APPENDIX B

Noise and Vibration Assessment

FINAL REPORT

APPIN MINE VENTILATION AND ACCESS PROJECT

MENANGLE, NSW

NOISE AND VIBRATION IMPACT ASSESSMENT
RWDI # 2101914
June 24, 2021

SUBMITTED TO

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1 INTRODUCTION

1.1 Overview

The Appin Mine (the Mine) is an existing underground coal mine situated in the Southern Coalfield of New South Wales (NSW) approximately 25 kilometres north-west of Wollongong. The Mine is owned and operated by Endeavour Coal Pty Ltd, a subsidiary of Illawarra Coal Holdings Pty Ltd, which is a wholly owned subsidiary of South32 Limited. Appin Mine, Cordeaux Colliery and Dendrobium Mine (and associated facilities) collectively operate as South32 Illawarra Metallurgical Coal (IMC).

IMC received Project Approval 08_0150 (the Appin Mine approval) from the Planning Assessment Commission of NSW under delegation of the Minister for Planning and Infrastructure on 22 December 2011 for current and proposed mining of the Bulli Seam Operations (BSO). The Appin Mine approval was gazetted as a State Significant Development for the purposes of future modifications on 23 November 2018.

IMC is seeking to modify the existing Appin Mine approval, pursuant to Section 4.55(2) of the NSW Environment Planning and Assessment Act 1979 (EP&A Act), to incorporate the construction and operation of infrastructure critical to the ongoing viability of the Mine referred to as the Appin Mine Ventilation and Access Project (hereafter referred to as the Project).

RWDI has been commissioned to prepare a noise and vibration impact assessment for the Project. This report presents quantitative assessments of potential noise and vibration impacts associated with the construction and operation of the Project and has been prepared in accordance with the following NSW Government guidelines and policies:

- *Noise Policy for Industry.*
- *Interim Construction Noise Guideline.*
- *NSW Road Noise Policy.*
- *Assessing Vibration: a technical guideline.*

1.2 Existing Operations

The Appin Mine approval incorporates the underground longwall mining operations, which extract coal from the Bulli Seam using underground longwall mining methods, and the associated surface activities. The Mine primarily produces hard coking (metallurgical) coal and has an approved operational capacity of up to 10.5 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal until 2041.

Longwall mining is currently being undertaken in the approved mining domains, Area 9 and Area 7, following completion of longwall mining activities at West Cliff Colliery in early 2016. Key surface facilities at the Mine include the:

- Appin East Colliery (Appin East);
- Appin West Colliery (Appin West);
- Appin North Colliery (Appin North);
- West Cliff Coal Preparation Plant (WCCPP);
- West Cliff Emplacement Area (WCEA);
- Appin East No.1 and No. 2 ventilation shaft site;

- Appin East No. 3 ventilation shaft site;
- Appin West No. 6 ventilation shaft site; and
- Douglas Park substation site.

ROM coal is extracted from the Appin underground mining operations and delivered directly to the WCCPP by winder and conveyor, or is transported from Appin East via truck along Appin and Wedderburn Roads to the WCCPP. Processed coal (clean coal product) from the WCCPP is transported by road to the Port Kembla Coal Terminal (PKCT) for shipping to domestic and international customers, or to BlueScope Steel or other local customers.

The Mine is accessed via the shaft at Appin West and drifts at Appin North and Appin East. The Mine is ventilated by two distinct ventilation districts; Appin Mine and Appin North. The Appin Mine district is ventilated by two upcast shafts (No. 2 and No. 6), four downcast shafts (No. 1, No. 3, No. 4, and No. 5) and two intake drifts at Appin East. The Appin North district is ventilated by one upcast shaft (No. 1), one downcast shaft (No. 2) and one intake drift at Appin North.

1.3 Proposed Modification

1.3.1 Project Area (the Site)

The Project Area (hereafter referred to as the Site) is approximately 35 km northwest of Wollongong and 8 km northwest of Appin (Figure 1). The township of Menangle is located approximately 1.3 km to the northeast of the Site. The Site is located on land owned by IMC, within the Bulli Seam Operations Project Longwall Mining Area and within the South Campbelltown Mine Subsidence District in the Southern Coalfield of NSW.

The Site will incorporate Ventilation Shaft 7, Ventilation Shaft 8, mine access facilities and additional areas for associated works and infrastructure, such as the construction site access and the provision of services to the Site. The boundary of the Site and the extent of the assessment area are shown on Figure 2.

Infrastructure that will be developed on the Site will be positioned to align with the approved layout of the underground workings for Appin Area 7 (Figure 3), to be proximal to required services and to minimise the potential impacts on the environment and communities, including Menangle and Douglas Park.

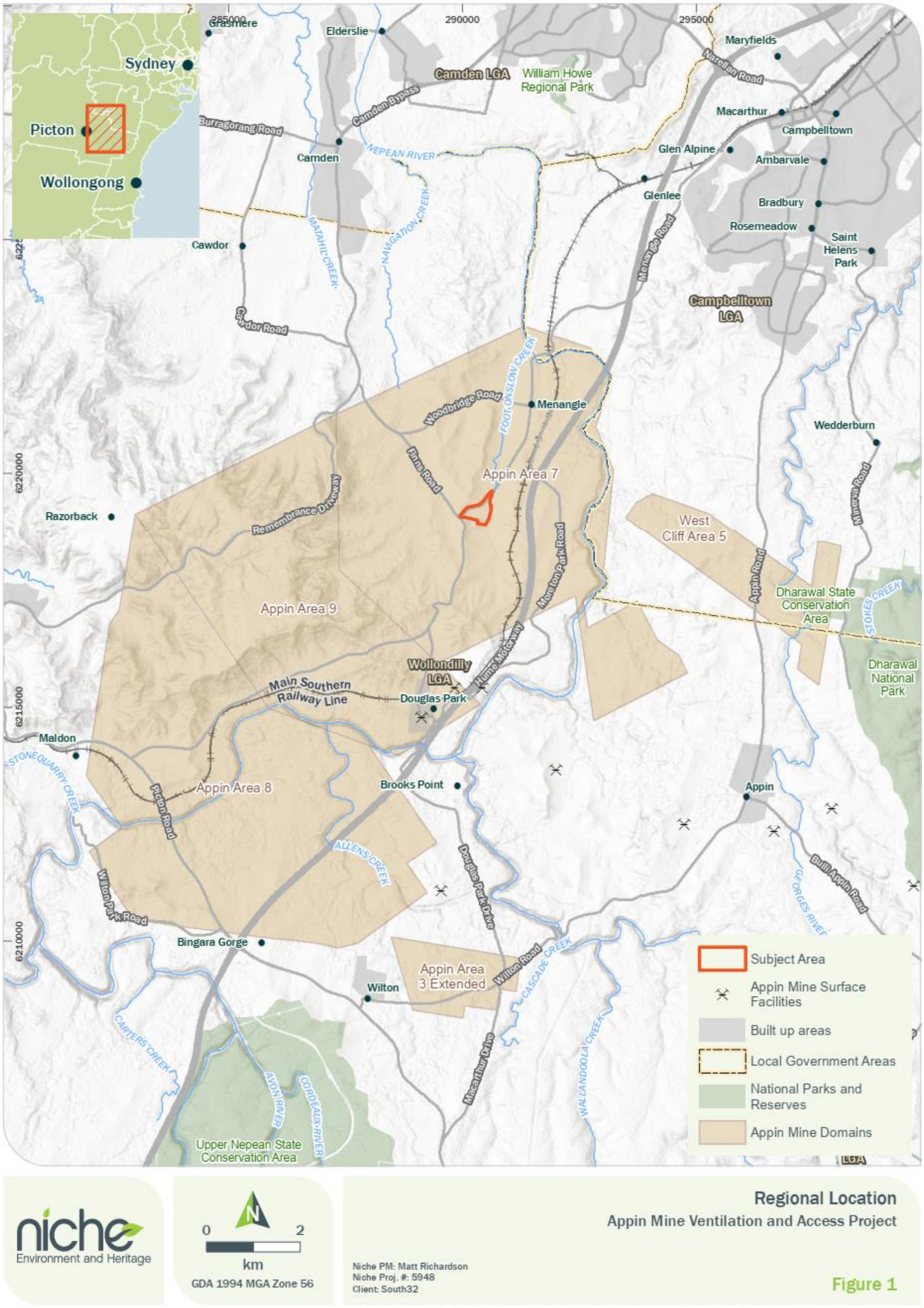


Figure 1: Location

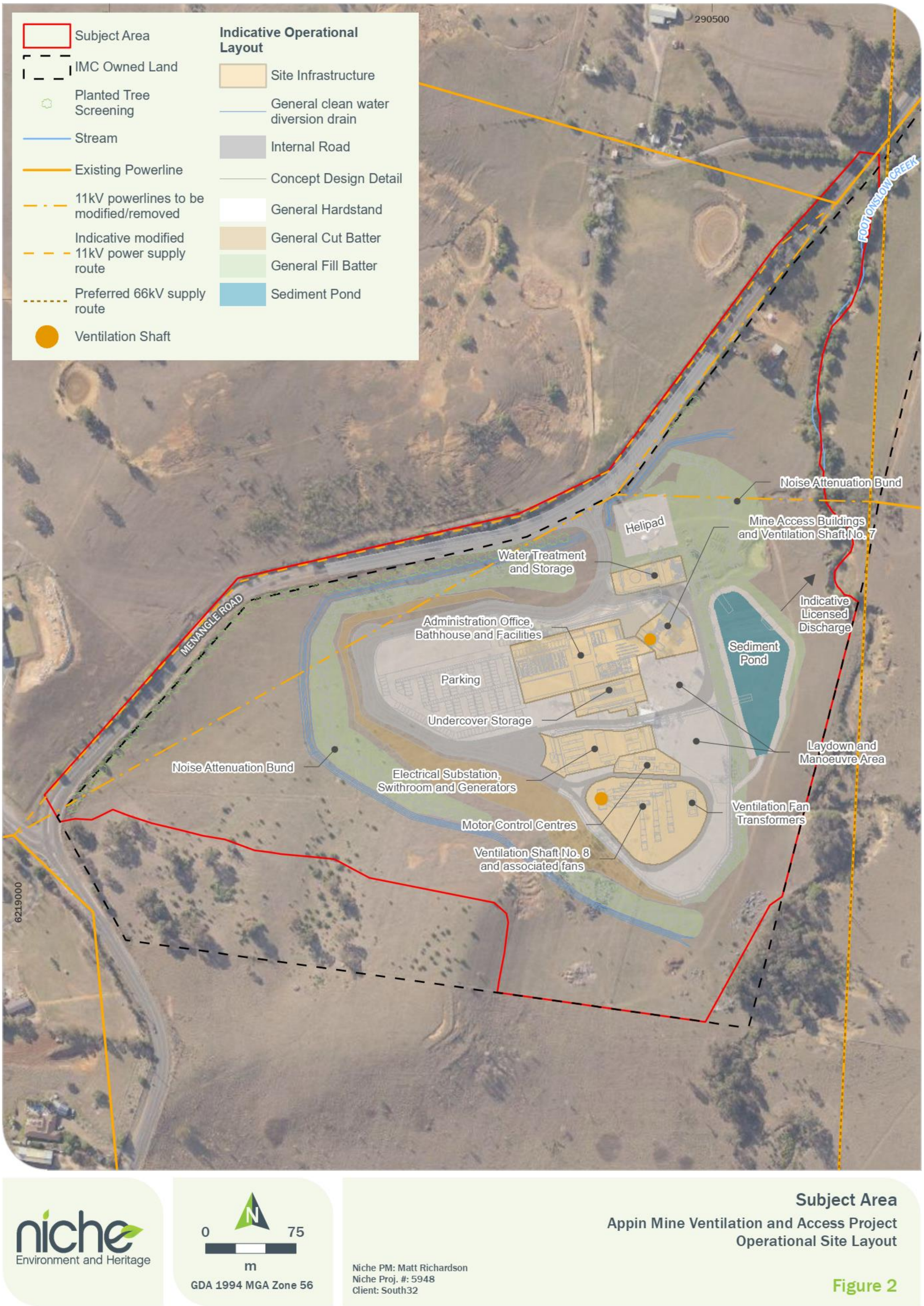


Figure 2: Subject Area

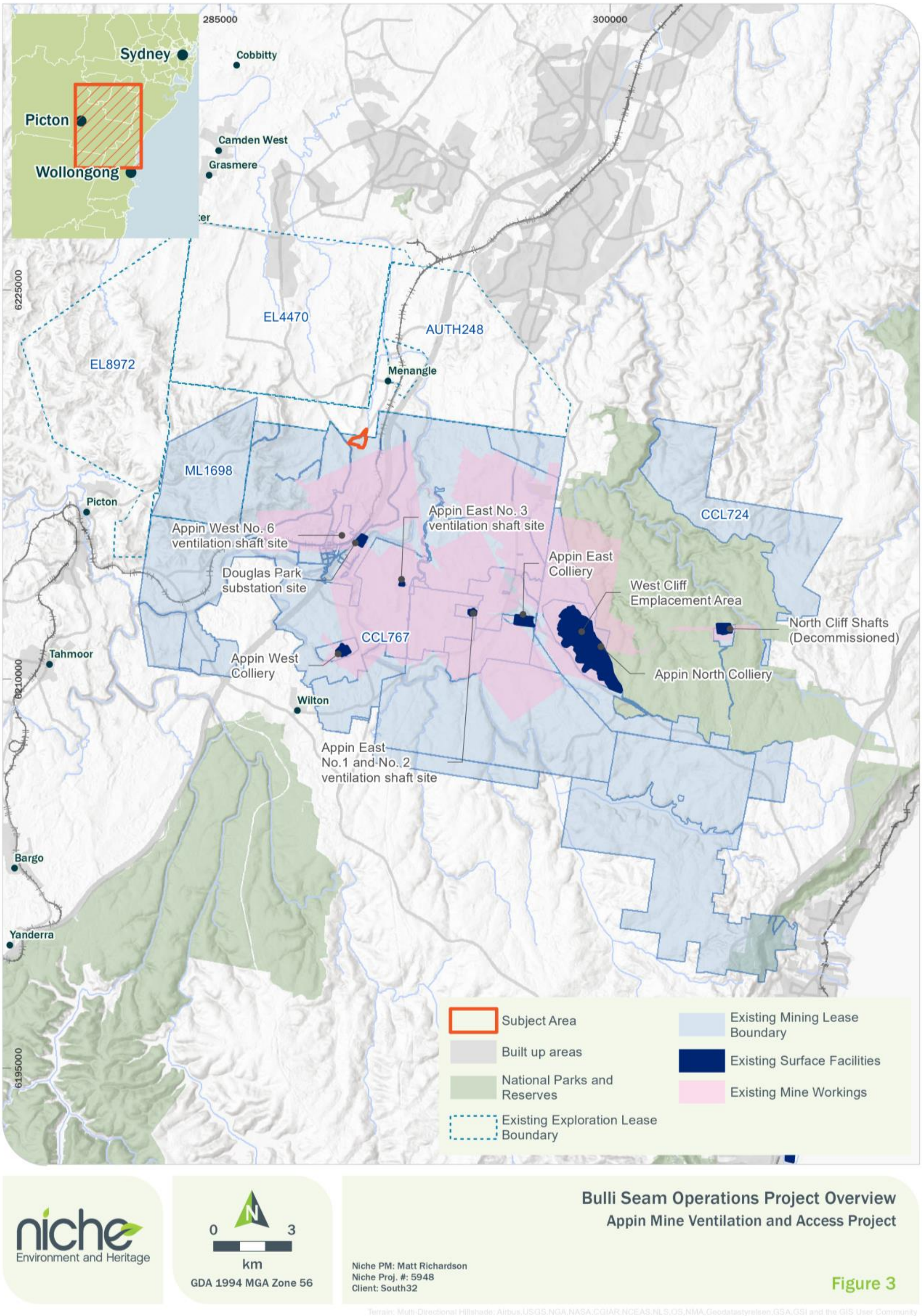


Figure 3: Lease Area

1.3.2 Appin Mine Ventilation and Mine Access Project (the Project)

An integral requirement of underground mining is adequate ventilation infrastructure and mine access facilities to ensure a safe and efficient underground working environment. Appin Mine operations are progressing further away from the existing surface infrastructure located in the Appin and Douglas Park areas, and additional infrastructure is required to support the ongoing operations.

The Project involves the construction and operation of a downcast ventilation shaft (Ventilation Shaft 7), an upcast ventilation shaft (Ventilation Shaft 8), three (3) extraction fans, ducting and evases and associated ancillary infrastructure. Based on the current mining schedule, the additional ventilation shafts are required to be operational prior to 2025.

The Project also involves the development of mine access facilities including a headframe and personnel and materials winder (within Ventilation Shaft 7) and surface facilities consisting of offices, stores, bathhouse facilities and car parking areas. The establishment of these facilities would provide access for personnel and consumable materials to the Mine and will increase the safety and efficiency of transporting personnel and consumable materials underground.

To support the key infrastructure noted above, the Project will also include the following activities:

- installation of temporary and permanent site access arrangements, including upgrade or improvement to the Menangle Road intersection, internal roadways, associated hardstand and car parking areas;
- site preparation, including clearing of vegetation, demolition of existing structures and earthworks;
- installation of appropriate security (e.g. fencing) to prevent unauthorised access to the site;
- installation of a power supply, water supply and transmission and associated electrical switch rooms, transformers and ancillary infrastructure;
- shaft material/spoil handling and emplacement activities and associated revegetation and landscaping activities to minimise visual impact of the site;
- installation of personnel amenities such as bathhouses (e.g. changerooms), administration facilities and mines rescue facilities;
- installation of diesel storage tanks and associated pipelines;
- progressive development of sumps, pumps, pipelines, water storages and other water management infrastructure including fire protection and sewerage treatment facilities;
- installation covered storage areas;
- installation of communications equipment including fibre optic cable and wireless infrastructure;
- installation of service boreholes to provide underground services;
- controlled release of excess water and/or re-use of water where practicable;
- progressive rehabilitation of disturbed areas post construction;
- installation of erosion and sediment control infrastructure, where required; and
- other associated minor infrastructure, plant, equipment and activities.

The Project would be similar to previously approved ventilation and mine access infrastructure of the Appin Mine and will not increase the volume of coal produced. Coal handling infrastructure is not proposed as part of the Project.

The shafts would be constructed from the surface down to the underground workings using conventional shaft sinking methods (mechanical excavation, drilling and controlled blasting) with material from the excavation being removed from the top of the shaft. The excavated material resulting from the construction of the shafts would be used as engineered fill and for construction of earth screening bunds and sediment dams. Where practicable, excess material would be stockpiled on-site, revegetated and used for future rehabilitation of the shaft site upon decommissioning. The two shafts would be lined progressively during excavation.

The Project will comprise multiple phases of construction and operation.

Construction of the ventilation shafts is critical to the ongoing safe and efficient operation of the Appin Mine, and as such, will take priority for the construction phase. Construction of the downcast shaft will commence first. Once the shaft sinking is complete and the ventilation infrastructure is installed, each shaft will commence commissioning and operation immediately.

The construction phase (12-18 months) for establishing mine access infrastructure would occur subsequent to the ventilation infrastructure. Construction of mine access infrastructure will be influenced by scheduling and timing of longwall operations over the life of the BSO Project and will be developed in parallel with the requirements of the ongoing mining operations.

Activities associated with sinking the shafts would occur 24 hours per day, seven days per week. The remainder of construction activities associated with the facility (e.g. installation of surface infrastructure) would generally be limited to daytime construction hours. Once operational, the site would be required to operate 24 hours per day, seven days per week, consistent with other similar facilities of the Mine.

2 EXISTING ENVIRONMENT

2.1 Sensitive Receivers

A number of rural residential properties are the nearest and most potentially affected receivers near the Site. These sensitive receivers are identified in Table 1 and shown in Figure 4.

The receiver identified as "R1" is within the construction boundary, is currently unoccupied, and will be demolished as part of the preparatory works or utilised by the Project for the duration of the Project construction and operation phase. R1 is therefore not considered as a sensitive receiver in this assessment.

Table 1: Sensitive Receivers

Receiver ID	Address
R1	345 Menangle Road, Menangle
R2	310 Menangle Road, Menangle
R3	30 Finns Road, Menangle
R4	15 Finns Road, Menangle
R5	3 Finns Road, Menangle
R6	430 Menangle Road, Menangle
R7	436 Menangle Road, Menangle
R8	450 Menangle Road, Menangle
R9	470 Menangle Road, Menangle
R10	475 Menangle Road, Menangle
R11	485 Menangle Road, Menangle
R12	486 Menangle Road, Menangle
R13	775 Moreton Park Road, Menangle
R14	251 Menangle Road, Menangle
R15	235 Menangle Road, Menangle
R16	310 Menangle Road, Menangle
R17	195 Menangle Road, Menangle
R18	110 Finns Road, Menangle
R19	25 Carrolls Road, Menangle
R20	47 Carrolls Road, Menangle
R21	45 Finns Road, Menangle
R22	45 Carrolls Road, Menangle

Receiver ID	Address
R23	35 Finns Road, Menangle
R24	5 Finns Road, Menangle
R25	454 Menangle Road, Menangle
R26	460 Menangle Road, Menangle
R27	474 Menangle Road, Menangle
R28	514 Menangle Road, Menangle
R29	490 Menangle Road, Menangle
R30	510 Menangle Road, Menangle
R31	520 Menangle Road, Menangle
R32	530 Menangle Road Douglas, Park
R33	516 Menangle Road, Menangle
R34	165 Carrolls Road, Menangle
R35	115 Carrolls Road, Menangle

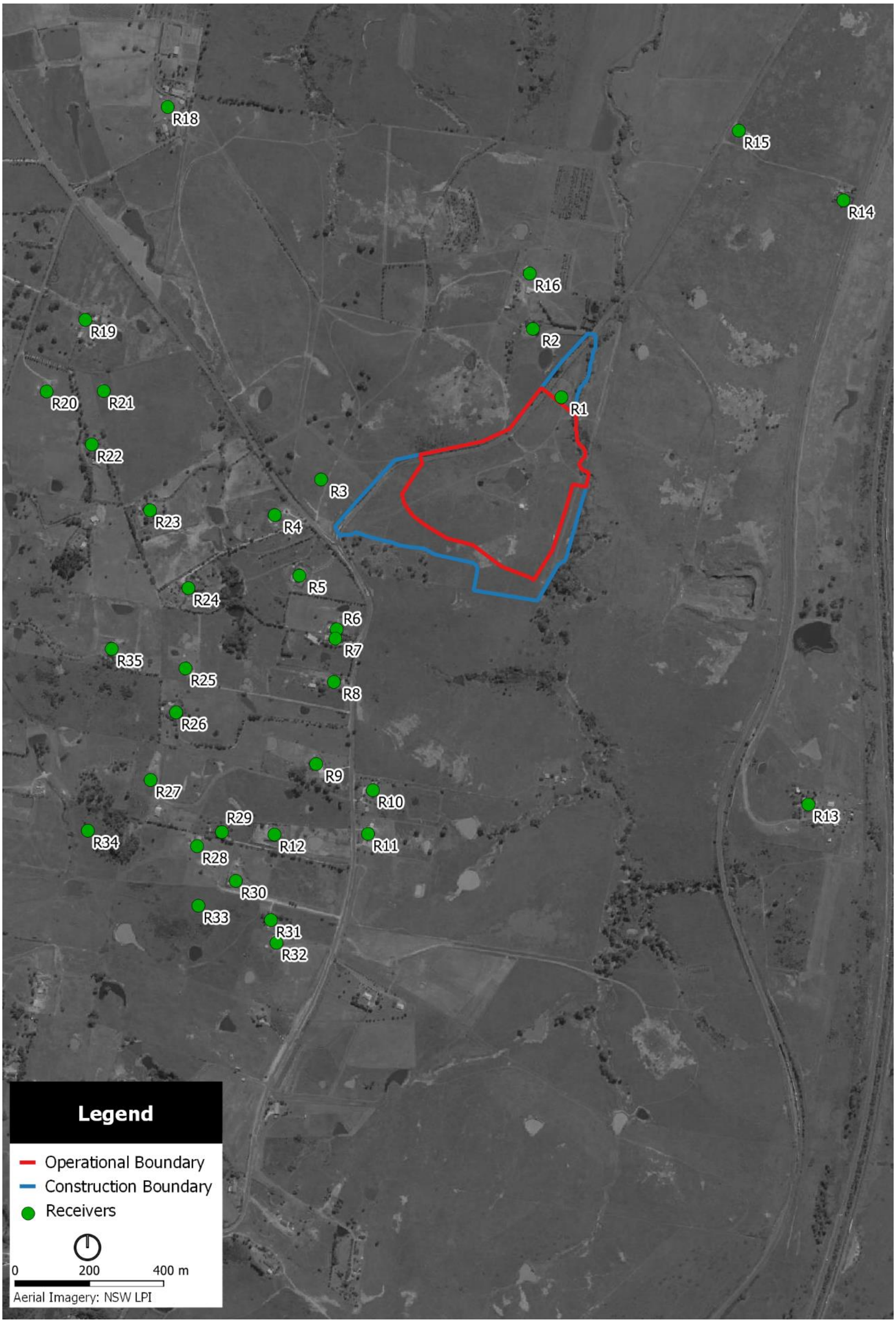


Figure 4: Sensitive Receivers

2.2 Existing Noise Levels

Unattended noise monitoring was conducted in October and November 2020 to quantify the existing ambient noise levels at sensitive receivers. Noise monitoring was undertaken at several locations, identified in Table 2 and shown in Figure 5.

The noise monitoring locations were chosen to be representative of the nearest and most potentially affected sensitive receivers near the Site.

The noise monitoring equipment used for these measurements consisted of an environmental noise logger set to A-weighted, fast response. This equipment is capable of remotely monitoring and storing noise level descriptors for later detailed analysis. The equipment calibration was checked before and after the survey and no significant drift was noted.

From the background noise levels (L_{A90}) the Rating Background Levels (RBLs) were determined using the methodology recommended in the *Noise Policy for Industry* (NPfI).

The existing ambient noise levels are presented in Table 2. Daily plots of the noise logger data are presented in Appendix A.

Some level of insect noise was noted at some locations during site visits and through aural analysis of the logger data. Accordingly, the minimum RBLs for the day, evening and night time assessment periods, which have been confirmed as not being affected by insect noise via aural analysis, will be used to represent existing background noise levels at sensitive receivers considered in this assessment. These RBL values are highlighted in Table 2 via bold text.

