	+		+		+	+	+	+	+		+	+		+		+			+	+
Psittacidae	*Trichoglossus chlorolepidotus*	Scaly-breasted Lorikeet																		+			+	
Psittacidae	*Trichoglossus haematodus*	Rainbow Lorikeet		+	+	+	+	+	+	+		+	+	+		+		+	+	+		+		+
Psophodidea	*Psophodes olivaceus*	Eastern Whipbird					+	+	+	+		+	+		+	+	+	+	+	+	+	+	+	+
Ptilonorhynchidae	*Ptilonorhynchus violaceus*	Satin Bowerbird		+		+		+		+		+							+		+	+	+	
Ptilonorhynchidae	*Sericulus chrysocephalus*	Regent Bowerbird																						+

Family	Scientific Name	Common Name	Spring 2008		Spring 2009		Summer 2010		Spring 2011		Spring 2012		Spring 2013		Spring 2014		Spring 2015		Spring 2016		Spring 2017		Spring 2018	
			North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South
Rallidae	*Porphyrio porphyrio*	Purple Swamphen											+	+			+					+		
Rhipiduridae	*Rhipidura albiscapa*	Grey Fantail	+	+	+	+								+	+	+	+	+	+	+	+	+	+	+
Rhipiduridae	*Rhipidura leucophrys*	Willie Wagtail			+		+									+		+		+	+	+		
Rhipiduridae	*Rhipidura rufifrons*	Rufous Fantail		+																			+	
Strigidae	*Ninox strenua*	# Powerful Owl																+						
Sturnidae	*Sturnus tristis*	*Common Myna																						
Sturnidae	*Sturnus vulgaris*	*Common Starling	+		+		+		+		+		+	+										
Threskiornithidae	*Threskiornis spinicollis*	Straw-necked Ibis																						
Timaliidae	*Zosterops lateralis*	Silvereye		+		+			+	+	+	+			+		+		+	+	+	+	+	
TOTALS			**41**	**36**	**47**	**25**	**45**	**24**	**38**	**31**	**28**	**22**	**30**	**33**	**21**	**22**	**21**	**28**	**22**	**36**	**31**	**35**	**27**	**24**

* denotes an introduced species; # denotes a threatened species under the NSW BC Act 2016 and/or the Commonwealth EPBC Act 1999.

APPENDIX 4. BIRD SPECIES LIST – NORTH SWAMP

Family	Scientific Name	Common Name	2008/2009	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014	2014/2015	2015/2016	2016/2017	2017/2018	2018/2019
Acanthizidae	*Acanthiza lineata*	Striated Thornbill							+				
Acanthizidae	*Acanthiza nana*	Yellow Thornbill	+			+	+	+	+	+			
Acanthizidae	*Acanthiza pusilla*	Brown Thornbill				+		+	+	+			+
Acanthizidae	*Sericornis frontalis*	White-browed Scrubwren	+	+	+	+	+	+		+		+	+
Accipitridae	*Accipiter novaehollandiae*	Grey Goshawk											+
Accipitridae	*Aquila audax*	Wedge-tailed Eagle	+			+	+	+				+	
Accipitridae	*Circus approximans*	Swamp Harrier	+	+	+	+		+		+		+	
Accipitridae	*Elanus axillaris*	Black-shouldered Kite						+				+	
Accipitridae	*Haliaeetus leucogaster*	# White-bellied Sea-Eagle			+			+	+	+		+	+
Accipitridae	*Haliastur sphenurus*	Whistling Kite	+					+		+	+	+	
Acrocephalidae	*Acrocephalus australis*	Australian Reed-Warbler	+	+	+	+	+	+	+	+		+	+
Alcedinidae	*Ceyx azureus*	Azure Kingfisher						+		+			
Anatidae	*Anas castanea*	Chestnut Teal	+	+	+	+	+	+	+	+	+	+	+
Anatidae	*Anas gracilis*	Grey Teal	+	+			+		+			+	
Anatidae	*Anas platyrhynchos*	* Northern Mallard	+										
Anatidae	*Anas rhynchotis*	Australasian Shoveler	+	+								+	
Anatidae	*Anas superciliosa*	Pacific Black Duck	+	+	+	+	+	+	+	+	+	+	+
Anatidae	*Aythya australis*	Hardhead	+	+		+			+				
Anatidae	*Chenonetta jubata*	Australian Wood Duck	+				+					+	
Anatidae	*Cygnus atratus*	Black Swan	+	+	+	+	+	+	+	+	+	+	+
Anatidae	*Dendrocygna arcuata*	Wandering Whistling-Duck	+										
Anhingidae	*Anhinga melanogaster*	Australasian Darter	+			+		+	+	+			
Ardeidae	*Ardea ibis*	Cattle Egret	+	+	+	+	+	+	+	+		+	+

Family	Scientific Name	Common Name	2008/2009	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014	2014/2015	2015/2016	2016/2017	2017/2018	2018/2019
Ardeidae	*Ardea intermedia*	Intermediate Egret		+			+	+	+	+		+	+
Ardeidae	*Ardea modesta*	Eastern Great Egret					+	+		+			
Ardeidae	*Ardea pacifica*	White-necked Heron					+	+	+	+		+	
Ardeidae	*Egretta garzetta*	Little Egret								+			
Ardeidae	*Egretta novaehollandiae*	White-faced Heron	+	+	+	+	+	+	+	+		+	+
Artamidae	*Artamus leucorynchus*	White-breasted Woodswallow	+		+	+	+	+		+	+	+	+
Artamidae	*Cracticus nigrogularis*	Pied Butcherbird	+	+	+	+			+	+	+	+	+
Artamidae	*Cracticus tibicen*	Australian Magpie		+	+	+	+	+		+	+	+	
Artamidae	*Cracticus torquatus*	Grey Butcherbird	+	+		+		+				+	
Cacatuidae	*Cacatua galerita*	Sulphur-crested Cockatoo	+	+				+				+	+
Cacatuidae	*Cacatua sanguinea*	Little Corella	+										
Cacatuidae	*Calyptorhynchus funereus*	Yellow-tailed Black-Cockatoo									+		
Campephagidae	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike	+	+	+	+	+	+	+	+		+	
Charadriidae	*Vanellus miles*	Masked Lapwing	+	+	+	+	+	+	+	+	+		
Ciconiidae	*Ephippiorhynchus asiaticus*	# Black-necked Stork							+				
Cisticolidae	*Cisticola exilis*	Golden-headed Cisticola		+		+	+		+	+	+	+	
Columbidae	*Geopelia humeralis*	Bar-Shouldered Dove								+			+
Columbidae	*Leucosarcia picata*	Wonga Pigeon	+										
Columbidae	*Ocyphaps lophotes*	Crested Pigeon	+	+			+	+					
Columbidae	*Streptopelia chinensis*	*Spotted Dove	+			+							
Coraciidae	*Eurystomus orientalis*	Dollarbird							+	+			
Corvidae	*Corvus coronoides*	Australian Raven	+	+	+		+	+	+	+	+	+	
Cuculidae	*Cacomantis flabelliformis*	Fan-tailed Cuckoo	+		+	+	+	+	+			+	
Cuculidae	*Cacomantis variolosus*	Brush Cuckoo	+	+									
Cuculidae	*Centropus phasianinus*	Pheasant Coucal		+			+	+					
Cuculidae	*Eudynamys orientalis*	Eastern Koel	+	+					+				

Family	Scientific Name	Common Name	2008/2009	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014	2014/2015	2015/2016	2016/2017	2017/2018	2018/2019
Cuculidae	*Scythrops novaehollandiae*	Channel-billed Cuckoo				+		+				+	
Estrildidae	*Neochmia temporalis*	Red-browed Finch	+	+	+	+	+	+	+	+			+
Falconidae	*Falco longipennis*	Australian Hobby			+								
Halcyonidae	*Dacelo novaeguineae*	Laughing Kookaburra	+	+	+	+	+	+	+	+		+	
Halcyonidae	*Todiramphus sanctus*	Sacred Kingfisher	+	+	+	+	+	+	+	+	+	+	+
Hirundinidae	*Hirundo neoxena*	Welcome Swallow	+	+	+	+	+	+	+	+		+	+
Hirundinidae	*Petrochelidon ariel*	Fairy Martin								+		+	
Jacanidae	*Irediparra gallinacea*	# Comb-crested Jacana					+						
Maluridae	*Malurus cyaneus*	Superb Fairy-wren	+	+	+	+	+	+	+	+	+	+	+
Maluridae	*Malurus lamberti*	Variegated Fairy-wren	+		+				+				
Maluridae	*Stipiturus malachurus*	Southern Emu-wren							+				
Megaluridae	*Megalurus gramineus*	Little Grassbird	+	+	+	+	+	+	+	+	+	+	+
Megaluridae	*Megalurus timoriensis*	Tawny Grassbird							+				+
Meliphagidae	*Acanthorhynchus tenuirostris*	Eastern Spinebill					+	+		+			
Meliphagidae	*Lichenostomus chrysops*	Yellow-faced Honeyeater	+	+	+			+	+	+		+	
Meliphagidae	*Manorina melanocephala*	Noisy Miner	+										
Meliphagidae	*Manorina melanophrys*	Bell Miner	+	+	+					+		+	
Meliphagidae	*Meliphaga lewinii*	Lewin's Honeyeater	+	+	+	+	+	+	+	+			
Meliphagidae	*Myzomela sanguinolenta*	Scarlet Honeyeater			+		+		+	+	+		+
Meliphagidae	*Philemon corniculatus*	Noisy Friarbird			+					+			
Monarchidae	*Grallina cyanoleuca*	Magpie-lark	+	+	+	+	+	+	+	+			
Nectariniidae	*Dicaeum hirundinaceum*	Mistletoebird			+	+			+	+		+	
Pachycephalidae	*Pachycephala pectoralis*	Golden Whistler	+	+					+				+
Pachycephalidae	*Pachycephala rufiventris*	Rufous Whistler	+	+			+		+	+			
Pardalotidae	*Pardalotus punctatus*	Spotted Pardalote	+										
Pelecanidae	*Pelecanus conspicillatus*	Australian Pelican		+						+			

Family	Scientific Name	Common Name	2008/2009	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014	2014/2015	2015/2016	2016/2017	2017/2018	2018/2019
Petroicidae	*Eopsaltria australis*	Eastern Yellow Robin	+	+	+	+	+	+	+	+			+
Phalacrocoracidae	*Microcarbo melanoleucos*	Little Pied Cormorant	+	+				+		+			
Phalacrocoracidae	*Phalacrocorax carbo*	Great Cormorant						+		+			
Phalacrocoracidae	*Phalacrocorax sulcirostris*	Little Black Cormorant	+	+	+	+	+	+	+	+			
Phalacrocoracidae	*Phalacrocorax varius*	Pied Cormorant	+			+	+			+		+	+
Phasianidae	*Coturnix ypsilophora*	Brown Quail									+		+
Podicipedidae	*Tachybaptus novaehollandiae*	Australasian Grebe	+	+		+	+	+	+	+	+	+	
Psittacidae	*Platycercus eximius*	Eastern Rosella	+	+			+			+			
Psittacidae	*Trichoglossus haematodus*	Rainbow Lorikeet		+	+			+		+			+
Psophodidae	*Psophodes olivaceus*	Eastern Whipbird	+	+	+	+	+	+	+	+		+	+
Rallidae	*Fulica atra*	Eurasian Coot					+	+	+	+			
Rallidae	*Gallinula tenebrosa*	Dusky Moorhen	+				+	+	+		+	+	
Rallidae	*Porphyrio porphyrio*	Purple Swamphen	+	+	+	+	+	+	+	+	+	+	+
Recurvirostridae	*Himantopus himantopus*	Black-winged Stilt					+	+				+	
Rhipiduridae	*Rhipidura albiscapa*	Grey Fantail	+	+	+	+	+	+	+	+	+	+	+
Rhipiduridae	*Rhipidura leucophrys*	Willie Wagtail	+	+	+	+	+	+	+	+	+	+	
Rhipiduridae	*Rhipidura rufifrons*	Rufous Fantail											+
Sturnidae	*Sturnus tristis*	*Common Myna	+		+	+				+			
Sturnidae	*Sturnus vulgaris*	*Common Starling	+	+									
Threskiornithidae	*Platalea flavipes*	Yellow-billed Spoonbill		+									
Threskiornithidae	*Platalea regia*	Royal Spoonbill	+	+			+			+	+		
Threskiornithidae	*Threskiornis molucca*	Australian White Ibis	+	+	+	+	+			+		+	+
Threskiornithidae	*Threskiornis spinicollis*	Straw-necked Ibis	+				+		+	+		+	
Timaliidae	*Zosterops lateralis*	Silvereye	+	+	+	+	+	+	+	+		+	+
		TOTALS	**64**	**52**	**41**	**43**	**51**	**54**	**51**	**62**	**22**	**47**	**36**

* denotes an introduced species; # denotes a threatened species under the NSW BC Act 2016 and/or the Commonwealth EPBC Act 1999.

APPENDIX 5. BIRD SPECIES LIST – MAIN SWAMP

Family	Scientific Name	Common Name	2008/2009	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014	2014/2015	2015/2016	2016/2017	2017/2018	2018/2019
Acanthizidae	*Acanthiza lineata*	Striated Thornbill										+	
Acanthizidae	*Acanthiza nana*	Yellow Thornbill	+	+	+	+	+	+	+	+	+		
Acanthizidae	*Acanthiza pusilla*	Brown Thornbill		+		+	+	+					
Acanthizidae	*Gerygone mouki*	Brown Gerygone								+			
Acanthizidae	*Gerygone olivacea*	White-throated Gerygone							+				
Acanthizidae	*Sericornis frontalis*	White-browed Scrubwren		+	+	+	+	+	+	+	+	+	+
Accipitridae	*Accipiter novaehollandiae*	Grey Goshawk	+						+			+	
Accipitridae	*Aquila audax*	Wedge-tailed Eagle		+									
Accipitridae	*Circus approximans*	Swamp Harrier	+	+	+	+	+			+			
Accipitridae	*Haliaeetus leucogaster*	# White-bellied Sea-Eagle								+	+		+
Accipitridae	*Haliastur sphenurus*	Whistling Kite	+		+					+	+	+	
Acrocephalidae	*Acrocephalus australis*	Australian Reed-Warbler	+	+		+	+	+	+	+	+	+	+
Anatidae	*Anas castanea*	Chestnut Teal	+	+	+	+	+	+	+	+	+	+	+
Anatidae	*Anas gracilis*	Grey Teal				+	+		+				+
Anatidae	*Anas superciliosa*	Pacific Black Duck	+	+	+	+	+	+	+	+	+	+	+
Anatidae	*Aythya australis*	Hardhead				+					+		+
Anatidae	*Chenonetta jubata*	Australian Wood Duck					+				+		
Anatidae	*Cygnus atratus*	Black Swan	+	+	+	+	+	+	+	+	+	+	+
Anatidae	*Spatula rhynchotis*	Australasian Shoveler											+
Anhingidae	*Anhinga melanogaster*	Australasian Darter				+				+			
Ardeidae	*Ardea ibis*	Cattle Egret	+	+	+		+	+	+	+	+		+
Ardeidae	*Ardea intermedia*	Intermediate Egret					+						+
Ardeidae	*Ardea modesta*	Eastern Great Egret		+			+			+			
Ardeidae	*Ardea pacifica*	White-necked Heron					+						

Family	Scientific Name	Common Name	2008/2009	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014	2014/2015	2015/2016	2016/2017	2017/2018	2018/2019
Ardeidae	*Botaurus poiciloptilus*	# Australasian Bittern											+
Ardeidae	*Egretta garzetta*	Little Egret								+			
Ardeidae	*Egretta novaehollandiae*	White-faced Heron	+		+	+	+	+	+	+	+		+
Artamidae	*Artamus leucorynchus*	White-breasted Woodswallow	+		+				+	+	+	+	
Artamidae	*Cracticus nigrogularis*	Pied Butcherbird			+	+			+	+			
Artamidae	*Cracticus tibicen*	Australian Magpie		+	+				+	+			
Artamidae	*Cracticus torquatus*	Grey Butcherbird	+	+	+		+	+	+				
Artamidae	*Strepera graculina*	Pied Currawong					+						
Cacatuidae	*Cacatua galerita*	Sulphur-crested Cockatoo	+			+							+
Cacatuidae	*Cacatua sanguinea*	Little Corella						+		+			
Cacatuidae	*Calyptorhynchus funereus*	Yellow-tailed Black-Cockatoo									+		
Cacatuidae	*Eolophus roseicapillus*	Galah					+					+	+
Campephagidae	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike		+				+	+	+	+	+	
Campephagidae	*Coracina tenuirostris*	Cicadabird		+	+	+							
Charadriidae	*Vanellus miles*	Masked Lapwing	+					+		+			+
Cisticolidae	*Cisticola exilis*	Golden-headed Cisticola	+	+	+	+							
Climacteridae	*Cormobates leucophaea*	White-throated Treecreeper							+				
Columbidae	*Ocyphaps lophotes*	Crested Pigeon										+	
Coraciidae	*Eurystomus orientalis*	Dollarbird			+		+	+	+	+		+	+
Corvidae	*Corvus coronoides*	Australian Raven	+	+			+	+	+	+		+	+
Cuculidae	*Cacomantis flabelliformis*	Fan-tailed Cuckoo	+			+		+	+				
Cuculidae	*Cacomantis variolosus*	Brush Cuckoo	+					+					
Cuculidae	*Chalcites lucidus*	Shining Bronze-Cuckoo	+										
Cuculidae	*Scythrops novaehollandiae*	Channel-billed Cuckoo		+			+	+		+			
Estrildidae	*Neochmia temporalis*	Red-browed Finch	+	+	+		+	+	+	+	+	+	
Halcyonidae	*Dacelo novaeguineae*	Laughing Kookaburra	+									+	
Halcyonidae	*Todiramphus sanctus*	Sacred Kingfisher	+	+	+			+				+	

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Family	Scientific Name	Common Name	2008/2009	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014	2014/2015	2015/2016	2016/2017	2017/2018	2018/2019
Hirundinidae	*Hirundo neoxena*	Welcome Swallow	+	+	+	+	+	+	+	+	+	+	+
Hirundinidae	*Petrochelidon ariel*	Fairy Martin	+	+	+			+					+
Maluridae	*Malurus cyaneus*	Superb Fairy-wren	+	+	+	+	+	+	+	+	+	+	+
Maluridae	*Malurus lamberti*	Variegated Fairy-wren	+	+			+						
Megaluridae	*Megalurus gramineus*	Little Grassbird		+	+	+	+	+		+			+
Megaluridae	*Megalurus timoriensis*	Tawny Grassbird		+						+			
Meliphagidae	*Acanthorhynchus tenuirostris*	Eastern Spinebill			+			+		+		+	
Meliphagidae	*Lichenostomus chrysops*	Yellow-faced Honeyeater	+	+		+	+	+		+		+	+
Meliphagidae	*Manorina melanocephala*	Noisy Miner	+	+									
Meliphagidae	*Manorina melanophrys*	Bell Miner	+	+					+		+	+	+
Meliphagidae	*Meliphaga lewinii*	Lewin's Honeyeater			+	+				+			
Meliphagidae	*Myzomela sanguinolenta*	Scarlet Honeyeater			+	+	+		+		+	+	+
Meliphagidae	*Philemon corniculatus*	Noisy Friarbird								+			
Meliphagidae	*Phylidonyris niger*	White-cheeked Honeyeater								+			
Monarchidae	*Grallina cyanoleuca*	Magpie-lark	+	+	+		+	+	+	+		+	
Monarchidae	*Myiagra rubecula*	Leaden Flycatcher	+										
Nectariniidae	*Dicaeum hirundinaceum*	Mistletoebird			+			+			+		
Oriolidae	*Oriolus sagittatus*	Olive-backed Oriole		+				+					
Pachycephalidae	*Pachycephala pectoralis*	Golden Whistler					+			+			
Pachycephalidae	*Pachycephala rufiventris*	Rufous Whistler			+								
Pelecanidae	*Pelecanus conspicillatus*	Australian Pelican								+			
Petroicidae	*Eopsaltria australis*	Eastern Yellow Robin			+	+	+	+	+	+		+	
Phalacrocoracidae	*Microcarbo melanoleucos*	Little Pied Cormorant	+			+	+	+		+	+		+
Phalacrocoracidae	*Phalacrocorax carbo*	Great Cormorant			+		+	+		+			+
Phalacrocoracidae	*Phalacrocorax sulcirostris*	Little Black Cormorant			+			+		+			+
Phalacrocoracidae	*Phalacrocorax varius*	Pied Cormorant					+						+
Phasianidae	*Coturnix ypsilophora*	Brown Quail								+			

Family	Scientific Name	Common Name	2008/2009	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014	2014/2015	2015/2016	2016/2017	2017/2018	2018/2019
Podicipedidae	*Tachybaptus novaehollandiae*	Australasian Grebe	+			+					+		+
Psittacidae	*Platycercus eximius*	Eastern Rosella						+			+		
Psittacidae	*Trichoglossus haematodus*	Rainbow Lorikeet		+					+	+	+	+	+
Psophodidae	*Psophodes olivaceus*	Eastern Whipbird					+	+		+			
Rallidae	*Fulica atra*	Eurasian Coot				+	+		+	+	+		
Rallidae	*Gallinula tenebrosa*	Dusky Moorhen	+	+	+	+	+	+	+		+	+	+
Rallidae	*Porphyrio porphyrio*	Purple Swamphen	+	+	+	+	+	+	+	+	+	+	+
Recurvirostridae	*Himantopus himantopus*	Black-winged Stilt					+			+			
Rhipiduridae	*Rhipidura albiscapa*	Grey Fantail	+	+	+	+	+	+	+	+	+	+	
Rhipiduridae	*Rhipidura leucophrys*	Willie Wagtail	+	+	+	+	+	+	+	+		+	+
Scolopacidae	*Gallinago hardwickii*	M Latham's Snipe					+						
Sturnidae	*Sturnus tristis*	*Common Myna			+	+							
Sturnidae	*Sturnus vulgaris*	*Common Starling			+					+			
Threskiornithidae	*Platalea flavipes*	Royal Spoonbill								+	+		
Threskiornithidae	*Plegadis falcinellus*	Glossy Ibis					+						
Threskiornithidae	*Threskiornis molucca*	Australian White Ibis	+				+		+	+			+
Threskiornithidae	*Threskiornis spinicollis*	Straw-necked Ibis	+				+	+	+	+			+
Timaliidae	*Zosterops lateralis*	Silvereye	+	+	+		+	+	+	+		+	+
		TOTALS	**40**	**37**	**38**	**32**	**46**	**41**	**36**	**54**	**30**	**31**	**37**

* denotes an introduced species; # denotes a threatened species under the NSW BC Act 2016 and/or the Commonwealth EPBC Act 1999; M denotes a migratory species listed under the Commonwealth EPBC Act 1999.