Table 2: Ambient Noise Monitoring Results

Monitoring Location	Monitoring Period	Time of Day [a]	Noise Level (dBA)	
			RBL	$L_{Aeq,period}$
M1 – 345 Menangle Road, Menangle	19/10/20 – 03/11/20	Day	43	62
		Evening	41	62
		Night	39	56
	11/11/20 – 23/11/20	Day	40	64
		Evening	**39**	**59**
		Night	**34**	**55**
M2 –15 Finns Road, Menangle	19/10/20 – 03/11/20	Day	41	65
		Evening	42	62
		Night	39	58
	11/11/20 – 23/11/20	Day	**38**	**63**
		Evening	43	60
		Night	39	59

Monitoring Location	Monitoring Period	Time of Day [a]	Noise Level (dBA)	
			RBL	$L_{Aeq,period}$
M3 – 436 Menangle Road, Menangle	19/10/20 – 03/11/20	Day	42	64
		Evening	41	60
		Night	40	60
	11/11/20 – 23/11/20	Day	40	64
		Evening	42	59
		Night	40	55
M4 – 775 Moreton Park Road, Menangle	19/10/20 – 03/11/20	Day	48	65
		Evening	44	62
		Night	39	58

a. Day = 7.00am – 6.00pm; Evening = 6.00pm – 10.00pm; Night = 10.00pm – 7:00am

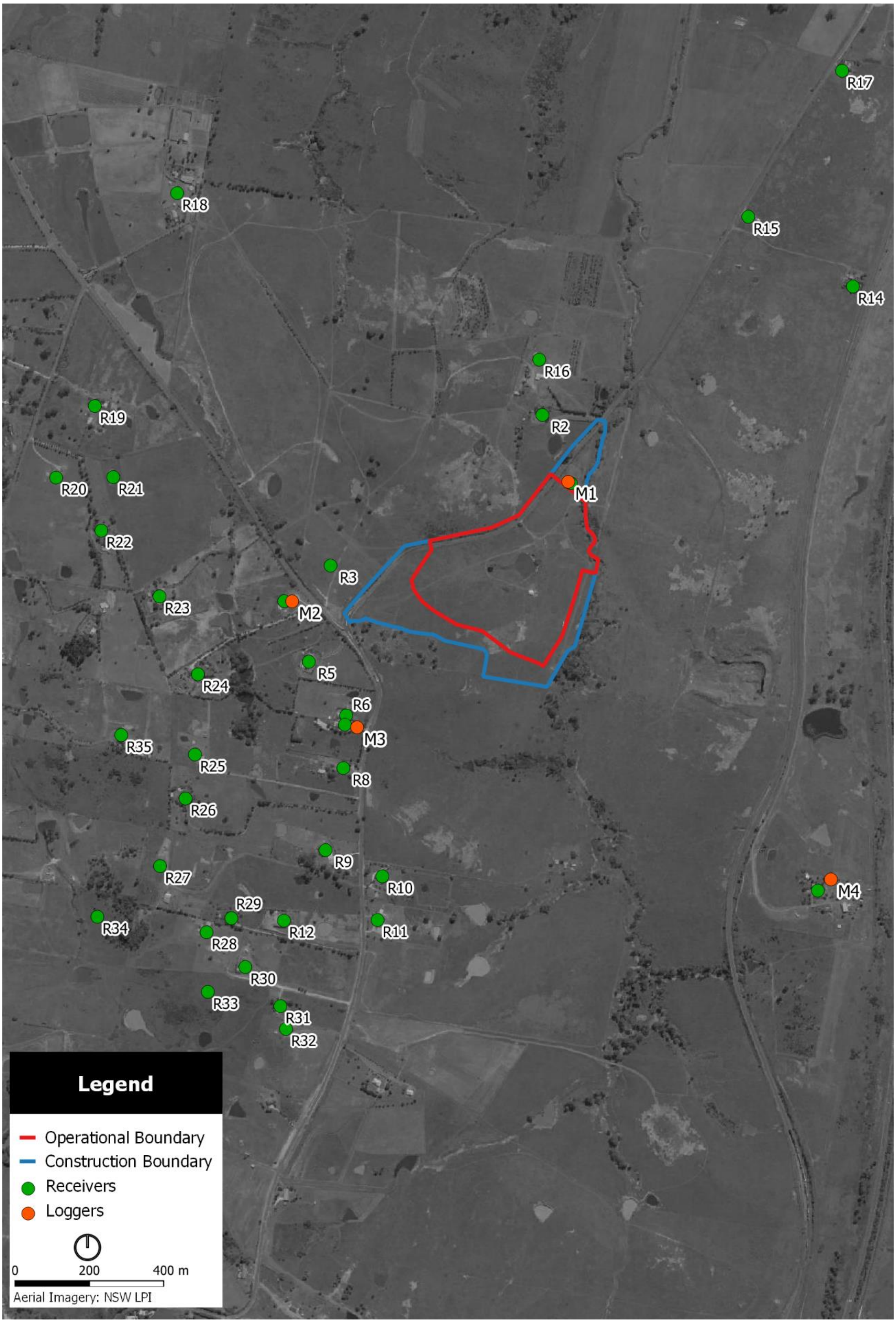


Figure 5: Noise Monitoring Locations

3 OPERATIONAL NOISE ASSESSMENT

3.1 Operational Noise Trigger Levels

The NPfI provides a framework for assessing environmental noise impacts from industrial premises and industrial development proposals in New South Wales.

The NPfI recommends the development of project noise trigger levels, which provide a benchmark for assessing a proposal or site. The project noise trigger levels should not be interpreted as mandatory noise criteria but, rather, as noise levels that, if exceeded, would indicate a potential noise impact on the community.

The project noise trigger level is the lower value of the project intrusiveness noise level and the project amenity noise level. The project intrusiveness noise level assesses the likelihood of noise being intrusive above the ambient noise level and is applied to residential receivers only. The project amenity noise level ensures the total industrial noise from all sources in the area does not rise above a maximum acceptable level.

3.1.1 Project Intrusiveness Noise Levels

The intrusiveness noise level is the noise level 5 dBA above the background noise level for each time period (daytime, evening or night time) of interest at a residential receiver. The background noise level is derived from the measured L_{A90} noise levels.

The NPfI stipulates that project intrusiveness noise levels should not be set below 40 dBA during the daytime and 35 dBA in the evening and night time. Additionally, the NPfI recommends that the project intrusiveness noise level for evening is set at no greater than that for the daytime, and that the project intrusiveness level for night time is set at no greater than that for the evening and daytime.

Intrusiveness noise levels for the project are summarised in Table 3.

Table 3: Project Intrusiveness Noise Levels

Receiver	Time of Day [a]	RBL (dBA)	Project Intrusiveness Noise Level (dBA)
All nearby residences	Day	38	43
	Evening	39	43
	Night	34	39

a. Day = 7.00am – 6.00pm; Evening = 6.00pm – 10.00pm; Night = 10.00pm – 7:00am

3.1.2 Project Amenity Noise Levels

Project amenity noise levels aim to set a limit on continuing increases in noise levels from all industrial noise sources affecting a variety of receiver types; that is, the ambient noise level in an area from all industrial noise sources remains below recommended amenity noise levels.

The amenity assessment is based on noise criteria specific to land use and associated activities. The criteria relate only to industrial-type noise and do not include transportation noise (when on public transport corridors), noise from motor sport, construction noise, community noise, blasting, shooting ranges, occupational workplace noise, wind farms, amplified music/patron noise.

The amenity noise level aims to limit continuing increases in noise levels which may occur if the intrusiveness level alone is applied to successive development within an area.

The recommended amenity noise level represents the objective for total industrial noise at a receiver location. The project amenity noise level represents the objective for noise from a single industrial development at a receiver location.

To prevent increases in industrial noise due to the cumulative effect of several developments, the project amenity noise level for each new source of industrial noise is set at 5dBA below the recommended amenity noise level.

The following exceptions apply to determining the project amenity noise level:

- For high-traffic areas the amenity criterion for industrial noise becomes the $L_{Aeq,period\ (traffic)}$ minus 15dBA.
- In proposed developments in major industrial clusters.
- If the resulting project amenity noise level is 10dB or more, lower than the existing industrial noise level, the project amenity noise level can be set at 10dB below existing industrial noise levels if it can be demonstrated that existing industrial noise levels are unlikely to reduce over time.
- Where cumulative industrial noise is not a consideration because no other industries are present in, or likely to be introduced into the area, the relevant amenity noise level is assigned as the project amenity noise level for the development.

Amenity noise levels are not used directly as regulatory limits. They are used in combination with the project intrusiveness noise level to assess the potential impact of noise, assess mitigation options and determine achievable noise requirements.

The project amenity noise levels are calculated from the recommended amenity noise levels presented in Table 4.

Table 4: Recommended Amenity Noise Levels

Receiver	Noise Amenity Area	Time of Day [a]	Recommended Amenity Noise Level ($L_{Aeq,period}$ dBA)
Residential	Rural	Day	50
		Evening	45
		Night	40
	Suburban	Day	55
		Evening	45
		Night	40
	Urban	Day	60
		Evening	50
		Night	45
Hotels, motels, caretakers' quarters, holiday accommodation, permanent resident caravan parks	See column 4	See column 4	5dB(A) above the recommended amenity noise level for a residence for the relevant noise amenity area and time of day.
School classroom-internal	All	Noisiest 1-hour period when in use	35
Hospital ward internal external	All	Noisiest 1-hour	35
	All	Noisiest 1-hour	50
Place of worship-internal	All	When in use	40
Area specifically reserved for passive recreation (e.g. national park)	All	When in use	50
Active recreation area (e.g. school playground, golf course)	All	When in use	55
Commercial premises	All	When in use	65
Industrial premises	All	When in use	65
Industrial interface (applicable only to residential noise amenity areas)	All	All	Add 5dB(A) to recommended noise amenity area

a. Day = 7.00am – 6.00pm; Evening = 6.00pm – 10.00pm; Night = 10.00pm – 7:00am

Recommended amenity noise levels presented in Table 4 represent the objective for total industrial noise at a receiver location. No other industries are present, or likely to be introduced in the area surrounding the Project. Therefore, the recommended amenity noise levels presented in Table 4 are assigned as the project amenity noise levels for the Project.

Due to different averaging periods for the $L_{Aeq,15min}$ and $L_{Aeq,period}$ noise descriptors, the values of project intrusiveness and amenity noise levels cannot be compared directly when identifying noise trigger levels i.e. the most stringent values of each category. In order to make a comparison between descriptors, the NPfI assumes that the $L_{Aeq,15min}$ equivalent of an $L_{Aeq,period}$ noise level is equal to the $L_{Aeq,15min}$ level plus 3dB.

The most potentially affected residential receivers near the Site are classified as being in a "rural" noise amenity area. The project amenity noise levels for the Project are presented in Table 5.

Table 5: Project Amenity Noise Levels

Receiver	Time of Day [a]	Recommended Amenity Noise Level ($L_{Aeq,period}$)	Project Amenity Noise Level ($L_{Aeq,15min}$)
All nearby residences	Day	50	53
	Evening	45	48
	Night	40	43

a. Day = 7.00am – 6.00pm; Evening = 6.00pm – 10.00pm; Night = 10.00pm – 7:00am

3.1.3 Project Noise Trigger Levels

Table 6 below shows the project noise levels for sensitive receivers, with the project noise trigger levels shown in bold, being the lower value of the project intrusiveness noise level and the project amenity noise level.

Table 6: Project Noise Trigger Levels

Receiver	Time of Day [a]	Project Intrusiveness Noise Levels ($L_{Aeq,15min}$)	Project Amenity Noise Level ($L_{Aeq,15min}$)
All nearby residences	Day	**43**	53
	Evening	**43**	48
	Night	**39**	43

a. Day = 7.00am – 6.00pm; Evening = 6.00pm – 10.00pm; Night = 10.00pm – 7:00am

3.1.4 Maximum Noise Trigger Levels

Noise sources at night occurring over a short duration have the potential to cause sleep disturbance despite complying with project noise trigger levels. Approval is sought for the Project to operate on a 24-hour basis as required. Therefore, maximum noise level events need to be considered for potential sleep disturbance.

The NPfI recommends that, where the night time L_{Amax} receiver noise levels from a development exceeds 52 dBA or the RBL plus 15 dBA, whichever is the greater, then a more detailed assessment of potential sleep disturbance impacts is warranted. Table 7 presents the maximum noise trigger levels for the receivers identified in this assessment.

Table 7: Maximum Noise Trigger Levels

Receiver	RBL	RBL + 15 dBA	Maximum Noise Trigger Level (L_{Amax})
All nearby residences	39	54	54

Additionally, in instances where night time $L_{Aeq,15min}$ noise levels exceed 40 dBA or the prevailing RBL plus 5 dBA, whichever is the greater, then a detailed assessment of potential sleep disturbance impacts is warranted. Since the night time project noise trigger level is less than 40 dBA for all nearby receivers, compliance with these noise trigger levels will ensure that no further assessment of night time $L_{Aeq,15min}$ noise levels, with regard to sleep disturbance, would be required.

3.2 Noise Modelling Methodology and Assumptions

Operational noise emissions associated with the Project were modelled using the CadnaA acoustic noise prediction software and the CONCAWE noise prediction algorithm. The CONCAWE noise propagation model is used around the world and is widely accepted as an appropriate model for predicting noise over significant distances. Factors addressed in the noise modelling are:

- Equipment noise level emissions and locations
- Shielding from structures
- Noise attenuation due to geometric spreading
- Meteorological conditions
- Ground absorption
- Atmospheric absorption.

3.2.1 Meteorological Effects

At relatively large distances from a source, the resultant noise levels at receivers can be influenced by meteorological conditions, particularly temperature inversions and gradient winds. Where these factors are a feature of an area, their effect on resultant noise levels should be taken into account.

In accordance with the NPfI, the following default conditions have been modelled to account for potential noise enhancing meteorology:

- Stability category D with 3.0 m/s source-to-receiver winds during the daytime and evening.
- Stability category F with 2.0 m/s source-to-receiver winds during the night time.

The CadnaA noise modelling software includes a feature that allows the model to be run with the “worst-case wind direction”. This option produces the highest noise level for each receiver due to noise-enhancing winds and has been used in the modelling.

Predicted noise levels associated with both standard meteorological conditions (“calm”) and noise enhancing (“NE”) meteorological conditions are presented in this assessment.

3.3 Operational Noise Sources and Assessment Scenarios

3.3.1 Noise Sources and Sound Power Levels

The most significant operational noise sources for the Project are discussed below and summarised in Table 8.

3.3.1.1 Ventilation Fans and Substation

The design installation sound power levels have been provided by IMC and are presented in Table 8. The data supplied represent sound power levels for two fans operating simultaneously.

IMC advises that the electrical substation at the Site will be similar to that currently operating at the Ventilation Shaft No.6 (VS6) site near Douglas Park. RWDI conducted measurements of this substation in April 2021.

3.3.1.2 Mine Access

During the operation of the mine access facilities, in addition to the ventilation fans and substation, the most significant noise sources would be trucks and mobile plant such as forklifts, the water treatment plant (WTP), and employee vehicles.

All heavy vehicle movements would generally be limited to daytime hours only. However for assessment purposes, it is assumed that heavy vehicle movements may also occur during the evening. Where practicable, forklift operations would be limited to daytime hours, however some forklift use would be required on a 24/7 basis to support provision of supplies, consumables and/or utilities underground. Most employee vehicle movements would occur during shift changes, and could therefore occur during either the day, evening or night time assessment periods.

Car-park movements under Australian conditions can be modelled using an L_{Aeq} sound power level of 64 dBA for one car movement per hour (Nicol & Johnson 2011[1]). It should be noted that this noise level incorporates all vehicle associated activities including; cars starting, doors and boots closing, and people talking.

Table 8: Operational Sound Power Levels

Item	Description	SWL (dBA)	Reference
Ventilation Fans and Substation			
Ventilation Fans	2 fans operating continuously	101	IMC
Substation	Continuous operation	87	VS6 measurements
Pit Top			
Forklift	8-tonne	99	RWDI database
Trucks	2 trucks per hour	103 (per truck)	RWDI database
Cars	115 vehicles per hour	64 (per vehicle)	Nicol & Johnson, 2011
WTP	Continuous operation	90	RWDI database

[1] *Prediction of parking area noise in Australian Conditions*, paper number 39, Proceedings of ACOUSTICS 2011, Laurence Nicol and Paul Johnson

3.4 Assessment of Impacts

The following sections present the predicted $L_{Aeq,15min}$ noise levels at sensitive receivers due to the operation of the Project. Noise levels are presented for the operation of the ventilation fans (and substation) alone, and with the mine access.

3.4.1 Predicted $L_{Aeq,15min}$ Operational Noise Levels – Ventilation Fans Only

The predicted $L_{Aeq,15min}$ noise levels at sensitive receivers due to the operation of the ventilation fans (and substation) are presented in Table 9.

Table 9: Predicted $L_{Aeq,15min}$ Operational Noise Levels, Ventilation Fans Only

Receiver	Predicted Noise Level		Project Noise Trigger Level			Complies?
	Calm	NE	Day	Evening	Night	
R2	32	36	43	43	39	Yes
R3	27	31	43	43	39	Yes
R4	<20	21	43	43	39	Yes
R5	<20	21	43	43	39	Yes
R6	20	23	43	43	39	Yes
R7	20	23	43	43	39	Yes
R8	<20	22	43	43	39	Yes
R9	<20	<20	43	43	39	Yes
R10	21	24	43	43	39	Yes
R11	20	24	43	43	39	Yes
R12	<20	<20	43	43	39	Yes
R13	24	28	43	43	39	Yes
R14	<20	<20	43	43	39	Yes
R15	22	26	43	43	39	Yes
R16	24	29	43	43	39	Yes
R17	<20	<20	43	43	39	Yes
R18	<20	<20	43	43	39	Yes
R19	<20	<20	43	43	39	Yes
R20	<20	<20	43	43	39	Yes
R21	<20	<20	43	43	39	Yes
R22	<20	<20	43	43	39	Yes
R23	<20	<20	43	43	39	Yes

Receiver	Predicted Noise Level		Project Noise Trigger Level			Complies?
	Calm	NE	Day	Evening	Night	
R24	<20	<20	43	43	39	Yes
R25	<20	<20	43	43	39	Yes
R26	<20	<20	43	43	39	Yes
R27	<20	<20	43	43	39	Yes
R28	<20	<20	43	43	39	Yes
R29	<20	<20	43	43	39	Yes
R30	<20	<20	43	43	39	Yes
R31	<20	<20	43	43	39	Yes
R32	<20	<20	43	43	39	Yes
R33	<20	<20	43	43	39	Yes
R34	<20	<20	43	43	39	Yes
R35	<20	<20	43	43	39	Yes

Review of Table 9 indicates compliance with the project noise trigger levels at all times and at all receivers during operation of the ventilation fans.

Contour plots of predicted $L_{Aeq,15min}$ noise levels from the operation of the fans are shown in Figure 6 and Figure 7.

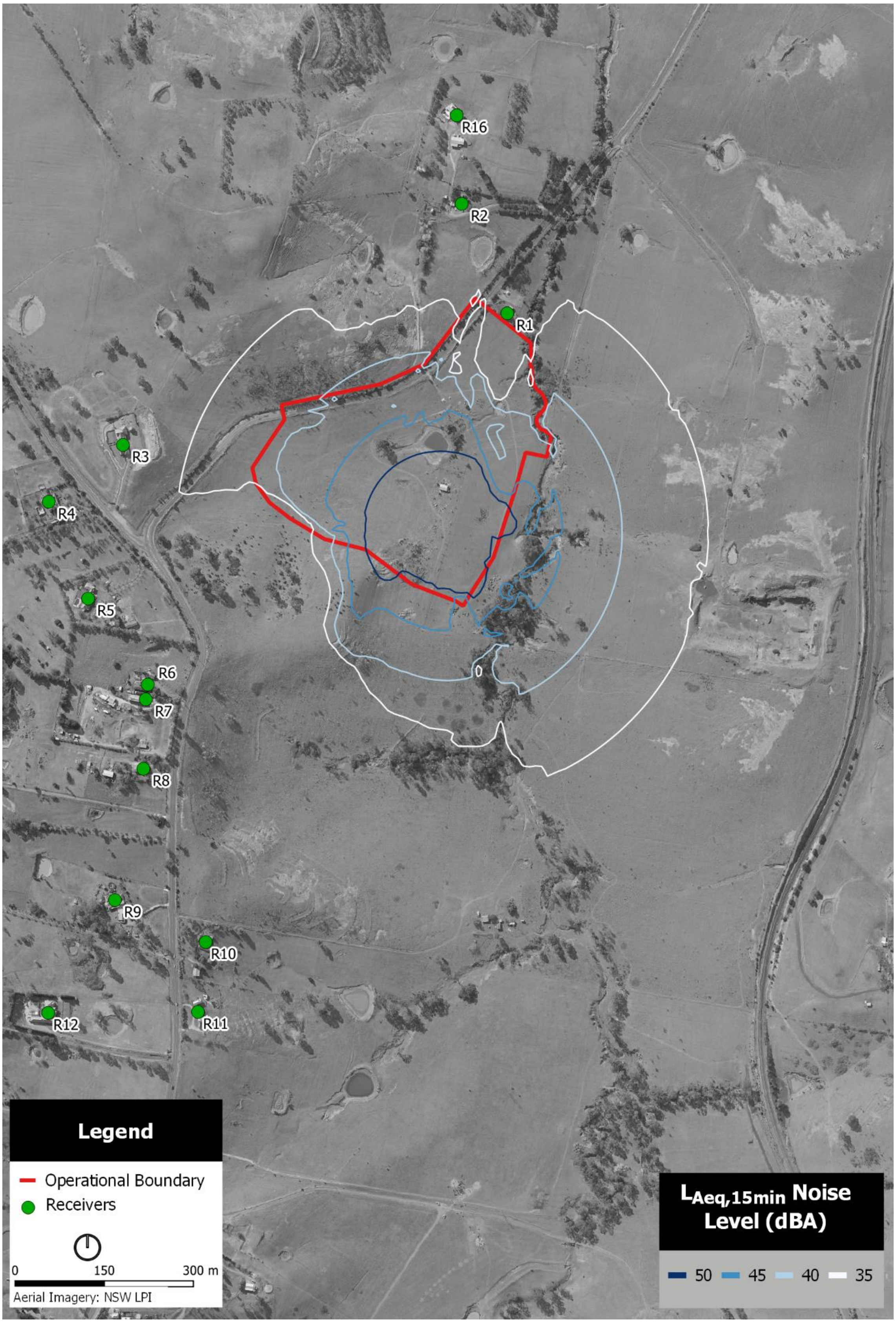


Figure 6: Predicted Noise Levels – Ventilation Fans Only, Calm Meteorology

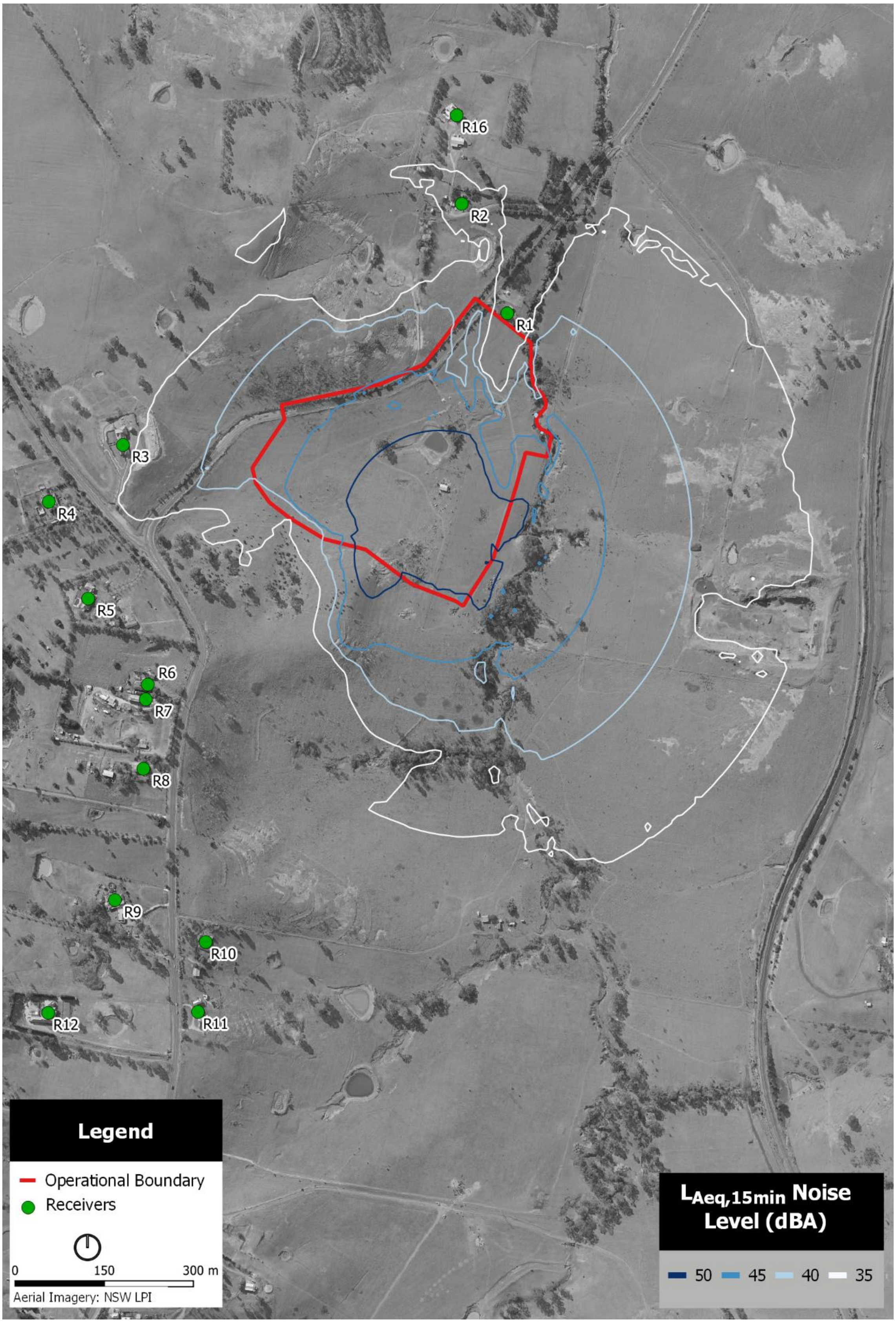


Figure 7: Predicted Noise Levels – Ventilation Fans Only, Noise-enhancing Meteorology

3.4.2 Predicted $L_{Aeq,15min}$ Operational Noise Levels – Ventilation Fans and Mine Access

The predicted $L_{Aeq,15min}$ noise levels at sensitive receivers due to the operation of the ventilation fans and the mine access are presented in Table 10.

Table 10: Predicted $L_{Aeq,15min}$ Operational Noise Levels, Ventilation Fans and Mine Access

Receiver	Predicted Noise Level				Project Noise Trigger Level			Complies?
	Day/Evening		Night					
	Calm	NE	Calm	NE	Day	Evening	Night	
R2	33	38	33	37	43	43	39	Yes
R3	29	33	28	32	43	43	39	Yes
R4	<20	22	<20	22	43	43	39	Yes
R5	<20	22	<20	22	43	43	39	Yes
R6	21	24	21	24	43	43	39	Yes
R7	20	24	20	23	43	43	39	Yes
R8	<20	22	<20	22	43	43	39	Yes
R9	<20	<20	<20	<20	43	43	39	Yes
R10	21	25	21	25	43	43	39	Yes
R11	20	24	20	24	43	43	39	Yes
R12	<20	<20	<20	<20	43	43	39	Yes
R13	25	29	25	29	43	43	39	Yes
R14	<20	<20	<20	<20	43	43	39	Yes
R15	22	27	22	26	43	43	39	Yes
R16	26	31	26	30	43	43	39	Yes
R17	<20	<20	<20	<20	43	43	39	Yes
R18	<20	<20	<20	<20	43	43	39	Yes
R19	<20	<20	<20	<20	43	43	39	Yes
R20	<20	<20	<20	<20	43	43	39	Yes
R21	<20	<20	<20	<20	43	43	39	Yes
R22	<20	<20	<20	<20	43	43	39	Yes
R23	<20	<20	<20	<20	43	43	39	Yes
R24	<20	<20	<20	<20	43	43	39	Yes
R25	<20	<20	<20	<20	43	43	39	Yes

Receiver	Predicted Noise Level				Project Noise Trigger Level			Complies?
	Day/Evening		Night					
	Calm	NE	Calm	NE	Day	Evening	Night	
R26	<20	<20	<20	<20	43	43	39	Yes
R27	<20	<20	<20	<20	43	43	39	Yes
R28	<20	<20	<20	<20	43	43	39	Yes
R29	<20	<20	<20	<20	43	43	39	Yes
R30	<20	<20	<20	<20	43	43	39	Yes
R31	<20	<20	<20	<20	43	43	39	Yes
R32	<20	<20	<20	<20	43	43	39	Yes
R33	<20	<20	<20	<20	43	43	39	Yes
R34	<20	<20	<20	<20	43	43	39	Yes
R35	<20	<20	<20	<20	43	43	39	Yes

Review of Table 10 indicates compliance with the project noise trigger levels at all times and at all receivers during operation of the ventilation fans and mine access.

Contour plots of predicted $L_{Aeq,15min}$ noise levels from the operation of the fans and mine access are shown in Figure 8, Figure 9, Figure 10 and Figure 11.

Figure 8: Predicted Day/Evening Noise Levels – Ventilation Fans and Mine Access, Calm Meteorology

Figure 9: Predicted Day/Evening Noise Levels – Ventilation Fans and Mine Access, Noise-enhancing Meteorology

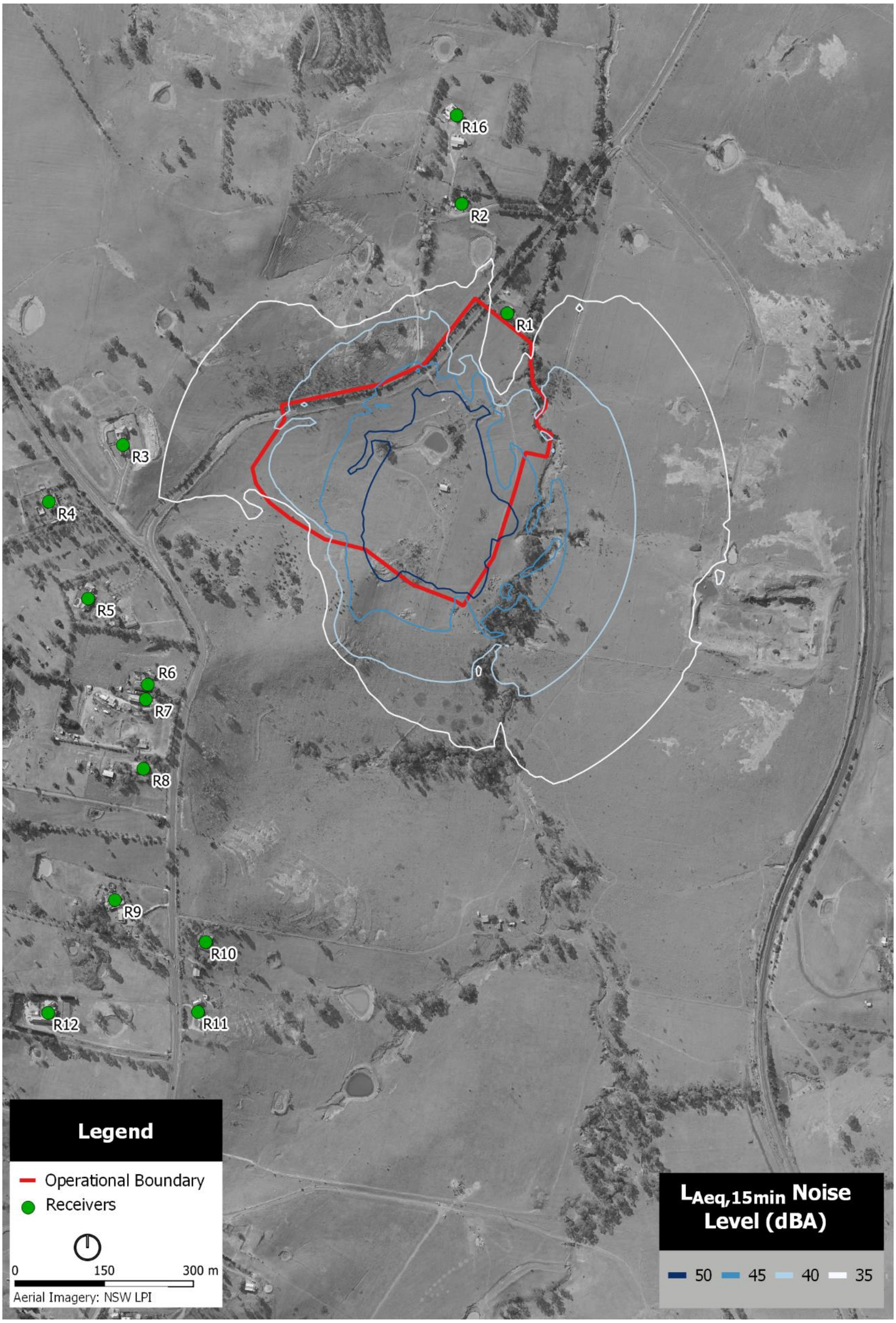


Figure 10: Predicted Night Noise Levels – Ventilation Fans and Mine Access, Calm Meteorology

Figure 11 Predicted Night Noise Levels – Ventilation Fans and Mine Access, Noise-enhancing Meteorology

3.4.3 Potential Low Frequency Noise Impacts

The NPfI recommends modifying factors be applied to account for increased annoyance from low frequency noise when the difference between the C-weighted and A-weighted $L_{Aeq,15min}$ noise levels exceed 15 dB, and sufficient acoustic energy from the source is identified in third octave bands between 10Hz and 160Hz. The third octave band threshold levels are presented in Table 11.

Table 11: NPfI Low Frequency Noise Thresholds

Hz/dBZ	One-third Octave $L_{Zeq,15minute}$ Threshold												
f (Hz)	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160
dBZ	92	89	86	77	69	61	54	50	50	48	48	46	44

If the one-third octave band noise levels at receivers exceed any of the trigger levels in Table 11 by up to 5 dB, a 2 dB adjustment should be added to the measured $L_{Aeq,15min}$ noise levels during the evening and night time periods.

If the one-third octave band noise levels at receivers exceed any of the trigger levels in Table 11 by more than 5 dB, a 2 dB adjustment should be added to the measured $L_{Aeq,15min}$ noise levels during the daytime and a 5 dB adjustment should be added to the measured $L_{Aeq,15min}$ noise levels during the evening and night time periods.

The applicability of low frequency noise penalties per the NPfI can only be confirmed through compliance measurements. However, the EPA has requested assessment of potential low frequency noise impacts for several recent extractive industry project. Accordingly, such an assessment is provided herein. It is noted that the prediction of one-third octave band noise levels is somewhat difficult due to limited capabilities of noise prediction software and algorithms and particularly relevant to the Project, the limited availability of source sound power level data in one-third octave bands.

The design sound power level data provided by IMC does not provide one-third octave band information and does not extend down to 10 Hz. Therefore, for assessment purposes, the predicted octave band noise levels at receivers have been extrapolated to one-third octave band levels by assuming equal sound energy in each one-third octave within any octave band. For instance, if the predicted 63 Hz octave band noise level at a receiver was 50.0 dB, then it would be assumed that the noise level in the 50 Hz, 63 Hz and 80 Hz one-third octave band levels were equal to 45.2 dB. IMC advises that the sound power level of the fans at the 16 Hz octave band is typically 10 dB below that at 32 Hz octave band. For assessment purposes, it is conservatively assumed that the fans have constant sound power in each one-third octave band below 32 Hz.

Predicted noise levels at R2 under noise enhancing meteorological conditions during the operation of the ventilation fans and the mine access have been analysed for potential low frequency noise penalties. This receiver has been chosen for this analysis since, considering the predicted noise levels in Table 10, this is the only location where the addition of a penalty for low frequency noise could affect the predicted compliance with the project noise trigger levels.

Table 12: NPfI Low Frequency Penalty – R2

Frequency (Hz)	One-third octave band noise levels (dBZ)													Penalty
	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	
NPfI Trigger Level	92	89	86	77	69	61	54	50	50	48	48	46	44	
R2 Predicted Level (NE)	65	65	65	65	65	60	**55**	**54**	50	46	40	37	34	**2 dB**

The results in Table 12 indicated the potential for a low frequency noise penalty of 2 dB to be applied at R2. If such a penalty were to be applied at R2, then the predicted night time $L_{Aeq,15min}$ operational noise level of 37 dBA under noise enhancing meteorological conditions would be increased to 39 dBA. This noise level would still comply with the night time project noise trigger levels of 39 dBA at R2.

3.4.4 Sleep Disturbance Assessment

The most likely potential sources of maximum noise levels during site operations would be the audible alarm that sounds prior to the operation of the winder/cage, or the reversing alarm on the forklift.

Based on measurements previously conducted by RWDI, the L_{Amax} sound power level of audible alarms of this type is typically 105 dBA.

The predicted L_{Amax} noise levels at sensitive receivers due to the operation of the winder/cage alarm are presented in Table 13.

Table 13: Predicted L_{Amax} Noise Levels

Receiver	Predicted Noise Level		Maximum Noise Trigger Level	Complies?
	Calm	NE		
R2	32	37	54	Yes
R3	25	30	54	Yes
R4	<20	<20	54	Yes
R5	<20	<20	54	Yes
R6	<20	<20	54	Yes
R7	<20	<20	54	Yes
R8	<20	<20	54	Yes
R9	<20	<20	54	Yes
R10	<20	<20	54	Yes
R11	<20	<20	54	Yes

Receiver	Predicted Noise Level		Maximum Noise Trigger Level	Complies?
	Calm	NE		
R12	<20	<20	54	Yes
R13	<20	23	54	Yes
R14	<20	<20	54	Yes
R15	<20	<20	54	Yes
R16	25	30	54	Yes
R17	<20	<20	54	Yes
R18	<20	<20	54	Yes
R19	<20	<20	54	Yes
R20	<20	<20	54	Yes
R21	<20	<20	54	Yes
R22	<20	<20	54	Yes
R23	<20	<20	54	Yes
R24	<20	<20	54	Yes
R25	<20	<20	54	Yes
R26	<20	<20	54	Yes
R27	<20	<20	54	Yes
R28	<20	<20	54	Yes
R29	<20	<20	54	Yes
R30	<20	<20	54	Yes
R31	<20	<20	54	Yes
R32	<20	<20	54	Yes
R33	<20	<20	54	Yes
R34	<20	<20	54	Yes
R35	<20	<20	54	Yes

The predicted L_{Amax} noise levels in Table 13 comply with the maximum noise trigger levels at all receivers. Furthermore, as discussed in Sections 3.4.1 and 3.4.2, the predicted $L_{Aeq,15min}$ operational noise levels are below 40 dBA at all sensitive receivers. Therefore, $L_{Aeq,15min}$ operational noise levels are unlikely to cause sleep disturbance impacts.

3.4.5 Voluntary Land Acquisition and Mitigation Policy

The Project is classified as a State significant mining/extractive industry development and therefore, the *Voluntary Land Acquisition and Mitigation Policy* (VLAMP) must be considered.

The predicted noise levels associated with the operation of the Project comply with the established noise trigger levels at all sensitive receivers. Additionally, the predicted noise levels associated with the operation of the Project do not exceed the acceptable noise level plus 5 dB in Table 2.2 of the NPfI on more than 25% of any privately owned land where there is an existing dwelling or where a dwelling could be built under existing planning controls.

Therefore, no voluntary mitigation or land acquisition rights, as prescribed by the VLAMP, would be applicable to the Proposal.

4 ROAD NOISE ASSESSMENT

The following section assesses potential road noise impacts on sensitive receivers due to traffic generated by the Project.

During operations, heavy vehicles accessing the Site would do so via Picton Road and Menangle Road. Approximately 93% of light vehicles would also use this route, with the remaining light vehicles accessing the Site via Menangle Road to the north of the Site. Therefore, sensitive receivers most potentially affected by road noise impacts during operations would be residents along Menangle Road, south of the Site.

During construction, night time concrete deliveries will access the Site from the North. Therefore, sensitive receivers most potentially affected by road noise impacts during construction would be residents along Menangle Road, north of the Site.

4.1 Road Noise Criteria

The *NSW Road Noise Policy* (RNP) sets out criteria for assessment of noise from traffic on public roads. The RNP sets out noise assessment criteria for “freeways”, “arterial”, “sub-arterial” and “local roads”.

In accordance with the RNP, Menangle Road is considered an arterial road. The RNP impact assessment criteria for residential land uses impacted by additional traffic on arterial roads are presented in Table 14.

Table 14: RNP Impact Assessment Criteria

Road	Category	Impact Assessment Criteria (dBA)	
		Day [a]	Night [a]
Menangle Road	Arterial	$L_{Aeq,15hour}$ 60	$L_{Aeq,9\ hour}$ 55

a. Day = 7.00am – 10.00pm; Night = 10.00pm – 7.00am

With regard to the permissible increase in road traffic noise from a land use development the RNP states:

> *“For existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level should be limited to 2 dB above that of the corresponding ‘no build option’.”*

4.2 Road Noise Modelling

Noise levels were calculated using procedures based on the CoRTN (Calculation of Road Traffic Noise) (UK Department of Transport, 1988) prediction algorithms. The standard prediction procedures were modified as follows:

- L_{Aeq} values were calculated from the L_{A10} values predicted by the CoRTN algorithms using the well-validated approximation $L_{Aeq,1hour} = L_{A10,1hr} - 3$ (NSW RTA, 2001). It is worth noting the predicted $L_{Aeq,1hr}$ is equivalent to the $L_{Aeq,period}$ as required by the noise criteria since the input is the “average” traffic flow per hour over the given daytime and night time periods.

- Noise source heights were set at 0.5m for cars, 1.5m for heavy vehicle engines and 3.6m for heavy vehicle exhausts, representative of typical values for Australian vehicles (Road Traffic Noise: Interim Traffic Noise Policy, 1992).
- Noise from a heavy vehicle exhaust is 8 dBA lower than the (steady continuous) noise from the engine.

The calculations have been implemented in CandaA, using the "CoRTN Australia" model option, and are based upon the following assumptions:

- Vehicle speeds are 80 km/h along Menangle Road.
- A +2.5 dBA correction has been applied for façade reflections.
- Road surfaces - +0 dB Asphalt.

4.3 Operational Road Noise Impacts

4.3.1 Traffic Volumes

4.3.1.1 Existing Traffic Flows

Existing traffic flows along Menangle Road, south of Finns Road, were determined by a traffic count survey conducted between 19 and 25 November 2020. The existing 7 day average traffic flows identified during the survey are summarised in Table 15

Table 15: Existing Traffic Flows (7 Day Average)

Road	Day [a]		Night [a]	
	Volume	% Heavy	Volume	% Heavy
Menangle Road (South of Finns Road)	4,912	6.3 %	615	8.3 %

a. Day = 7.00am – 10.00pm; Night = 10.00pm – 7.00am

4.3.1.2 Traffic Generated by the Project

The Project would generate approximately 574 light vehicle and 24 heavy vehicle movements per day during operations. Approximately 164 light vehicle movements would occur during the night, with the remainder occurring during the day. All heavy vehicle movements would occur during the day.

Table 16 summarises the existing ("no-build") and future ("build") traffic volumes and percent heavy vehicles ("mix") along Menangle Road, south of the Site.

Table 16: Traffic Volume and Mix

Road	Time [a]	Existing (no-build)		Future (build)	
		Volume	% Heavy	Volume	% Heavy
Menangle Road (South of Finns Road)	Day	4,912	6.3 %	5,342	6.1%
	Night	615	8.3 %	779	6.5%

a. Day = 7.00am – 10.00pm; Night = 10.00pm – 7.00am

4.3.2 Predicted Road Noise Levels

Using the traffic data in Table 16, road noise levels at the most potentially affected sensitive receivers along Menangle Road, south of Finns Road, have been predicted for the "no-build" and "build" scenarios and are shown in Table 17.

Table 17: Predicted $L_{Aeq,period}$ Road Noise Levels

Road	No-Build		Build		RNP Criteria		Difference	
	Day [a]	Night [a]	Day [a]	Night [a]	Day [a]	Night [a]	Day [a]	Night [a]
Menangle Road (South of Finns Road)	59.4	50.9	59.7	51.5	60	55	0.3	0.6

a. Day = 7.00am – 10.00pm; Night = 10.00pm – 7.00am

Review of Table 17 indicates that the predicted road noise levels at the façade of the most potentially affected receivers along Menangle Road, south of Finns Road, comply with the RNP impact assessment criteria.

4.4 Construction Road Noise Impacts

4.4.1 Traffic Volumes

4.4.1.1 Existing Traffic Flows

Existing traffic flows along Menangle Road, north of Finns Road, were determined by a traffic count survey conducted between 19 and 25 November 2020. The existing 7 day average traffic flows identified during the survey are summarised in Table 15

Table 18: Existing Traffic Flows, 7 Day Average

Road	Day [a]		Night [a]	
	Volume	% Heavy	Volume	% Heavy
Menangle Road (North of Finns Road)	2,590	9.7%	309	11.8%

a. Day = 7.00am – 10.00pm; Night = 10.00pm – 7.00am

4.4.1.2 Traffic Generated by the Project

The Project would generate approximately 152 light vehicle and 72 heavy vehicle movements per day during construction. Up to 16 heavy vehicle movements, associated with concrete deliveries, would occur during the night.

4.4.2 Predicted Road Noise Level Increases During Construction

Potential increases in road noise levels during the construction of the Project at the most potentially affected sensitive receivers along Menangle Road, north of Finns Road, have been predicted and are shown in Table 19.

Table 19: Predicted Increases in $L_{Aeq,period}$ Road Noise Levels

Road	Difference	
	Day [a]	Night [a]
Menangle Road (North of Finns Road)	0.6	0.9

a. Day = 7.00am – 10.00pm; Night = 10.00pm – 7.00am

Review of Table 19 indicates that the predicted increases in road noise levels due to construction traffic at the most potentially affected receivers along Menangle Road, to the north of Finns Road, are less than 2 dBA. In accordance with the RNP, this increase in noise levels would not be noticeable to the average person and therefore does not warrant mitigation.

5 CONSTRUCTION NOISE AND VIBRATION ASSESSMENT

This section presents an assessment of potential noise and vibration impacts associated with general construction activities for the Project. Potential impacts associated with blasting are presented in Section 6.

5.1 Construction Noise Management Levels

The *Interim Construction Noise Guideline* (ICNG) (DECC, 2009) recommends noise management levels (NML) to reduce the likelihood of noise impacts arising from construction activities. The ICNG NML for residential receivers are shown in Table 20.

Table 20: Construction NML for Residential Receivers

Time of Day	NML ($L_{Aeq,15min}$)	How to Apply
Recommended standard hours: **Monday to Friday: 7am to 6pm** **Saturday: 8am to 1pm** **No work on Sundays or Public Holidays**	Noise affected RBL + 10 dBA	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq,15min}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to minimise noise. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dBA	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the proponent should consider very carefully if there is any other feasible and reasonable way to reduce noise to below this level. If no quieter work method is feasible and reasonable, and the works proceed, the proponent should communicate with the impacted residents by clearly explaining the duration and noise level of the works, and by describing any respite periods that will be provided.
Outside recommended standard hours	Noise affected RBL + 5 dBA	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5dB(A) above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see ICNG section 7.2.2

Based on the established RBLs, construction noise management levels for sensitive receivers near the Project site are presented in Table 21.

Table 21: Project-Specific Construction NML, $L_{Aeq,\ 15min}$ - dBA

Receiver	Standard Construction Hours [a]		Outside of Recommended Standard Hours (OOH)		
	Noise-Affected Level	Highly Noise-Affected Level	Day [b]	Evening [c]	Night [d]
All Residences	48	75	43	43	39

a. 7am – 6pm Monday to Friday; 8am – 1pm Saturday
b. 1pm – 6pm Saturday; 8am – 6pm Sunday and Public Holidays
c. 6pm – 10pm All days
d. 10pm – 7am Monday to Friday; 10pm – 8am Saturday, Sunday and Public Holidays.

5.2 Construction Activities, Plant and Sound Power Levels

Based on information provided to RWDI, a summary of the indicative construction and operational schedule for the site is presented in Table 22.

Table 22: Indicative Construction and Operational Schedule

Activity	Start	Finish	Duration
Site establishment, bulk earthworks, construction utilities, pre-sinking and access upgrades	July 2022	March 2023	7 months
Construction of permanent HV power supply infrastructure	March 2023	May 2024	14 months
Ventilation Shaft 7 (VS7) sinking and lining	August 2023	December 2024	17 months
Ventilation Shaft 8 (VS8) sinking and lining	June 2023	October 2024	17 months
Construction of fans, evase(s) and ancillary site infrastructure for ventilation shafts	February 2023	December 2024	22 months
Construction of mine access infrastructure: winder, evase, headframe and ancillary site infrastructure	July 2024	2025	12 -18 months
Commissioning and operation of ventilation shafts	November 2024	2045	21 years
Commissioning and operation mine access infrastructure	2025	2045	20 years
De-commissioning and site rehabilitation	2045	2050	5 years

5.2.1 Acoustic Sheds

It is proposed that some construction activities associated with shaft sinking would be conducted outside of standard construction hours and that, if these works are approved, acoustic sheds will be constructed over the VS7 and VS8 shaft construction areas to mitigate noise emissions associated with the construction of the VS7 and VS8 shafts during out of hours (OOH) work.

The noise reduction expected to be achieved by various acoustic shed constructions (indicative) are presented in Table 23. The actual noise reduction required from the shed(s) would be confirmed during detailed design. For assessment purposes, a noise reduction of 25 dBA has been applied.

OOH shaft sinking would not occur prior to the construction of the shed(s) unless the relevant construction NMLs are met.

Table 23: Noise Reduction Performance of Acoustic Shed Constructions

<table>
<tr><th>Typical Noise Reduction (NR)</th><th>Typical Façade Construction</th><th>Typical Internal Treatment</th><th>Typical Door Requirements</th><th>Typical Ventilation Requirements</th></tr>
<tr><td>10 dBA</td><td>0.6mm Colourbond, 4.7kg/m2, minimum Rw+ctr18</td><td>None</td><td>Good quality roller door of 0.6mm steel + insulated pelmet</td><td>Allow for at least hard ducted internally lined bend between weather and ventilation system</td></tr>
<tr><td>20 dBA (option 1)</td><td>0.6mm Colourbond, 4.7kg/m2, minimum Rw+ctr18</td><td>Typically all walls and roof to be covered with 100mm thick, 32kg/m3 insulation with at least 10% perf facing NRC at least 0.95</td><td rowspan="2">> 0.6mm steel - Allow for acoustic seals or oversized guides and insulated pelmet in design & use as small an opening as permitted (good quality roller door will suffice)</td><td rowspan="2">Allow for medium performance acoustic louvre OR medium performance acoustic silencer</td></tr>
<tr><td>20 dBA (option 2)</td><td>Insulated façade material such as from Kingspan (metal/foam/metal) - typically 18kg/m2 and minimum Rw + ctr 22</td><td>Typically all walls and gable ends to be covered with 100mm thick, 32kg/m3 insulation with 10% perf facing NRC at least 0.95</td></tr>
</table>

Typical Noise Reduction (NR)	Typical Façade Construction	Typical Internal Treatment	Typical Door Requirements	Typical Ventilation Requirements
25 dBA	Insulated façade material such as from Kingspan (metal/foam/metal) - typically 18kg/m2 and minimum Rw + ctr 22	Typically all walls and roof to be covered with 100mm thick, 32kg/m3 insulation with 10% perf facing NRC at least 0.95	Double door system required > 0.6mm steel - Allow for acoustic seals or oversized guides and insulated pelmet in design & use as small an opening as permitted (good quality roller door will suffice) AND at night time a simple external hinged or sliding door with insulation on the inner face ie 100mm frame with 18mm ply on the outside and insulation 100mm on the inner face.	Allow for high performance acoustic louvre OR high performance acoustic silencer

5.2.2 Construction Activities, Equipment and Sound Power Levels

The likely construction activities and associated equipment, as advised by IMC, are summarised in Table 24. Table 24 nominates those activities which are proposed to be conducted outside of standard construction hours and indicates which construction activities will be contained within the acoustic sheds once they are constructed.

Table 24 presents sound power levels for individual items of construction equipment and overall activity sound power levels. The activity sound power levels are defined for both standard hours and out of hours, depending upon what equipment would be operating.

The activity sound power is considered to represent the typical worst-case level in a given 15-minute period. It is important to note that this sound power level is unlikely to be sustained at such a level for the duration of the activity. As a result, construction noise emissions during many 15-minute periods will be at lower levels.

Table 24: Construction Equipment Sound Power Levels

Activity	Equipment	Qty	Individual SWL (dBA)	Activity SWL (dBA)	
				Standard	Out of hours
Deliveries					
Deliveries for all activities	Trucks	2	103	106	n/a [b]
Services to Site					
Connection of utilities (power, water, communication etc)	Trencher	1	111	113	n/a [a]
	Underborer	1	95		
	Crane	1	105		
	Truck	1	103		
Civil Works					
Bulk earthworks	Excavator (incl. rock breaker)	2	122	127	n/a [a]
	Grader	2	113		
	Dump truck	2	110		
	Roller	1	109		
	Compactor	1	106		
	Dozer	2	116		
	Water truck	1	107		
	Borehole drill rig	1	103		
VS7 Shaft Construction					
Set up	Crane	1	105	111	n/a [a]
	Dump truck	1	110		
Shaft sinking	50t slewing crane	1	113	125	125
	Handheld airleg and rockdrill	1	124		
	Mini excavator (incl. rockbreaker attachment)	1	115		
	Emergency Power Genset and switching (500 kVA typical)	1	103		
	Ventilation Fan and Ducting	1	120		
	Ventilation Scrubber	1	100		
	Shaft Drilling Equipment	2	119		
	Mini Excavator (incl. rockbreaker attachment)	1	115		
	Dump truck [e]	1	110		
	Dozer [e]	1	116		
	Water Truck [e]	1	107		
	Shotcrete Delivery Equipment	1	106		

Activity	Equipment	Qty	Individual SWL (dBA)	Activity SWL (dBA)	
				Standard	Out of hours
	Concrete Delivery from offsite via Truck	2	110		
	Concrete Delivery System (pumps)	1	102		
VS8 Shaft Construction					
Set up	Crane	1	105	111	n/a [a]
	Dump truck	1	110		
Shaft sinking	50t Slewing Crane	1	113	125	125
	Handheld Airleg and Rockdrill	1	124		
	Mini Excavator (incl. rockbreaker attachment)	1	115		
	Emergency Power Genset and switching (500 kVA typical)1	1	103		
	Ventilation Fan and Ducting	1	120		
	Ventilation Scrubber	1	100		
	Shaft Drilling Equipment	2	119		
	Mini Excavator (incl. rockbreaker attachment)	1	122		
	Dump truck [d]	1	110		
	Dozer [d]	1	116		
	Water Truck [d]	1	107		
	Shotcrete Delivery Equipment	1	106		
	Concrete Delivery from offsite via Truck	2	110		
	Concrete Delivery System (pumps)	1	102		
Ventilation fans					
Installation of fans and related infrastructure	Cranes	2	105	111	n/a [a]
	Truck	2	103		
	Hand tools	As required	105		
Mine access infrastructure					
Installation of pit top building, headframe and winder, and ancillary site infrastructure	Cranes	2	105	111	n/a [a]
	Truck	2	103		
	Hand tools	As required	105		
Intersection works					
Pavement/asphalting	Pavement laying machine	1	114	118	n/a [c]

Activity	Equipment	Qty	Individual SWL (dBA)	Activity SWL (dBA)	
				Standard	Out of hours
	Dump truck	1	110		
	Asphalt truck and sprayer	1	103		
	Concrete truck	1	109		
	Smooth drum roller	1	107		
	Concrete saw	1	118		
Signposting and line marking	Road truck	1	108	111	n/a [c]
	Scissor lift	1	98		
	Franna crane	1	98		
	Line marking truck	1	108		

a. Activity not proposed during OOH periods.
b. Some oversized/special deliveries may be undertaken outside these hours to take advantage of reduced traffic volumes, or where police or other authorities require special arrangements to transport along public roads.
c. Some road works potentially requiring traffic management measures, such as line marking and cutting in the access road to Menangle Road, line marking the intersection and installation of asphaltic concrete, may be undertaken outside these hours (subject to Council's approval) to take advantage of reduced traffic volumes.
d. Activities related to shaft spoil handling, that will occur outside of the acoustic shed are restricted to daytime construction hours only.

5.3 Predicted Construction Noise Levels

Noise levels associated with the proposed construction works have been predicted using the same modelling approach outlined in Section 3.2.

Predicted noise levels have for shaft sinking activities are presented with and without noise attenuation provided by the acoustic sheds as discussed in Section 5.2.1 and Table 23. It is assumed for this assessment that the acoustic sheds will provide a noise reduction of 25dBA.

5.3.1 Construction Works During Standard Hours

Based on the construction activities and plant SWL presented in section 5.2.2, the predicted $L_{Aeq,15min}$ construction noise levels at sensitive receivers from the various construction activities during the ICNG's standard recommended hours are presented in Table 25. Predicted noise levels are given for both 'No Shed' and '25 dBA Shed' scenarios, referring to the acoustic shed.