APPENDIX 6. BIRD SPECIES LIST – SOUTH SWAMP

Family	Scientific Name	Common Name	2008/2009	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014	2014/2015	2015/2016	2016/2017	2017/2018	2018/2019
Acanthizidae	*Acanthiza lineata*	Striated Thornbill						+					
Acanthizidae	*Acanthiza nana*	Yellow Thornbill					+				+		
Acanthizidae	*Acanthiza pusilla*	Brown Thornbill	+					+		+			
Acanthizidae	*Gerygone olivacea*	White-throated Gerygone								+			
Acanthizidae	*Sericornis frontalis*	White-browed Scrubwren				+	+			+		+	
Accipitridae	*Accipiter fasciatus*	Brown Goshawk											+
Accipitridae	*Aviceda subcristata*	Pacific Baza			+								
Accipitridae	*Circus approximans*	Swamp Harrier	+		+				+	+		+	
Accipitridae	*Haliaeetus leucogaster*	# White-bellied Sea-Eagle			+		+	+		+			+
Accipitridae	*Haliastur sphenurus*	Whistling Kite	+	+	+		+			+		+	
Accipitridae	*Pandion haliaetus cristatus*	Eastern Osprey							+				
Acrocephalidae	*Acrocephalus australis*	Australian Reed-Warbler	+	+	+	+	+	+	+	+		+	+
Alcedinidae	*Alcedo azurea*	Azure Kingfisher				+	+				+		
Anatidae	*Anas castanea*	Chestnut Teal	+	+	+	+	+	+	+	+	+	+	+
Anatidae	*Anas gracilis*	Grey Teal		+		+	+		+		+	+	+
Anatidae	*Anas platyrhynchos*	Domestic Duck					+						
Anatidae	*Anas superciliosa*	Pacific Black Duck	+	+	+	+	+	+	+	+	+	+	+
Anatidae	*Aythya australis*	Hardhead				+						+	+
Anatidae	*Chenonetta jubata*	Australian Wood Duck			+		+	+	+		+	+	+
Anatidae	*Cygnus atratus*	Black Swan	+	+	+	+	+	+	+	+	+	+	+
Anhingidae	*Anhinga melanogaster*	Australasian Darter				+		+					
Apodidae	*Hirundapus caudacutus*	White-throated Needletail										+	
Ardeidae	*Ardea ibis*	Cattle Egret		+	+		+	+		+		+	+

Family	Scientific Name	Common Name	2008/2009	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014	2014/2015	2015/2016	2016/2017	2017/2018	2018/2019
Ardeidae	*Ardea intermedia*	Intermediate Egret					+	+	+	+			
Ardeidae	*Ardea modesta*	Eastern Great Egret					+		+	+			
Ardeidae	*Ardea pacifica*	White-necked Heron	+	+			+		+			+	+
Ardeidae	*Egretta garzetta*	Little Egret					+	+					
Ardeidae	*Egretta novaehollandiae*	White-faced Heron	+	+	+	+	+	+	+	+	+	+	+
Artamidae	*Artamus leucorynchus*	White-breasted Woodswallow	+	+	+	+	+	+	+	+	+	+	+
Artamidae	*Cracticus nigrogularis*	Pied Butcherbird	+	+					+				+
Artamidae	*Cracticus tibicen*	Australian Magpie	+	+	+	+	+	+		+		+	
Artamidae	*Cracticus torquatus*	Grey Butcherbird	+	+	+	+		+	+				
Artamidae	*Strepera graculina*	Pied Currawong	+										
Cacatuidae	*Cacatua galerita*	Sulphur-crested Cockatoo	+	+				+		+		+	
Cacatuidae	*Cacatua sanguinea*	Little Corella					+		+	+		+	+
Cacatuidae	*Eolophus roseicapillus*	Galah			+			+		+			+
Campephagidae	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike		+	+	+	+		+	+	+	+	+
Campephagidae	*Coracina tenuirostris*	Cicadabird	+	+									
Campephagidae	*Lalage tricolor*	White-winged Triller					+	+					
Charadriidae	*Vanellus miles*	Masked Lapwing	+	+	+				+	+	+	+	+
Ciconiidae	*Ephippiorhynchus asiaticus*	# Black-necked Stork									+		
Cisticolidae	*Cisticola exilis*	Golden-headed Cisticola	+	+	+		+	+	+			+	
Climacteridae	*Cormobates leucophaea*	White-throated Treecreeper							+	+			
Columbidae	*Geopelia humeralis*	Bar-shouldered Dove										+	
Columbidae	*Geopelia striata*	Peaceful Dove									+		
Columbidae	*Leucosarcia picata*	Wonga Pigeon						+					
Columbidae	*Ocyphaps lophotes*	Crested Pigeon										+	
Coraciidae	*Eurystomus orientalis*	Dollarbird	+		+	+	+	+	+	+			
Corvidae	*Corvus coronoides*	Australian Raven	+	+	+	+	+	+	+	+	+		

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Family	Scientific Name	Common Name	2008/2009	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014	2014/2015	2015/2016	2016/2017	2017/2018	2018/2019
Cuculidae	*Cacomantis flabelliformis*	Fan-tailed Cuckoo	+	+		+	+	+		+	+	+	
Cuculidae	*Cacomantis variolosus*	Brush Cuckoo	+	+	+			+					
Cuculidae	*Centropus phasianinus*	Pheasant Coucal		+	+								+
Cuculidae	*Chalcites lucidus*	Shining Bronze-Cuckoo	+										
Cuculidae	*Chrysococcyx basalis*	Horsfield's Bronze-Cuckoo					+						
Cuculidae	*Eudynamys orientalis*	Eastern Koel	+				+	+					
Cuculidae	*Scythrops novaehollandiae*	Channel-billed Cuckoo		+				+	+				
Estrildidae	*Neochmia temporalis*	Red-browed Finch	+				+		+	+		+	+
Halcyonidae	*Dacelo novaeguineae*	Laughing Kookaburra	+	+		+	+	+	+	+	+	+	+
Halcyonidae	*Todiramphus sanctus*	Sacred Kingfisher	+	+	+	+	+	+	+	+	+	+	+
Hirundinidae	*Hirundo neoxena*	Welcome Swallow	+	+	+	+	+	+	+	+	+	+	+
Hirundinidae	*Petrochelidon ariel*	Fairy Martin		+	+			+		+		+	
Maluridae	*Malurus cyaneus*	Superb Fairy-wren	+	+	+	+	+	+	+	+	+	+	+
Maluridae	*Malurus lamberti*	Variegated Fairy-wren				+	+						
Maluridae	*Stipiturus malachurus*	Southern Emu-wren											+
Megaluridae	*Megalurus gramineus*	Little Grassbird	+	+	+	+	+	+	+		+	+	+
Megaluridae	*Megalurus timoriensis*	Tawny Grassbird	+	+						+			
Meliphagidae	*Acanthorhynchus tenuirostris*	Eastern Spinebill					+						
Meliphagidae	*Lichenostomus chrysops*	Yellow-faced Honeyeater	+	+	+		+	+		+	+	+	+
Meliphagidae	*Lichenostomus leucotis*	White-eared Honeyeater					+						
Meliphagidae	*Manorina melanocephala*	Noisy Miner	+	+	+	+			+	+			
Meliphagidae	*Manorina melanophrys*	Bell Miner	+	+	+	+	+	+	+	+	+	+	
Meliphagidae	*Meliphaga lewinii*	Lewin's Honeyeater	+	+	+	+	+	+		+		+	
Meliphagidae	*Melithreptus lunatus*	White-naped Honeyeater								+		+	
Meliphagidae	*Myzomela sanguinolenta*	Scarlet Honeyeater							+	+		+	+
Meliphagidae	*Philemon corniculatus*	Noisy Friarbird	+						+	+			

Family	Scientific Name	Common Name	2008/2009	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014	2014/2015	2015/2016	2016/2017	2017/2018	2018/2019
Meliphagidae	*Phylidonyris niger*	White-cheeked Honeyeater								+		+	
Meliphagidae	*Plectorhyncha lanceolata*	Striped Honeyeater	+	+									
Meropidae	*Merops ornatus*	Rainbow Bee-eater	+										
Monarchidae	*Grallina cyanoleuca*	Magpie-lark	+	+	+	+	+	+	+	+		+	+
Monarchidae	*Myiagra rubecula*	Leaden Flycatcher	+										
Nectariniidae	*Dicaeum hirundinaceum*	Mistletoebird				+		+	+	+			+
Neosittidae	*Daphoenositta chrysoptera*	Varied Sittella						+		+			
Oriolidae	*Oriolus sagittatus*	Olive-backed Oriole		+	+		+	+			+	+	+
Oriolidae	*Sphecotheres vieilloti*	Australasian Figbird			+								
Pachycephalidae	*Colluricincla harmonica*	Grey Shrike-thrush					+	+					
Pachycephalidae	*Pachycephala pectoralis*	Golden Whistler	+	+					+			+	
Pachycephalidae	*Pachycephala rufiventris*	Rufous Whistler	+	+	+	+		+				+	+
Pardalotidae	*Pardalotus punctatus*	Spotted Pardalote	+	+								+	
Pelecanidae	*Pelecanus conspicillatus*	Australian Pelican					+						
Petroicidae	*Eopsaltria australis*	Eastern Yellow Robin		+		+				+			+
Phalacrocoracidae	*Microcarbo melanoleucos*	Little Pied Cormorant	+	+		+	+		+	+	+	+	+
Phalacrocoracidae	*Phalacrocorax carbo*	Great Cormorant				+				+			
Phalacrocoracidae	*Phalacrocorax sulcirostris*	Little Black Cormorant		+		+	+		+	+		+	+
Phalacrocoracidae	*Phalacrocorax varius*	Pied Cormorant				+	+						+
Podicipedidae	*Tachybaptus novaehollandiae*	Australasian Grebe		+		+	+	+		+		+	+
Psittacidae	*Alisterus scapularis*	Australian King-Parrot				+				+			
Psittacidae	*Platycercus eximius*	Eastern Rosella	+	+	+	+	+	+	+	+	+	+	+
Psittacidae	*Trichoglossus haematodus*	Rainbow Lorikeet	+	+	+	+	+		+	+		+	+
Psophodidae	*Psophodes olivaceus*	Eastern Whipbird	+	+	+	+	+	+	+	+		+	+
Rallidae	*Fulica atra*	Eurasian Coot		+		+	+	+	+	+	+	+	+
Rallidae	*Gallinula tenebrosa*	Dusky Moorhen	+	+	+	+	+	+	+	+	+	+	

Family	Scientific Name	Common Name	2008/2009	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014	2014/2015	2015/2016	2016/2017	2017/2018	2018/2019
Rallidae	*Porphyrio porphyrio*	Purple Swamphen	+	+	+	+	+	+	+	+	+	+	+
Recurvirostridae	*Himantopus himantopus*	Black-winged Stilt										+	
Rhipiduridae	*Rhipidura albiscapa*	Grey Fantail	+	+		+	+	+	+	+	+	+	+
Rhipiduridae	*Rhipidura leucophrys*	Willie Wagtail	+	+	+	+	+	+	+	+	+	+	+
Scolopacidae	*Gallinago hardwickii*	[M] Latham's Snipe					+			+		+	+
Sturnidae	*Sturnus tristis*	*Common Myna			+								
Sturnidae	*Sturnus vulgaris*	*Common Starling			+								
Threskiornithidae	*Platalea regia*	Royal Spoonbill		+			+		+	+			
Threskiornithidae	*Plegadis falcinellus*	Glossy Ibis					+						
Threskiornithidae	*Threskiornis molucca*	Australian White Ibis					+		+			+	+
Timaliidae	*Zosterops lateralis*	Silvereye					+	+				+	+
		TOTALS	**51**	**53**	**43**	**44**	**62**	**51**	**48**	**59**	**30**	**57**	**47**

* denotes an introduced species; # denotes a threatened species under the NSW BC Act 2016 and/or the Commonwealth EPBC Act 1999; [M] denotes a migratory species listed under the Commonwealth EPBC Act 1999.

APPENDIX 7. ROOSTING BIRD COUNTS FROM THE MAIN SWAMP

Family	Scientific Name	Common Name	15/10/2008	5/03/2009	18/11/2009	23/03/2010	23/12/2010	23/03/2011	19/10/2011	20/03/2012	2/11/2012	5/03/2013	4/12/2013	12/12/2013	10/03/2014	26/03/2015	13/12/2015	21/04/2016	24/10/2016	7/12/2017	30/04/2018	6/12/2018	11/04/2019
Anhingidae	*Anhinga melanogaster*	Australasian Darter													1								
Ardeidae	*Ardea ibis*	Cattle Egret	57	170	67		26		188	80		120		80		280	22		88	15	2	1	
Ardeidae	*Ardea pacifica*	White-necked Heron	1																				
Ardeidae	*Egretta garzetta*	Little Egret															7						
Ardeidae	*Egretta novaehollandiae*	White-faced Heron								4		20				29	1						
Monarchidae	*Grallina cyanoleuca*	Magpie-lark													1			3					
Phalacrocoracidae	*Phalacrocorax carbo*	Great Cormorant					2			15		2		3	7							2	
Phalacrocoracidae	*Phalacrocorax sulcirostris*	Little Black Cormorant	17	10	5		14		1	5	15			8	2		6					4	
Phalacrocoracidae	*Microcarbo melanoleucos*	Little Pied Cormorant			8	3						6	1	10								4	
Phalacrocoracidae	*Phalacrocorax varius*	Pied Cormorant										10											
Rallidae	*Porphyrio porphyrio*	Purple Swamphen											2										
Threskiornithidae	*Threskiornis molucca*	Australian White Ibis	9	50	37	44		2	1			5				276	53	36		1	8	3	112
Threskiornithidae	*Threskiornis spinicollis*	Straw-necked Ibis	125	40	8	3						400				13		18			20	3	11
Ardeidae	*Ardea intermedia*	Intermediate Egret																				2	
		Total No. of Individuals	**209**	**270**	**125**	**50**	**42**	**2**	**190**	**104**	**15**	**563**	**3**	**101**	**11**	**598**	**89**	**57**	**88**	**16**	**30**	**19**	**123**

APPENDIX 8. SELECTION OF WATER BODY PHOTOGRAPHS

Plate 22: Stitched photograph of South Swamp taken in March 2012.