The results in Table 25 indicate that:

- Noise levels associated with construction activities during standard hours are predicted to comply with the NML at sensitive receivers during all proposed activities except for the civil works, shaft sinking without acoustic sheds, and intersection works;
- During the proposed civil works, noise levels are predicted to exceed the NML at R2 and R3 by 5 dBA and 1 dBA, respectively;
- During shaft sinking without an acoustic shed, noise levels are predicted to exceed the NML at R2 and R3 by up to 5 dBA and 1 dBA, respectively, and,
  During the proposed intersection works, noise levels at R2 are predicted to exceed the NML by up to 4 dBA.

Measures to manage construction noise levels down toward the NML are discussed in Section 5.3.3

Table 25: Predicted Construction Noise Levels during Standard Construction Hours – $L_{Aeq,15min}$ dBA

Receiver	Deliveries	Civil Works	Services to Site	VS7			VS8			Fans	Access	Intersection Works		NML	Exceedance
				Set up	Shaft Sinking		Set up	Shaft Sinking				Pavement	Line marking		
					No-shed	25 dBA Shed		No-shed	25 dBA Shed						
R2	32	**53**	39	39	**55**	30	36	**50**	25	36	41	**52**	45	48	**5 dB**
R3	28	**49**	35	33	48	23	35	**49**	24	35	34	46	39	48	**1 dB**
R4	<20	35	20	<20	33	<20	21	35	<20	21	<20	31	24	48	-
R5	<20	36	22	<20	34	<20	20	34	<20	20	20	33	26	48	-
R6	<20	38	24	22	37	<20	22	36	<20	22	23	35	28	48	-
R7	<20	37	23	20	36	<20	21	35	<20	21	22	34	27	48	-
R8	<20	35	20	20	35	<20	<20	33	<20	<20	21	32	25	48	-
R9	<20	28	<20	<20	27	<20	<20	28	<20	<20	<20	25	<20	48	-
R10	<20	35	21	<20	34	<20	21	35	<20	21	20	32	25	48	-
R11	<20	35	20	20	35	<20	21	34	<20	20	21	32	25	48	-
R12	<20	27	<20	<20	26	<20	<20	26	<20	<20	<20	23	<20	48	-
R13	23	44	29	29	44	<20	31	45	20	31	30	41	34	48	-
R14	<20	30	<20	<20	30	<20	<20	29	<20	<20	<20	27	20	48	-
R15	20	41	26	24	40	<20	25	39	<20	25	26	38	31	48	-
R16	24	45	31	33	48	23	31	45	20	31	34	45	38	48	-
R17	<20	32	<20	<20	32	<20	<20	31	<20	<20	<20	29	22	48	-
R18	<20	22	<20	<20	20	<20	<20	21	<20	<20	<20	<20	<20	48	-
R19	<20	26	<20	<20	25	<20	<20	25	<20	<20	<20	23	<20	48	-
R20	<20	25	<20	<20	24	<20	<20	23	<20	<20	<20	22	<20	48	-
R21	<20	28	<20	<20	28	<20	<20	27	<20	<20	<20	25	<20	48	-
R22	<20	28	<20	<20	27	<20	<20	27	<20	<20	<20	25	<20	48	-
R23	<20	29	<20	<20	28	<20	<20	30	<20	<20	<20	26	<20	48	-

Receiver	Deliveries	Civil Works	Services to Site	VS7			VS8			Fans	Access	Intersection Works		NML	Exceedance
				Set up	Shaft Sinking		Set up	Shaft Sinking				Pavement	Line marking		
					No-shed	25 dBA Shed		No-shed	25 dBA Shed						
R24	<20	32	<20	<20	31	<20	<20	29	<20	<20	<20	29	22	48	-
R25	<20	30	<20	<20	29	<20	<20	27	<20	<20	<20	27	20	48	-
R26	<20	30	<20	<20	28	<20	<20	26	<20	<20	<20	27	20	48	-
R27	<20	27	<20	<20	25	<20	<20	24	<20	<20	<20	24	<20	48	-
R28	<20	27	<20	<20	27	<20	<20	24	<20	<20	<20	24	<20	48	-
R29	<20	28	<20	<20	28	<20	<20	26	<20	<20	<20	25	<20	48	-
R30	<20	27	<20	<20	26	<20	<20	25	<20	<20	<20	23	<20	48	-
R31	<20	28	<20	<20	26	<20	<20	27	<20	<20	<20	24	<20	48	-
R32	<20	28	<20	<20	27	<20	<20	27	<20	<20	<20	25	<20	48	-
R33	<20	23	<20	<20	22	<20	<20	22	<20	<20	<20	<20	<20	48	-
R34	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	48	-
R35	<20	32	<20	<20	31	<20	<20	27	<20	<20	<20	29	22	48	-

5.3.2 Construction Works Outside of Standard Hours

Shaft sinking activities associated with the VS7 and VS8 shafts are proposed to occur 24 hours a day, 7 days a week. Predicted noise levels from individual OOH construction activities are presented in Table 26 and Table 27 for calm and noise enhancing meteorological conditions, respectively. In addition, Table 26 and Table 27 present the predicted noise level at receivers from the worst-case scenario of concurrent construction activities that are likely to occur on site. This worst-case scenario consists of truck deliveries (assuming two truck deliveries within a 15-minute period) and shaft drilling occurring at both the VS7 and VS8 sites concurrently.

Predicted noise levels have been assessed against the ICNG's OOH NML. For clarity, OOH works are any works conducted during the evening on week days (6pm – 10pm), night (10pm – 7am), Saturday outside the hours of 8am – 1pm, or on Sundays or public holidays. Predicted noise levels have also be assessed against calm and noise-enhancing meteorological conditions during the night-time period as discussed in section 3.2.1.

The results in Table 26 indicate that:

- Predicted noise levels associated with the proposed OOH construction activities comply with the NML under calm meteorological conditions at all receivers, and for all activities, except shaft sinking without the use of acoustic sheds;
- Without the use of acoustic sheds, predicted noise levels associated with OOH construction activities under calm meteorological conditions exceed the NML at five sensitive receivers, with the maximum predicted exceedance being 17 dBA at R2.
- The use of acoustic sheds with 25 dBA noise reduction results in predicted levels complying with the OOH NML under calm meteorological conditions.

The results in Table 27 indicate that:

- Predicted noise levels associated with the proposed OOH construction activities comply with the NML under noise enhancing meteorological conditions at all receivers during deliveries;
- Without the use of acoustic sheds, predicted noise levels associated with OOH construction activities under noise enhancing meteorological conditions exceed the NML at 13 sensitive receivers, with the maximum predicted exceedance being 22 dBA at R2.
- The use of acoustic sheds with 25 dBA noise reduction results in predicted levels complying with the OOH NML under noise enhancing meteorological conditions.

The predicted OOH construction noise levels in Table 26 and Table 27 show that acoustic sheds would be required to achieve compliance with the NML at all sensitive receivers. The required noise reduction of the sheds would be confirmed during detailed design. If quieter construction methods are able to be used, the acoustic performance of the sheds could be lowered, potentially reducing cost and complexity. Additionally, the required acoustic performance of the sheds could be lowered further by entering into negotiated noise agreements with some of the most potentially affected receivers.

Table 26: Predicted $L_{Aeq,15min}$ Construction Noise Levels from OOH Activities – Calm Meteorological Conditions

Receiver	Deliveries	VS7 Shaft sinking		VS8 Shaft sinking		Worst Case Concurrent Activity Noise Impact [a]		NML (OOH)		Exceedance			
										No-Shed		25 dBA Shed	
		No-Shed	25 dBA Shed	No-Shed	25 dBA Shed	No-Shed	25 dBA Shed	Day/ Evening	Night	Day/ Evening	Night	Day/ Evening	Night
R2	32	**55**	30	**50**	25	**56**	31	43	39	**13 dB**	**17 dB**	-	-
R3	28	**48**	23	**49**	24	**52**	27	43	39	**9 dB**	**13 dB**	-	-
R4	<20	33	<20	35	<20	37	<20	43	39	-	-	-	-
R5	<20	34	<20	34	<20	37	<20	43	39	-	-	-	-
R6	<20	37	<20	36	<20	39	<20	43	39	-	-	-	-
R7	<20	36	<20	35	<20	38	<20	43	39	-	-	-	-
R8	<20	35	<20	33	<20	37	<20	43	39	-	-	-	-
R9	<20	27	<20	28	<20	30	<20	43	39	-	-	-	-
R10	<20	34	<20	35	<20	38	<20	43	39	-	-	-	-
R11	<20	35	<20	34	<20	38	<20	43	39	-	-	-	-
R12	<20	26	<20	26	<20	29	<20	43	39	-	-	-	-
R13	23	**44**	<20	**45**	20	**47**	22	43	39	**4 dB**	**8 dB**	-	-
R14	<20	30	<20	29	<20	33	<20	43	39	-	-	-	-
R15	20	**40**	<20	39	<20	**42**	<20	43	39	-	**3 dB**	-	-
R16	24	**48**	23	**45**	20	**50**	25	43	39	**7 dB**	**11 dB**	-	-
R17	<20	32	<20	31	<20	34	<20	43	39	-	-	-	-
R18	<20	20	<20	21	<20	24	<20	43	39	-	-	-	-
R19	<20	25	<20	25	<20	28	<20	43	39	-	-	-	-
R20	<20	24	<20	23	<20	27	<20	43	39	-	-	-	-

Receiver	Deliveries	VS7 Shaft sinking		VS8 Shaft sinking		Worst Case Concurrent Activity Noise Impact [a]		NML (OOH)		Exceedance			
										No-Shed		25 dBA Shed	
		No-Shed	25 dBA Shed	No-Shed	25 dBA Shed	No-Shed	25 dBA Shed	Day/ Evening	Night	Day/ Evening	Night	Day/ Evening	Night
R21	<20	28	<20	27	<20	30	<20	43	39	-	-	-	-
R22	<20	27	<20	27	<20	30	<20	43	39	-	-	-	-
R23	<20	28	<20	30	<20	32	<20	43	39	-	-	-	-
R24	<20	31	<20	29	<20	33	<20	43	39	-	-	-	-
R25	<20	29	<20	27	<20	31	<20	43	39	-	-	-	-
R26	<20	28	<20	26	<20	30	<20	43	39	-	-	-	-
R27	<20	25	<20	24	<20	27	<20	43	39	-	-	-	-
R28	<20	27	<20	24	<20	29	<20	43	39	-	-	-	-
R29	<20	28	<20	26	<20	30	<20	43	39	-	-	-	-
R30	<20	26	<20	25	<20	28	<20	43	39	-	-	-	-
R31	<20	26	<20	27	<20	29	<20	43	39	-	-	-	-
R32	<20	27	<20	27	<20	30	<20	43	39	-	-	-	-
R33	<20	22	<20	22	<20	25	<20	43	39	-	-	-	-
R34	<20	<20	<20	<20	<20	20	<20	43	39	-	-	-	-
R35	<20	31	<20	27	<20	32	<20	43	39	-	-	-	-

a. Applies to concurrent drilling of VS7 and VS8.

Table 27: Predicted $L_{Aeq,15min}$ Construction Noise Levels from OOH Activities – Noise Enhancing Meteorological Conditions

Receiver	Deliveries	VS7 Shaft sinking		VS8 Shaft sinking		Worst Case Concurrent Activity Noise Impact [a]		NML (OOH)		Exceedance			
										No-Shed		25 dBA Shed	
		No-Shed	25 dBA Shed	No-Shed	25 dBA Shed	No-Shed	25 dBA Shed	Day/ Evening	Night	Day/ Evening	Night	Day/ Evening	Night
R2	37	**59**	34	**55**	30	**61**	36	43	39	**18 dB**	**22 dB**	-	-
R3	33	**53**	28	**54**	29	**57**	32	43	39	**14 dB**	**18 dB**	-	-
R4	<20	38	<20	39	<20	**42**	<20	43	39	-	**3 dB**	-	-
R5	20	39	<20	39	<20	**42**	<20	43	39	-	**3 dB**	-	-
R6	22	**42**	<20	**41**	<20	**44**	<20	43	39	**1 dB**	**5 dB**	-	-
R7	21	**41**	<20	**40**	<20	**43**	<20	43	39	-	**4 dB**	-	-
R8	<20	**40**	<20	38	<20	**42**	<20	43	39	-	**3 dB**	-	-
R9	<20	32	<20	33	<20	35	<20	43	39	-	-	-	-
R10	20	**40**	<20	**40**	<20	**43**	<20	43	39	-	**4 dB**	-	-
R11	<20	**41**	<20	**40**	<20	**43**	<20	43	39	-	**4 dB**	-	-
R12	<20	31	<20	31	<20	34	<20	43	39	-	-	-	-
R13	28	**49**	24	**50**	25	**53**	28	43	39	**10 dB**	**14 dB**	-	-
R14	<20	36	<20	35	<20	38	<20	43	39	-	-	-	-
R15	25	**45**	20	**44**	<20	**47**	22	43	39	**4 dB**	**8 dB**	-	-
R16	29	**53**	28	**50**	25	**55**	30	43	39	**12 dB**	**16 dB**	-	-
R17	<20	38	<20	36	<20	**40**	<20	43	39	-	**1 dB**	-	-
R18	<20	26	<20	27	<20	29	<20	43	39	-	-	-	-
R19	<20	31	<20	31	<20	34	<20	43	39	-	-	-	-
R20	<20	30	<20	29	<20	32	<20	43	39	-	-	-	-

Receiver	Deliveries	VS7 Shaft sinking		VS8 Shaft sinking		Worst Case Concurrent Activity Noise Impact [a]		NML (OOH)		Exceedance			
										No-Shed		25 dBA Shed	
		No-Shed	25 dBA Shed	No-Shed	25 dBA Shed	No-Shed	25 dBA Shed	Day/ Evening	Night	Day/ Evening	Night	Day/ Evening	Night
R21	<20	33	<20	32	<20	36	<20	43	39	-	-	-	-
R22	<20	33	<20	33	<20	36	<20	43	39	-	-	-	-
R23	<20	33	<20	35	<20	37	<20	43	39	-	-	-	-
R24	<20	37	<20	34	<20	39	<20	43	39	-	-	-	-
R25	<20	34	<20	32	<20	36	<20	43	39	-	-	-	-
R26	<20	34	<20	31	<20	36	<20	43	39	-	-	-	-
R27	<20	31	<20	29	<20	33	<20	43	39	-	-	-	-
R28	<20	32	<20	30	<20	34	<20	43	39	-	-	-	-
R29	<20	33	<20	31	<20	35	<20	43	39	-	-	-	-
R30	<20	31	<20	30	<20	34	<20	43	39	-	-	-	-
R31	<20	32	<20	32	<20	35	<20	43	39	-	-	-	-
R32	<20	33	<20	33	<20	36	<20	43	39	-	-	-	-
R33	<20	28	<20	27	<20	30	<20	43	39	-	-	-	-
R34	<20	22	<20	22	<20	25	<20	43	39	-	-	-	-
R35	<20	36	<20	33	<20	38	<20	43	39	-	-	-	-

a. Applies to concurrent drilling of VS7 and VS8.

5.3.3 Construction Noise Mitigation

Noise levels from construction activities during standard hours are predicted to exceed the NMLs of the ICNG at receivers R2 and R3 by 1 to 5 dBA. Therefore, in accordance with the ICNG, all reasonable and feasible measures should be applied to manage construction noise emissions from the site. In particular, the following is recommended:

A detailed Construction Noise Management Plan (CNMP) should be prepared and should include, but not be limited to the following:

- Identification of nearby residences and other sensitive land uses;
- Description of approved hours of work;
- Description and identification of construction activities, including work areas, equipment and duration;
- Description of what work practices (generic and specific) will be applied to minimise noise;
- Consider the selection of plant and processes with reduced noise emissions;
- A complaints handling process;
- Noise monitoring procedures;
- Overview of community consultation required for identified high impact works;
- Overview of community consultation process and assessment required for identified additional works outside of standard construction hours;
- Induction and training will be provided to relevant staff and sub- contractors outlining their responsibilities with regard to noise; and
- Development of a "Driver's Code of Conduct".

Examples of typical construction noise mitigation measures are provided in Table 28, along with the likely reduction in noise levels. Where reasonable and feasible, these measures should be employed during the construction of the Project.

Table 28: Indicative Construction Noise Mitigation Measures

Mitigation Measure	Anticipated Noise Reduction, dBA
Administrative Controls	
Operate during approved hours	N/A
Undertake regular noise monitoring to determine the impact of operating plant on sensitive receivers	N/A
Appropriate training of onsite staff	N/A
Undertake community consultation and respond to complaints in accordance with established project procedures	N/A
Turning off machinery when not in use	0-5
Respite periods for pile drivers and rock breakers	N/A
Undertake noisier activities during standard construction hours	N/A
Engineering Controls	
Portable temporary screens	5-10
Screen or enclosure for stationary equipment	10-15

Mitigation Measure	Anticipated Noise Reduction, dBA
Maximising the offset distance between noisy plant items and sensitive receivers	3-6
Avoiding using noisy plant simultaneously and / or close together, adjacent to sensitive receivers	2-3
Orienting equipment away from sensitive receivers	3-5
Carrying out loading and unloading away from sensitive receivers	3-5
Using dampened tips on rock breakers	3-6
Using noise source controls, such as the use of residential class mufflers, to reduce noise from all plant and equipment including bulldozers, cranes, graders, excavators and trucks	5-10
Selecting site access points and roads as far as reasonably practicable away from sensitive receivers	3-6
Using spotters, closed circuit television monitors, “smart” reversing alarms, or “squawker” type reversing alarms in place of traditional reversing alarms	2-5
Employ non noise-generating structures such as site offices, storage sheds, stockpiles and tanks as noise barriers	5-10

5.4 Construction Vibration Assessment – Safe Working Distances

The following section presents an assessment of potential vibration impacts associated with general construction activities for the Project. Vibratory rollers would be the most likely potential source of potential vibration impacts associated with the Proposal.

The recommended safe working distances for vibration intensive plant suggested in the Transport for New South Wales *Construction Noise Strategy* have been adopted in this assessment to evaluate the potential for vibration impacts from the proposed works.

Table 29 sets out the recommended safe working distances for vibratory rollers of various sizes.

Table 29: Recommended Safe Working Distances for Vibration Intensive Plant

Item	Description	Safe Working Distance	
		Cosmetic Damage	Human Comfort
Vibratory roller	<50 kN (typically 1-2 tonnes)	5 m	15 m to 20 m
	<100 kN (typically 2-4 tonnes)	6 m	20 m
	<200 kN (typically 4-6 tonnes)	12 m	40 m
	<300 kN (typically 7-13 tonnes)	15 m	100 m
	>300 kN (typically 13-18 tonnes)	20 m	100 m
	>300 kN (>18 tonnes)	25 m	100 m

Review of the information in Table 29 indicates that the safe working distances for building damage and human comfort applicable to the largest vibratory roller are 25 metres and 100 metres, respectively. During the construction of the Project, vibratory rollers are unlikely to be operated within 25 meters of off-site buildings or within 100 metres of residential receivers. Therefore, vibration impacts during general construction activities are considered unlikely.

6 CONSTRUCTION BLASTING ASSESSMENT

The following section establishes relevant impact assessment criteria for blasting activities and provides a preliminary assessment of potential blasting impacts.

6.1 Overview of Construction Blasting Program

6.1.1 Ventilation shaft construction overview

The shafts would be constructed using a combination of two conventional shaft sinking methods: mechanical excavation and controlled blasting. Conventional shaft sinking (also known as blind sinking) involves excavating from the surface down to the required depth.

Mechanical excavation would involve the use of excavation equipment to break apart the rock. Sometimes additional methods such as jack-hammering or controlled blasting are required to break apart sections of harder rock. The broken material is then removed from the shaft using machinery such as excavators.

Controlled blasting involves the pre-planned and safe use of small explosive charges to break up hard rock, such as sandstone, into removable pieces. The method involves pre-drilling a series of small diameter holes in the rock face, loading the holes with small explosive charges and electronically detonating them. It is a common excavation methodology that has been safely used on many other Australian projects, including relatively shallow tunnelling projects. The controlled blasting method would be conducted incrementally from the final pre-sink depth to the final depth.

The increments and rate of excavation is dependent on the method, rock strata properties and stability and the expertise of the contractor. These aspects would be determined in conjunction with the contractor during detailed design.

One of the key advantages of controlled blasting is that it can result in reduced duration of ground borne noise and vibration impacts for local communities as well as a reduction in the overall construction time in comparison to using boring techniques or mechanical excavation.

The sequencing of construction of VS7 and VS8 will be determined during the detailed design phase of the Project. Impact assessments have taken a conservative approach and assessed a 'worst case scenario', assuming concurrent shaft construction.

6.1.2 Shaft construction engineering phases

After site establishment, the shaft will be constructed in two distinct engineering phases:

- pre-sink; and
- main shaft construction.

6.1.2.1 Pre-sink

The pre-sink phase would involve the construction of a temporary headframe and winder, establishment of a shaft collar and intake evase, and excavation of the shaft to the required depth for the installation of the sinking stage in preparation for the main shaft construction (generally 30-50 metres). The pre-sink would use both mechanical excavation and controlled blasting to excavate the shaft.

Initially, broken rock would be removed from the shaft via standard civil excavation methods. Once the shaft collar and shaft excavation headframe are installed, broken rock would be removed via kibbles.

The shaft collar would be installed to support the temporary headframe and final ventilation ducting. This collar is constructed of heavily reinforced concrete designed to withstand the stress loads and vibration during the shaft excavation and prevent surface water ingress into the shaft.

Prior to the commencement of works for the main shaft, the following plant and equipment would be assembled and installed for each shaft:

- shaft sinking head frame;
- winder, winder house and associated control systems;
- kibble and kibble winder; and
- stage.

Installation and operation of this plant and equipment provides the means for the main shaft construction team to access progressively deeper shaft depths during the main shaft construction phase.

As previously noted, it is proposed that acoustic sheds will be constructed over the VS7 and VS8 shaft construction areas to mitigate noise emissions associated with the OOH construction of the VS7 and VS8 shafts. The sheds would be constructed following the pre-sink phase to allow for the sinking headframe and stage to be installed, although opportunities to install prior to the pre-sink will be investigated during detailed design.

6.1.2.2 Main Shaft Construction

The main shaft construction phase will be undertaken from the final pre-sink depth to the final shaft depth by blind sinking using the controlled blasting method. The headframe, winding equipment, kibble and stage provide access to the shaft for personnel, equipment and removal of broken rock.

Excavation by controlled blasting would generally follow a repetitive shaft sinking cycle:

- Progressive incremental drilling and loading of boreholes into the base of the shaft with explosive charges and stemming material;
- Controlled blasting using electronically sequentially timed detonation of explosives to manage the amount of energy released, known as construction blasts;
- Removal (mucking out) of the spoil via the kibble;
- Installation of rock support; and
- Installation of permanent shaft lining.

6.2 Construction Blasting Criteria

6.2.1 Potential Noise and Vibration Impacts during Blasting

The potential noise and vibration impacts during blasting are identified and discussed below.

6.2.1.1 Overpressure

Overpressure from blasting refers to the transient, but elevated, levels of pressure above atmospheric pressure. It is measured irrespective of frequency with no weighting, and on this basis, is distinguished from noise criteria.

The overpressure limits are expressed in dB(L). Air pressure levels expressed in dB(A) endeavour to quantify the impact of noise in terms of human hearing, removing the inaudible frequency components below 20Hz, and above 20kHz. Air pressure levels expressed in dB(L) represent a complete spectrum (excluding components less than 2Hz), and therefore include a significant amount of inaudible frequencies.

6.2.1.2 Maximum Noise Levels

Since blasting is typically limited to daytime hours, audible noise from blasts, which can typically be described as a “pop”, is unlikely to cause annoyance. However, if the audible noise associated with a blast is sufficiently loud, blast events occurring at night, could lead to sleep disturbance impacts. The L_{Amax} noise descriptor is appropriate for describing the magnitude of the audible noise from blasts.

6.2.1.3 Vibration

Ground vibrations, if uncontrolled, have the potential to impact on both human comfort and structural integrity. Most international standards and legislation are designed to ensure that blast-induced vibration levels are maintained at or below levels of human tolerance. These documents therefore limit the permissible levels of vibration to well below those capable of causing structural, or even cosmetic, damage to residential structures. Whilst compliance with such limits does not necessarily ensure residents surrounding the operation will not perceive the vibration from blasting, it ensures that most of the residents will be tolerant of any blasting and further guarantees that property damage is eliminated. Peak Particle Velocity (PPV) in millimetres per second (mm/s) is appropriate for quantifying the vibration from blasts.

6.2.2 Local Guidelines and Standards

In NSW, criteria for projects undertaking blasting are generally drawn from the following guidelines/standards:

- The Australian Standard AS2187.2-2006 “Explosives-Storage, transport and use, Part 2: Use of Explosives”; and
- The Australian and New Zealand Environment Council (ANZEC) Guidelines: “Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration”.

Construction blasting activities are typically limited to 9.00am – 5.00pm Monday to Saturday. However, as outlined in Section 6.1, blasting activities at any time of the day are proposed. Accordingly, overpressure and vibration criteria are proposed for various times of day. Additionally, L_{Amax} criteria are proposed during night time blasting to protect against sleep disturbance impacts.

6.2.3 Daytime Construction Blasting Criteria

The EPA guideline *Assessing Vibration: a technical guideline* (DEC, 2006) defers to the *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration* prepared by the Australian and New Zealand Environment Council (ANZEC). Human annoyance criteria for daytime blasting for any privately owned receivers or other sensitive locations are:

- Maximum overpressure due to blasting should not exceed 115 dBL for more than 5% of blasts in any year and should not exceed 120 dBL for and blast; and
- Maximum peak particle velocity (PPV) should not exceed 5 mm/s for more than 5% of blasts in any year and should not exceed 10 mm/s for any blast.

The ANZEC guideline also recommends a PPV limit of 2.0 mm/s as a long term goal.

In accordance with the ANZEC guideline, the above criteria are applicable during the hours of 9.00am – 5.00pm.

It should be noted that the criteria above are intended to avoid annoyance (i.e. amenity) impacts from blasting activities. Damage to structures occurs at significantly higher overpressure (>133 dBL) and vibration (>20 mm/s) levels than those which lead to annoyance. Therefore, compliance with the above criteria would ensure negligible risk of damage to off-site structures from blasting activities.

6.2.4 Out of Hours (OOH) Construction Blasting Criteria

The Project will seek approval for blasting to occur at any time of day. The intent of blasting outside daytime hours would be to reduce overall construction impacts, by reducing the duration of the works, without significant additional impacts. The approach is considerate of the increasing distance from sensitive receivers given the vertical excavation being undertaken, as outlined in Section 6.3.

There are no current guidelines or policies in Australia or its states and territories that suggest overpressure or vibration criteria for OOH blasting. Therefore, criteria are proposed based on a review of available literature.

In the event that OOH blasting is conducted, sensitive receivers would be consulted and, where required, the OOH blasting criteria would be reviewed to ensure that overpressure and vibration impacts associated with OOH blasts are appropriate. This approach is further outlined in Section 6.4.1).

6.2.4.1 Vibration

DEC (2006) provides guidance for assessing human exposure to vibration. The publication is based on British Standard BS 6472:1992 – *Guide to evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz).* The recommended night time (10.00pm – 7.00am) PPV vibration limit for residences in DEC (2006) is 2.8 mm/s.

It is noted that BS 6472:1992 has been superseded by, relevant to blasting, BS 6472:2008-2 *Guide to evaluation of human exposure to vibration in buildings – Part 2: Blast induced vibration*. The recommended PPV vibration limits for residences in BS 6472:2008-2 are presented in Table 30 .

Table 30: BS 6472:2008-2 Residential Blasting Limits (up to 3 Blast Events per Day)

Place	Time [a]	Satisfactory PPV Magnitude (mm/s)
Residential	Day	6.0
	Night	2.0
	Other times	4.5

a. Day = 8.00am – 6.00pm Monday to Friday and 8.00am – 1.-00pm Saturday; Night = 11.00pm – 7.00am.

The PPV limits recommended in BS 6472:2008-2 are proposed for OOH blasting. It is noted that the night time period defined in BS 6472:2008-2 is 11.00pm – 7.00am, which is slightly different to the night time period of 10.00pm – 7.00am typically used in NSW noise policies and guidelines. it is proposed to adopt the numerical night time PPV limit from BS 6472:2008-2 and apply it over the 10.00pm – 7.00am night time period as typically defined in NSW.

6.2.4.2 Overpressure

A review of relevant literature suggests that peak noise levels associated with impulsive sources, such as explosive blasts, below 115 dBL will contribute little to annoyance[2] are unlikely to generate complaints[3]. Accordingly, the 115 dBL overpressure criterion recommended in the ANZEC guideline is considered appropriate to protect amenity during OOH blasting.

6.2.4.3 Sleep Disturbance

In addition to criteria for overpressure and vibration during OOH blasting, L_{Amax} noise levels and potential sleep disturbance impacts at night should be considered.

In addition to the maximum noise trigger levels recommended in the NPfI, the NSW *Road Noise Policy* states that, from the research on sleep disturbance to date, it can be concluded that:

- Maximum internal noise levels below 50-55dBA are unlikely to cause awakening.
- One or two noise events per night with maximum internal noise levels of 65-70dBA are not likely to significantly affect health and wellbeing.

It is noted that internal L_{Amax} noise levels associated with blasts would be somewhat lower than external noise levels during these events due to noise reduction across the façade of the dwelling. The noise reduction across the façade is expected to be in the range of 5-10 dBA. Therefore, since typically only 2 blasts could occur per night, external L_{Amax} noise levels associated with night time blasting below 75 dBA are considered unlikely to cause sleep disturbance impacts.

[2] R. Rylander and B. Lundquist, "Annoyance caused by noise from heavy weapon shooting ranges," J. Sound Vib. 192, 199–202 (1996)
[3] L., Pater, "Noise abatement program for explosive operations at NSWC/DL," Paper presented at the 17th Explosives Safety Seminar of the Department of Defense Safety Board, Denver, CO (1976)

6.2.5 Summary of Proposed Construction Blasting Criteria

The proposed construction blasting criteria for the Project are summarised in Table 31.

Table 31: Proposed Project Construction Blasting Criteria

Time [a]	Overpressure (dBL) [b]	Vibration, PPV (mm/s)	L_{Amax} (dBA)
Day	115	5 [c]	-
Night	115	2	75
Other times	115	4.5	-

a. Day = 9.00am – 5.00pm; Night = 10.00pm – 7.00am.
b. Maximum overpressure due to blasting should not exceed 115 dBL for more than 5% of blasts in any year and should not exceed 120 dBL for any blast.
c. Maximum peak particle velocity (PPV) should not exceed 5 mm/s for more than 5% of blasts in any year and should not exceed 10 mm/s for any blast.

6.3 Predicted Blasting Impacts

Potential overpressure and vibration impacts from blasts have been predicted using generic equations from AS 2187.2-2006. These predictions have been made using conservative site constants and indicative values for maximum instantaneous charges (MIC).

A preliminary blasting impact assessment for the Project, prepared by Prism Mining Pty Ltd, indicated that the blast design for the Project may use MIC in the range of 3-6 kilograms. For the purposes of this assessment, an MIC of 3.0 kilograms is assumed.

The predicted blasting impacts presented herein should be regarded as indicative only. Blast overpressure and vibration are dependent upon several factors, including the blast design, meteorological conditions (overpressure only) and the properties of the site (rock type, terrain, etc).

To accurately predict blast impacts, a series of small trial blasts would be conducted during detailed design to establish a “site law”. In conjunction with the detailed blast design, the site law would then be used to predict blast impacts more accurately and identify the need for any further mitigation measures.

It is also noted that blast impacts, specifically overpressure, are likely to reduce as the blasting progresses down the depths of the shafts. However, it is difficult to predict these effects and they can only be reliably identified through measurements.

Potential overpressure and vibration impacts have been assessed against the daytime (ANZEC) blasting criteria only. OOH blasting would not be conducted prior to the development of a site law and a detailed OOH blast design, and a demonstration during daytime hours that OOH blasting criteria can be achieved, as developed in the Blast Management Strategy.

6.3.1 Predicted Blast Overpressure

Using equations from AS 2187.2-2006, potential overpressure impacts from blasts can be predicted based on the MIC and two site constants using the following formula:

$$P = K_a \left(\frac{R}{Q^{1/3}}\right)^a$$

Where:

- P = pressure, in kilopascals
- R = distance between charge and point of measurement, in metres
- Q = maximum instantaneous charge (effective charge mass per delay) in kilograms
- K_a, a = constants related to site and rock properties for estimation purposes

The following equation can be used to express overpressure in decibels:

$$SPL = 20Log\frac{P}{P_0}$$

Where the reference pressure (P_0) = 20 μPa.

According to AS 2187.2-2006, for confined blasthole charges, when using a site exponent (a) of -1.45, the site constant (K_a) is commonly in the range of 10 to 100. For assessment purposes, K_a is assumed to be 100, which is conservative.

Predicted overpressure levels at sensitive receivers due to blasts occurring at the VS7 and VS8 shafts are presented in Table 32.

Table 32: Predicted Blast Overpressure Levels at Sensitive Receivers, MIC = 3.0 kg

Receiver	Distance to Blast (m)		Predicted Overpressure (dBL)		Criterion	Exceedance
	VS7	VS8	VS7	VS8		
R2	413	549	**123**	**119**	115	**8**
R3	529	503	**120**	**120**	115	**5**
R4	654	606	**117**	**118**	115	**3**
R5	631	554	**117**	**119**	115	**4**
R6	628	520	**117**	**120**	115	**5**
R7	650	539	**117**	**119**	115	**4**
R8	728	605	**116**	**118**	115	**3**
R9	924	794	113	114	115	-
R10	908	771	113	115	115	-
R11	1,012	874	111	113	115	-
R12	1,137	1,006	110	112	115	-

Receiver	Distance to Blast (m)		Predicted Overpressure (dBL)		Criterion	Exceedance
	VS7	VS8	VS7	VS8		
R13	1,136	1,072	110	111	115	-
R14	1,149	1,269	110	109	115	-
R15	1,101	1,236	110	109	115	-
R16	552	687	**119**	**116**	115	**4**
R17	1,572	1,706	106	105	115	-
R18	1,390	1,463	107	107	115	-
R19	1,224	1,239	109	109	115	-
R20	1,294	1,287	108	108	115	-
R21	1,142	1,137	110	110	115	-
R22	1,146	1,125	110	110	115	-
R23	991	948	112	112	115	-
R24	929	857	113	114	115	-
R25	1,014	918	111	113	115	-
R26	1,110	1,006	110	112	115	-
R27	1,253	1,142	109	110	115	-
R28	1,281	1,156	108	110	115	-
R29	1,216	1,090	109	111	115	-
R30	1,299	1,169	108	110	115	-
R31	1,345	1,210	108	109	115	-
R32	1,384	1,248	107	109	115	-
R33	1,412	1,283	107	108	115	-
R34	1,475	1,363	107	108	115	-
R35	1,177	1,095	110	110	115	-

The predicted overpressure levels in Table 32 exceed the criterion at several receivers. The predicted exceedances are up to 8 dBL. As outlined previously, overpressure levels are very difficult to accurately model. Due to the vertical orientation of the vent shafts, which isn't accounted for in the predictions, overpressure levels at sensitive receivers are anticipated to be significantly lower than those presented herein.

A range of mitigation measures are available to reduce blast overpressure, which have not been factored into this assessment. These include “blast mats” and “water curtains” which typically provide 5-10 dB reduction in overpressure levels. These also include detailed blast design, considering options such as limiting diameter and length of rounds, splitting the round into two benches and/or adjusting blast hole firing sequence. Additionally, acoustics sheds will be used for much of the shaft construction and are likely to reduce overpressure levels by 10 dB or more. The final selection of mitigation measures would be conducted following the development of a site law and the detailed blast design(s). Mitigation measures are further discussed in Section 6.4.

6.3.2 Predicted Blast Vibration

Using equations from AS 2187.2-2006, potential vibration impacts from blasts can be predicted based on the MIC and two site constants using the following formula:

$$V = K_g \left(\frac{R}{\sqrt{Q}}\right)^{-B}$$

Where:

- V = ground vibration as vector peak particle velocity, in millimetres per second
- R = distance between charge and point of measurement, in metres
- Q = maximum instantaneous charge (effective charge mass per delay) in kilograms
- K_g, B = constants related to site and rock properties for estimation purposes

In accordance with AS 2187.2-2006, conservative values have been chosen for K_g (4,560) and B (1.6).

Predicted vibration levels at sensitive receivers due to blasts occurring at the VS7 and VS8 shafts are presented in Table 32.

Table 33: Predicted Blast Vibration Levels at Sensitive Receivers, MIC = 3.0 kg

Receiver	Distance to Blast (m)		Predicted PPV (mm/s)		Criteria		Exceedance
	VS7	VS8	VS7	VS8	Day	Night	
R2	413	549	0.7	0.5	5	2	-
R3	529	503	0.5	0.5	5	2	-
R4	654	606	0.3	0.4	5	2	-
R5	631	554	0.4	0.4	5	2	-
R6	628	520	0.4	0.5	5	2	-
R7	650	539	0.3	0.5	5	2	-
R8	728	605	0.3	0.4	5	2	-
R9	924	794	0.2	0.3	5	2	-
R10	908	771	0.2	0.3	5	2	-
R11	1,012	874	0.2	0.2	5	2	-
R12	1,137	1,006	0.1	0.2	5	2	-

Receiver	Distance to Blast (m)		Predicted PPV (mm/s)		Criteria		Exceedance
	VS7	VS8	VS7	VS8	Day	Night	
R13	1,136	1,072	0.1	0.2	5	2	-
R14	1,149	1,269	0.1	0.1	5	2	-
R15	1,101	1,236	0.1	0.1	5	2	-
R16	552	687	0.4	0.3	5	2	-
R17	1,572	1,706	0.1	0.1	5	2	-
R18	1,390	1,463	0.1	0.1	5	2	-
R19	1,224	1,239	0.1	0.1	5	2	-
R20	1,294	1,287	0.1	0.1	5	2	-
R21	1,142	1,137	0.1	0.1	5	2	-
R22	1,146	1,125	0.1	0.1	5	2	-
R23	991	948	0.2	0.2	5	2	-
R24	929	857	0.2	0.2	5	2	-
R25	1,014	918	0.2	0.2	5	2	-
R26	1,110	1,006	0.1	0.2	5	2	-
R27	1,253	1,142	0.1	0.1	5	2	-
R28	1,281	1,156	0.1	0.1	5	2	-
R29	1,216	1,090	0.1	0.2	5	2	-
R30	1,299	1,169	0.1	0.1	5	2	-
R31	1,345	1,210	0.1	0.1	5	2	-
R32	1,384	1,248	0.1	0.1	5	2	-
R33	1,412	1,283	0.1	0.1	5	2	-
R34	1,475	1,363	0.1	0.1	5	2	-
R35	1,177	1,095	0.1	0.2	5	2	-

The predicted vibration values in Table 33 are well below the criterion at all sensitive receivers. This indicates that the blast design is likely to be limited by overpressure, not vibration.

6.4 Mitigation of Blasting Impacts

6.4.1 Blast Management Strategy

A Blast Management Strategy will be prepared in accordance with relevant guidelines before blasting begins. The Blast Management strategy will include:

- details of blasting to be performed, the program and method;
- identification of all potentially affected receivers;
- establishment of appropriate criteria for blast overpressure and ground vibration levels at each receiver;
- establishment of appropriate criteria to transition from Phase One to Phase Two construction blasting (refer to Section 6.4.1.1);
- details of the storage and handling arrangements for explosive materials and the proposed transport of those materials to the construction site;
- identification of hazardous situations that may arise from the storage and handling of explosives,
- the blasting process and recovery of the blast site after detonation of the explosives;
- determination of potential noise and vibration and risk impacts from blasting and appropriate best management practices;
- details of the proposed blasting monitoring program; and
- consultation, impact mitigation and notification procedures for all potentially affected receivers.

The Blast Management Strategy would be developed in consultation with relevant stakeholders and reviewed by a suitably qualified and experienced person. Consultation with receivers identified as potentially affected would occur throughout all phases of the blasting program.

Blast monitoring would be carried out in accordance with the guidelines provided in Australian Standard AS 2187.2-2006 and be undertaken by a specialist consultant. It is proposed to implement an automated monitoring system whereby monitor data is instantly and automatically uploaded to a central server.

6.4.1.1 Construction blast cycle and timing

Shaft sinking using controlled blasting is a cyclical process which relies on a repetitive sequence of activities (as described in Section 6.1.2). Depending on variables such as the ground conditions, size of the round and depth of the working face, the cycle can take between 24 and 32 hours to complete. In order to reduce the overall length of the shaft construction phase, construction blasts should occur regularly in accordance with this sequence (a construction blast in each shaft every 24 to 32 hours) wherever possible.

To support this cycle, activities that support shaft construction may need to occur 24 hours per day, up to seven days per week. Spoil handling and emplacement would be carried out during periods anticipated to have the least impact on sensitive receivers. This is expected to be during standard construction hours.

Generally during construction, exposure to noise and vibration would be greater when works are close to a receiver location and would decrease when the work is further away. Due to the vertical nature of shaft-sinking, as excavation is progressing down the shaft the distance increases and exposure to impacts from each detonation would typically decrease at a receiver.

In consideration of the construction program, blasting cycle and the need to minimise impacts, a two phased management approach to undertaking blasts is proposed, as outlined below. In both phases, typically up to one construction blast per shaft, per day is anticipated.

Construction Blasting Phase One

During Phase One of the blasting program, construction blasting would be restricted to standard construction hours only. This phase would generally align to the pre-sink phase of shaft sinking when the acoustic shed(s) and other noise mitigations are under construction. During this phase, a monitoring program would closely monitor for impacts generated by the construction blasts and seek feedback from potentially affected receivers.

The data and feedback collected during Phase One would be used review and revise the Blast Management Strategy, prior to commencement of Phase Two.

Construction Blasting Phase Two

During Phase Two of the blasting program, construction blasting would occur to 24 hours a day, 7 days a week. This phase would generally align with the main-sink phase of shaft sinking, when the acoustic shed(s) and other noise mitigations are in place and the working area of the shaft has reached a depth of approximately 30-50 metres.

Due to the length of the shaft sinking cycle, during Phase Two, the construction blasts will not occur every night and will not at the same time each day. Where possible construction blasts would be carried out during periods anticipated to have the least impact on receivers.

Construction blasting in both phases will be undertaken as per the Projects Blast Management Strategy to be developed during detailed project design. A detailed blast design will also be completed during the detailed project design.

6.4.1.2 Adaptive management approach

The proposed approach to blast management has been developed considering the expert advice provided by Heilig and Partners Pty Ltd, and a preliminary blasting impact assessment for the Project, prepared by Prism Mining Pty Ltd. Predictions from the preliminary impact assessment identified that conservative assessment criteria for sensitive receivers were able to be achieved. The assessment recommended further refinement and development of the site law during the detailed design, as is standard industry practice.

A 'trial blast' involves firing a number of small explosive charges in the ground to be blasted and monitoring the resultant vibrations at key monitoring locations around the site. The purpose of a trial blast is to:

- Confirm the site law (the site-specific relationship between explosive charge weight, distance to sensitive receivers and magnitude of vibration);
- Confirm blast design parameters on a smaller scale prior to full scale construction blasting;
- Confirm monitoring results are in-line with predictions; and
- Optimise the site blasting procedures.

As noted in Section 6.3, during the detailed design phase, a trial blast will be undertaken to further refine the Site Law. Monitoring will include but not limited to:

- Overpressure (dB);
- Vibration (PPV);
- Frequency (Hz); and
- Geotechnical Conditions.

This assessment includes blast parameters based on assumed ground characteristics of the site and preliminary blast designs. These parameters are subject to change pending the results of the trial blast and development of the blast design. Additional site investigations (trial blasts) may be conducted prior to construction blasting commencing to refine suitable blast designs to comply with project blasting noise, overpressure and vibration criteria.

The trial blasts and construction blasts shall be designed by a specialist blasting consultant. Subsequent construction blast designs shall consider the performance of previous construction blasts thus enabling IMC continuously to improve the efficiency and technical performance of the blasts whilst controlling environmental impacts such as vibration and overpressure.

6.4.2 **Flyrock**

Safety and complete control of flyrock is paramount in any form of blasting. Flyrock refers to the unexpected movement of rock around the blast pattern. Some movement of rock is unavoidable and is required in order to render the broken rock amenable to excavation. As demonstrated on other comparable Projects, with tight controls and procedures commensurate with best practice, fly rock can be safely controlled.

Preliminary models have been developed for the Project by Prism Mining Pty Ltd for the blast design, considering the management of flyrock. This preliminary assessment identifies options for controls, particularly for initial (shallow) surface blasts, including smaller diameter (stemmed) blast holes on a reduced round length, and additional buffering. These controls will be developed during detailed design based on detailed ground conditions and the site law.

In addition to appropriate blast designs to suit ground conditions and control impacts, a high level of operational control will also be required, particularly for initial blasting from surface, with appropriate safety and quality assurance measures.

6.4.3 **Other Mitigations**

Other mitigations and controls are available to the Project to ensure safe and effective construction blasting and to minimise environmental impacts. Controls that may be adopted to manage the impacts of blasting are listed below. These will be determined during detailed design with the input of the blasting specialist and contractor:

- Engagement of an appropriately qualified person to oversee the process of blasting. This should include participation in all associated processes, including blast planning and design, supervision of blasting process (drilling, charging, stemming, tie-up and firing), and review of monitored blasting outcomes, with adjustment of blast designs and operational processes to ensure acceptable environmental compliance.

- Monitoring at sensitive locations in order to validate ground vibration models and initial overpressure estimates. All blasts should be monitored for peak ground vibration and overpressure levels, with monitoring locations at the nearest sensitive receivers, until this can be proven to be unnecessary as depth of operations increase.
- Limiting initial shaft development rounds in diameter and length to control ground vibration, overpressure and fly-rock. Additional mitigating control options could include splitting the round into two benches with reduced duration; and/or adjusting blast hole firing sequence.
- The use of controls such as the selection of stemming material, water curtains, acoustic sheds and blast mats to control overpressure and flyrock.

Given the shaft will reach underground coal workings, additional risks associated with drilling, blasting and mining over voids; and operating in gassy and coal dust environments, should be assessed.

7 CONCLUSION

IMC is seeking to modify the existing Appin Mine approval, pursuant to Section 4.55(2) of the NSW Environment Planning and Assessment Act 1979 (EP&A Act), to incorporate the Project, the construction and operation of infrastructure critical to the ongoing viability of the Mine.

RWDI has been commissioned to prepare a noise and vibration impact assessment for the Project.

Existing ambient noise levels have been established at nearby sensitive receivers via long-term unattended noise monitoring. The noise monitoring data has been processed in accordance with the NPfI to establish the RBLs at sensitive receivers.

Noise impacts associated with the operation of the Project have been assessed in accordance with the NPfI. Project noise trigger levels have been established for the day, evening and night time periods.

A computer noise model has been developed to predict the $L_{Aeq,15min}$ operational noise levels at sensitive receivers. Both temperature inversions and gradient winds are considered to be a feature of the area and have been incorporated into the noise model via default parameters outlined in the NPfI.

Based on information from IMC, operating parameters, equipment and source sound power levels have been developed to describe two noise assessment scenarios for the Project.

$L_{Aeq,15min}$ operational noise levels have been predicted at sensitive receivers for each assessment scenario, for both calm and noise-enhancing meteorological conditions. The predicted noise levels comply with the established project noise trigger levels for all scenarios.

The Project will generate additional traffic along the surrounding public road network. The increase will be most prominent along Menangle Road, south of the Site.

Road noise impacts associated with the operation of the Project have been assessed in accordance with the RNP, and predicted road noise levels associated with the Project comply with the RNP impact assessment criteria.

Noise impacts from the construction of the Project have been assessed in accordance with the ICNG. Construction NMLs have been established for sensitive receivers based on the established RBL. A computer noise model has been developed to predict $L_{Aeq,15min}$ construction noise levels at sensitive receivers.

Construction noise levels have been predicted for a range of construction activities during both standard and out of hours periods. The predicted $L_{Aeq,15min}$ construction noise levels exceed the established NML at two sensitive receivers during standard construction hours by up to 5 dBA. Therefore, it is recommended that a CNMP be developed and that all reasonable and feasible measures be implemented to reduce construction noise levels towards the NML. No exceedances of the 75 dBA highly affected level were predicted. Predicted $L_{Aeq,15min}$ construction noise levels comply with the established criteria for all out of hours works, subject to the use of acoustic sheds for shaft sinking activities.

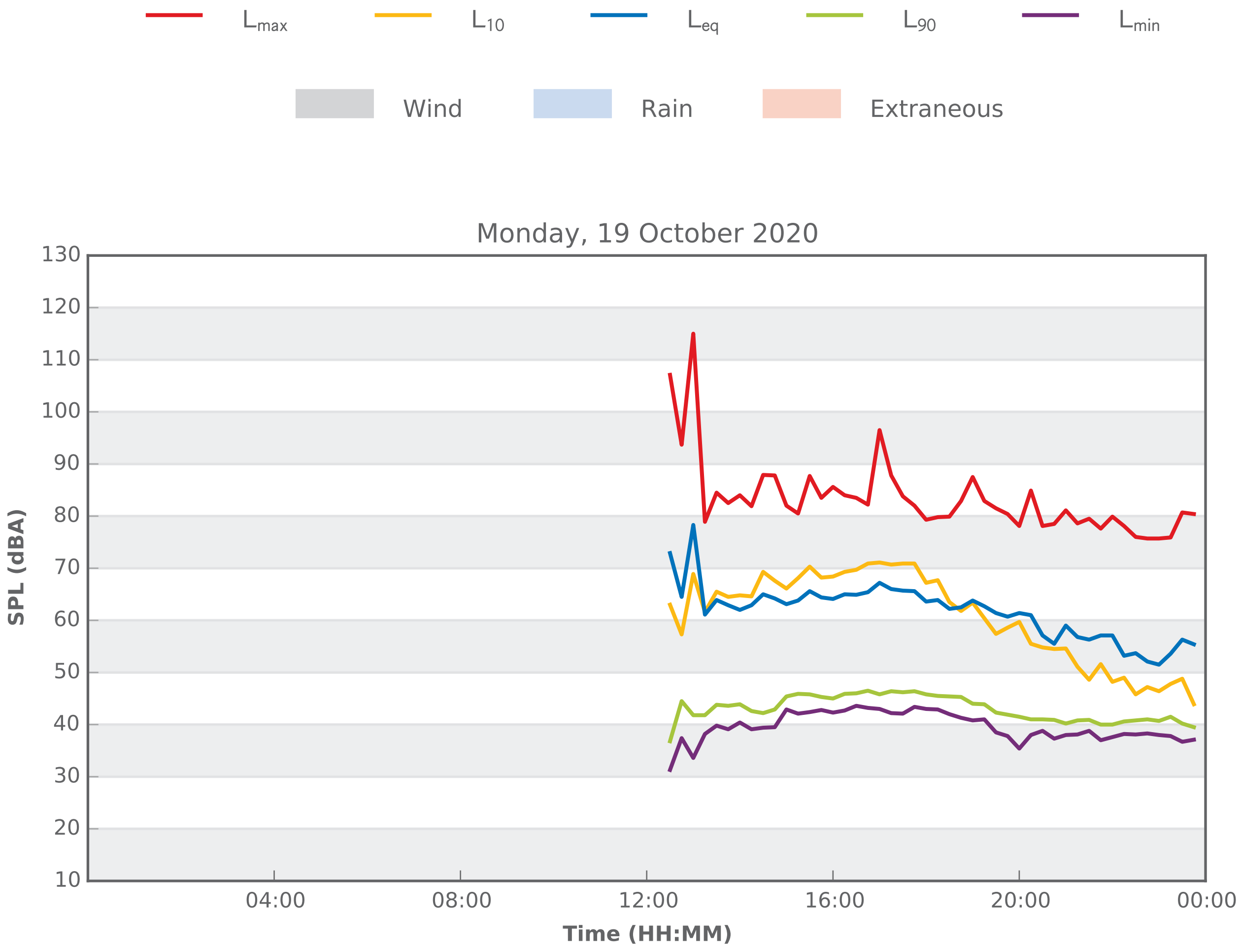
Construction of the Project will involve controlled blasting. Blasting is proposed to be conducted on a 24/7 basis. Overpressure and vibration criteria for blasting during standard hours have been established in accordance with the ANZEC guideline. Criteria for overpressure, maximum noise levels and vibration for out of hours blasting have been established from relevant guidelines and standards.

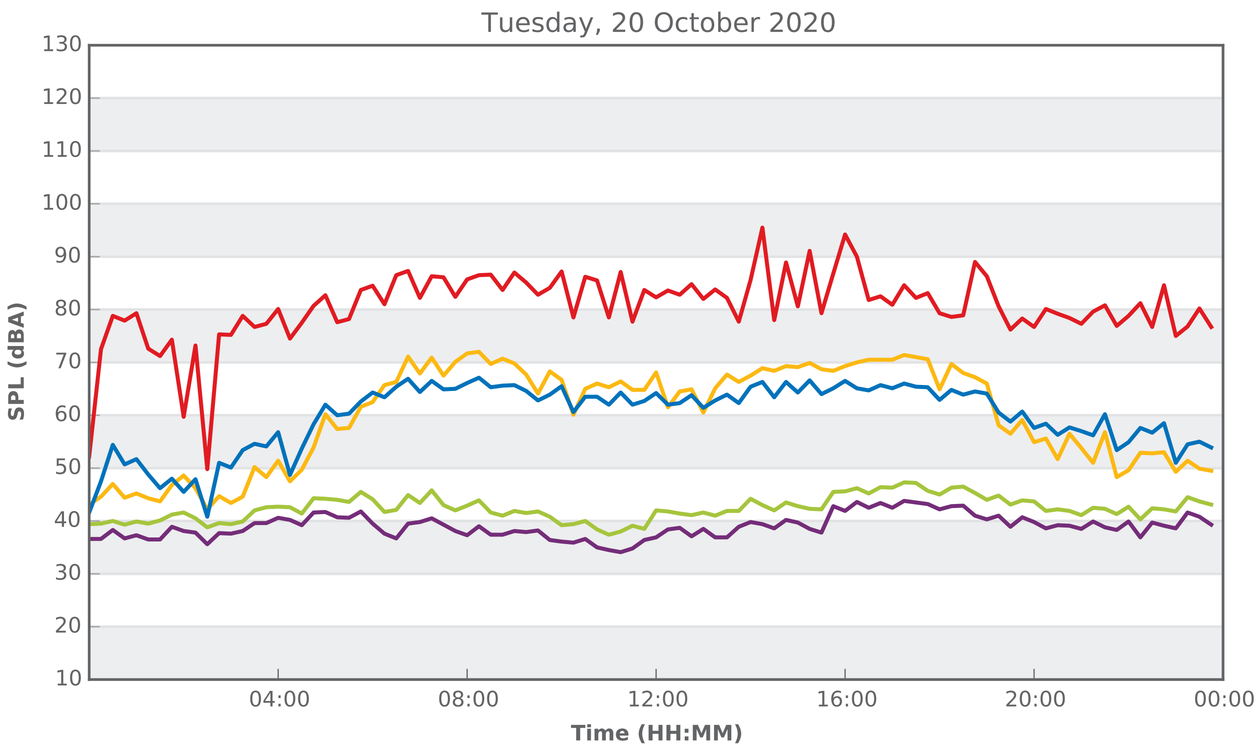
Indicative overpressure and vibration levels have been predicted using equations from AS 2187.2-2006 and default site parameters. The results indicate that the blast design is likely to be limited by overpressure, not vibration. Trial blasts would be conducted to develop a site law and a detailed blast design which achieves compliance with the established criteria.