Plate 23: Stitched photograph of South Swamp taken in March 2015

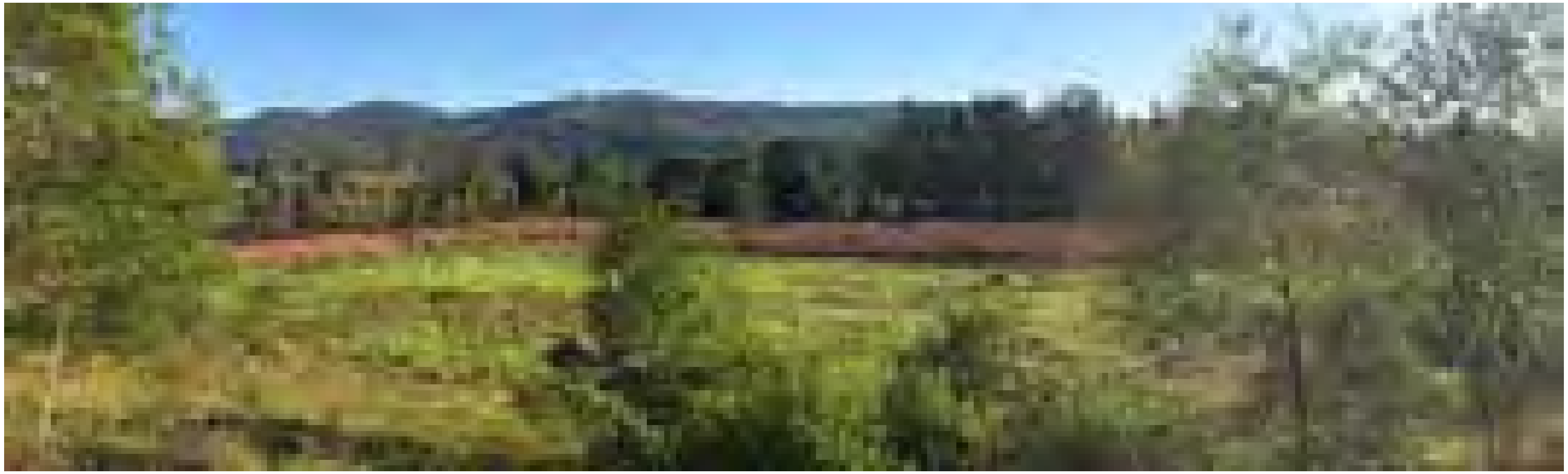

Plate 24: Stitched photograph of South Swamp taken in April 2018

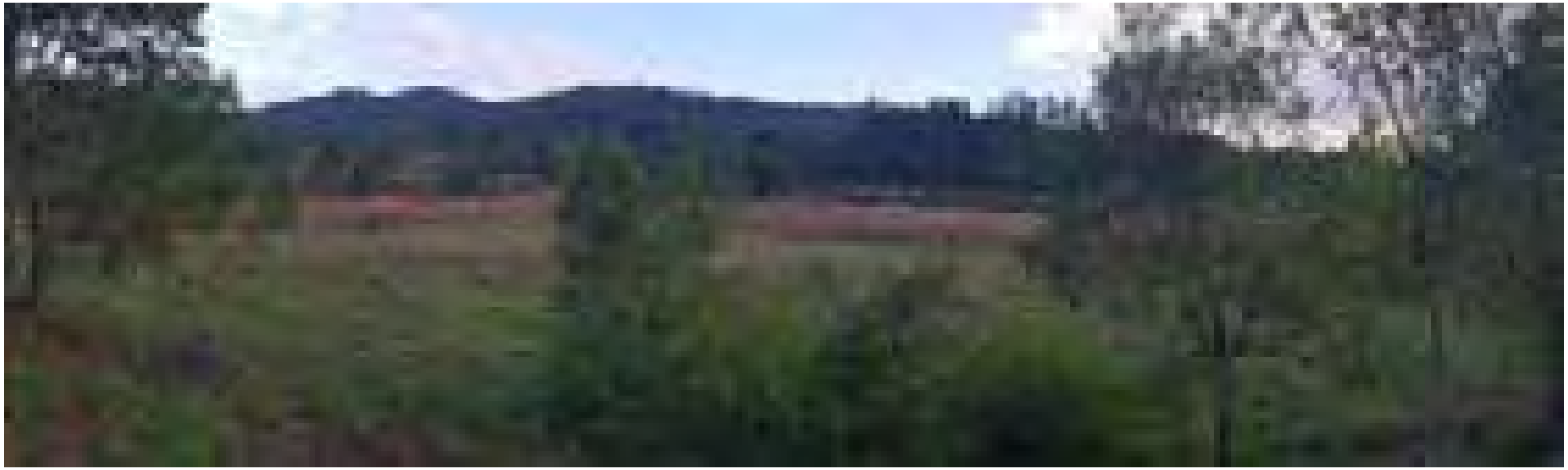

Figure 20: Stitched photograph of South Swamp taken in April 2019

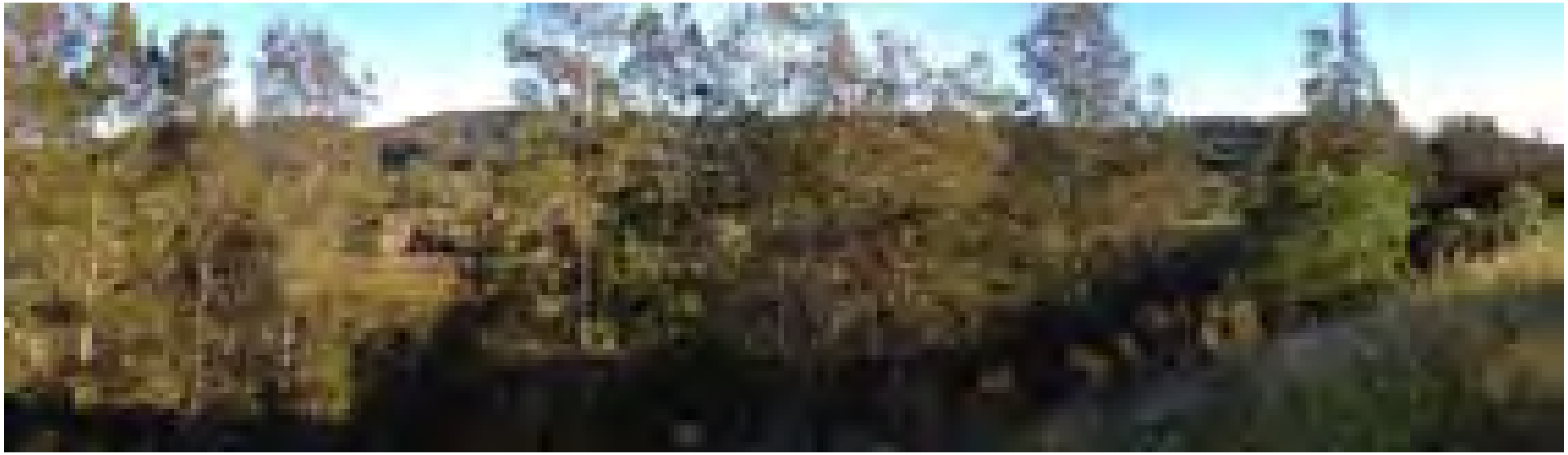

Plate 25: **Stitched photograph of Main Swamp taken in March 2012.**

Plate 26: **Stitched photograph of Main Swamp taken in March 2014.**

Plate 27: **Stitched photograph of Main Swamp taken in April 2018.**

Figure 21: **Stitched photograph of Main Swamp taken in April 2019.**

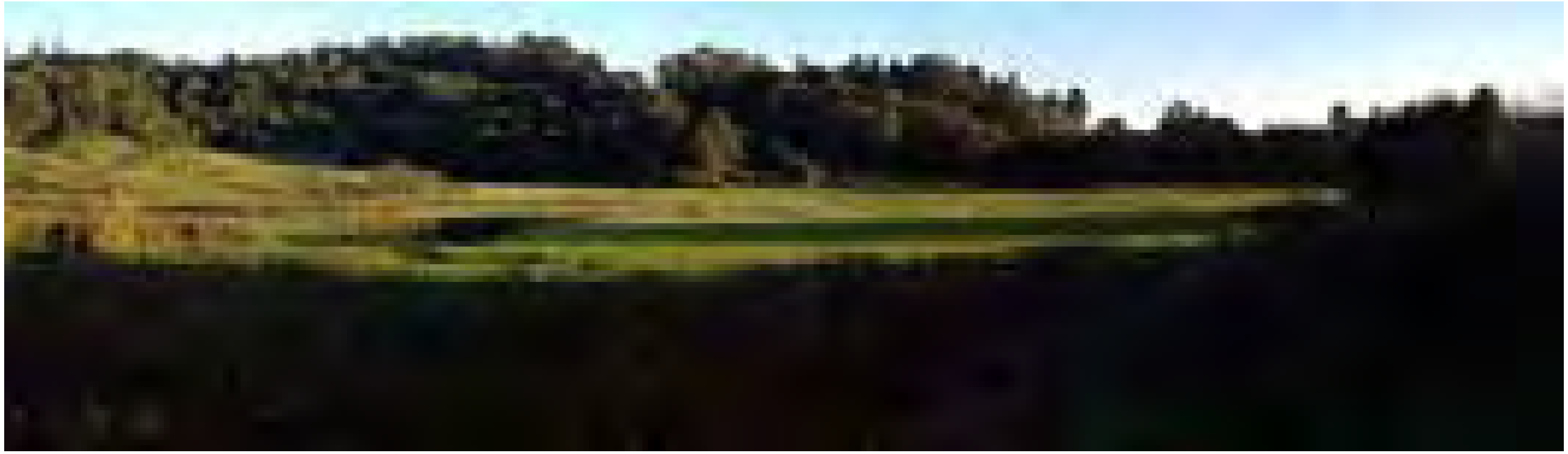

Plate 28: **Stitched photograph of North Swamp taken in March 2012.**

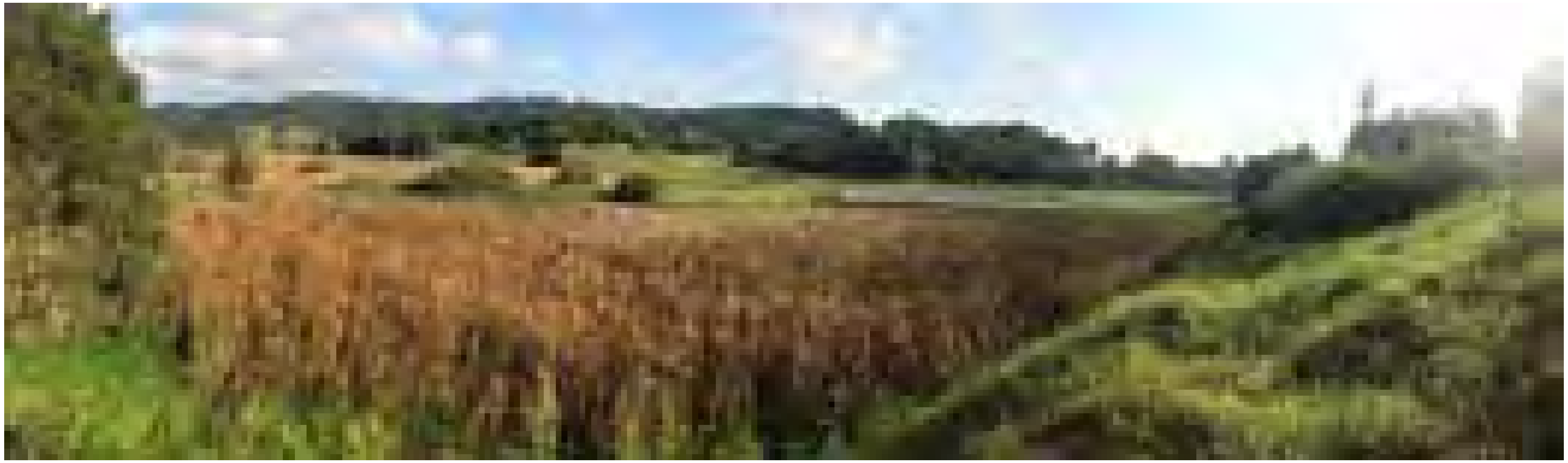
Plate 29: Stitched photograph of North Swamp taken in March 2015.

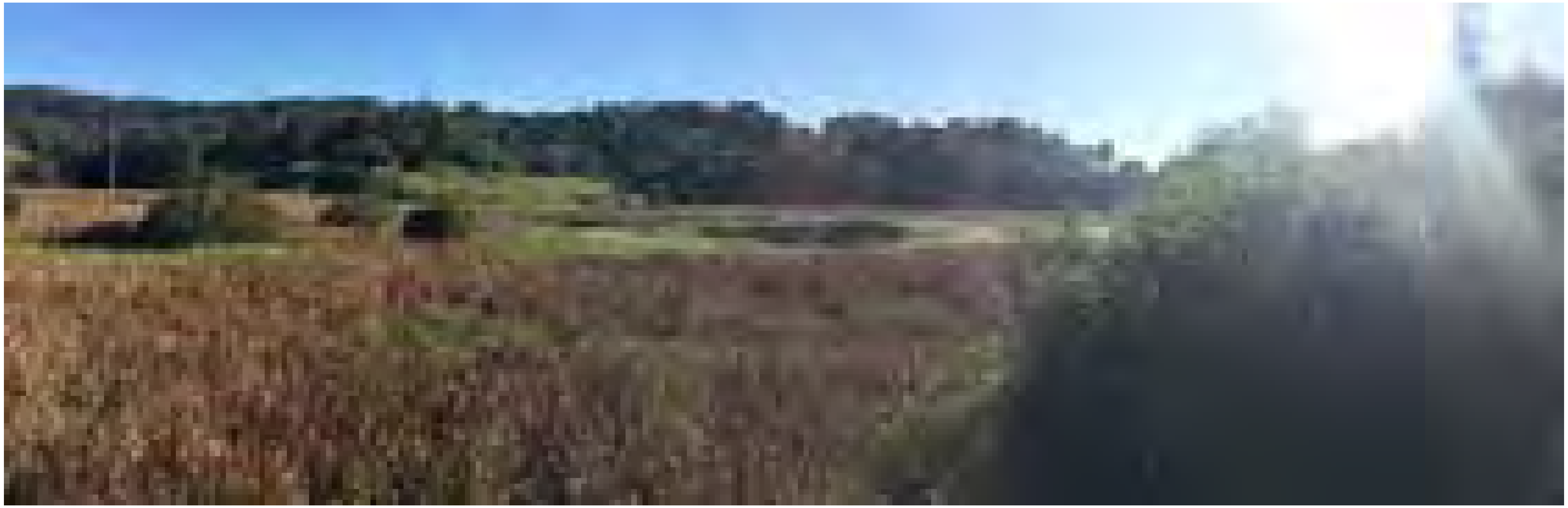
Plate 30: Stitched photograph of North Swamp taken in April 2018.

Figure 22: Stitched photograph of North Swamp taken in April 2019.

APPENDIX 9. STAFF CONTRIBUTIONS

The following staff were involved in the compilation of this report.

Name	Qualification	Title/Experience	Contribution
Bradley Deane	BBioCons / MWldMgmt	Environmental Consultant / GIS Support	Map preparation
Gayle Joyce	BSc (Forestry) (Hons)	GIS Specialist	Map preparation
Kristy Peters	B.ParkMgt/BSc. (Hons)	Senior Ecologist	Bird surveys, report review
Nigel Fisher	BSc (Hons), PhD	Restoration Ecologist	Flora survey, report writing
Elise Connolly	Dip Cons Land Mgt, AdvDip EnvMgt	Ecologist	Flora survey
Mark Dean	BEnvSc&Mgt	Ecologist	Fauna survey, report writing
Daniel O'Brien	BEnvSc&Mgt (Hons)	Ecologist	Fauna survey, report writing
Ben Stewart	MMarSc&Mgt	Ecologist	Report amendment

APPENDIX 10. LICENSING

Kleinfelder employees involved in the current study are licensed or approved under the *Biodiversity Conservation Act 2016* (License Number: SL100730, Expiry: 31 March 2020) and the Animal Research Act 1985 to harm/trap/release protected native fauna and to pick for identification purposes native flora and to undertake fauna surveys.

Appendix 4

Aquatic Monitoring Report:

Autumn 2019 and Spring 2019

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Tasman Coal Aquatic Monitoring Report

Autumn 2019

Prepared for Donaldson Coal Pty Ltd

July 2019

Document control

Project no.:	4920
Project client:	Donaldson Coal Pty Ltd
Project office:	Sydney
Document description:	Aquatic monitoring report Autumn 2019
Project Manager:	Matthew Russell
Authors:	Matthew Russell
Internal review	Lisa Carter
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Local Government Area:	Newcastle\Maitland

Author	Revision number	Internal review	Date issued	Signature
David Wilkinson	D1	Lisa Carter		

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Cover photograph: Blue Gum Creek

Executive summary

The Tasman Coal mine ceased production in July 2013 and the site has subsequently been undergoing rehabilitation since September 2014. As part of environmental monitoring requirements for the Tasman Coal mine, the aquatic ecological health of Blue Gum Creek is monitored. The aquatic monitoring program includes methods for measuring macroinvertebrates as well as water quality and catchment riparian conditions.

The aim of the aquatic monitoring program is to assess river health of Blue Gum Creek. The monitoring includes:

- Assessment of stream condition using Riparian and Channel and Environment (RCE) inventory assessment.
- Assessment of habitat condition using the AUSRIVAS proforma.
- Assessment of water quality against default ANZECC trigger values.
- Assessment of the macroinvertebrate community condition using Stream Invertebrate Grade Number Average Level (SIGNAL).

The report found that aquatic environments downstream of Tasman Coal rehabilitation works have moderate riparian and channel morphology condition. Assessment of macroinvertebrates using weighted SIGNAL scores showed that Blue Gum Creek was in poor stream health, however some pollution sensitive taxa (Leptophlebiidae) were sampled which shows that despite the poor overall health it does provide suitable habitat for this sensitive family.

Blue Gum Creek continues to exhibit degradation and poor stream health. This is indicated by pollution tolerant macroinvertebrate communities present, presence of weeds, and filamentous algae. Ongoing issues with siltation and erosion appear to be continuing to impact at the downstream site. As discussed in previous reports, these disturbances appear unrelated to the mine’s previous operations, but rather the combination of past and ongoing land use management issues in the broader catchment and low flows.

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Glossary and abbreviations

ANZECC	Australian and New Zealand Environment and Conservation Council
Anthropogenic	Caused or produced by humans
Aquatic macroinvertebrates	Animals that have no backbone, are visible with the naked eye and spend all or part of their life in water
AUSRIVAS	Australian Rivers Assessment system
CMA	Catchment Management Area
Drainage	Natural or artificial means for the interception and removal of surface or subsurface water.
Ecology	The study of the relationship between living things and the environment.
Ephemeral	Existing for a shot amount of time
Habitat	The place where a species, population or ecological community lives (whether permanently, periodically or occasionally).
RCE inventory	Riparian and Channel and Environment inventory assessment
Riparian	Relating to the banks of a natural waterway.
SIGNAL	Stream Invertebrate Grade Number Average Level. SIGNAL2 scores are indicative only and pollution does not refer to just anthropogenic sources. Environmental stress may result in poor water quality occurring naturally in waterways such as those conditions found in ephemeral streams. Low family richness and the occurrence of pollution tolerant invertebrates can give a low SIGNAL score even when they are natural condition.
Stress	Response to a stressor such as an environmental condition or a stimulus

1. Introduction

1.1 Background

The Tasman Coal mine ceased production in July 2013 and the site has subsequently been undergoing rehabilitation since September 2014. Monitoring of stream health of Blue Gum Creek is conducted biannually as part of the environmental monitoring requirements for the Tasman Coal mine . The aquatic monitoring program includes monitoring macroinvertebrates, water quality and catchment-riparian condition. These measures are used to evaluate the effectiveness of water quality protection measures established during development of the area for mining, and success of catchment rehabilitation.

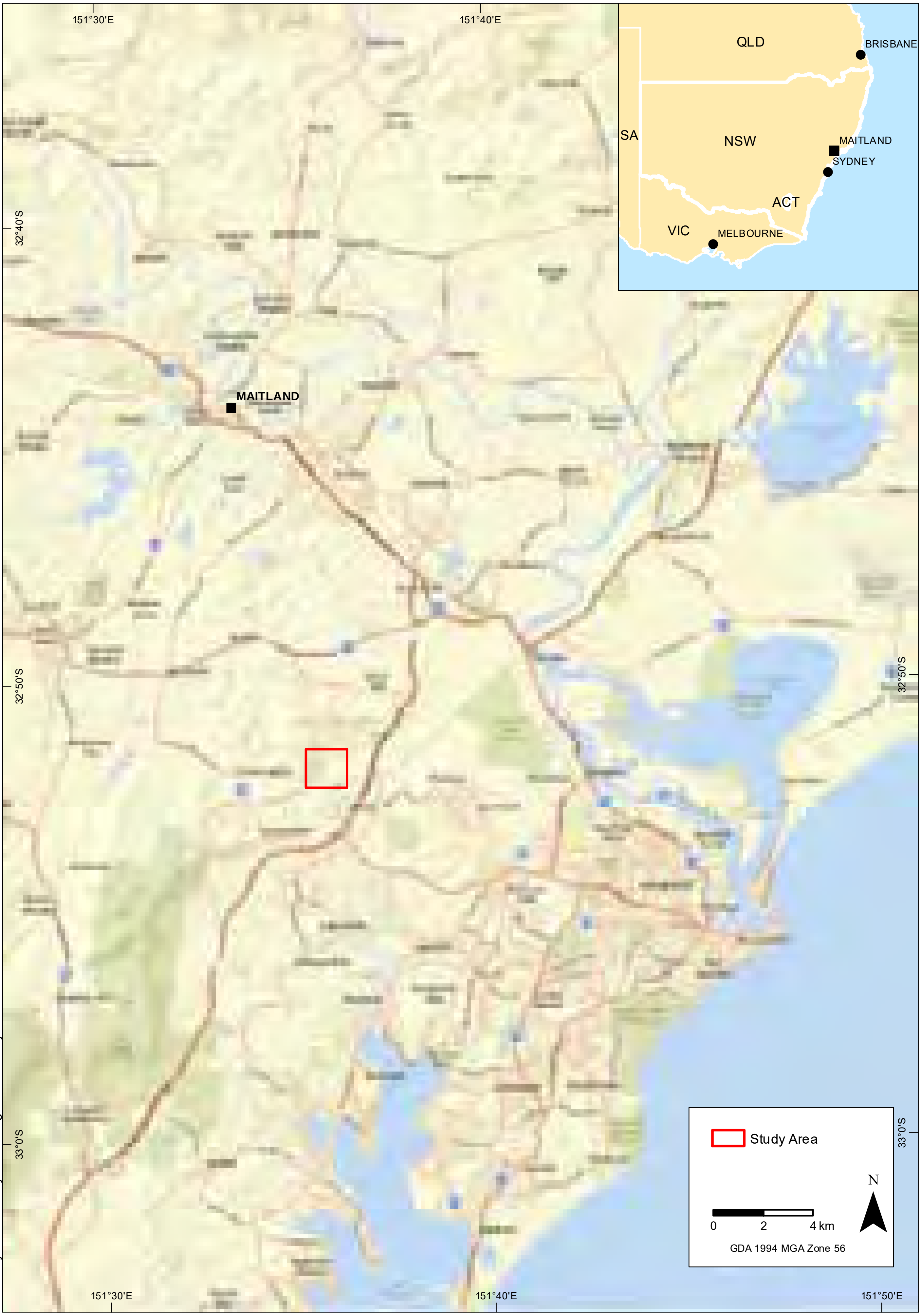
1.2 Catchment characteristics

Blue Gum Creek originates at Mount Sugarloaf, approximately two kilometres north-west of West Wallsend. It drains a catchment area of approximately 16 square kilometres upstream of Pambalong Nature Reserve. The catchment upstream of the monitoring sites is predominantly bushland, with areas that include the rehabilitated mine site and the Hunter Expressway corridor. Stockrington Quarry is also located inside the catchment to the north of Blue Gum Creek. The lower catchment includes rural land use with grazing, which occurs adjacent to the downstream monitoring site (Figure 1).

1.3 Aim

The aim of the aquatic monitoring program is to assess river health of Blue Gum Creek to determine if water quality protection measures and catchment rehabilitation are having a positive influence on the environment. The monitoring includes:

- Assessment of stream condition using Riparian and Channel and Environment (RCE) inventory assessment.
- Assessment of habitat condition using the AUSRIVAS proforma.
- Assessment of water quality against default ANZECC trigger values.
- Assessment of the macroinvertebrate community condition using Stream Invertebrate Grade Number Average Level (SIGNAL).



Regional location of study area

Tasman Coal - Aquatic Monitoring

FIGURE 1

2. Methods

2.1 Location of sampling sites

Two sampling sites are required to be sampled on Blue Gum Creek (Figure 2, Table 1). These are located downstream of the Tasman Coal rehabilitation area.

Table 1. Location of sampling sites

Site name	Stream	Location	Easting	Northing
BGC@SR	Blue Gum Creek	Blue Gum Creek upstream of Stockrington Road	368006	6362135
BGC@DHB	Blue Gum Creek	Blue Gum Creek downstream at Dog Hole Bridge	369275	6363473

2.2 Field methods

Field surveys for this monitoring event were undertaken on 28 May 2019. The field methods were consistent with standardised techniques in field sampling as prescribed by AUSRIVAS (Turak *et al*. 2000). The AUSRIVAS methods of sampling both pools and riffles have been modified for this project, as no suitable in-stream riffle features are present.

2.2.1 Aquatic habitat and stream condition

Riparian, Channel and Environment Inventory assessment (RCE)

The RCE Inventory (Chessman *et al*. 1997) provides a comparative measure of stream condition by assessing both the stream and its riparian environment in terms of habitat diversity, habitat condition and the degree of human-induced disturbance. Thirteen categories each receive a score between 1 and 4 based on their condition, resulting in an accumulated score of between 13 and 52. The maximum score (52) indicates a stream with little or no obvious physical disruption and the lowest score (13) indicates a heavily channelled stream without any riparian vegetation. An RCE score greater than 40 indicates a stream considered to be in good condition with potential for higher biodiversity values. RCE scores of 20-40 indicate a stream is in moderate condition and below 20 indicates that the stream is in very poor condition. This assessment provided a score for the general condition of the stream and must be interpreted accordingly.

Habitat description

A description of aquatic habitat was also produced using the AUSRIVAS proforma. The survey is a rapid visual assessment used to describe the habitat based on the following parameters:

- geomorphology
- channel diversity
- bank stability
- riparian vegetation and adjacent land use
- water quality
- macrophytes
- local impacts and land use practices.

Drawn by: GT Project Manager: MR Project Number: 2469 Date: 5/08/2015

Location of study sites

Tasman Coal - Aquatic Monitoring

FIGURE 2

Imagery: (c) Nearmap (May 2015)

2.2.2 Water quality

Water quality was measured *in situ* using a calibrated Yeokal 611 water quality probe at each site. The following variables were recorded:

- temperature (°C)
- conductivity (µS/cm)
- pH
- dissolved oxygen (DO)(% saturation and mg/L)
- turbidity (NTU).

Alkalinity (mg $CaCO_3$/L) was measured with a standard titration kit. Water quality data were compared with the ANZECC (2000) default guideline values to physical and chemical stressors for protection of slightly upland aquatic ecosystems in South-Eastern Australia.

2.2.3 Macroinvertebrates

Samples were collected from pool edges for a length of 10 metres, either as a continuous line or in disconnected segments. Sampling in segments was often undertaken to ensure the sampling of sub-habitats such as macrophyte beds, bank overhangs, submerged branches and root mats. Segmented sampling was also employed where pool length was short and it was logistically difficult to sample in a continuous line (e.g. in-stream logs). A 250 µm dip net was drawn through the water with short sweeps towards the bank to dislodge benthic fauna while scraping submerged rocks and debris, sides of the stream bank and the bed substrate (Plate 1). Further sweeps in the water column targeted the suspended fauna.

Plate 1: Sampling method – dip netting

Each sample was rinsed from the net onto a white sorting tray from which animals were picked using forceps, pipettes and/or paint brushes. Each tray was picked for a minimum period of 40 minutes, after which they were picked at 10 minute intervals for either a total of one hour or until no new specimens had been found. Care was taken to collect cryptic and fast moving animals, in addition to those that were conspicuous or slow. The animals collected at each site were placed into a labelled jar containing 70% ethanol.

Laboratory methods-invertebrate identification

Macroinvertebrate samples were identified to family level with the exception of Oligochaeta (to class), Polychaeta (to class), Ostracoda (to subclass), Nematoda (to phylum), Nemertea (to phylum), Acarina (to order) and Chironomidae (to subfamily). Keys used include:

- Dean, J., Rosalind, M., St Clair, M., and Cartwright, D. (2004). Identification keys to Australian families and genera of caddis-fly larvae (Trichoptera). Cooperative Research Centre for Freshwater Ecology.
- Gooderham, J. and Tsyrlin, E. (2002). The Waterbug Book: A guide to the Freshwater Macroinvertebrates of Temperate Australia, CSIRO Publishing.
- Hawking J. and Theischinger G. (1999). A guide to the identification of larvae of Australian families and to the identification of ecology of larvae from NSW. Cooperative Research Centre for Freshwater Ecology.
- Madden, C. (2010). Key to genera of Australian Chironomidae. Museum Victoria Science Reports 12,1-31.
- Madden, C. (2011). Draft identification key to families of Diptera larvae of Australian inland waters. La Trobe University.
- Smith, B. (1996). Identification keys to the families and genera of bivalve and gastropod molluscs found in Australian inland waters. Murray Darling Freshwater Research Centre.
- Website - http://www.mdfrc.org.au/bugguide/.

2.2.1 Data analysis

SIGNAL2: (Stream Invertebrate Grade Number Average Level) scores

The revised SIGNAL2 biotic index developed by Chessman (2003a, b) was used to determine the "environmental quality" of sites. This method assigns grade numbers to each macroinvertebrate family or taxa found, based largely on their response to a range of environmental conditions (Table 2). The sum of all grade numbers for that habitat is then divided by the total number of families recorded in each habitat to calculate the SIGNAL2 index. A weighted SIGNAL2 score was also calculated (see Chessman 2003b). The SIGNAL2 index therefore uses the average sensitivity of macroinvertebrate families to present a snapshot of biotic integrity at a site.

Table 3 provides a broad guide for interpreting the health of the site according to the SIGNAL 2 score of the site.

Table 2. SIGNAL Grade and the Level of Pollution Tolerance

SIGNAL Grade	Pollution Tolerance
10-8	Indicates a greater sensitivity to pollution
7-5	Indicates a sensitivity to pollution
4-3	Indicates a tolerance to pollution
2-1	Indicates a greater tolerance to pollution

Table 3. Guide to interpreting the SIGNAL 2 scores

SIGNAL 2 Score	Habitat quality
Greater than 6	Healthy habitat
Between 5 and 6	Mild pollution
Between 4 and 5	Moderate pollution
Less than 4	Severe pollution

(Source: Gooderham J and Tsyrlin E 2002)

*Note that SIGNAL2 scores are indicative only and that pollution does not refer to just anthropogenic pollution. Environmental stress may result in poor water quality occurring naturally in waterways. Low family richness and the occurrence of pollution tolerant invertebrates can give a low SIGNAL score even when they are in natural condition.

2.2.2 Opportunistic observations

Opportunistic visual observations of aquatic fauna were recorded during sampling at each sampling site.

3. Results

3.1 Weather conditions

Surveys were conducted on 28 May 2019. The weather was mild (approximately 18°C) with light winds. The highest daily rainfall in the previous five months occurred in March, with daily total of 66.3 mm (Figure 3). There was little rain fall in the two weeks prior to sampling. There were low flows at the time of sampling.

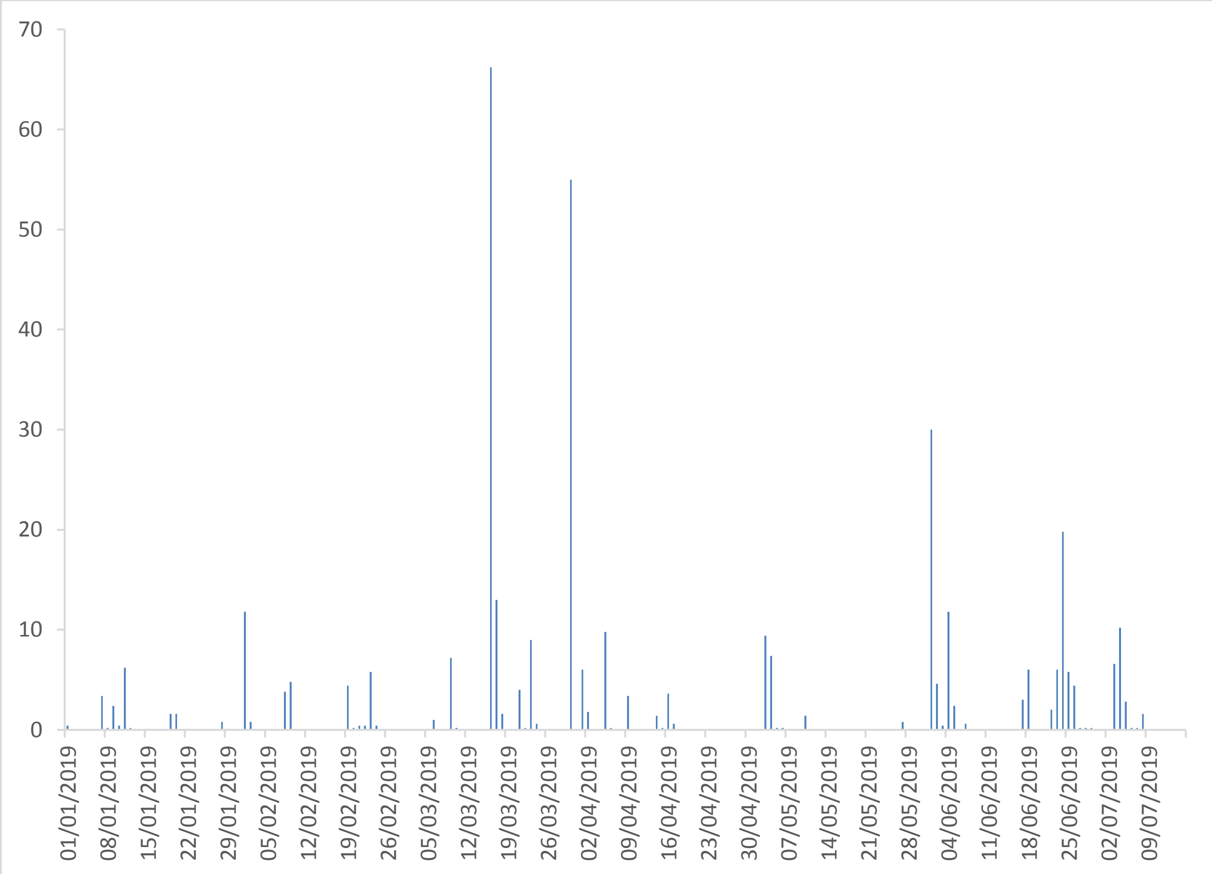


Figure 3: Total daily rainfall at Abel rain gauge (January –July 2019). Source: Donaldson Coal

3.2 Aquatic habitat

The aquatic habitat of the study area comprises pools with no riffles present. Water level was low during the survey. The sampling sites generally had moderate riparian and channel health (RCE 20-40) which is consistent with previous monitoring events. The upstream site (BGC@SR) had a mixture of native and exotic vegetation, however the channel was stable and no erosion or sedimentation present. The Blue Gum Creek downstream site (BGC@DHB) had fine sand/silt substrate and showed some evidence of erosion and sedimentation. Duck Weed (*Spirodela spp.*) was present at the downstream site. Both sampling sites had significant algae growth. Table 4 shows the RCE inventory scores of each sampling site.

Table 4. RCE inventory scores

Site number	Autumn 2015	Spring 2015	Autumn 2016	Spring 2016	Autumn 2016	Spring 2017	Autumn 2018	Spring 2018	Autumn 2019
BGC@SR	33	36	39	40	38	-	39	38	38
BGC@DHB	36	36	39	32	38	35	36	36	35

3.2.1 Blue Gum Creek at Stockrington Road

The aquatic habitat of Blue Gum Creek at Stockrington Road (BGC@SR) (Plate 2) at the time of the Autumn 2019 monitoring surveys is detailed in Table 5.

Plate 2. Blue Gum Creek at Stockrington Road.

Table 5. Blue Gum Creek at Stockrington Road habitat results

	Attribute	Blue Gum Creek at Stockrington road upstream
	Photograph	Plate 2
Riparian	RCE score	38
	Vegetation	Canopy vegetation included Blue Gum (*Eucalyptus saligna*), Cheese Tree (*Glochidion ferdinandi*), Coachwood (*Ceratopetalum apetalum*) and Sandpaper fig (*Ficus coronata*). The mid-storey was dominated by Lantana (*Lantana camara*), Tobacco Bush (*Solanum mauritianum*), Cheese Tree (*G. Ferdinandi*) and the groundcover by native and exotic grasses and herbs.
	Stream shading	Low
	Exotic vegetation	Lantana (*L. camara*), Crofton Weed (*Ageratina adenophora*), Tobacco bush (*S. mauritianum*)
Stream characteristics	Modal width (m)	2
	Substrate	Silt 70%/Boulder 20%/Sand 10%
	Flow/depth	No flow/<1m
	Macrophytes/algae	Slender knot weed (*Persicaria decipiens*), Cat tail *Typha sp.* /Lots of algae
	Water quality observations	Poor, Lots of filamentous algae
Comments		Similar to previous sampling conditions, although water quality appears to have deteriorated and appears soupy.

3.2.2 Blue Gum Creek at Dog Hole Bridge

The aquatic habitat of Blue Gum Creek at Dog Hole Bridge (BGC@DHB) (Plate 3) at the time of the Autumn 2019 monitoring surveys is detailed in Table 6.

Plate 3. Blue Gum Creek at Dog Hole Bridge

Table 6. Blue Gum Creek at Dog Hole Bridge habitat results

	Attribute	Blue Gum Creek at Dog Hole Bridge
	Photograph	Plate 3
Riparian	RCE score	35
	Vegetation	Canopy vegetation included Blue Gum (*E. saligna*) and Lilly Pilly (*Syzygium smithii*). The mid-storey was dominated by Lantana *(L. camara*), Cheese Tree (*G. ferdinandi*) and Privet (*Ligustrum sinense*) and the ground cover by native grasses, herbs, and Scurvy Weed (*Commelina cyanea*).
	Stream shading	Moderate
	Exotic vegetation	Lantana (*L. camara*), Privet (*Ligustrum sinense*)
Stream characteristics	Modal width (m)	2.5
	Substrate	Boulder 5%/ Cobble 20%/ Gravel 10%/ Silt 55%/ Sand 10%
	Flow/depth	No flow/<1m
	Macrophytes/algae	Slender Knot weed (*P. decipiens*), Duck Weed (*Spirodela* spp.) Lots of algae
	Water quality observations	Poor, Lots of algae and macrophytes.
Comments		Similar to previous sampling conditions. No flow. Bank clear of some vegetation.

3.3 Water quality

Water quality results (Table 7), showed that the temperature was consistent between both upstream (BG@SR) and downstream (BG@DHB) sites (10.69°C and 10.68 °C respectively). Conductivity was relatively high at both sites (976µ/cm and 973 µ/cm); exceeding the default ANZECC guideline of 350 µ/cm but below the EPL limit of 2000 µ/cm. Turbidity measurements were low at the upstream site, 4.4 NTU (BGC@SR) and high at the downstream site, 130.4 NTU (BGC@DHB), exceeding ANZECC guidelines. Dissolved Oxygen (DO) was low; 27.8% saturation upstream and 14% saturation downstream which is below the ANZECC guideline of 80-110%. The pH readings of 7.31 and 6.83 were both within ANZECC guidelines. Alkalinity was 120 mg $CaCO_3$/L upstream and 140 $CaCO_3$/L downstream.

Table 7. Water quality results

Site number	Temp (C°)	Conductivity (µS/cm)	Turbidity (NTU)	Dissolved Oxygen (% sat)	pH	Alkalinity (mg $CaCO_3$/L)
BGC@SR	10.69	976	4.4	27.8	7.31	120
BGC@DHB	10.68	973	130.4	14	6.83	140

ANZECC guidelines for upland streams: Electrical conductivity (30-350 µS/cm)/ EPL Limit 2000 µ/cm, Turbidity (6-50 NTU), pH (6.5-8), Dissolved Oxygen (80-110%). Text in bold indicate those variables that exceed the default trigger values.

Note: For some waterways, default ANZECC guidelines do not reflect typical background water quality and chemistry. Therefore, an assessment of water quality monitoring data against default values can suggest the condition of the waterway is outside the normal range, or polluted, when in fact it is 'clean', or vice versa.

3.4 Macroinvertebrates

SIGNAL2 results for the two sampling sites are provided in Table 8. Raw data is provided in Annex 1.

Table 8. Macroinvertebrate results

Site number	Number of Taxa	SIGNAL2	SIGNAL2 weighted
BGC@SR	19	4.05	4.28
BGC@DHB	13	4	4.44

The sampling sites had a low- moderate diversity of macroinvertebrate families (13-19) (Table 8). SIGNAL2 and weighted SIGNAL 2 scores indicated that the sites had moderate pollution (~4 SIGNAL), with a dominance of pollution tolerant macroinvertebrate families. However, pollution sensitive mayflies Leptophlebiidae (SIGNAL 8) and caddis flies Leptoceridae (SIGNAL 6) were recorded at both sampling sites. Other sensitive species include beetle larvae Elmidae (SIGNAL 8) at Blue Gum Creek upstream site and Scirtidae (SIGNAL 6) at Blue Gum Creek downstream site. There has been an increase in SIGNAL 2 score since sampling in Spring 2018 (Table 9). The SIGNAL bi-plot (Figure 4) indicates that the downstream sites are potentially suffering from urban, industrial or agricultural pollution and upstream high nutrients or salinity.

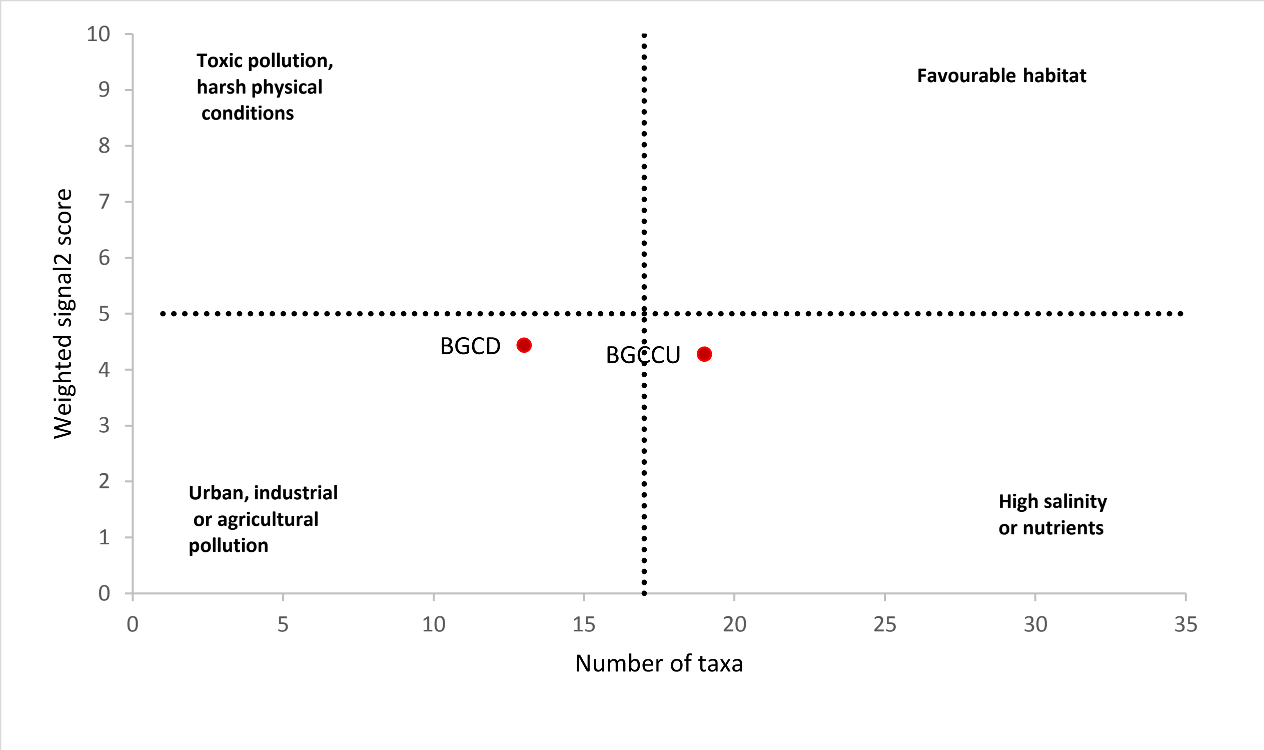


Figure 4. SIGNAL 2 Bi-plot

Table 9. 2015, 2016, 2017, 2018, 2019 weighted SIGNAL scores

Site number	Autumn 2015 Weighted SIGNAL 2	Spring 2015 Weighted SIGNAL 2	Autumn 2016 Weighted SIGNAL 2	Spring 2016 Weighted SIGNAL 2	Autumn 2017 Weighted SIGNAL 2	Spring 2017 Weighted Signal	Autumn 2018 Weighted SIGNAL 2	Spring 2018 Weighted SIGNAL 2	Autumn 2019 Weighted SIGNAL 2
BGC@SR	4.45	3.29	3.75	3.98	3.41	-	3.96	3.18	4.28
BGC@DHB	4.1	3.17	3.76	2.73	2.94	3.43	3.81	3.54	4.44

3.5 Other fauna

Introduced fish *Gambusia holbrooki* were observed at the Blue Gum Creek upstream site (BGC@SR).