A blast management strategy has been outlined, including a range of blasting mitigation measures.

APPENDIX A: DAILY NOISE LOGGER PLOTS

345 Menangle Road, Menangle





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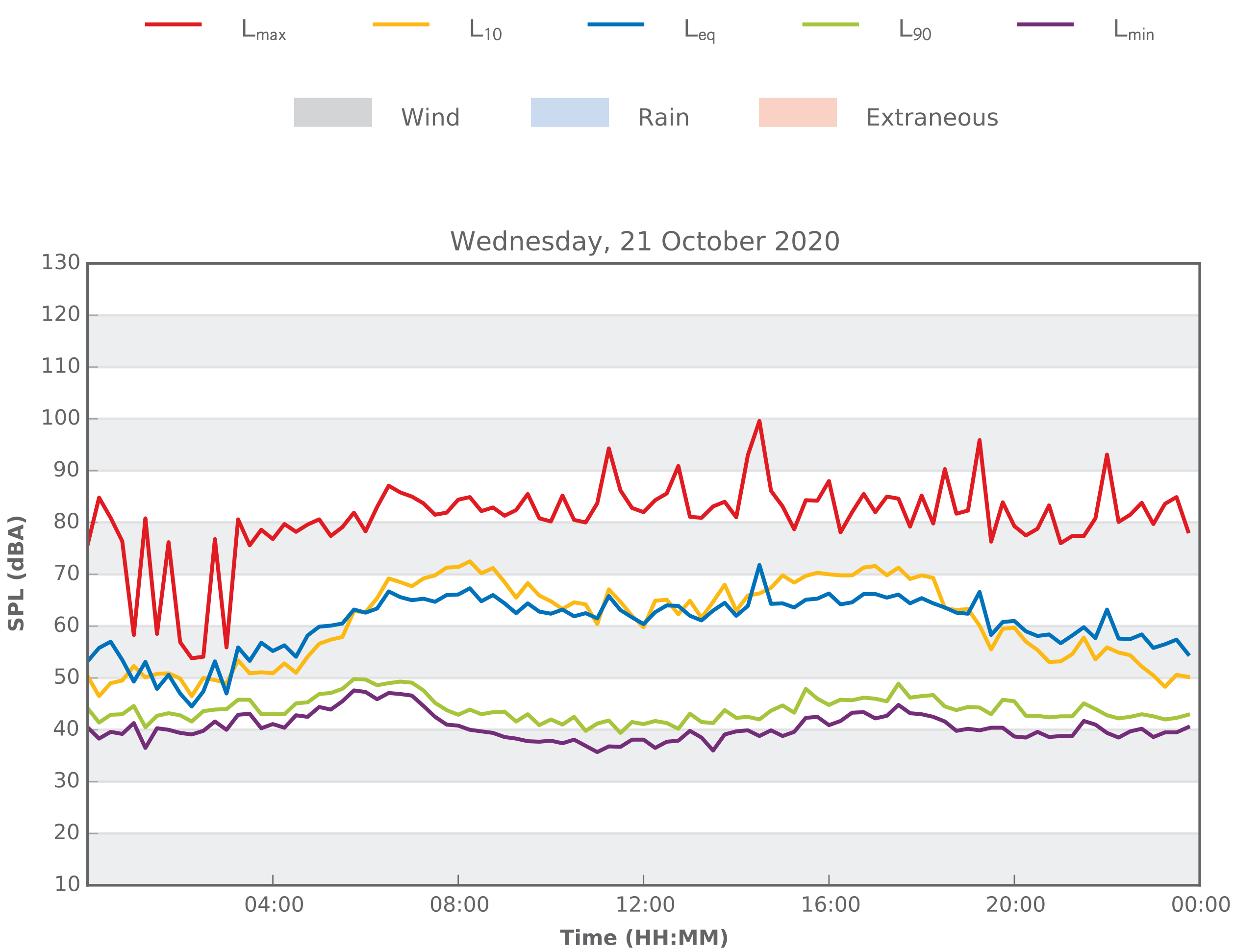

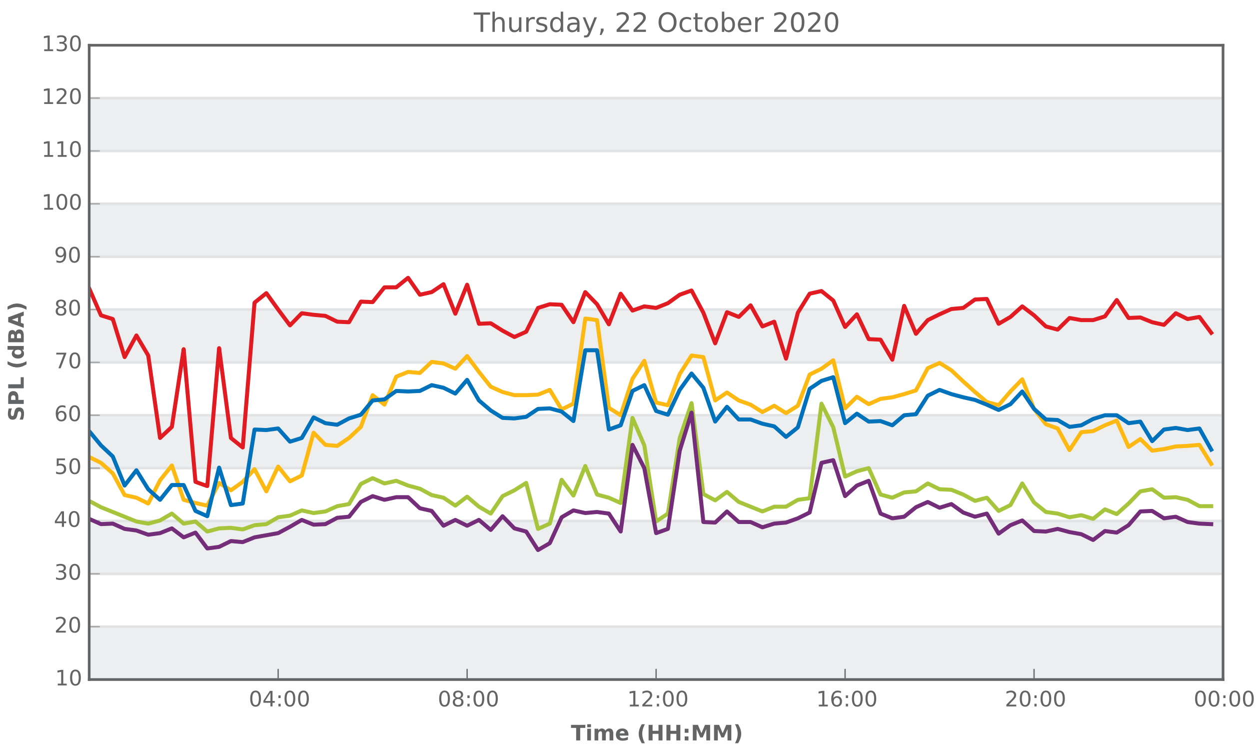

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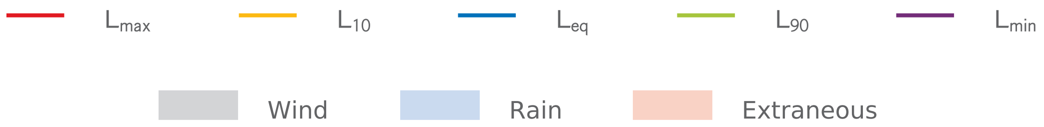

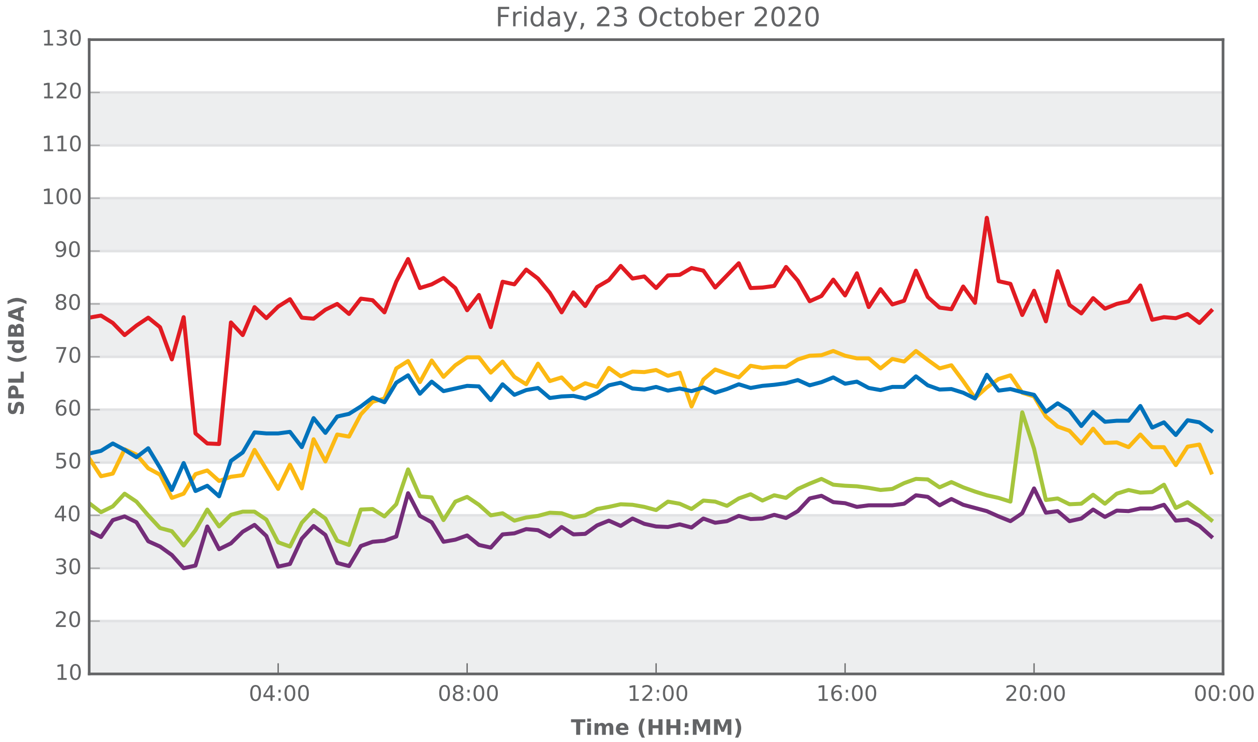

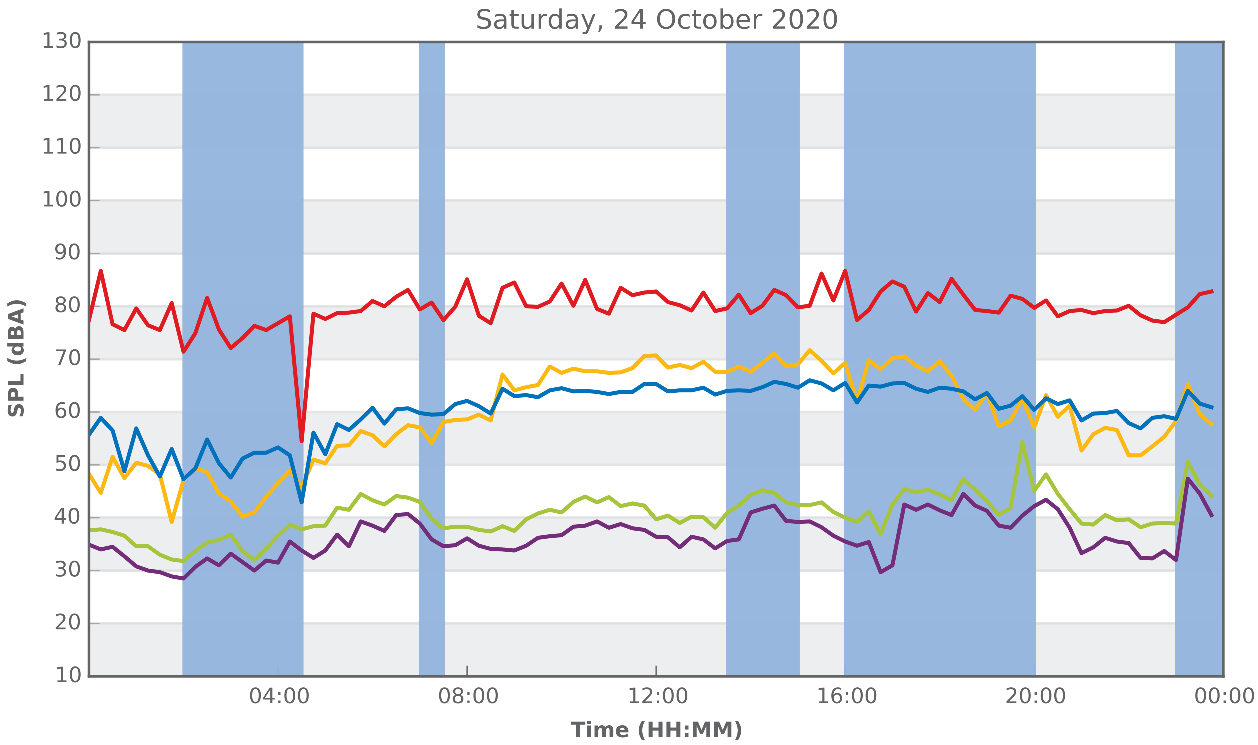

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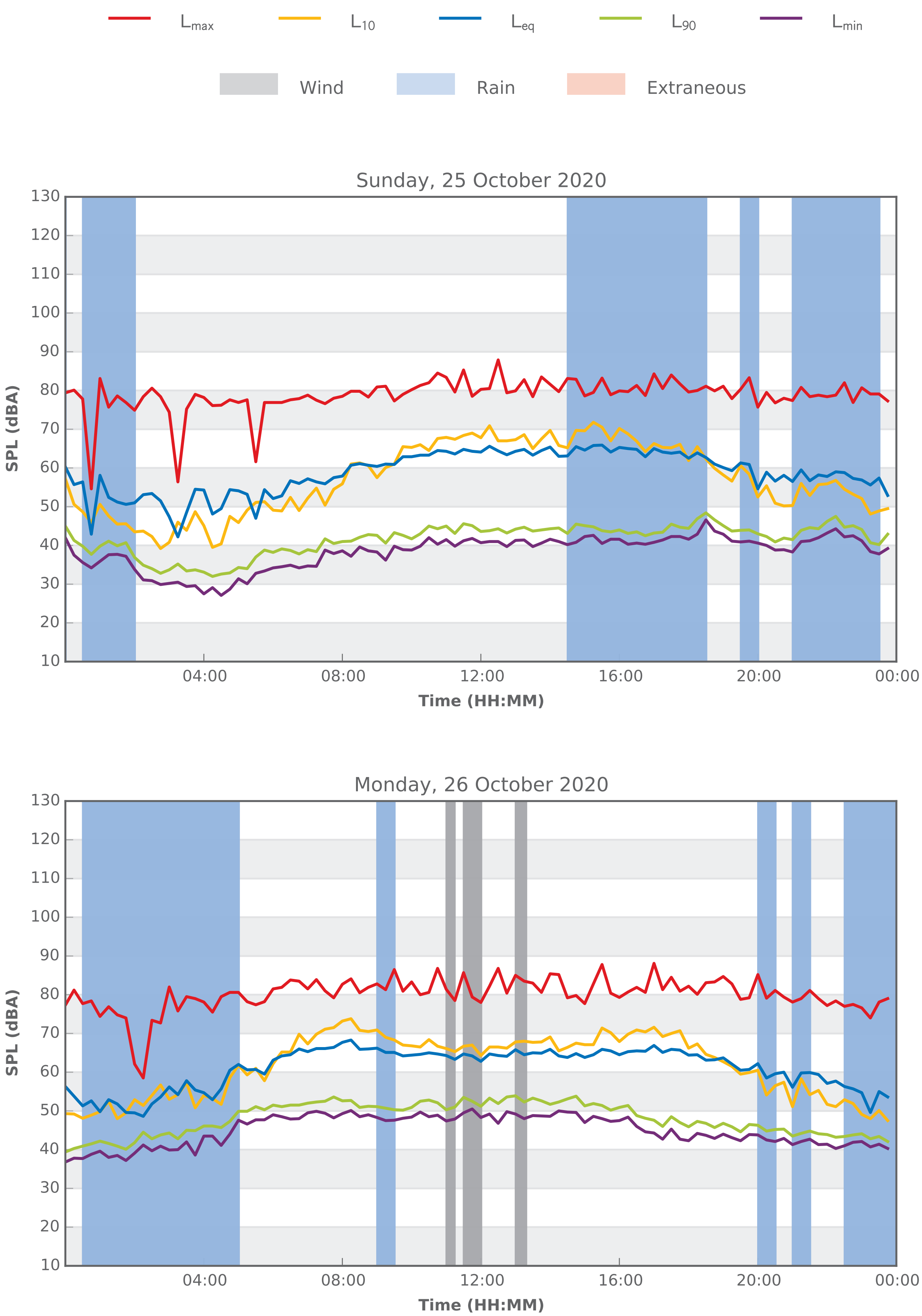

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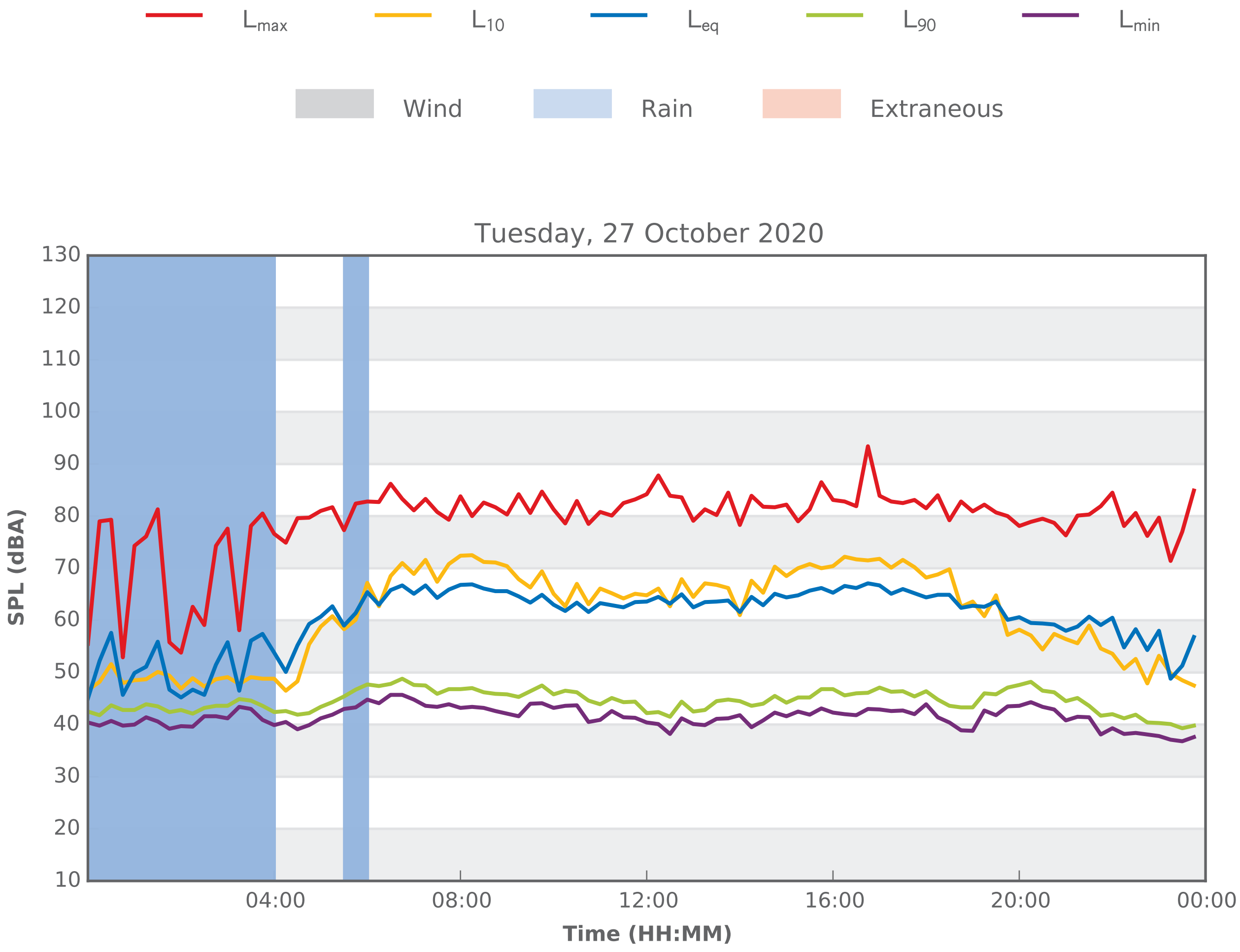

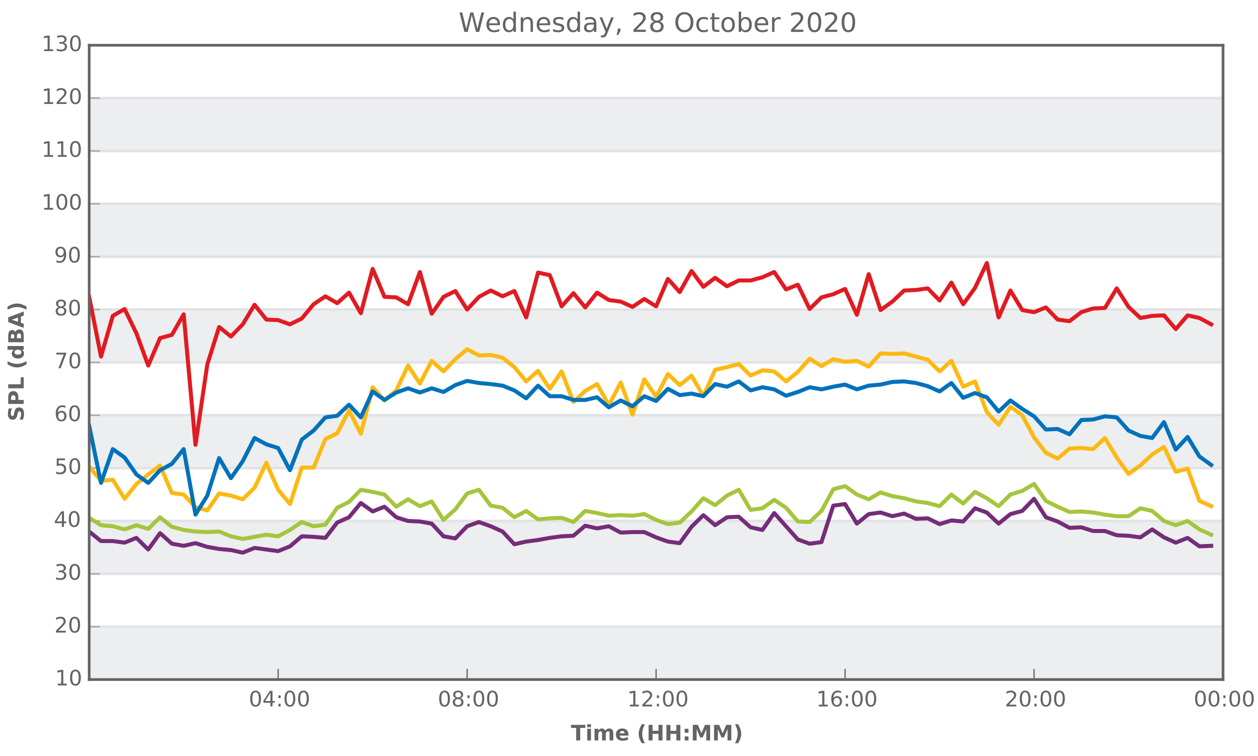

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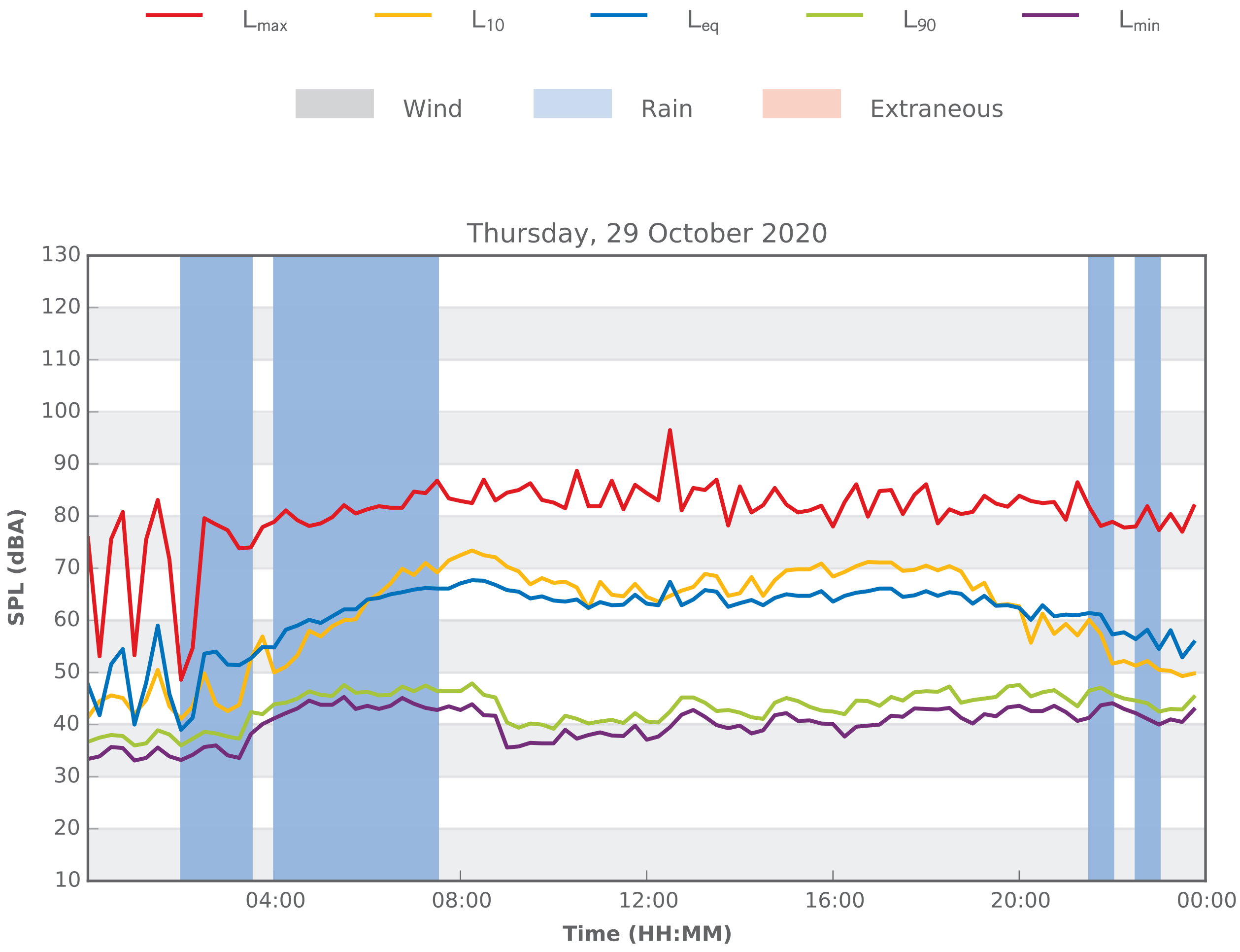