4. Discussion

4.1 RCE Inventory Scores

RCE Inventory scores were similar to previous results with scores between 20-40 indicating moderate condition. These scores are similar to those calculated in Spring 2018 (Table 4) and are within the range of scores (33-40) recorded since commencement of the monitoring program (Tuft 2013).

4.2 SIGNAL Scores and stream health

The low SIGNAL scores recorded (~4) are consistent with previous monitoring and potentially the result of the creek being highly disturbed. Disturbances include presence of weeds, and visible erosion and siltation at the downstream site. There was also filamentous algae present at both sites, potentially indicating high nutrients. The low flows are also likely contributing to a reduction in the quality and quantity of pool habitat for aquatic species.

Despite some poor SIGNAL scores at both sites, there remains potential for improvements in stream health with the presence of sensitive mayfly taxa Leptophlebiidae (SIGNAL 8) (Annex 1), indicating that Blue Gum Creek can support some sensitive taxa. The results are consistent with conclusions from previous monitoring reports that found both sites show a predominance of pollution tolerant families and few sensitive taxa (Tuft 2014; Niche 2015 a, b; Niche 2016 a, b; Niche 2017 a, b, Niche 2018a, b).

4.3 Water quality

This report identified elevated electrical conductivity (EC) within Blue Gum Creek. Although relatively high and exceeding ANZECC default guidelines, these levels are consistent with recent surveys (Niche 2017a, b; Niche 2018a, b) and results prior to the commencement of the mine operations (Newcastle Coal 2002). High alkalinity in Blue Gum Creek indicates that the waterway has a high buffering capacity; providing it with a high resistance to changes in pH. Despite exceedances in EC and dissolved oxygen, these results are likely within the pre – mine variability of Blue Gum Creek.

5. Conclusion

Blue Gum Creek continues to exhibit aquatic monitoring results that indicate degradation and poor stream health. This is indicated by the dominance of pollution tolerant macroinvertebrate communities present, presence of weeds and filamentous algae. Ongoing issues with siltation and erosion appear to be continuing to impact on this waterway. As discussed in previous reports, these disturbances appear unrelated to the Tasman Coal mine's previous operations, but rather past and ongoing land use management issues exacerbated by low flows.

6. References

Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) (2000). National water quality management strategy and assessment guidelines: Australian and New Zealand guidelines for fresh and marine water quality ANZECC/ARMCANZ.

Chessman B. C., Growns J.E and Kotlash A.R. (1997) Objective derivation of macroinvertebrate family sensitivity grade numbers for the SIGNAL biotic index: allocation to the Hunter River system, NewSouth Wales. *Marine and Freshwater Research.* **48**, 159-172.

Chessman B. (2003a) New sensitivity grades for Australian macroinvertebrates. Marine and Freshwater Research **54,** 95-1032

Chessman B. (2003b) SIGNAL 2 – A Scoring System for Macro-invertebrate ('Water Bugs') in Australian Rivers, Monitoring River Heath Initiative Technical Report no 31, Commonwealth of Australia, Canberra DWR, 199

Dean, J., Rosalind, M., St Clair, M., and Cartwright, D. (2004) Identification keys to Australian families and genera of caddis-fly larvae (Trichoptera) Cooperative Research Centre for Freshwater Ecology.

Gooderham, J. and Tsyrlin, E. (2002). The Waterbug Book: A guide to the Freshwater Macroinvertebrates of Temperate Australia, CSIRO Publishing.

Hawking and Theischinger (1999) A guide to the identification of larvae of Australian families and to the identification of ecology of larvae from NSW.

Niche Environment and Heritage (2015a). Tasman Coal Aquatic Monitoring Report – Autumn 2015. Prepared for Tasman Coal.

Niche Environment and Heritage (2015b). Tasman Coal Aquatic Monitoring Report – Spring 2015. Prepared for Tasman Coal.

Niche Environment and Heritage (2016a). Tasman Coal Aquatic Monitoring Report – Autumn 2016. Prepared for Tasman Coal.

Niche Environment and Heritage (2016b). Tasman Coal Aquatic Monitoring Report – Spring 2016. Prepared for Tasman Coal.

Niche Environment and Heritage (2017a). Tasman Coal Aquatic Monitoring Report – Autumn 2017. Prepared for Tasman Coal.

Niche Environment and Heritage (2017b). Tasman Coal Aquatic Monitoring Report – Spring 2017. Prepared for Tasman Coal.

Niche Environment and Heritage (2018a). Tasman Coal Aquatic Monitoring Report – Spring 2017. Prepared for Tasman Coal.

Niche Environment and Heritage (2018b). Tasman Coal Aquatic Monitoring Report – Spring 2017. Prepared for Tasman Coal.

Madden, C. (2010) Key to genera of Australian Chironomidae. Museum Victoria Science Reports **12,** 1-31.

Madden, C. (2011) Draft identification key to families of Diptera larvae of Australian inland waters La Trobe University.

Robyn Tuft and Associates (2014). Tasman Coal Mine Macroinvertebrate Sampling Program Pre-mining Survey – November 2014

Smith, B. (1996) Identification keys to the families and genera of bivalve and gastropod molluscs found in Australian inland waters Murray Darling Freshwater Research Centre.

Turak E., Waddell N., and Johnstone G. (2000) NSW AUSRIVAS Sampling and Processing Manual. Department of Environment and Conservation.

Websites

http://ausrivas.ewater.com.au/

http://www.mdfrc.org.au/bugguide/

http://www.bom.gov.au/

Annex 1. Macroinvertebrate survey results

	Blue Gum Creek at Stockrington Road upstream site	Blue Gum Creek at Dog Hole Bridge downstream site
Hydrobiidae	5	
Oligochaeta	1	
Atyidae	3	
Dytiscidae	9	17
Elmidae	1	
Hydrophilidae	6	
Scirtidae		17
Dixidae	1	
Ceratopogonidae	1	
Tanypodinae	6	
Chironominae	7	70
Baetidae	7	
Leptophlebiidae	31	24
Corixidae	1	1
Coenagrionidae	1	2
Megapodagrionidae		1
Gomphidae	1	1
Hemicorduliidae	2	2
Libellulidae	1	
Leptoceridae	3	2
Micronectidae	2	1
Sphaeriidae		3
Glossiphoniidae		1

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Tasman Coal Aquatic Monitoring Report

Spring 2019

Prepared for Donaldson Coal Pty Ltd | 24 September 2019

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Environment and Heritage

Document control

Project number	Client	Project manager	LGA
4920	Donaldson Coal	Matthew Russell	Newcastle/Maitland

Version	Author	Review	Status	Date
D1	David Wilkinson	Matthew Russell	Draft	20/09/2019
Rev1			Final	24/09/2019

Executive summary

The Tasman Coal mine ceased production in July 2013 and the site has subsequently been undergoing rehabilitation since September 2014. As part of environmental monitoring requirements for the Tasman Coal mine, the aquatic ecological health of Blue Gum Creek is monitored. The aquatic monitoring program includes methods for measuring macroinvertebrates as well as water quality and catchment riparian conditions.

The aim of the aquatic monitoring program is to assess river health of Blue Gum Creek. The monitoring includes:

- Assessment of stream condition using Riparian and Channel and Environment (RCE) inventory assessment.
- Assessment of habitat condition using the AUSRIVAS proforma.
- Assessment of water quality against default ANZECC trigger values.
- Assessment of the macroinvertebrate community condition using Stream Invertebrate Grade Number Average Level (SIGNAL).

The report found that aquatic environments downstream of Tasman Coal rehabilitation works have moderate riparian and channel morphology condition. Assessment of macroinvertebrates using weighted SIGNAL scores showed that Blue Gum Creek was in poor stream health, however some pollution sensitive taxa (Leptophlebiidae) were sampled which shows that despite the poor overall health it does provide suitable habitat for this sensitive family.

Blue Gum Creek continues to exhibit degradation and poor stream health. This is indicated by pollution tolerant macroinvertebrate communities present, presence of weeds, and filamentous algae. However algae coverage had reduced in the upstream site since Autumn 2019 survey and showed visual improvement in aquatic habitat. Ongoing issues with siltation and erosion appear to be continuing to impact at the downstream site. As discussed in previous reports, these disturbances appear unrelated to the mine's previous operations, but rather the combination of past and ongoing land use management issues in the broader catchment and low flows.

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Glossary and abbreviations

ANZECC	Australian and New Zealand Environment and Conservation Council
Anthropogenic	Caused or produced by humans
Aquatic macroinvertebrates	Animals that have no backbone, are visible with the naked eye and spend all or part of their life in water
AUSRIVAS	Australian Rivers Assessment System
CMA	Catchment Management Area
Drainage	Natural or artificial means for the interception and removal of surface or subsurface water.
Ecology	The study of the relationship between living things and the environment.
Ephemeral	Existing for a short amount of time.
Habitat	The place where a species, population or ecological community lives (whether permanently, periodically or occasionally).
LMP	Landscape Management Plan
RCE inventory	Riparian and Channel and Environment inventory assessment.
Riparian	Relating to the banks of a natural waterway.
SIGNAL	Stream Invertebrate Grade Number Average Level. SIGNAL2 scores are indicative only and pollution does not refer to just anthropogenic sources. Environmental stress may result in poor water quality occurring naturally in waterways such as those conditions found in ephemeral streams. Low family richness and the occurrence of pollution tolerant invertebrates can give a low SIGNAL score even though they are a natural condition
Stress	Response to a stressor such as an environmental condition or a stimulus.

1. Introduction

1.1 Background

The Tasman Coal mine ceased production in July 2013 and the site has subsequently been undergoing rehabilitation since September 2014. Monitoring of stream health of Blue Gum Creek is conducted biannually as part of the environmental monitoring requirements for the Tasman Coal mine. The aquatic monitoring program includes monitoring macroinvertebrates, water quality and catchment-riparian condition. These measures are used to evaluate the effectiveness of water quality protection measures established during development of the area for mining, and success of catchment rehabilitation.

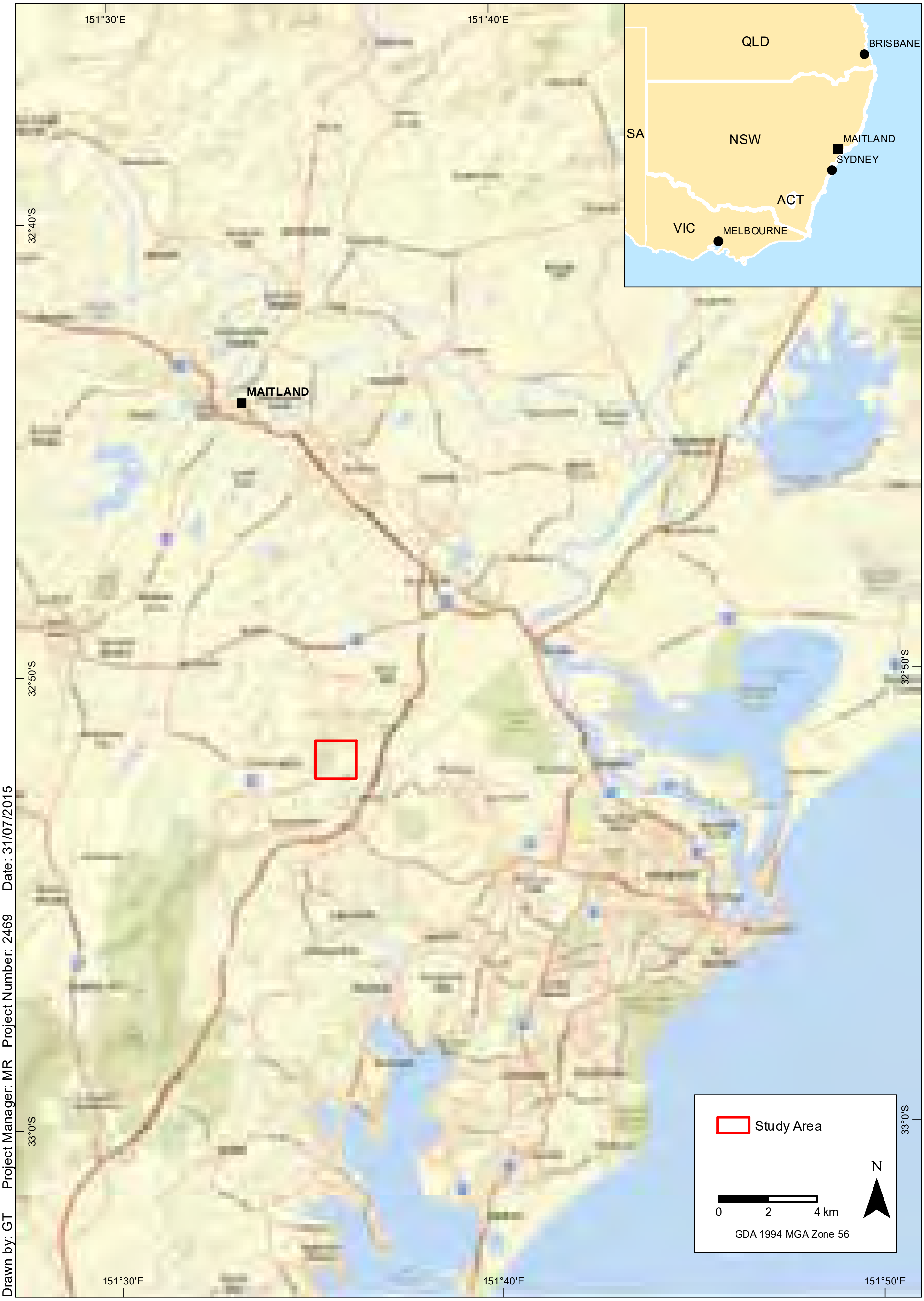
1.2 Catchment characteristics

Blue Gum Creek originates at Mount Sugarloaf, approximately two kilometres north-west of West Wallsend. It drains a catchment area of approximately 16 square kilometres upstream of Pambalong Nature Reserve. The catchment upstream of the monitoring sites is predominantly bushland, with areas that include the rehabilitated mine site and the Hunter Expressway corridor. Stockrington Quarry is also located inside the catchment to the north of Blue Gum Creek. The lower catchment includes rural land use with grazing, which occurs adjacent to the downstream monitoring site (Figure 1).

1.3 Aim

The aim of the aquatic monitoring program is to assess river health of Blue Gum Creek to determine if water quality protection measures and catchment rehabilitation are having a positive influence on the environment. The monitoring includes:

- Assessment of stream condition using Riparian and Channel and Environment (RCE) inventory assessment.
- Assessment of habitat condition using the AUSRIVAS proforma.
- Assessment of water quality against default ANZECC trigger values.
- Assessment of the macroinvertebrate community condition using Stream Invertebrate Grade Number Average Level (SIGNAL).



Regional location of study area
Tasman Coal - Aquatic Monitoring

FIGURE 1

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2. Methods

2.1 Location of monitoring sites

Two sampling sites are required to be sampled on Blue Gum Creek (Figure 2; Table 1). These are located downstream of the Tasman Coal rehabilitation area.

Table 1: Location of sampling sites

Site acronym	Stream	Location	Easting	Northing
BGC SR	Blue Gum Creek	Blue Gum Creek upstream of Stockrington Road	368006	6362135
BGC DHB	Blue Gum Creek	Blue Gum Creek downstream at Dog Hole Bridge	369275	6363473

2.2 Field methods

Field surveys for this monitoring event were undertaken on 16 September 2019. The field methods were consistent with standardised techniques in field sampling as prescribed by AUSRIVAS (Turak et al. 2000). The AUSRIVAS methods of sampling both pools and riffles have been modified for this project, as no suitable in-stream riffle features are present.

2.2.1 Aquatic habitat and stream condition

Riparian, Channel and Environment inventory assessment (RCE)

The RCE Inventory (Chessman *et al*. 1997) provides a comparative measure of stream condition by assessing both the stream and its riparian environment in terms of habitat diversity, habitat condition and the degree of human-induced disturbance. Thirteen categories each receive a score between one and four based on their condition, resulting in an accumulated score of between 13 and 52. The maximum score (52) indicates a stream with little or no obvious physical disruption and the lowest score (13) indicates a heavily channelled stream without any riparian vegetation. This assessment provides an assessment of the general condition of the stream and must be interpreted accordingly.

Habitat description

A description of aquatic habitat was also produced using the AUSRIVAS proforma. The survey is a rapid visual assessment used to describe the habitat based on the following parameters:

- Geomorphology
- Channel diversity
- Bank stability
- Riparian vegetation and adjacent land use
- Water quality
- Macrophytes
- Local impacts and land use practices.

Drawn by: GT Project Manager: MR Project Number: 2469 Date: 5/08/2015

Location of study sites

Tasman Coal - Aquatic Monitoring

FIGURE 2

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Imagery: (c) Nearmap (May 2015)

2.2.2 Water quality

Surface water quality was measured *in situ* using a Yeokal 611 water quality probe at each site. The following variables were recorded:

- Temperature (°C)
- Conductivity (µS/cm)
- pH
- Dissolved oxygen (DO)(% saturation and mg/L)
- Turbidity (NTU).

Alkalinity (mg $CaCO_3$/L) was measured with a standard titration kit. Water quality data were compared with the ANZECC (2000) default guideline values to physical and chemical stressors for protection of slightly upland aquatic ecosystems in South-Eastern Australia.

2.2.3 Macroinvertebrates

Samples of macroinvertebrates were collected from pool edges for a length of 10 metres, either as a continuous line or in disconnected segments. Sampling in segments was often undertaken to ensure the sampling of sub-habitats such as macrophyte beds, bank overhangs, submerged branches and root mats. Segmented sampling was also employed where pool length was short and it was logistically difficult to sample in a continuous line (e.g. in-stream logs). A 250 µm dip net was drawn through the water with short sweeps towards the bank to dislodge benthic fauna while scraping submerged rocks and debris, sides of the stream bank and the bed substrate (Plate 1). Further sweeps in the water column targeted the suspended fauna.

Plate 1: Sampling method

Each sample was rinsed from the net onto a white sorting tray from which animals were picked using forceps, pipettes and or paint brushes. Each tray was picked for a minimum period of 40 minutes, after which they were picked at 10 minute intervals for either a total of one hour or until no new specimens had been found. Care was taken to collect cryptic and fast moving animals, in addition to those that were conspicuous or slow. The animals collected at each site were placed into a labelled jar containing 70% ethanol.

Laboratory methods-invertebrate identification

Macroinvertebrate samples were identified to family level with the exception of Oligochaeta (to class), Polychaeta (to class), Ostracoda (to subclass), Nematoda (to phylum), Nemertea (to phylum), Acarina (to order) and Chironomidae (to subfamily). Keys used to identify taxa included:

- Centre for Freshwater Ecosystems (n.d.) – Identification Key and Ecology of Australian Freshwater Invertebrates. http://www.mdfrc.org.au/bugguide/.
- Dean, J., Rosalind, M., St Clair, M., and Cartwright, D. (2004) Identification keys to Australian families and genera of caddis-fly larvae (Trichoptera) Cooperative Research Centre for Freshwater Ecology.
- Gooderham, J. and Tsyrlin, E. (2002) The Waterbug Book: A guide to the Freshwater Macroinvertebrates of Temperate Australia, CSIRO Publishing.
- Hawking and Theischinger (1999) A guide to the identification of larvae of Australian families and to the identification of ecology of larvae from NSW.
- Madden, C. (2010) Key to genera of Australian Chironomidae. Museum Victoria Science Reports 12, 1-31.
- Madden, C. (2011) Draft identification key to families of Diptera larvae of Australian inland waters La Trobe University.
- Smith, B. (1996) Identification keys to the families and genera of bivalve and gastropod molluscs found in Australian inland waters Murray Darling Freshwater Research Centre.

2.3 Data analysis

2.3.1 SIGNAL: (Stream Invertebrate Grade Number Average Level) scores

The revised SIGNAL2 biotic index developed by Chessman (2003a and 2003b) was used to determine the "environmental quality" of sites. This method assigns grade numbers to each macroinvertebrate family or taxa found, based largely on their response to a range of environmental conditions (Table 2). The sum of all grade numbers for that habitat is then divided by the total number of families recorded in each habitat to calculate the SIGNAL2 index. A weighted SIGNAL2 score was also calculated (see Chessman 2003b). The SIGNAL2 index therefore uses the average sensitivity of macroinvertebrate families to present a snapshot of biotic integrity at a site.

Table 3 provides a broad guide for interpreting the health of the site according to the SIGNAL2 score of the site.

Table 2: SIGNAL Grade and the Level of Pollution Tolerance

SIGNAL Grade	Pollution Tolerance
10-8	Indicates a greater sensitivity to pollution
7-5	Indicates a sensitivity to pollution
4-3	Indicates a tolerance to pollution
2-1	Indicates a greater tolerance to pollution

Table 3: Guide to interpreting the SIGNAL2 scores

SIGNAL2 Score	Habitat quality
Greater than 6	Healthy habitat
Between 5 and 6	Mild pollution
Between 4 and 5	Moderate pollution
Less than 4	Severe pollution

(Source: Gooderham and Tsyrlin 2002)

*Note that SIGNAL2 scores are indicative only and that pollution does not refer to just anthropogenic pollution. Environmental stress may result in poor water quality occurring naturally in waterways. Low family richness and the occurrence of pollution tolerant invertebrates can give a low SIGNAL score even when they are in natural condition.

2.3.2 Opportunistic observations

Opportunistic visual observations of aquatic fauna were recorded during the surveys at each site.

3. Results

3.1 Weather conditions

Surveys were conducted on 16 September 2019. The weather was mild (approximately 24°C) with light to moderate winds. There was low-moderate rain fall in the month prior to sampling (maximum daily rainfall was 44 mm on 30 August 2019; Figure 3). There were low flows within the study area at the time of sampling.

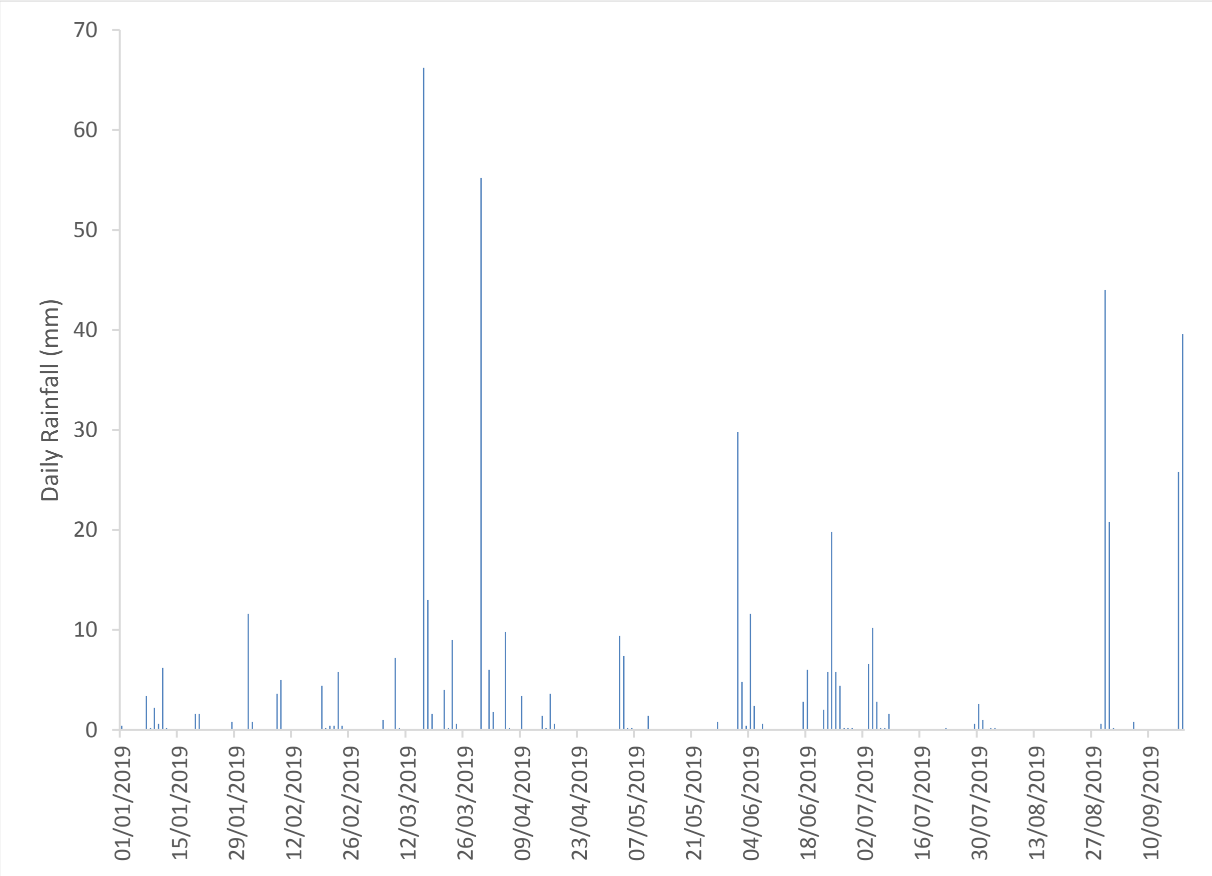

Figure 3: Total daily rainfall at Abel rain gauge (January –September 2019). Source: Donaldson Coal

3.2 Aquatic habitat/condition

The aquatic habitat of the study area comprises pools with no riffles present. Water level was low during the survey. The sampling sites generally had moderate riparian and channel health (RCE 20-40) which is consistent with previous monitoring events. The upstream site (BGC SR) had a mixture of native and exotic vegetation, however the channel was stable and no erosion was present. There was a fine layer of sedimentation present on the creek banks (covering the rocks and vegetation) most likely fluvial deposition from recent rainfall events. The Blue Gum Creek downstream site (BGC DHB) had fine sand/silt substrate and showed some evidence of erosion and sedimentation. Duck Weed (*Spirodela* spp.) was present at the downstream site. Both sampling sites had slight algae growth with a notable reduction at the upstream site. Table 4 shows the RCE inventory scores of each sampling site.

Table 4: RCE inventory scores (2015-2019)

Site	Autumn 2015	Spring 2015	Autumn 2016	Spring 2016	Autumn 2017	Spring 2017	Autumn 2018	Spring 2018	Autumn 2019	Spring 2019
BGC SR	33	36	39	40	38	-	39	38	38	40
BGC DHB	36	36	39	32	38	35	36	36	35	36

An RCE score greater than 40 indicates a stream considered to be in good condition with potential for higher biodiversity values. RCE Scores of 20-40 indicate a stream is in moderate condition and below 20 indicates that the stream is in very poor condition

3.2.1 Blue Gum Creek at Stockrington Road

The aquatic habitat at Blue Gum Creek at Stockrington Road (Plate 2) at the time of the spring 2019 monitoring surveys is detailed in Table 5.

Blue Gum Creek at Stockrington (Downstream)

Blue Gum Creek at Stockrington (Upstream)

Plate 2: Blue Gum Creek at Stockrington

Table 5: Blue Gum Creek at Stockrington habitat results

	Attribute	Blue Gum Creek at Stockrington
	Photograph	Plate 2
Riparian	RCE score	40
	Vegetation	Canopy vegetation included Blue Gum (*Eucalyptus saligna*), Cheese Tree (*Glochidion ferdinandi*), Coachwood (*Ceratopetalum apetalum*) and Sandpaper fig (*Ficus coronata*). The mid-storey was dominated by Lantana (*Lantana camara*), Tobacco Bush (*Solanum mauritianum*), Cheese Tree (*G. Ferdinandi*) and the groundcover by native and exotic grasses and herbs.
	Stream shading	Low
	Exotic vegetation	*Lantana (L. camara), Crofton Weed (Ageratina adenophora), Tobacco bush (S. mauritianum)*
Stream characteristics	Modal width (m)	2
	Substrate	Silt 70%/Boulder 20%/Sand 10%
	Flow/depth	No flow/<1m
	Macrophytes/algae	Slender knot weed (*Persicaria decipiens*), Cat tail *Typha sp.* / algae
	Water quality observations	Clearer than previous sampling in Autumn 2019. Some algal growth
Comments		Similar to previous sampling conditions; although water quality seems to have improved slightly with clearer water and less algae. Evidence of sedimentation on dry banks and vegetation. Less algal growth than Autumn 2019 survey.

3.2.2 Blue Gum Creek at Dog Hole Bridge

The aquatic habitat at Blue Gum Creek at Dog Hole Bridge (Plate 3) at the time of the spring 2019 monitoring surveys is detailed in Table 6.

Blue Gum Creek at Dog Hole Bridge (Downstream)

Blue Gum Creek at Dog Hole Bridge (Upstream)

Plate 3: Blue Gum Creek at Dog Hole Bridge

Table 6: Blue Gum Creek at Dog Hole Bridge habitat results

	Attribute	Blue Gum Creek at Dog Hole Bridge
	Photograph	Plate 3
Riparian	RCE score	36
	Vegetation	Canopy vegetation included Blue Gum (*E. saligna*) and Lilly Pilly (*Syzygium smithii*). The mid-storey was dominated by Lantana *(L. camara*), Cheese Tree (*G. ferdinandi*) and Privet (*Ligustrum sinense*) and the ground cover by native grasses, herbs, and Scurvy Weed (*Commelina cyanea*).
	Stream shading	Moderate
	Exotic vegetation	*Lantana camara, Privet (Ligustrum sinense)*
Stream characteristics	Modal width (m)	2.5m
	Substrate	Boulder 5%/ Cobble 20%/ Gravel 10%/ Silt 55%/ Sand 10%
	Flow/depth	No flow/<1m
	Macrophytes/algae	Slender Knot weed (*P. decipiens*), Duck Weed (*Spirodela* spp.) Some algae.
	Water quality observations	Low flow, some algae.
Comments		Similar to previous sampling / sedimentation from uprooted tree(s).

3.3 Water quality

Water quality results (Table 7), showed that the temperature was similar between both upstream (BGC SR) and downstream (BGC DHB) sites (14.43°C and 13.15 °C respectively). Conductivity was similar at both sites (619µS/cm and 518 µ/cm); exceeding the default ANZECC guideline of 350 µS/cm but below the EPL limit of 2000 µS/cm. Turbidity measurements were low at the upstream site, 7 NTU (BGC SR) and higher at the downstream site, 43.4 NTU (BGC DHB), however neither exceeding ANZECC guidelines. Dissolved Oxygen (DO) was low; 34.8% saturation upstream and 18.3% saturation downstream which is below the ANZECC guideline of 80-110%. The pH readings of 7.5 and 7.0 were both within ANZECC guidelines. Alkalinity was 120 mg $CaCO_3$/L upstream and 100 $CaCO_3$/L downstream indicating that the stream has a good buffering capacity to changes in pH.

Table 7: Water quality results

Site acronym	Temp (C°)	Conductivity (µS/cm)	Turbidity (NTU)	Dissolved Oxygen (% sat)	pH*	Alkalinity (mg $CaCO_3$/L)
BGC SR	14.43	**619**	7.0	**34.8**	7.5	120
BGC DHB	13.15	**518**	43.4	**18.3**	7.0	100

ANZECC trigger values for upland streams: Electrical conductivity (30-350 µS/cm), Turbidity (6-50 NTU), pH (6.5-8), Dissolved Oxygen (80-110%). Text in bold indicate those variables that exceed the default trigger values.

3.4 Macroinvertebrates

SIGNAL2 results for the two sampled sites are provided in Table 8. Raw data is provided in Annex 1.

Table 8. Macroinvertebrate SIGNAL2 results

Site acronym	Number of Taxa	SIGNAL2 Score	SIGNAL2 weighted Score
BGC SR	12	3.41	4.05
BGC DHB	21	3.76	4.11

The sampling sites had a low - moderate diversity of macroinvertebrate families (12-21) (Table 8). SIGNAL2 and weighted SIGNAL 2 scores indicated that the sites had moderate pollution (~4 SIGNAL), with a dominance of pollution tolerant macroinvertebrate families. However, pollution sensitive mayflies Leptophlebiidae (SIGNAL 8) were recorded at both sites and caddis flies Leptoceridae (SIGNAL 6) were recorded only at the Dog Hole Bridge site (Downstream). Other sensitive species include mites (Acarina) (SIGNAL 6) at both sites and Scirtidae (SIGNAL 6) at Blue Gum Creek downstream site. There has been a slight decrease in SIGNAL 2 score since sampling in Autumn 2019 (Table 9). The SIGNAL bi-plot (Figure 4) indicates that the upstream sites are potentially suffering from urban, industrial or agricultural pollution and downstream high nutrients or salinity.

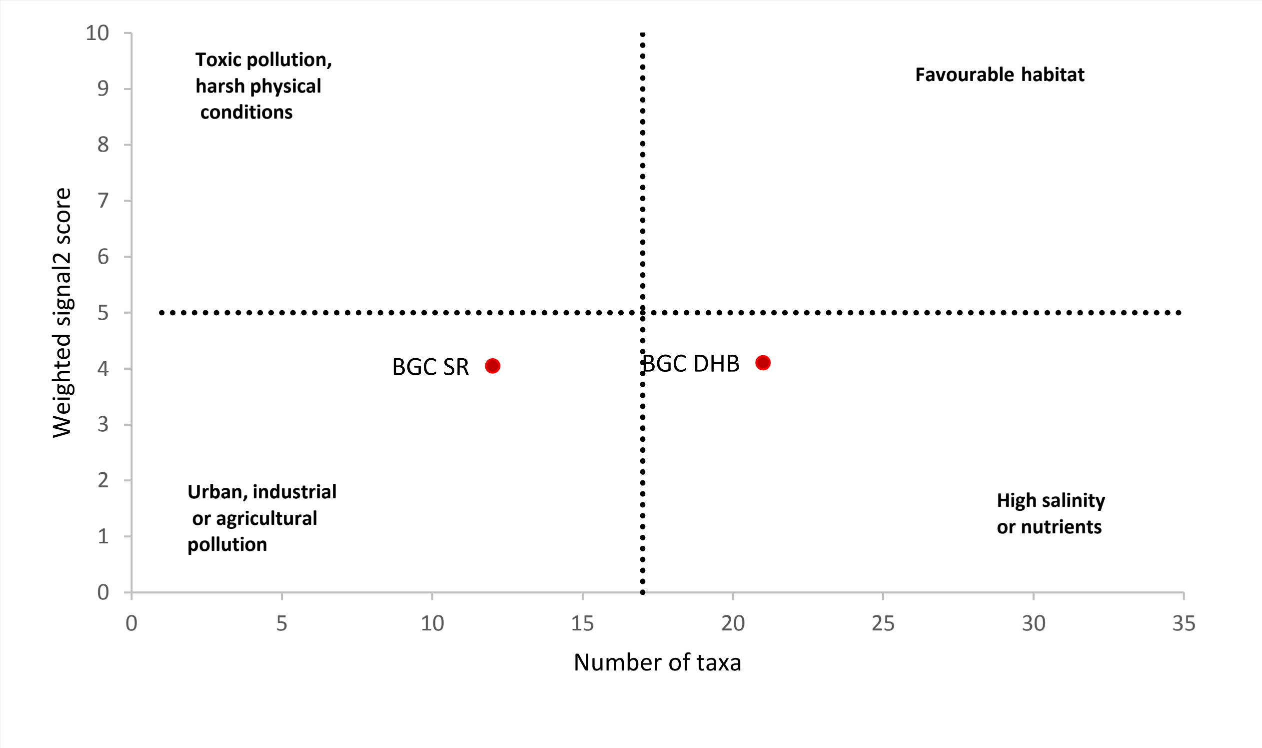

Figure 4. SIGNAL2 Bi-plot

Table 9. Weighted SIGNAL2 scores (2015, 2016, 2017, 2018 and 2019)

Site	SIGNAL2 weighted Autumn 2015	SIGNAL2 weighted Spring 2015	SIGNAL2 Weighted Autumn 2016	SIOGNAL2 Weighted Spring 2016	SIOGNAL2 Weighted Autumn 2017	SIGNAL2 weighted Spring 2017	SIGNAL2 weighted Autumn 2018	SIGNAL2 weighted Spring 2018	SIGNAL2 weighted Autumn 2019	SIGNAL2 weighted Spring 2019
BGCSR	4.45	3.29	3.75	3.98	3.41	-	3.96	3.18	4.28	4.05
BGCDHB	4.1	3.17	3.76	2.73	2.94	3.43	3.81	3.54	4.44	4.11

3.5 Other fauna

No other aquatic fauna were observed at the time of the Spring 2019 sampling.

4. Discussion

4.1 RCE scores

RCE Inventory scores were similar to previous monitoring results with scores ranging 20-40, indicating moderate condition. These scores are similar to those calculated in Autumn 2019 (Table 4) and are within the range of scores (33-40) recorded since commencement of the monitoring program (Tuft 2013).

4.2 SIGNALs scores and macroinvertebrate communities

The low SIGNAL scores recorded (~4) are consistent with previous monitoring and potentially the result of the creek being highly disturbed. Disturbances include presence of weeds, and visible erosion and siltation at the downstream site. There was filamentous algae present at both sites, potentially indicating high nutrients, however this algal growth was lower than previous survey in Autumn 2019. The low flows are also likely contributing to a reduction in the quality and quantity of pool habitat for aquatic species, as a result of the extended dry periods and lack of consistent rain fall. However recent flow appear to have improved aquatic habitat slightly at the upstream site.

Despite some poor SIGNAL scores at both sites, there remains potential for improvements in stream health with the presence of sensitive mayfly taxa Leptophlebiidae (SIGNAL 8) (Annex 1), indicating that Blue Gum Creek can support some sensitive taxa. The results are consistent with conclusions from previous monitoring reports that found both sites show a predominance of pollution tolerant families and few sensitive taxa (Tuft 2014; Niche 2015 a, b; Niche 2016 a, b; Niche 2017 a, b, Niche 2018a, b, Niche 2019a).

4.3 Water quality

This report identified elevated electrical conductivity (EC) within Blue Gum Creek. Although relatively high and exceeding ANZECC default guidelines, these levels are consistent with recent surveys (Niche 2017a, b; Niche 2018a, b; Niche 2019a) and results prior to the commencement of the mine operations (Newcastle Coal 2002). High alkalinity in Blue Gum Creek indicates that the waterway has a high buffering capacity; providing it with a high resistance to changes in pH. Despite exceedances in EC and low dissolved oxygen, these results are likely within the pre–mine variability of Blue Gum Creek.

5. Conclusion and recommendations

5.1 Conclusions

Blue Gum Creek continues to exhibit aquatic monitoring results that indicate degradation and poor stream health. This is indicated by the dominance of pollution tolerant macroinvertebrate communities present, presence of weeds and filamentous algae. The upstream site aquatic habitat however appeared to have improved since survey in Autumn 2019, a likely response to recent rainfall and river flow. Ongoing issues with siltation and erosion appear to be continuing to impact on this waterway downstream. As discussed in previous reports, these disturbances appear unrelated to the Tasman Coal mine's previous operations, but rather past and ongoing land use management issues exacerbated by low flows.