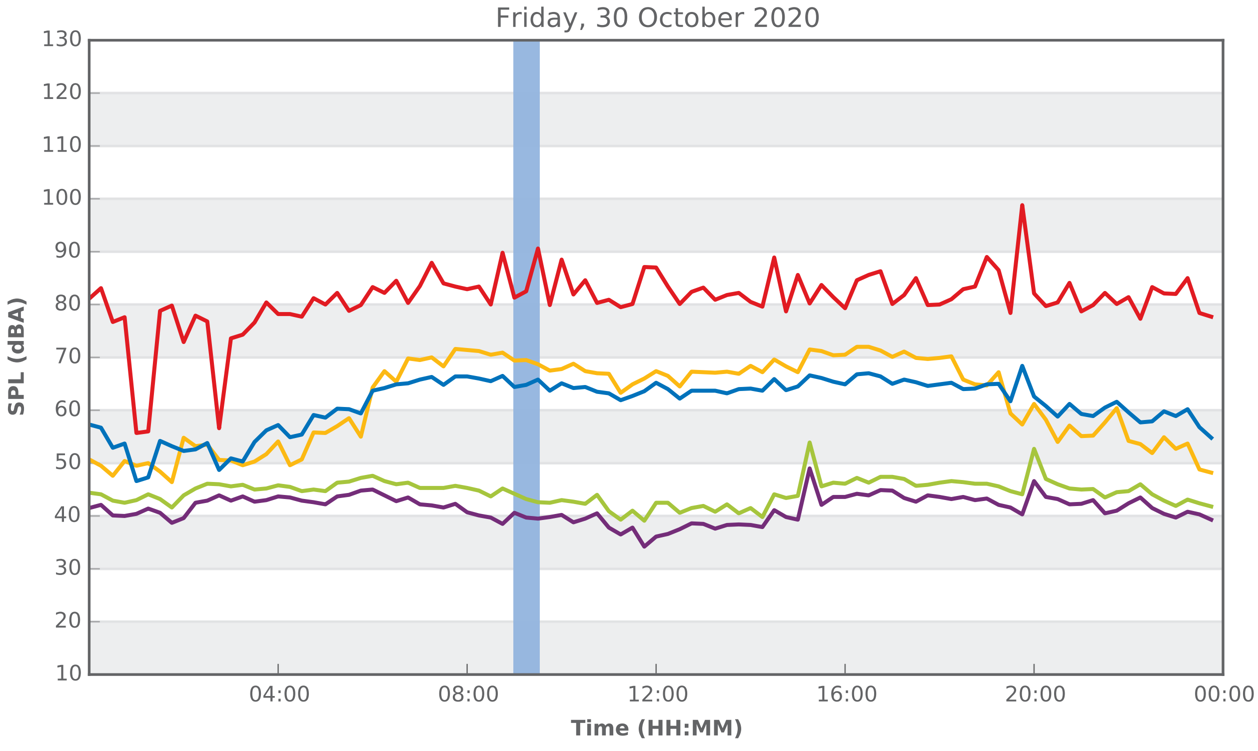

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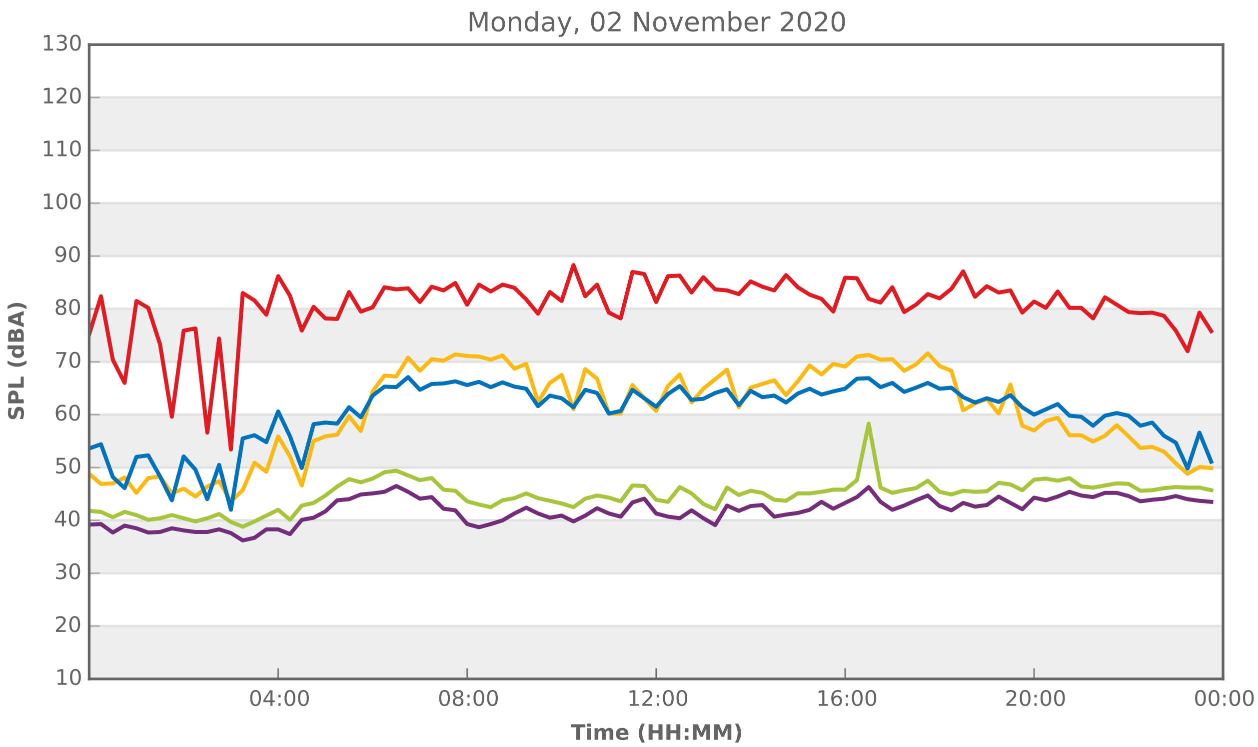
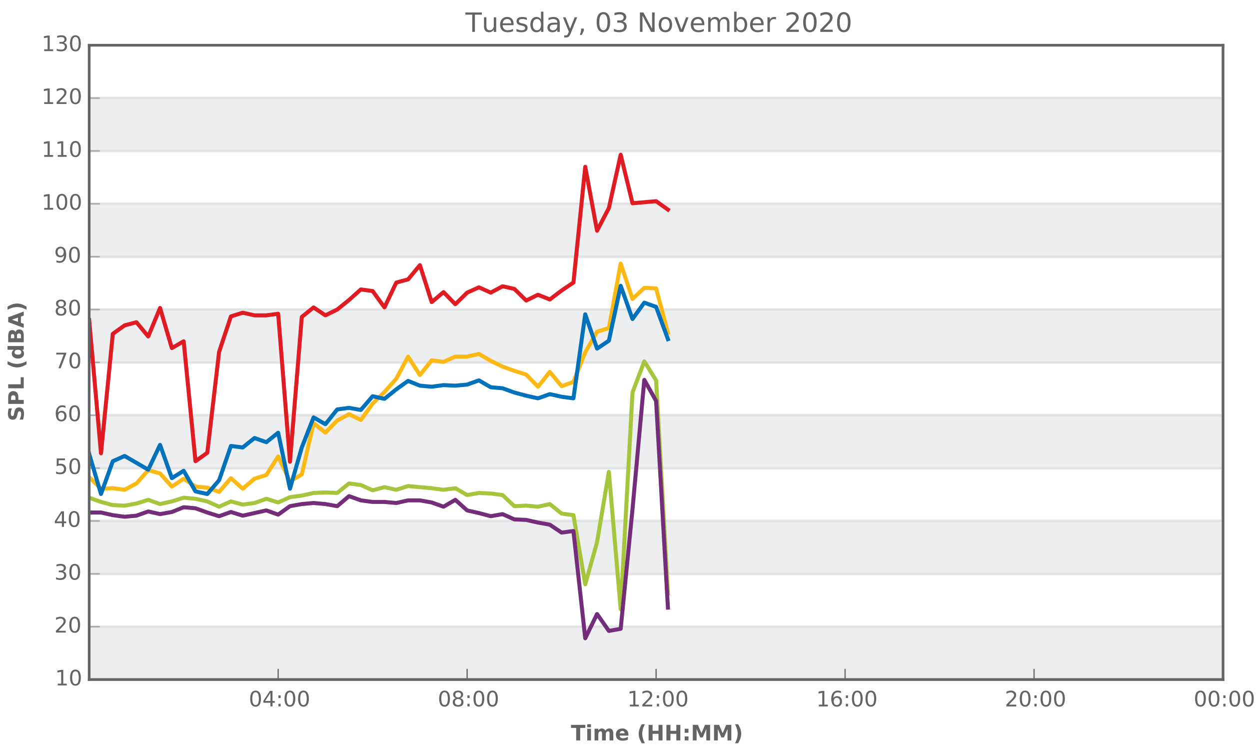
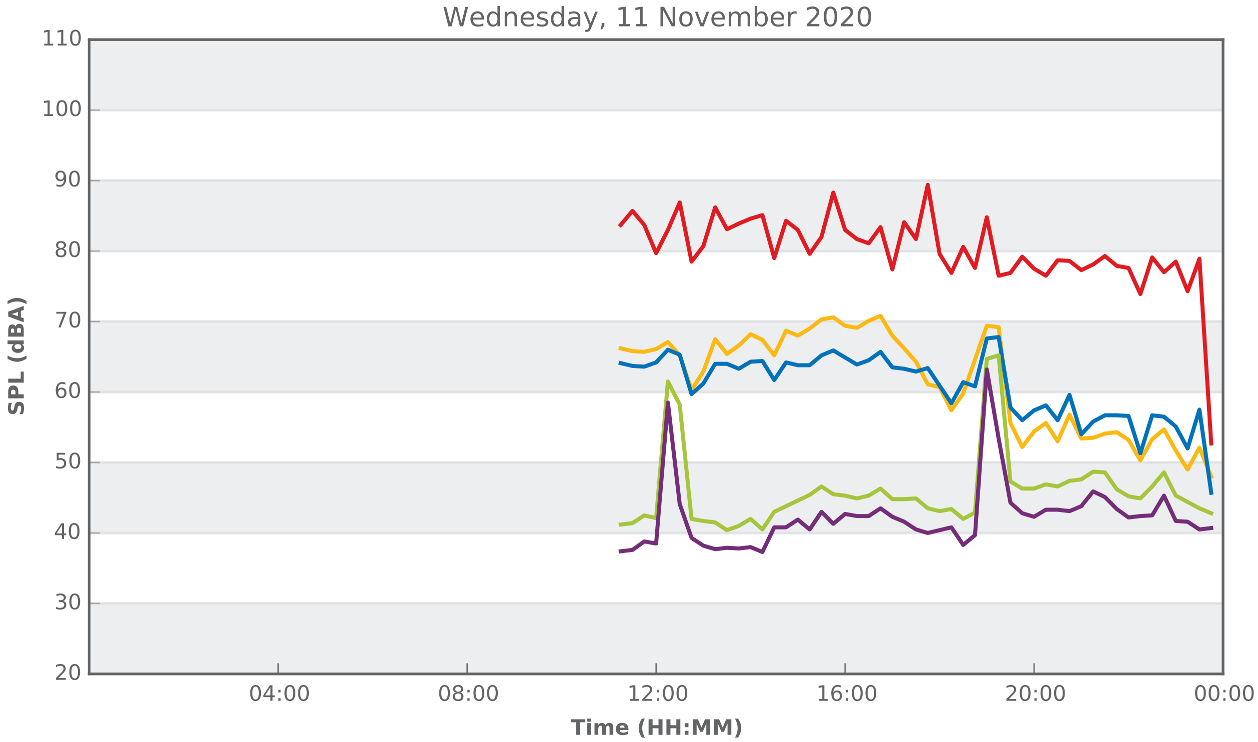


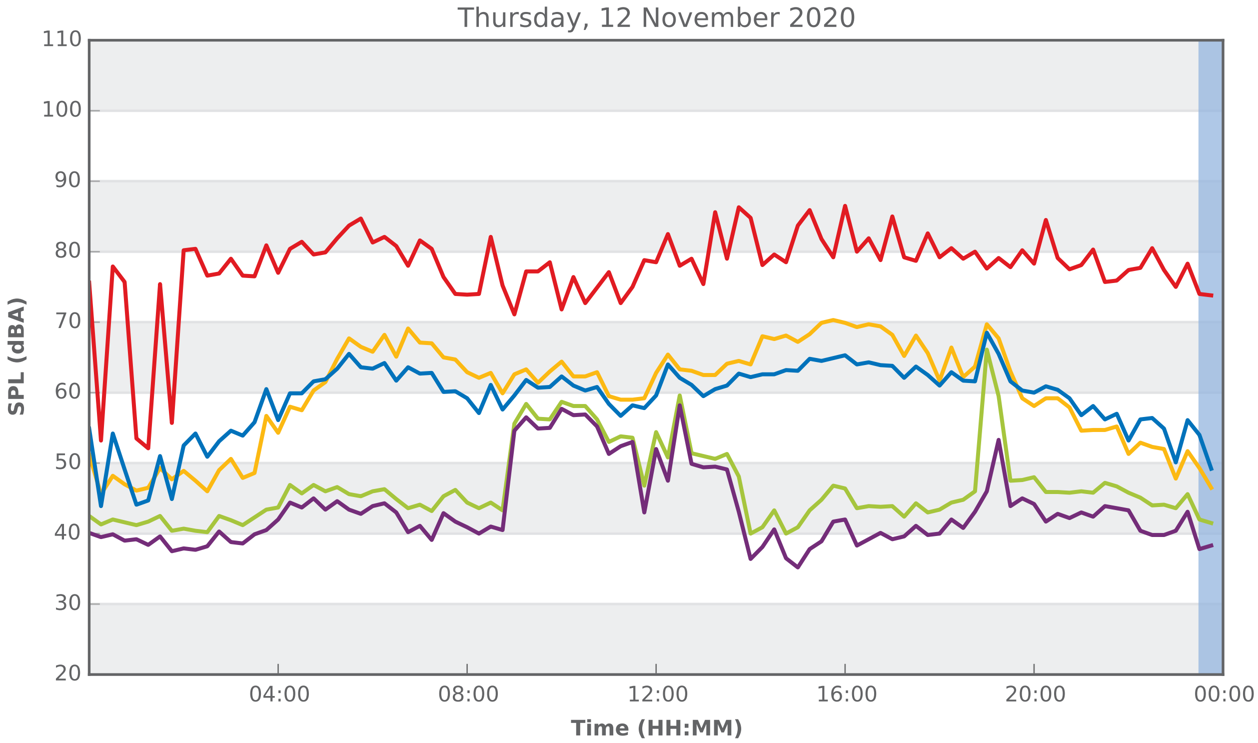


345 Menangle Road, Menangle

Lmax L10 Leq L90 Lmin

Wind Rain Extraneous





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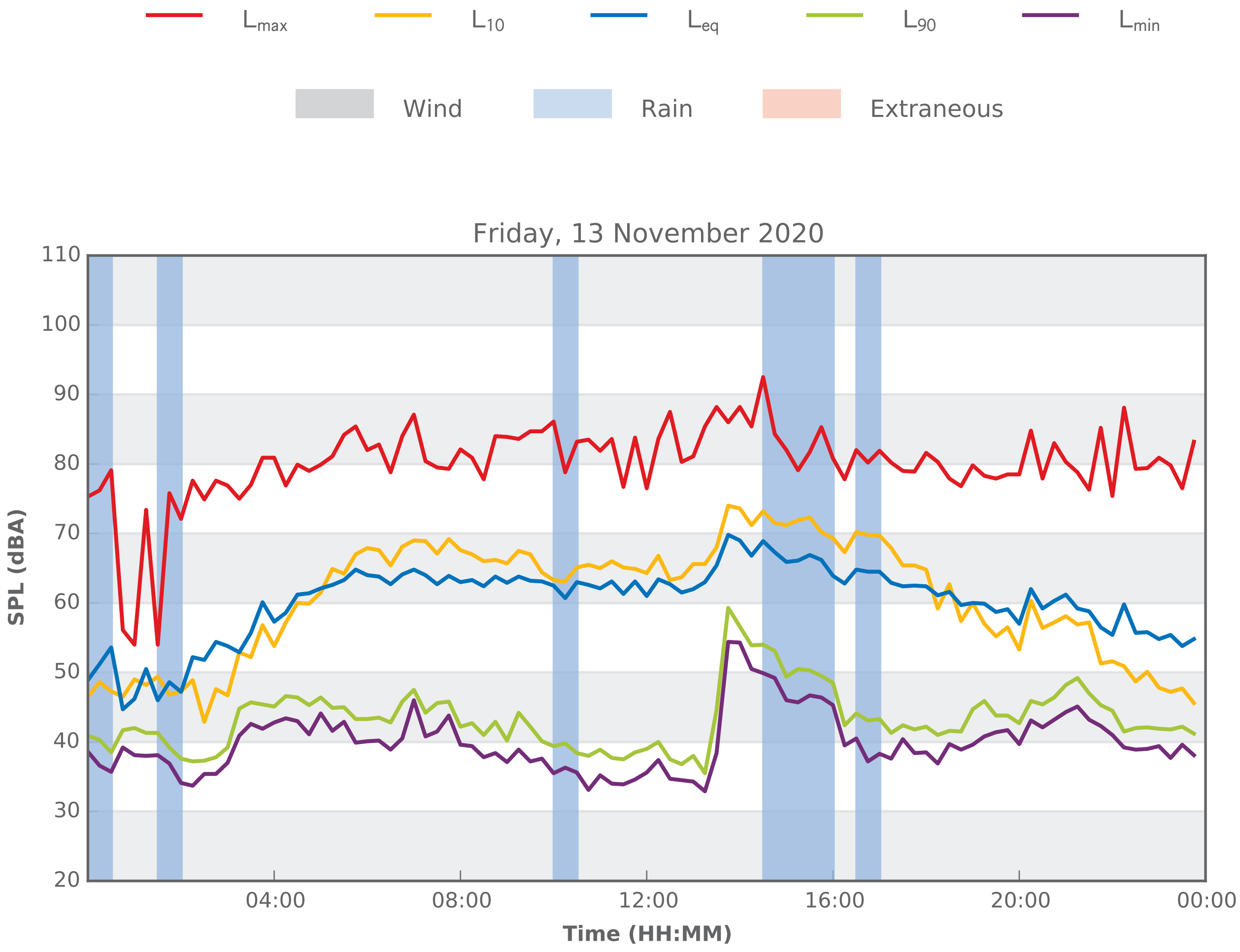

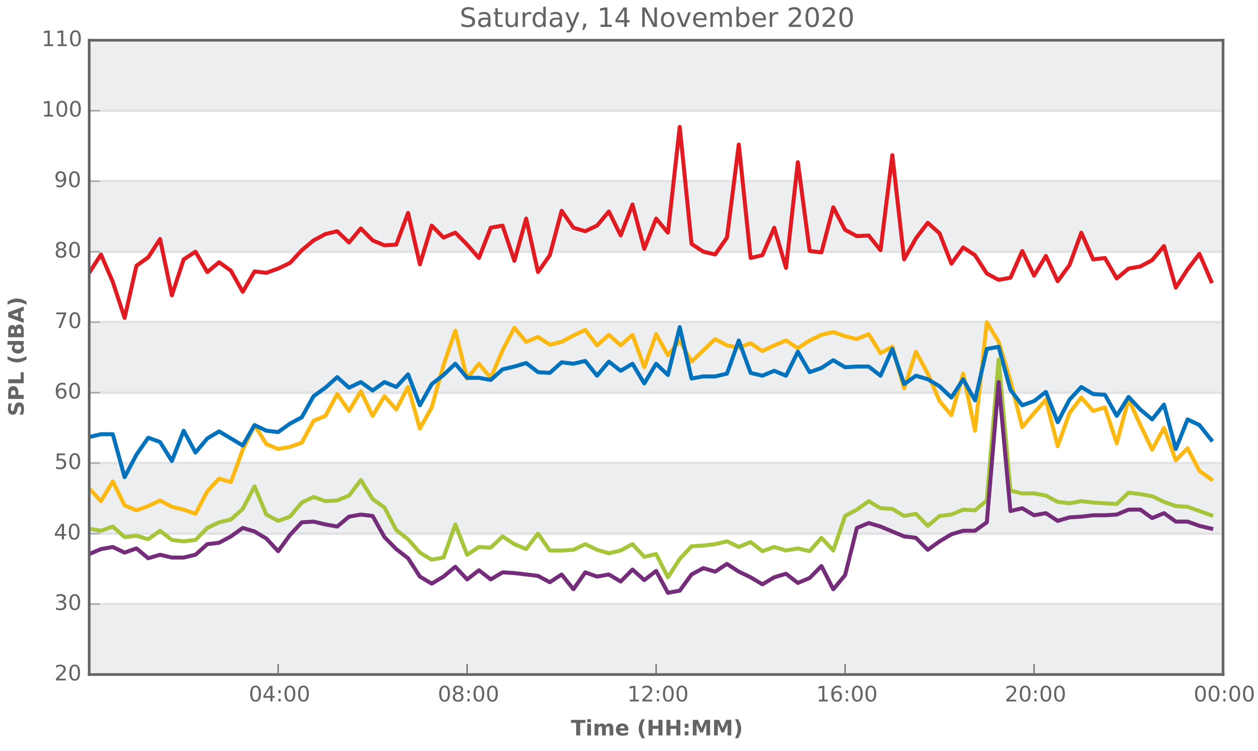

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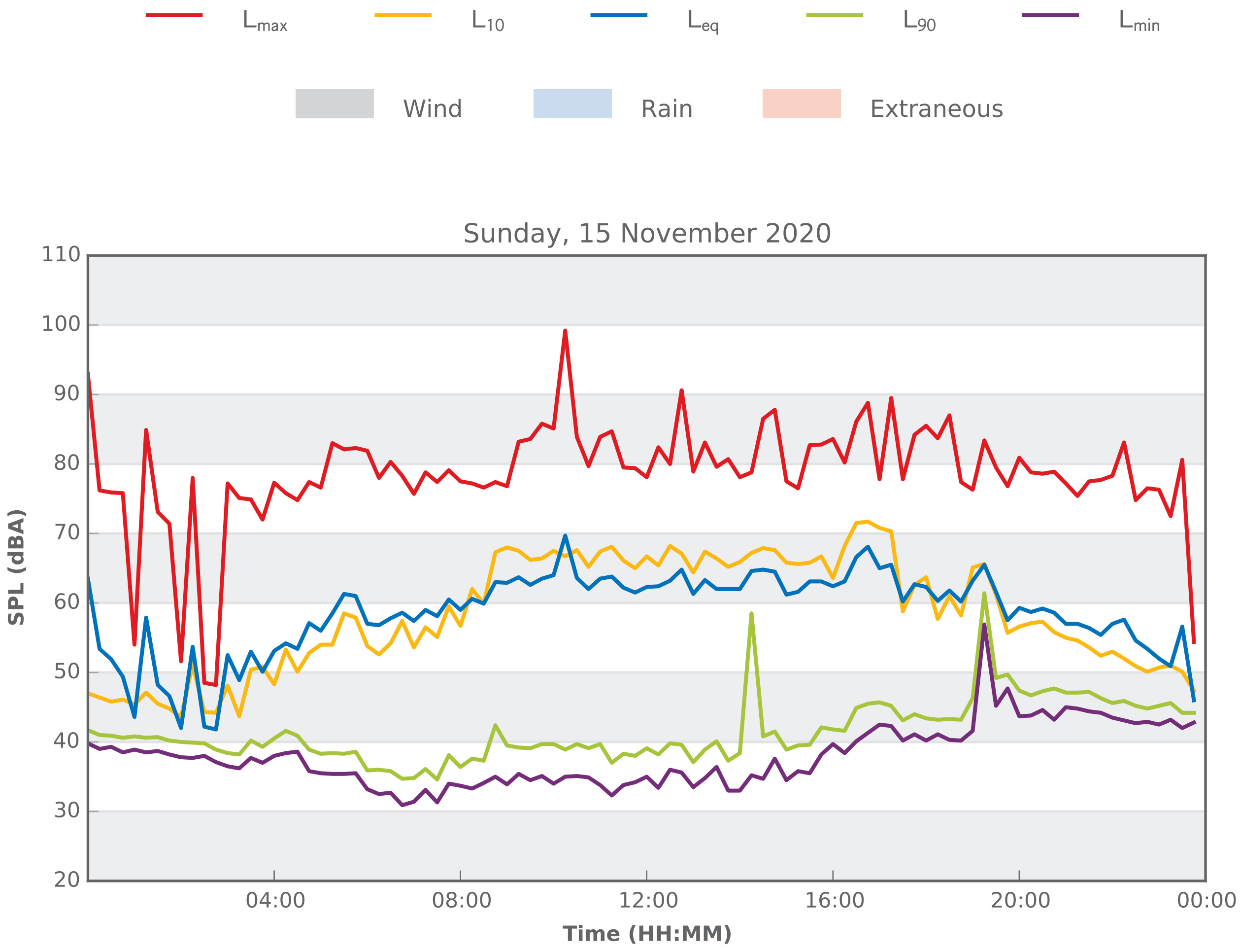
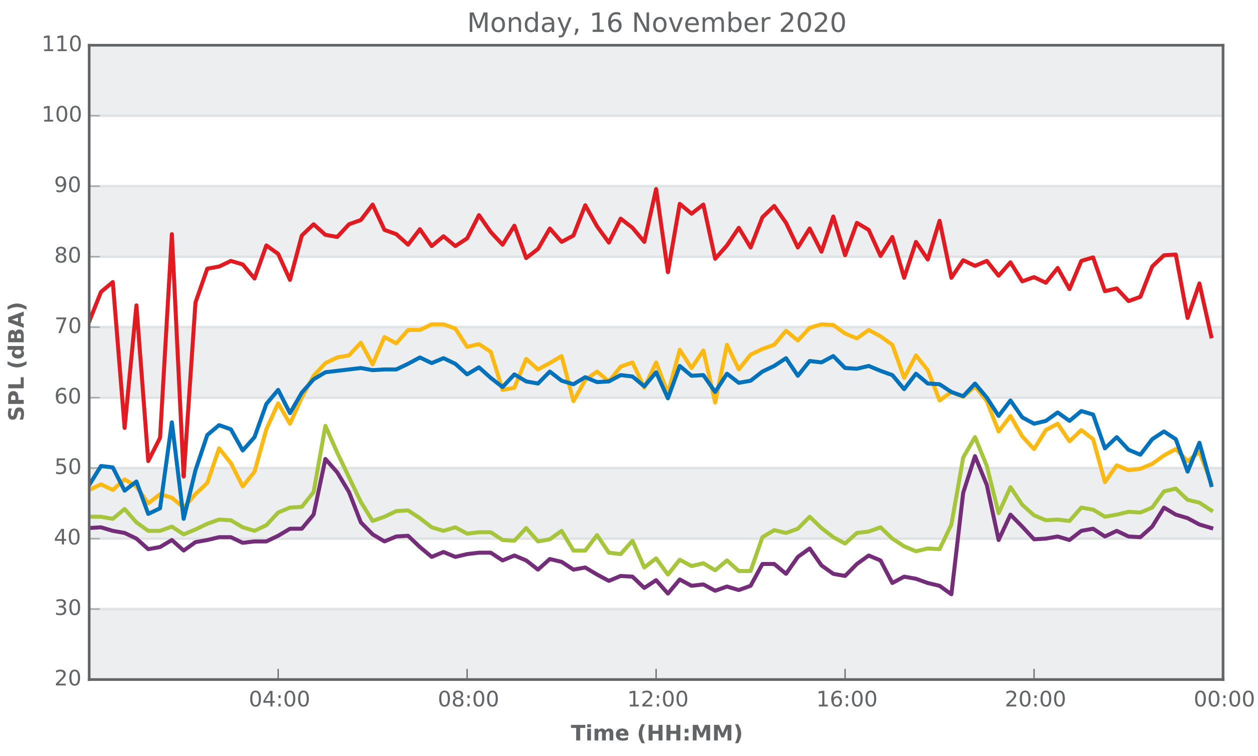
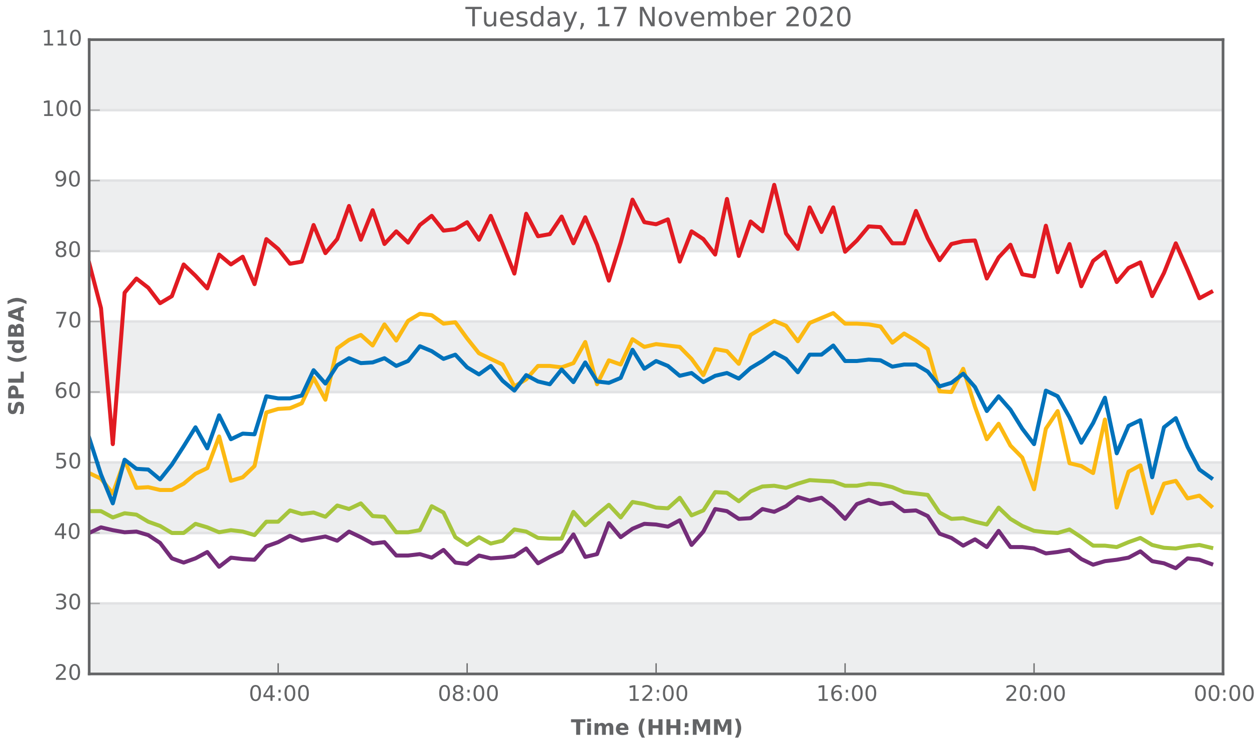