6. References

Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) (2000). National water quality management strategy and assessment guidelines: Australian and New Zealand guidelines for fresh and marine water quality ANZECC/ARMCANZ.

Chessman B. C., Growns J.E and Kotlash A.R. (1997) Objective derivation of macroinvertebrate family sensitivity grade numbers for the SIGNAL biotic index: allocation to the Hunter River system, NewSouth Wales. *Marine and Freshwater Research.* **48**, 159-172.

Chessman B. (2003a) New sensitivity grades for Australian macroinvertebrates. Marine and Freshwater Research **54,** 95-1032

Chessman B. (2003b) SIGNAL 2 – A Scoring System for Macro-invertebrate ('Water Bugs') in Australian Rivers, Monitoring River Heath Initiative Technical Report no 31, Commonwealth of Australia, Canberra DWR, 199

Dean, J., Rosalind, M., St Clair, M., and Cartwright, D. (2004) Identification keys to Australian families and genera of caddis-fly larvae (Trichoptera) Cooperative Research Centre for Freshwater Ecology.

Gooderham, J. and Tsyrlin, E. (2002). The Waterbug Book: A guide to the Freshwater Macroinvertebrates of Temperate Australia, CSIRO Publishing.

Hawking and Theischinger (1999) A guide to the identification of larvae of Australian families and to the identification of ecology of larvae from NSW.

Niche Environment and Heritage (2015a). Tasman Coal Aquatic Monitoring Report – Autumn 2015. Prepared for Tasman Coal.

Niche Environment and Heritage (2015b). Tasman Coal Aquatic Monitoring Report – Spring 2015. Prepared for Tasman Coal.

Niche Environment and Heritage (2016a). Tasman Coal Aquatic Monitoring Report – Autumn 2016. Prepared for Tasman Coal.

Niche Environment and Heritage (2016b). Tasman Coal Aquatic Monitoring Report – Spring 2016. Prepared for Tasman Coal.

Niche Environment and Heritage (2017a). Tasman Coal Aquatic Monitoring Report – Autumn 2017. Prepared for Tasman Coal.

Niche Environment and Heritage (2017b). Tasman Coal Aquatic Monitoring Report – Spring 2017. Prepared for Tasman Coal.

Niche Environment and Heritage (2018a). Tasman Coal Aquatic Monitoring Report – Autumn 2018. Prepared for Tasman Coal.

Niche Environment and Heritage (2018b). Tasman Coal Aquatic Monitoring Report – Spring 2018. Prepared for Tasman Coal.

Niche Environment and Heritage (2019a). Tasman Coal Aquatic Monitoring Report – Autumn 2019. Prepared for Tasman Coal.

Madden, C. (2010) Key to genera of Australian Chironomidae. Museum Victoria Science Reports **12,** 1-31.

Madden, C. (2011) Draft identification key to families of Diptera larvae of Australian inland waters La Trobe University.

Robyn Tuft and Associates (2014). Tasman Coal Mine Macroinvertebrate Sampling Program Pre-mining Survey – November 2014

Smith, B. (1996) Identification keys to the families and genera of bivalve and gastropod molluscs found in Australian inland waters Murray Darling Freshwater Research Centre.

Turak E., Waddell N., and Johnstone G. (2000) NSW AUSRIVAS Sampling and Processing Manual. Department of Environment and Conservation.

Websites

http://ausrivas.ewater.com.au/

http://www.mdfrc.org.au/bugguide/

http://www.bom.gov.au/

Annex 1. Macroinvertebrate survey results

	Blue Gum Creek	
Site	**Stockrington Road**	**Dog Hole bridge**
Turbellaria	2	
Tateidae formerly - Hydrobiidae		42
Planorbidae	2	1
Physidae	1	3
Oligochaeta	6	1
Acarina	3	2
Dytiscidae		3
Gyrinidae		1
Hydrophilidae		17
Scirtidae		2
Hydrochidae		1
Tipulidae		1
Tanypodinae		2
Chironominae		1
Baetidae	1	4
Leptophlebiidae	13	116
Corixidae	5	2
Pleidae	1	
Megapodagrionidae		1
Hemicorduliidae	2	
Libellulidae	1	
Leptoceridae		5

	Blue Gum Creek	
Site	**Stockrington Road**	**Dog Hole bridge**
Micronectidae – formerly Corixidae	2	1
Sphaeriidae		3
Glossiphoniidae		1

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Ecology and biodiversity

Heritage management

Environmental management and approvals

Environmental offsetting

Appendix 5

Subsidence Management Plan

End of Year Report 2019

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DONALDSONCOAL
Part of the Yancoal Australia Group

Abel Mine
Subsidence Management Plan
End of Year Report 2019

31 March 2020

Approved by

William Farnworth
Operations Manager
Donaldson Coal

TABLE OF CONTENTS

TABLES

ATTACHMENTS

1 INTRODUCTION

This Subsidence Management Plan End of Year Report fulfils the requirements of Condition 19 of the Abel Subsidence Management Plan (SMP) Approval Conditions for Area 1 and Condition 18 of the Approval Conditions for Area 2, 3 and 4.

A summary of monitoring results for the period January to December 2019 is presented in this report. Mining activities were suspended on 28th April 2016 due to the Mine being placed on Care and Maintenance. Therefore no pillar extraction was undertaken during this reporting period.

Subsidence surveys, photographic monitoring and visual inspections were conducted over all pillar extraction areas in accordance with the approved Subsidence Monitoring Programs, with environmental monitoring conducted in accordance with the approved Environmental Management Plan.

2 PURPOSE AND SCOPE

The purpose of this document is to comply with the relevant approval condition which states:

"The Leaseholder shall prepare an end of year report. This report shall be submitted to the Director Environmental Sustainability, within the first three months of the subsequent year. The end of year report must:

(a) include a summary of the subsidence and environmental results for the year;

(b) include an analysis of these monitoring results against the relevant;

- *impact assessment criteria;*
- *monitoring results from previous years; and*
- *predictions in the SMP.*

(c) identify any trends in the monitoring results over the life of the activity; and

(d) describe what actions were taken to ensure adequate management of any potential subsidence impacts due to mining."

3 SMP PILLAR EXTRACTION DURING REPORTING PERIOD

Area 1

SMP Approval was granted for Abel Area 1 (Panels 1 to 14 inclusive plus East Mains) on 27 May 2010. Pillar extraction has continued in East Mains during 2014. A Variation application for SMP Area 1 was submitted on the 8 August 2011 and was approved on the 29 September 2011. This variation was related to Panels 9 – 13 being removed from the SMP approved area. No extraction took place in this area during this period.

Area 2

SMP Approval was granted for Abel Area 2 (Panels 14 – 26) on 7 December 2011. A variation was submitted on 19 December 2011 relating to the removal of Panel 14 and the shortening of Panels 15 – 19. The second variation submitted, relating to partial pillar extraction Panel 20 – 22, was approved on the 3 September 2012. A third variation submitted, relating to Panels 19 & 19A, was approved on the 21 December 2012. A fourth variation submitted relating to Panel 22, was approved on the 16 April 2013. No extraction took place in this area during this period.

Area 3

SMP Approval was granted for Abel Area 3 (Panels 23 – 26 and part East Install Headings) on 16 July 2013. A variation was submitted to increase the width to part of Panel 24 and was approved on the 23 December 2013. No extraction took place in this area during this period.

Area 4

SMP/EP Approval was granted for Abel Area 4 (Panels 27 – 35) on the 19th September 2014. A variation was submitted to remove the Subsidence Control Zones around the protected farm dams and was approved on the 11th November 2014. The second variation submitted, relating to Panel 28 panel layout, was approved on 1 April 2015. The third variation submitted, relating to modifying the layout of Panels 29, 31, 33 and 35 which is now to be extracted in the Lower Donaldson Seam, was approved on 13 August 2015. The fourth variation submitted, relating to the removal of the Subsidence Control Zones beneath a principal residence. No extraction took place in this area during this period.

Table 1 below provides approval, plus mining commencement and completion dates for the Panels extracted since approval was granted.

Table 1 – Approval and Extraction Dates

Panel	Approval Date	Extraction Commenced	Extraction Completed
Panel 1	27 May 2010	12 July 2010	22 December 2010
Panel 2	27 May 2010	17 September 2010	12 November 2010
Panel 3	27 May 2010	7 January 2011	19 April 2011
Panel 4	27 May 2010	14 March 2011	20 July 2011
Panel 5	27 May 2010	30 May 2011	24 September 2011
Panel 6	27 May 2010	22 September 2011	2 February 2012
Panel 7	27 May 2010	19 November 2011	31 May 2012
Panel 8	7 December 2011	31 March 2012	17 July 2012
Panel 15	7 December 2011	20 February 2012	26 March 2012
Panel 20	3 September 2012	12 September 2012	3 December 2012
Panel 21	3 September 2012	8 November 2012	18 April 2013
East Mains	27 May 2010	18 July 2012	5 July 2014
East Install Headings	7 December 2011	4 December 2012	17 September 2014
Tailgate Headings	7 December 2011	5 June 2012	10 September 2012
Panel 19A	21 December 2012	20 January 2013	25 May 2013
Panel 19	21 December 2012	25 May 2013	7 August 2013
Panel 22	16 April 2013	19 April 2013	19 July 2013
Panel 23	16 July 2013	22 July 2013	10 March 2014
Panel 24	16 July 2013	16 September 2013	10 July 2014
Panel 25	16 July 2013	11 May 2014	8 May 2015
Panel 26	16 July 2013	11 August 2014	17 June 2015
Panel 27	19 September 2014	30 September 2014	12 August 2015
Panel 28	19 September 2014	11 May 2015	3 February 2016
Panel 30	19 September 2014	22 June 2015	28 April 2016
Panel 31	19 September 2014	25 February 2016	28 April 2016

4 SUBSIDENCE AND ENVIRONMENTAL PROGRAMS AND MANAGEMENT PLANS

Subsidence Monitoring Programs consisting of a combination of subsidence surveys, visual inspections and photographic monitoring, have been developed in consultation with and approved by the Principal Subsidence Engineer, DPE for all Panels extracted to date. All required subsidence monitoring lines have been installed and subsidence surveys completed in accordance with the agreed Subsidence Monitoring Programs.

Management Plans have been prepared for the following infrastructure outlined in **Table 2** and have been approved by the Director of Mine Safety Operations.

Table 2 – Approved Management Plans

Infrastructure Owners	Management Plans	Approved
Ausgrid	Ausgrid Powerline Management Plan SMP Area 2 – Tailgate Headings	21 June 2012
	Ausgrid Powerline Management Plan SMP Area 2 - Panels 20 - 22	2 November 2012
	Ausgrid Powerline Management Plan SMP Area 1 – East Mains	12 July 2013
	Ausgrid Powerline Management Plan SMP Area 3	17 July 2013
	Ausgrid Powerline Management Plan EP / SMP Area 4	1 October 2014
Telstra	Telstra Corporation Management Plan SMP Area 2 (Panels 21 & 22)	21 December 2012
	Telstra Corporation Management Plan SMP Area 3 (Panels 23 & 24)	17 July 2013
	Telstra Corporation Management Plan SMP Area 3 Optic Fibre (Panels 23 & 24)	6 December 2013
	Telstra Corporation Management Plan SMP Area 3 (Panels 25)	11 April 2014
	Telstra Corporation Management Plan SMP Area 3 (Panels 26)	3 September 2014
Telstra	Telstra Corporation Management Plan EP / SMP Area 4 (Panels 27, 28, 29)	1 October 2014

Infrastructure Owners	Management Plans	Approved
TransGrid	TransGrid Towers Management Plan SMP Area 1	22 March 2012
	TransGrid Towers Management Plan SMP Area 2	16 January 2013
Cessnock City Council	Blackhill Road and Taylors Road Management Plan SMP Area 2	7 December 2012
	Blackhill Road Management Plan SMP Area 3	11 September 2013
	Public Roads Management Plan	23 December 2014
Hunter Water	Hunter Water Corporation Water Pipeline Management Plan SMP Area 2	21 June 2012
	Hunter Water Corporation Water Pipeline Management Plan SMP Area 1 – East Mains	12 December 2012

5 SUMMARY OF SUBSIDENCE IMPACTS

Visual inspections and photographic monitoring of various surface features were conducted throughout the year.

No surveys for subsidence, tilt and strain were undertaken during the year.

5.1 Impacts on General Surface and Roads / Tracks

Surface cracking had occurred generally as predicted on the surface above Panels 28, 30 & 31 in the both the cleared and vegetated areas, private access tracks, and sealed private access road, and sealed local government road.

Remedial works have been carried out in consultation and agreement with the landholder s and infrastructure owners.

5.2 Impacts on Hunter Water Corporation Waterline

No further impacts observed. Impacts were within predictions and infrastructure remained in a safe and serviceable condition.

5.3 Impacts on Ausgrid Powerlines

No further impacts observed. Impacts were within predictions and infrastructure remained in a safe and serviceable condition.

5.4 Impacts on TransGrid Transmission Towers

No further impacts observed. Impacts were within predictions and infrastructure remained in a safe and serviceable condition.

5.5 Impacts on Blackhill Road

No further impacts observed. Impacts were within predictions and infrastructure remained in a safe and serviceable condition.

5.6 Notification under SMP Approval Conditions

There have been no observed and/or reported subsidence impacts, incidents, service difficulties, community complaints, or any other relevant information, that would require notification under the approval conditions.

6 SUBSIDENCE SURVEY SUMMARY AND ANALYSIS

A record of all completed subsidence surveys is shown in **Table 3**.

A summary of subsidence, strain and tilt results are detailed in **Table 4** with comparison to the SMP predictions.

All required subsidence monitoring lines have been installed and all pre-mining subsidence surveys completed in accordance with the agreed Subsidence Monitoring Programs.

Table 3 – Subsidence Monitoring Survey Dates

Survey / Monitoring Line	Survey / Monitoring Description	Pre – Mining Survey	Survey / Inspection / Monitoring Dates	Post – Mining
Panel 1	*Subsidence survey*	Installation and pre-mining survey 7/07/2010	Weekly Surveys	11/02/2011 24/06/2011 1/08/2012
Panel 2	*Subsidence Survey*			22/12/2010 21/06/2011 20/06/2012 9/10/2013
Panel 3	*Subsidence survey*	*23/12/2010*	Weekly Surveys	*10/06/2011* *25/10/2011* *9/05/2012*

Survey / Monitoring Line	Survey / Monitoring Description	Pre – Mining Survey	Survey / Inspection / Monitoring Dates	Post – Mining
	Visual inspection		Weekly Surveys	
	Photographic monitoring	*23/12/2010*		
Panel 4	*Subsidence survey*	*4/03/2011*	Weekly Surveys	*24/08/2011* *9/05/2011* *3/09/2013*
	Visual inspection		Weekly Surveys	
	Photographic monitoring	*4/03/2011*		
Panel 5	*Subsidence survey*	*27/05/2011*		*4/11/2011* *2/05/2012* *18/02/2013* *14/09/2013*
	Visual inspection		Weekly Surveys	
	Photographic monitoring	*27/05/2011*		
Panel 6	*Subsidence survey*	*14/09/2011*		*1/05/2012* *4/09/2013*
	Visual inspection		Weekly Surveys	
	Photographic monitoring	*14/09/2011*		
Panel 7	*Subsidence survey*	*8/02/2012*		*2/08/2012* *28/05/2013* *13/09/2013*
	Visual inspection		Weekly Surveys	
	Photographic monitoring	*8/02/2012*		
Panel 8	*Subsidence survey*	*13/02/2012*		*31/10/2012* *17/05/2013*

Survey / Monitoring Line	Survey / Monitoring Description	Pre – Mining Survey	Survey / Inspection / Monitoring Dates	Post – Mining
				6/09/2013
	Visual inspection		Weekly Surveys	
	Photographic monitoring	*13/02/2012*		
Panel 15	*Subsidence survey*	*9/02/2012*		*27/04/2012* *14/01/2013* *17/05/2013*
	Visual inspection		Weekly Surveys	
	Photographic monitoring	*9/02/2012*		
Panel 20	*Subsidence survey*	*29/08/2012*		*10/01/2013* *8/01/2014* *9/07/2014*
	Visual inspection		Weekly Surveys	
	Photographic monitoring	*29/08/2012*		
Panel 19	*Subsidence survey*	*1/05/2013*		*14/09/2013* *9/07/2014*
	Visual inspection		Weekly Surveys	
	Photographic monitoring	*1/05/2013*		
Panel 19A	*Subsidence survey*	*7/01/2013*		*4/06/2013* *14/09/2013* *5/11/2013* *7/01/2014* *7/07/2014*
	Visual inspection		Weekly Surveys	
	Photographic monitoring	*7/01/2013*		

Survey / Monitoring Line	Survey / Monitoring Description	Pre – Mining Survey	Survey / Inspection / Monitoring Dates	Post – Mining
Panel 21	*Subsidence survey*	*7/11/2012*		*16/05/2013* *24/01/2014* *1/09/2014*
	Visual inspection		Weekly Surveys	
	Photographic monitoring	*7/11/2012*		
Panel 22	*Subsidence survey*	*11/04/2013*		*30/07/2013* *28/01/2014* *19/02/2015*
	Visual inspection		Weekly Surveys	
	Photographic monitoring	*11/04/2013*		
Panel 23	*Subsidence survey*	*12/07/2013*		*8/04/2014* *3/03/2015* *28/10/2015*
	Visual inspection		Daily	
	Photographic monitoring	*12/07/2013*		
Panel 24	*Subsidence survey*	*19/02/2013*		*1/10/2014* *3/03/2015* *22/10/2015*
	Visual inspection		Daily	
	Photographic monitoring	*19/02/2013*		
Panel 25	*Subsidence survey*	*13/03/2014*		*3/12/2015* *22/09/2015*
	Visual inspection		Daily	
	Photographic monitoring	*13/03/2014*		

Survey / Monitoring Line	Survey / Monitoring Description	Pre – Mining Survey	Survey / Inspection / Monitoring Dates	Post – Mining
Panel 26	*Subsidence survey*	*9/05/2014*		*6/08/2015* *31/01/2017*
	Visual inspection		Daily	
	Photographic monitoring	*9/05/2014*		
Panel 27	*Subsidence survey*	*16/10/2014*		*3/09/2015* *31/01/2017*
	Visual inspection		Daily	
	Photographic monitoring	*22/09/2014*		
Panel 28	*Subsidence survey*	*6/05/2014*		*20/12/2016* *28/11/2017*
	Visual inspection		*3 times a week*	
	Photographic monitoring	*6/05/2014*		
Panel 30	*Subsidence survey*	*30/11/2015*		*20/12/2016*
	Visual inspection		*3 times a week*	
	Photographic monitoring	*30/11/2015*		
Panel 31	*Subsidence survey*	*25/02/2016*		*5/12/2016*
	Visual inspection		*3 times a week*	
	Photographic monitoring	*25/02/2016*		
East Install Headings	*Subsidence survey*	*14/11/2012*		*23/01/2013* *8/01/2014*
	Visual inspection		Weekly Surveys	
	Photographic monitoring	*14/11/2012*		
	Subsidence survey	*18/05/2012*		*19/12/2012*

Survey / Monitoring Line	Survey / Monitoring Description	Pre – Mining Survey	Survey / Inspection / Monitoring Dates	Post – Mining
Tailgate Headings				*13/06/2013* *14/01/2014*
	Visual inspection		Weekly Surveys	
	Photographic monitoring	*18/05/2012*		
East Mains Headings	*Subsidence survey*	*9/07/2012*		*14/01/2013* *30/05/2013*
	Visual inspection		Weekly Surveys	
	Photographic monitoring	*9/07/2012*		
Blackhill Road	*Subsidence survey*	*19/02/2013*	*As detailed in Management Plan*	Same date as Panel surveys
	Visual inspection		*Daily Surveys*	
	Photographic monitoring	*19/02/2013*		
Hunter Water Corporation Pipeline	*Subsidence survey*	7/07/2010 over P1 8/09/2010 over P2	Weekly Surveys	*11/02/2011 & 24/06/2011 Over P1* *22/12/2010 & 21/06/2011 Over P2*
	Visual inspection		*As detailed in Management Plan*	
	Photographic monitoring			
Ausgrid Power Poles	*Subsidence survey*	Same date as Panel surveys	Weekly Surveys	Same date as Panel surveys
	Visual inspection		Weekly Surveys	
	Photographic monitoring	Same date as Panel surveys		
TransGrid	*Subsidence survey*	28/03/2012	*As detailed in Management Plan*	Same date as Panel surveys

Survey / Monitoring Line	Survey / Monitoring Description	Pre – Mining Survey	Survey / Inspection / Monitoring Dates	Post – Mining
Transmission Towers	*Visual inspection*		Daily Surveys	
	Photographic monitoring	28/03/2012		

Table 4 – Comparison of Subsidence Monitoring Results to SMP Predictions

PANEL 1 (W = 120 m; T = 2.35 - 3.0m)			
>75m Cover	**Predicted**	**Final Measured**	**Comment**
Subsidence	0.95 - 1.25m	0.72 - 1.228m	Measured subsidence < predictions
Tensile Strain	10 - 18 mm/m	4 - 12 mm/m (18 mm/m)	Measured tensile strains < predictions.
Compressive Strain	13 - 23 mm/m	5 - 14 mm/m	Measured compressive strains < predictions
Tilt	22 - 40 mm/m	22 - 46 mm/m	Measured tilts < predictions. One exceedance of 15%.
Other		Cracked Joint to Hunter Water Pipeline Repaired 11kv Power Line	All necessary repairs have been carried out.

PANEL 2 (W= 150m ; T = 2.5 m)			
< 75m Cover	**Predicted**	**Final Measured**	**Comment**
Subsidence	1.30 - 1.38m	0.977 - 1.041 m	Measured subsidence < predictions
Tensile Strain	18 - 31 mm/m	4 - 6 mm/m (5 mm/m)	Measured tensile strains < predictions
Compressive Strain	23 - 40 mm/m	4 - 7 mm/m	Measured compressive strains < predictions
Tilt	40 - 67 mm/m	22 - 32 mm/m	Measured tilts < predictions
Other			
>75m Cover	**Predicted**	**Final Measured**	**Comment**
Subsidence	1.20 - 1.32m	0.94 - 0.966m	Measured subsidence < predictions
Tensile Strain	13 - 20 mm/m	9 mm/m (15 mm/m)	Measured tensile strains < predictions
Compressive Strain	17 - 25 mm/m	6 mm/m	Measured compressive strains < predictions
Tilt	30 - 45 mm/m	27 mm/m	Measured tilts < predictions
Other			

PANEL 3 (W=160.5 m; T = 2.5 m)			
< 75m Cover	Predicted	Final Measured	Comment
Subsidence	1.33 - 1.34 m	1.003 m	Measured subsidence < predictions
Tensile Strain	19 - 31 mm/m	8 - 9 mm/m (26 mm/m)	Measured tensile strains < predictions
Compressive Strain	24 - 40 mm/m	5 - 7 mm/m	Measured compressive strains < predictions
Tilt	42 - 67 mm/m	28 - 39 mm/m	Measured tilts < predictions
Other			
>75m Cover	Predicted	Final Measured	Comment
Subsidence	1.26 - 1.27 m	0.884 - 0.982 m	Measured subsidence < predictions
Tensile Strain	14 - 21mm/m	8 mm/m (10 mm/m)	Measured tensile strains < predictions
Compressive Strain	18 - 27 mm/m	4 mm/m	Measured compressive strains < predictions
Tilt	33 - 49 mm/m	30 mm/m	Measured tilts < predictions
Other			

PANEL 4 (W= 160.5 m; T = 2.5 m)			
< 75m Cover	Predicted	Final Measured	Comment
Subsidence	1.27-1.29m	1.065m	Measured subsidence < predictions
Tensile Strain	19 - 31 mm/m	6 - 10 mm/m (37.5 mm/m)	Measured tensile strains < predictions with 1 exceedance of 20% at clay cap.
Compressive Strain	24 - 40 mm/m	6 - 18 mm/m	Measured compressive strains < predictions
Tilt	42 - 67 mm/m	36 - 60 mm/m	Measured tilts < predictions
Other			
>75m Cover	Predicted	Final Measured	Comment
Subsidence	1.29 - 1.32m	1.054 m	Measured subsidence < predictions
Tensile Strain	14 - 21mm/m	5 mm/m	Measured tensile strains < predictions
Compressive Strain	18 - 27 mm/m	5 mm/m	Measured compressive strains < predictions
Tilt	42 - 67 mm/m	25 - 36 mm/m	Measured tilts < predictions
Other			

PANEL 5 (W= 160.5 m; T = 2.5 m)			
< 75m Cover	Predicted	Final Measured	Comment
Subsidence	1.27-1.43	1.154m	Measured subsidence < predictions
Tensile Strain	14 - 15 mm/m	10 mm/m	Measured tensile strains < predictions
Compressive Strain	15 - 19 mm/m	4 mm/m	Measured compressive strains < predictions
Tilt	41 - 46 mm/m	68 mm/m	Measured tilts < predictions with 1 minor exceedance
Other			
>75m Cover	Predicted	Final Measured	Comment
Subsidence	1.42 - 1.43m	1.002 m	Measured subsidence < predictions
Tensile Strain	11 - 15 mm/m	2 mm/m	Measured tensile strains < predictions
Compressive Strain	15 - 18 mm/m	13 mm/m	Measured compressive strains < predictions
Tilt	38 - 46 mm/m	29.8 mm/m	Measured tilts < predictions
Other			

PANEL 6 (W= 160.5 m; T = 2.5 m)			
< 75m Cover	Predicted	Final Measured	Comment
Subsidence	1.21 - 1.32m	1.215m	Measured subsidence < predictions
Tensile Strain	14 mm/m	8 mm/m	Measured tensile strains < predictions
Compressive Strain	17 - 18 mm/m	21 mm/m	Measured compressive strains < predictions with 1 minor exceedance
Tilt	39 - 41 mm/m	89.6 mm/m	Measured tilts < predictions with 1 minor exceedance
Other			
>75m Cover	Predicted	Final Measured	Comment
Subsidence	1.32 - 1.42m	1.066 m	Measured subsidence < predictions
Tensile Strain	11 - 14mm/m	9 mm/m	Measured tensile strains < predictions
Compressive Strain	14 - 17 mm/m	7 mm/m	Measured compressive strains < predictions
Tilt	38 - 41 mm/m	30 mm/m	Measured tilts < predictions
Other			

PANEL 7 (W= 160.5 m; T = 2.5 m)			
< 75m Cover	Predicted	Final Measured	Comment
Subsidence	1.27 - 1.32m	0.771m	Measured subsidence < predictions
Tensile Strain	11 - 14 mm/m	5 mm/m	Measured tensile strains < predictions
Compressive Strain	14 - 18 mm/m	2 mm/m	Measured compressive strains < predictions
Tilt	41 mm/m	12 mm/m	Measured tilts < predictions
Other			
>75m Cover	Predicted	Final Measured	Comment
Subsidence	1.32 - 1.43m	1.336 m	Measured subsidence < predictions
Tensile Strain	11 - 15mm/m	23 mm/m	Measured tensile strains < predictions with 1 minor exceedance
Compressive Strain	14 - 18 mm/m	36 mm/m	Measured compressive strains < predictions with 1 minor exceedance
Tilt	41 mm/m	42.5 mm/m	Measured tilts < predictions with 1 minor exceedance
Other			

PANEL 8 (W= 160.5 m; T = 2.5 m)			
< 75m Cover	**Predicted**	**Final Measured**	**Comment**
Subsidence	< 1.32m	0.830m	Measured subsidence < predictions
Tensile Strain	14 - 15 mm/m	2 mm/m	Measured tensile strains < predictions
Compressive Strain	17 - 19 mm/m	3 mm/m	Measured compressive strains < predictions
Tilt	42 mm/m	11.4 mm/m	Measured tilts < predictions
Other			
>75m Cover	**Predicted**	**Final Measured**	**Comment**
Subsidence	1.25 - 1.32m	0.845 m	Measured subsidence < predictions
Tensile Strain	10 - 14mm/m	11 mm/m	Measured tensile strains < predictions with 1 minor exceedance
Compressive Strain	13 - 17 mm/m	6 mm/m	Measured compressive strains < predictions with 1 minor exceedance
Tilt	41 mm/m	33.8 mm/m	Measured tilts < predictions
Other			

PANEL 15 (W= 160.5 m; T = 2.5 m)			
>75m Cover	**Predicted**	**Final Measured**	**Comment**
Subsidence	1.17 - 1.23m	1.164m	Measured subsidence < predictions
Tensile Strain	7 - 12mm/m	15 mm/m	Measured tensile strains < predictions
Compressive Strain	9 - 15 mm/m	13 mm/m	Measured compressive strains < predictions
Tilt	19 - 32 mm/m	49 mm/m	Measured tilts < predictions with 2 minor exceedance
Other			

PANEL 20 (W= 128 m; T = 2.7 m)			
>75m Cover	**Predicted**	**Final Measured**	**Comment**
Subsidence	150 mm	62 mm	Measured subsidence < predictions
Tensile Strain	2 mm/m	1 mm/m	Measured tensile strains < predictions
Compressive Strain	2 mm/m	2 mm/m	Measured compressive strains < predictions
Tilt	3 mm/m	2.5 mm/m	Measured tilts < predictions
Other			

PANEL 21 (W= 212 m; T = 2.7 m)			
125m Cover	Predicted	Final Measured	Comment
Subsidence	150 mm	96 mm	Measured subsidence < predictions
Tensile Strain	2 mm/m	1 mm/m	Measured tensile strains < predictions
Compressive Strain	2 mm/m	1 mm/m	Measured compressive strains < predictions
Tilt	3 mm/m	2.1 mm/m	Measured tilts < predictions
Other			

TAILGATE HEADINGS (W= 80.5 m; T = 2.8 m)			
<110mCover	Predicted	Final Measured	Comment
Subsidence	0.88 – 0.99m	0.250m	Measured subsidence < predictions
Tensile Strain	8 - 9mm/m	2 mm/m	Measured tensile strains < predictions
Compressive Strain	8 - 9 mm/m	2 mm/m	Measured compressive strains < predictions
Tilt	18 - 33 mm/m	7 mm/m	Measured tilts < predictions
Other			

EAST INSTALL HEADINGS (W= 105m; T = 2.7 m)			
100m Cover	Predicted	Final Measured	Comment
Subsidence	0.9m	1.286m	Measured subsidence > predictions
Tensile Strain	13 – 19 mm/m	12 mm/m	Measured tensile strains < predictions
Compressive Strain	16 - 24 mm/m	9 mm/m	Measured compressive strains < predictions
Tilt	24 - 35 mm/m	44 mm/m	Measured tilts > predictions
Other			

EAST MAINS HEADINGS (W= 125m; T = 2.7 m)			
100m Cover	Predicted	Final Measured	Comment
Subsidence	1.59m	1.408m	Measured subsidence < predictions
Tensile Strain	10 - 16 mm/m	11 mm/m	Measured tensile strains < predictions
Compressive Strain	13 - 20 mm/m	15 mm/m	Measured compressive strains < predictions
Tilt	49 mm/m	48.6 mm/m	Measured tilts < predictions
Other			

Panel 19A (W= 227.9m; T = 2.6 m)			
100m Cover	Predicted	Final Measured	Comment
Subsidence	1.42m	1.261m	Measured subsidence < predictions
Tensile Strain	8 - 14 mm/m	3 - 12 mm/m	Measured tensile strains < predictions
Compressive Strain	11 - 18 mm/m	4 - 13 mm/m	Measured compressive strains < predictions
Tilt	40 mm/m	29 - 48 mm/m	Measured tilts < predictions with only a minor exceedance
Other			

PANEL 22 (W= 180.3 m; T = 2.8 m)			
125m Cover	Predicted	Final Measured	Comment
Subsidence	150 mm	44 mm	Measured subsidence < predictions
Tensile Strain	2 mm/m	1 mm/m	Measured tensile strains < predictions
Compressive Strain	2 mm/m	1 mm/m	Measured compressive strains < predictions
Other			

PANEL 23 (W= 215 m; T = 2.5 m)			
<130m Cover	Predicted	Final Measured	Comment
Subsidence	1.30m	0.983m	Measured subsidence < predictions
Tensile Strain	30 mm/m	13 mm/m	Measured tensile strains < predictions
Compressive Strain	30 mm/m	13 mm/m	Measured compressive strains < predictions
Other			

PANEL 24 (W= 220 m; T = 2.5 m)			
<130m Cover	Predicted	Final Measured	Comment
Subsidence	1.30m	1.061m	Measured subsidence < predictions
Tensile Strain	30 mm/m	7 mm/m	Measured tensile strains < predictions
Compressive Strain	30 mm/m	9 mm/m	Measured compressive strains < predictions
Other			

PANEL 25 (W= 220 m; T = 2.5 m)			
<130m Cover	**Predicted**	**Final Measured**	**Comment**
Subsidence	1.30m	1.087m	Measured subsidence < predictions
Tensile Strain	30 mm/m	21 mm/m	Measured tensile strains < predictions
Compressive Strain	30 mm/m	9 mm/m	Measured compressive strains < predictions
Other			

PANEL 26 (W= 220 m; T = 2.5 m)			
<130m Cover	**Predicted**	**Final Measured**	**Comment**
Subsidence	1.30m	1.130m	Measured subsidence < predictions
Tensile Strain	30 mm/m	9 mm/m	Measured tensile strains < predictions
Compressive Strain	30 mm/m	13 mm/m	Measured compressive strains < predictions
Other			

PANEL 27 (W= 190 m; T = 2.5 m)			
<170m Cover	**Predicted**	**Final Measured**	**Comment**
Subsidence	1.40m	1.005m	Measured subsidence < predictions
Tensile Strain	30 mm/m	2 mm/m	Measured tensile strains < predictions
Compressive Strain	30 mm/m	8 mm/m	Measured compressive strains < predictions
Other			

PANEL 28 (W= 190 m; T = 2.5 m)			
<190m Cover	**Predicted**	**Final Measured**	**Comment**
Subsidence	1.40m	1.319m	Measured subsidence < predictions
Tensile Strain	30 mm/m	1 mm/m	Measured tensile strains < predictions
Compressive Strain	30 mm/m	10 mm/m	Measured compressive strains < predictions
Other			

PANEL 30 (W= 190 m; T = 2.5 m)			
<200m Cover	**Predicted**	**Final Measured**	**Comment**
Subsidence	1.40m	1.131m	Measured subsidence < predictions
Tensile Strain	30 mm/m	11 mm/m	Measured tensile strains < predictions
Compressive Strain	30 mm/m	11 mm/m	Measured compressive strains < predictions
Other			

PANEL 31 (W= 170 m; T = 2.5 m)			
<200m Cover	**Predicted**	**Final Measured**	**Comment**
Subsidence	1.40m	0.307 m	Measured subsidence < predictions
Tensile Strain	30 mm/m	6 mm/m	Measured tensile strains < predictions
Compressive Strain	30 mm/m	7 mm/m	Measured compressive strains < predictions
Other			

7 PHOTOGRAPHIC MONITORING AND VISUAL INSPECTION SUMMARY AND ANALYSIS

Dates of photographic monitoring and visual inspections are shown in **Table 3.** No impacts or changes have been noted in either photographic monitoring or visual inspections and these results have been detailed in the Subsidence Management Status Report submitted in September 2018.

No evidence of impacts has been observed or noted during these inspections and monitoring.

Comparison of pre and post mining photographic monitoring did not reveal any evidence of impact.

8 ENVIRONMENTAL MONITORING SUMMARY AND ANALYSIS

Water

Monthly monitoring of regional groundwater levels and quality was undertaken throughout the year in accordance with the Site Water Management Plan and Integrated Monitoring Plan.

A summary of groundwater and surface water quality is provided in **Tables 5** and **6.**

Table 5 – Summary of Groundwater Quality Monitoring Results 1 January to 31 December 2019.

Sampling Site	pH	EC (µS/cm)	TSS (mg/L)
6	6.59 – 6.96 (6.78)	1,960 – 2,420 (2,264)	18– 134 (53)
13	No Access to site	No Access to site	No Access to site
JRD2	6.27 – 7.28 (6.96)	146 – 2,550 (2,134)	<5 – 136 (47)

Table 6 – Summary of Surface Water Quality Monitoring Results 1 January to 31 December 2019

Sampling Site	pH	EC (µS/cm)	Turbidity (NTU)	TSS (mg/L)
1	5.73 - 7.13 (6.77)	194 - 443 (326)	20.9 – 120 (48)	<5 – 50 (27.7)
8	6.3 – 7.2 (6.64)	275 – 498 (408)	10.9 – 31.2 (20.7)	10 – 26 (15.6)
10	6.54 – 7.7 (7.03)	410 – 1,676 (953)	5.9 – 45 (22.8)	<5 – 28 (11.9)
11	6.65 - 7.68 (7.15)	160 – 588 (264)	0.7 – 32 (7.11)	<5 -38 (10.6)
FMCU	6.7 - 7.22 (6.96)	151 – 314 (199)	20 – 48.1 (39.5)	<5 – 28 (13.6)
FMCD	7.44 – 8.67 (7.80)	148 – 332 (238)	5.3 – 16.9 (11.3)	<5 – 68 (12.5)

9 TRENDS IN MONITORING RESULTS

Surface Water

The pH values at all sites were slightly acidic to slightly alkaline. All results were within the upper and lower water quality trigger values for Lowland Rivers in NSW (8.5) outlined in the Guidelines for Fresh and Marine Water Quality (ANZECC 2000). Previously there have been short term declines in pH following significant rainfall events such as in November 2013 (261.8mm rainfall), April 2015 (412mm rainfall) and January 2016 (430.8mm). Overall, during the reporting period there were no significant differences in pH between the upstream and downstream sites.

The electrical conductivity (EC) results range between 148µS/cm and 1,676µS/cm for all sites. There were no occasions were electrical conductivity was recorded outside of water quality trigger values for Lowland Rivers in NSW (125 to 2,200µS/cm) (ANZECC 2000).

Whilst it is expected that rainfall will influence EC results, EC does not appear to be strongly correlated with the monthly rainfall. The average EC values upstream are typically similar or slightly higher than the corresponding downstream values. No other long-term trends in EC are apparent.

Turbidity and total suspended solids (TSS) levels at Sites 1 and FMCU exceeded the water quality trigger values for Lowland Rivers in NSW (6 to 50 NTU) outlined in the Guidelines for Fresh and Marine Water Quality (ANZECC 2000) and industry standard TSS criteria (50mg/L). These exceedances did not correspond to a high rainfall event. Sites 1 and FMCU are upstream monitoring locations and it is not considered that the mine activities contributed to these levels but rather localised conditions.

No long-term trends are apparent within the monitoring data with widely varying results with spikes in turbidity and TSS not necessarily correlated with monthly rainfall. Baseline monitoring results for both upstream and downstream sites have previously recorded significantly elevated TSS which are considered to form part of the natural variation.

Groundwater Levels

Piezometers located within and to the south of the Abel mine area are behaving predictably, with drawdown in the Donaldson Seams and by a lesser amount in most overburden piezometers responding as expected to mining activities. Piezometers to the west of the Abel mine area appear to be influenced by mining activity at Bloomfield Colliery.

Monitoring confirms that there is no evidence of any drawdown response in the alluvium or regolith groundwater. In particular, Piezometers 81A and 81B are located adjacent the Pambalong Nature Reserve.

Monitoring results from 81A (single vibrating wire transducer placed within the Lower Donaldson Seam) showed a drawdown response to mining the Donaldson Seam within the Abel Mine. However, Piezometer 81B is screened within overlying shallow Permian strata with water levels remaining stable. The lack of response in the shallow piezometer indicates there has been no mining impact on the Pambalong Nature Reserve.

Piezometers 63A and B are located to the east of the Abel Mine adjacent to the F3 Freeway and near the Hexham Swamp. However, it appears that the shallow Piezometer 63B has failed or the bore has collapsed. Notwithstanding this, review of the responses from other shallow alluvium and regolith bores is still consistent with there being no impact on the Hexham Swamp.

During the period access to Site 13 was restricted with no access granted by the property owner.

10 MANAGEMENT ACTIONS

Actions taken to ensure adequate management of any potential subsidence impacts due to mining include:

- Various monitoring programs, subsidence surveys, visual inspections, photographic monitoring to detect any impact;

- TARPs (Trigger, Action, Response Plans) forming part of approved Public Safety Management Plans and Environmental Monitoring Programs which include mitigation/remediation options and notification procedures relating to subsidence monitoring, surface cracking on both roads / fire trails and vegetated areas and impacts on rock mass / steep slopes and Aboriginal sites.