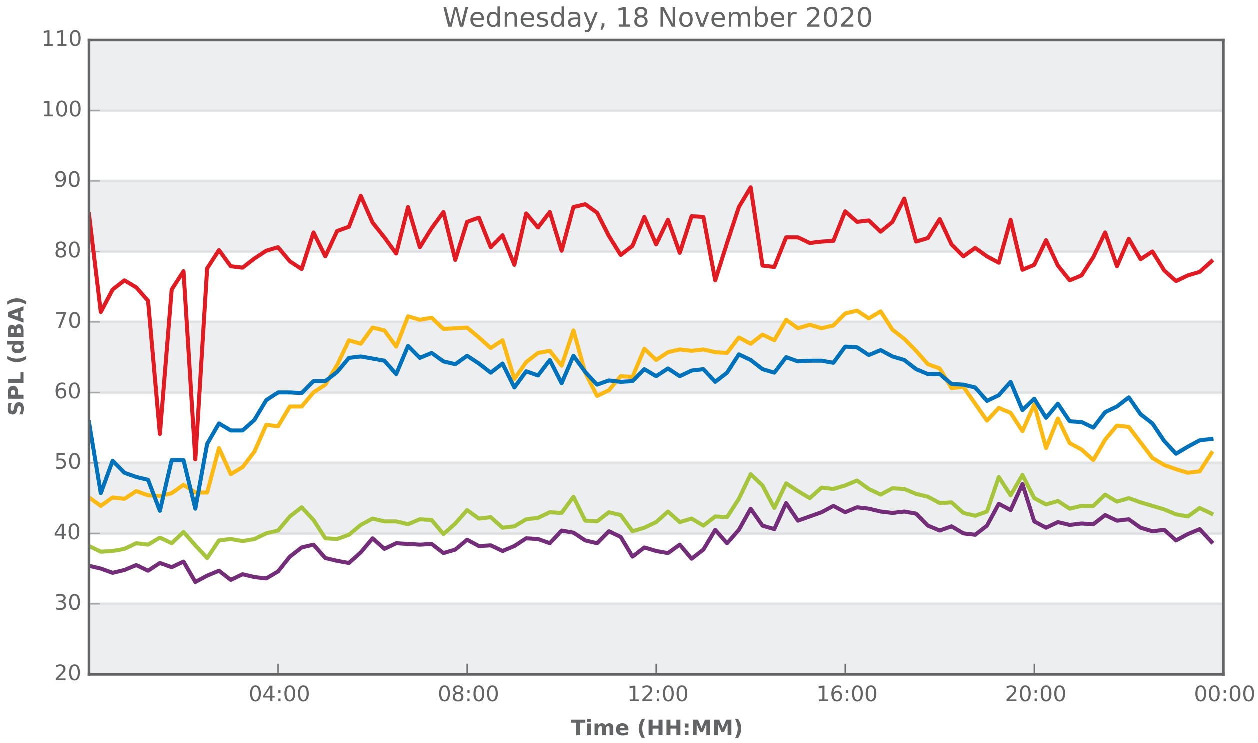


345 Menangle Road, Menangle

L_{max} L_{10} L_{eq} L_{90} L_{min}

Wind Rain Extraneous





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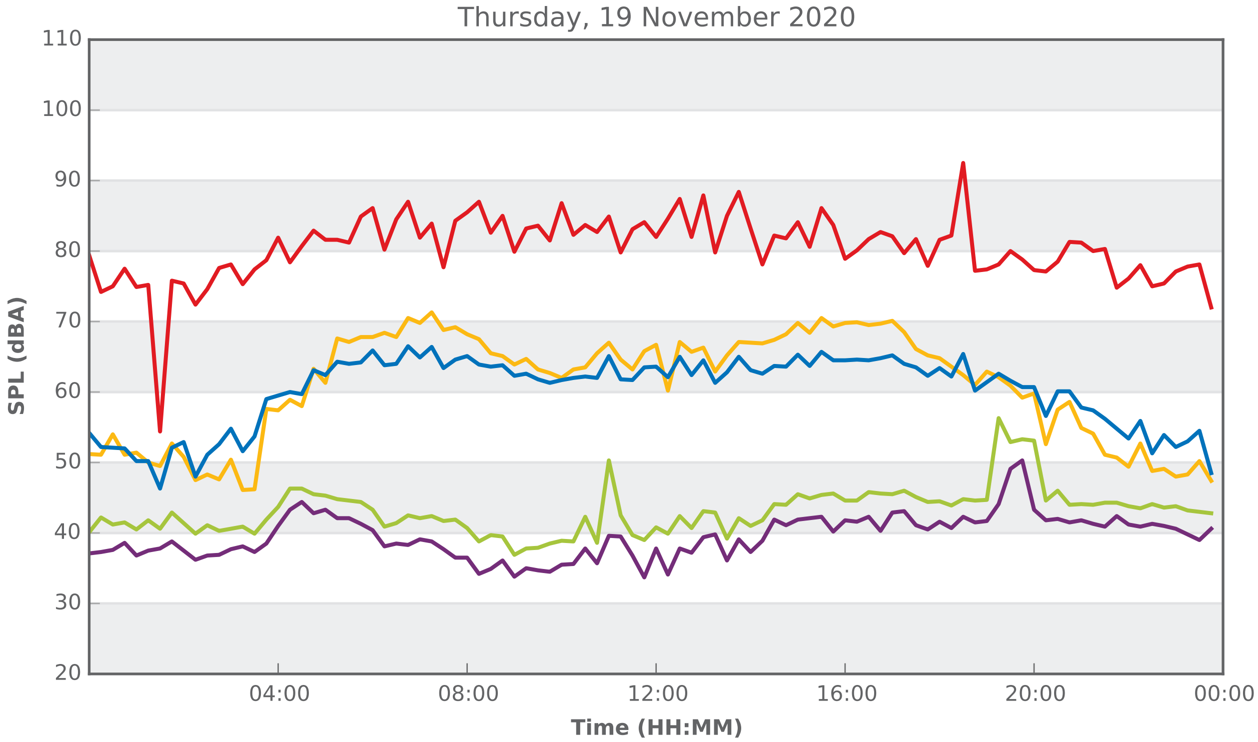

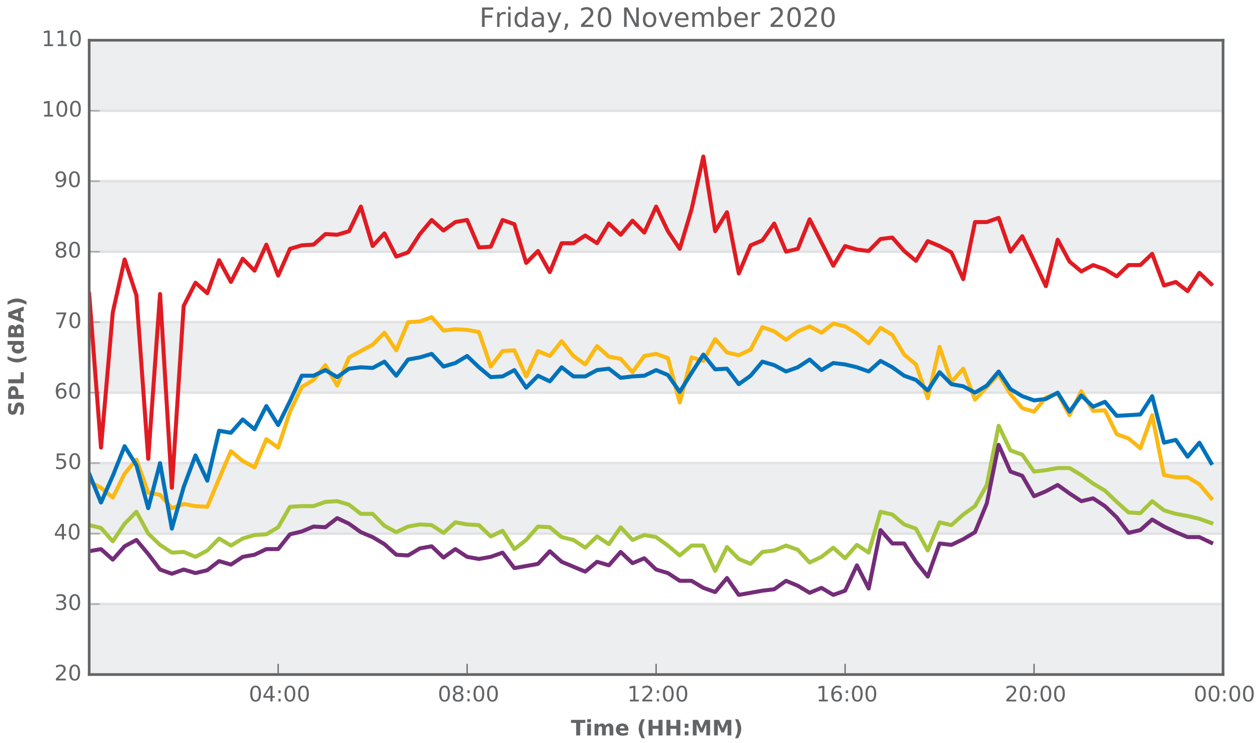

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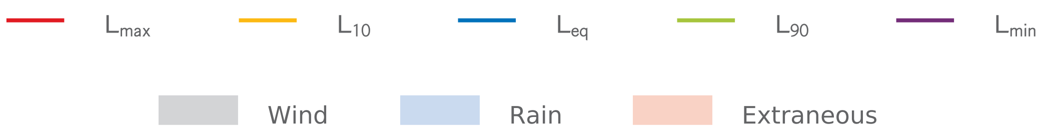
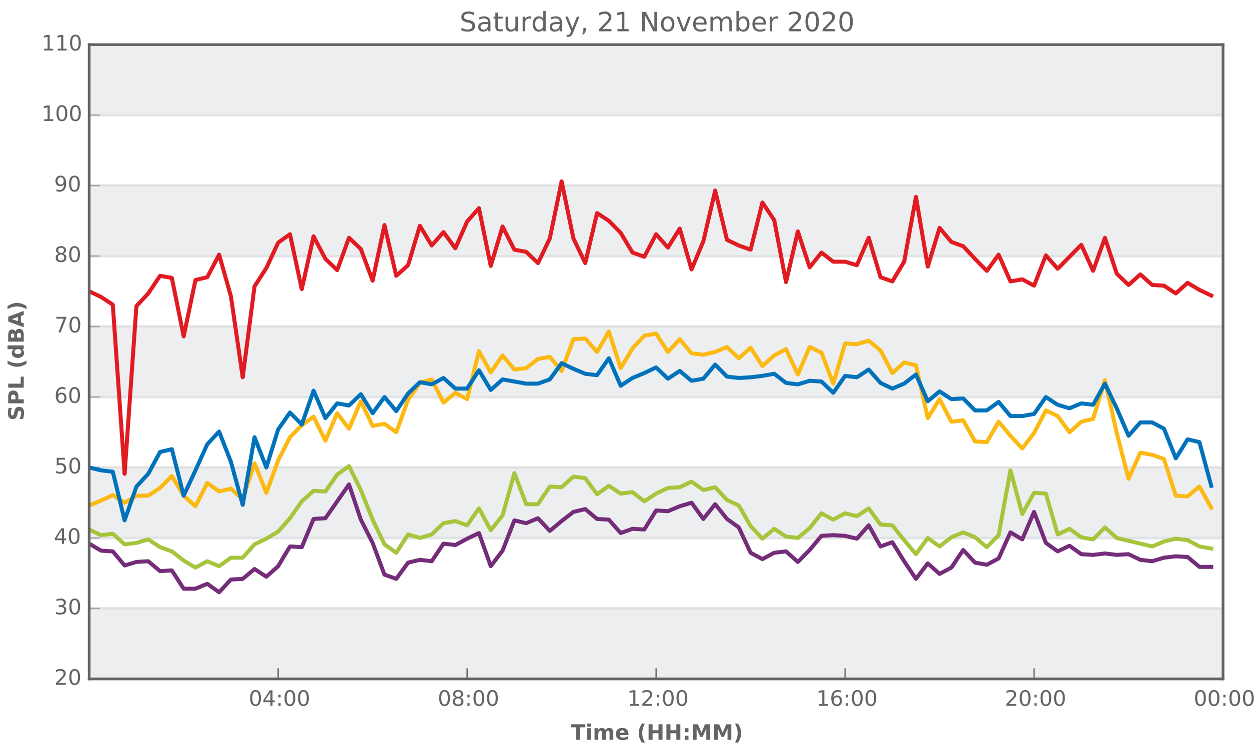
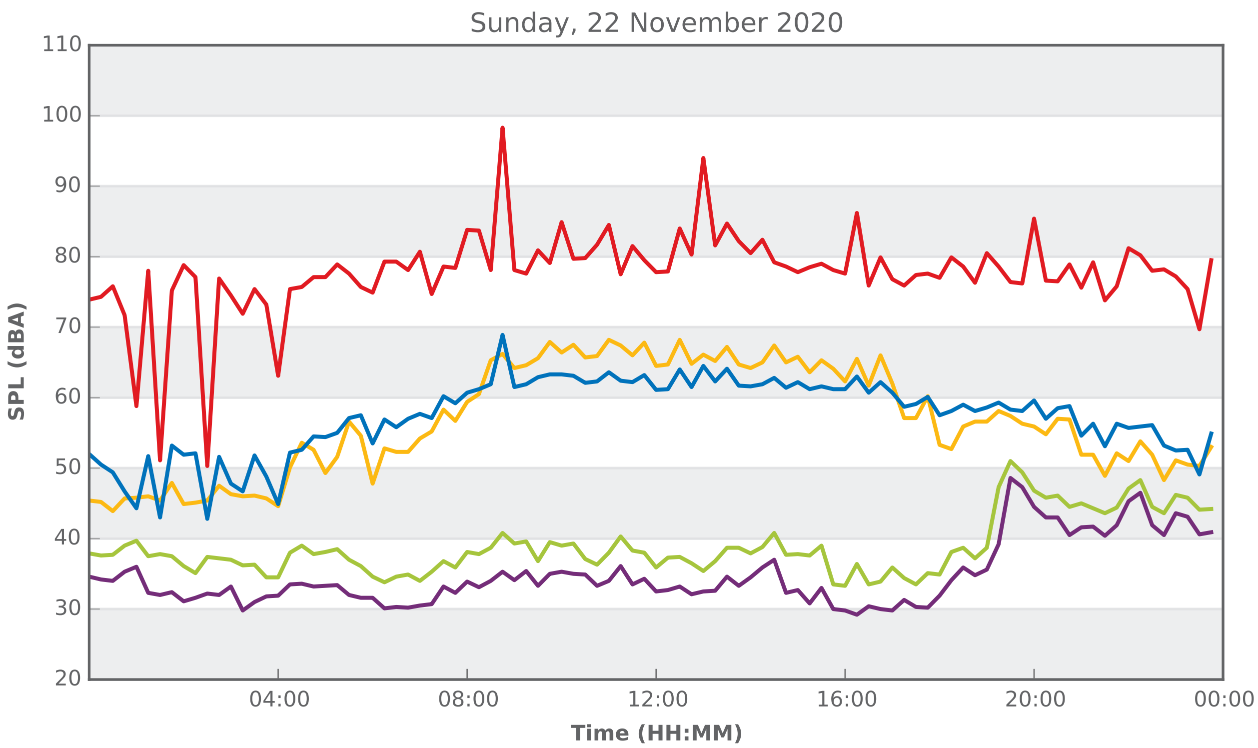
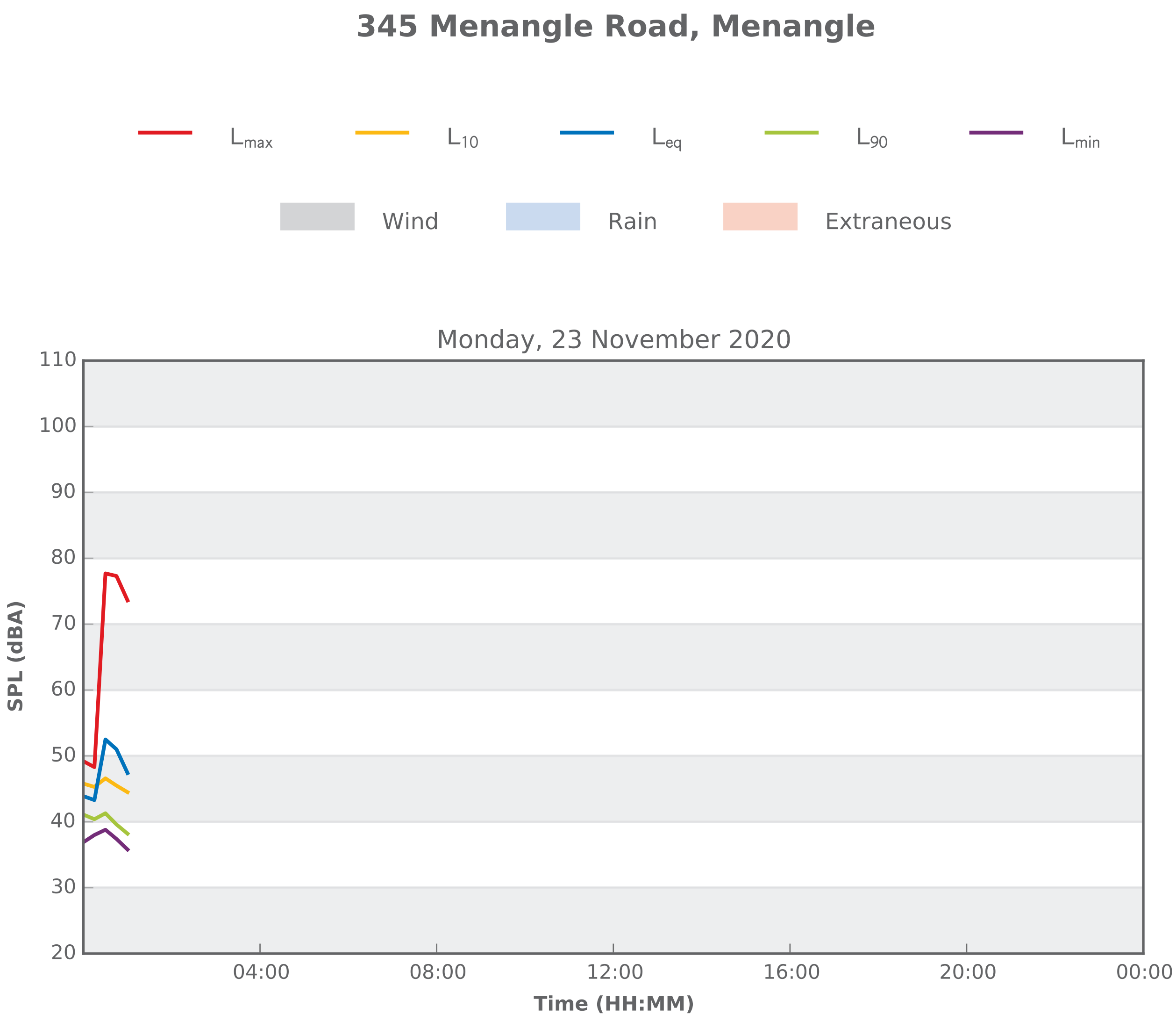




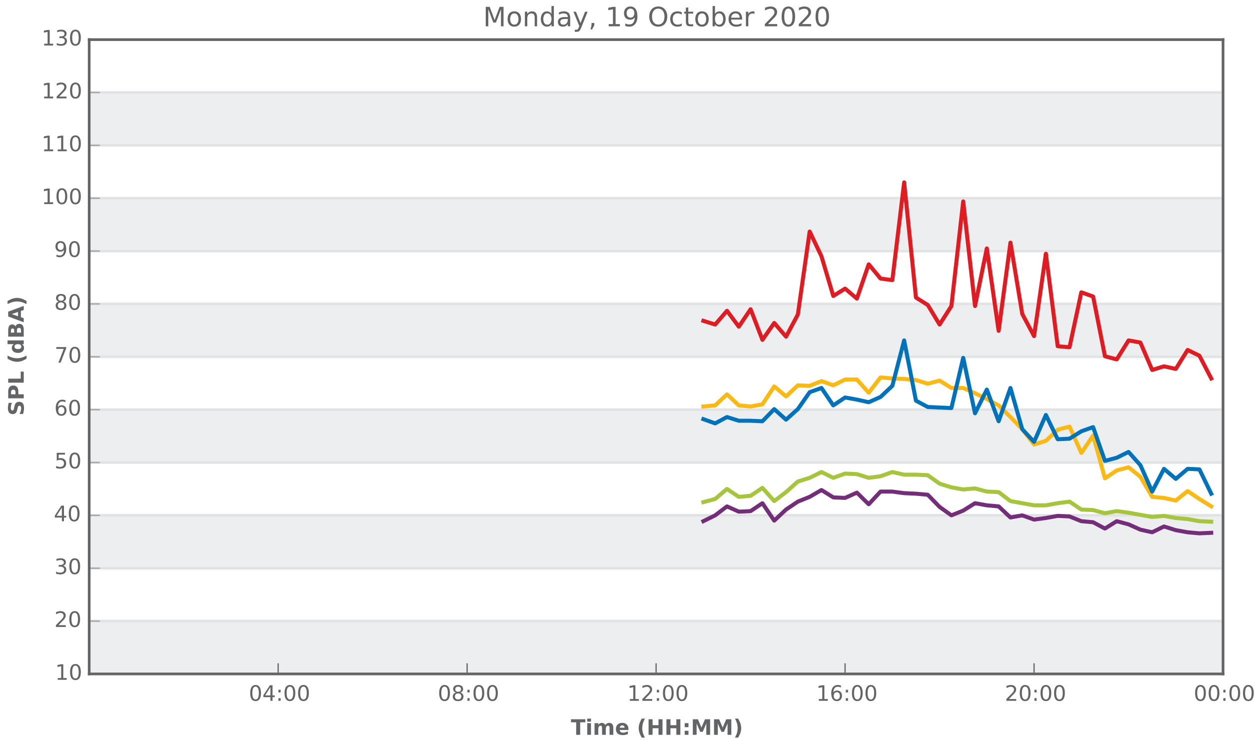


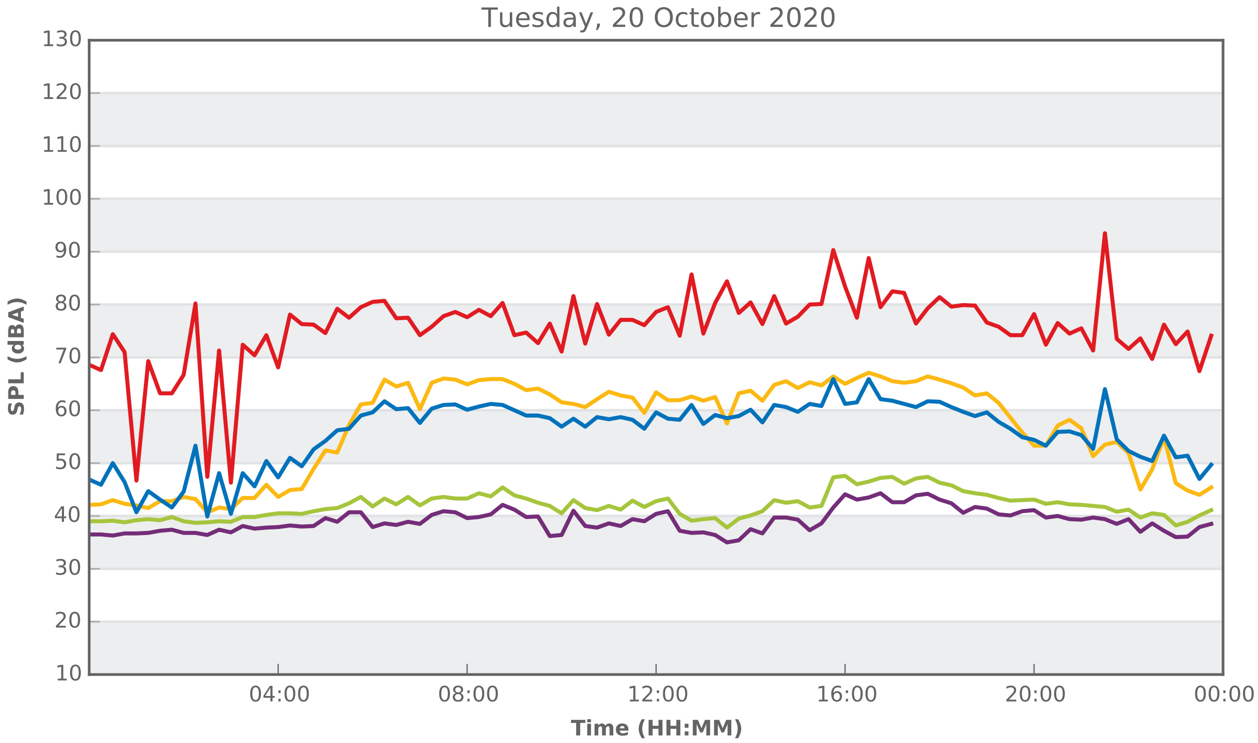

345 Menangle Road, Menangle
Lmax
L10
Leq
L90
Lmin
Wind
Rain
Extraneous
Monday, 23 November 2020
SPL (dBA)
110
100
90
80
70
60
50
40
30
20
04:00
08:00
12:00
16:00
20:00
00:00
Time (HH:MM)

15 Finns Road, Menangle

L_{max} L_{10} L_{eq} L_{90} L_{min}

Wind Rain Extraneous





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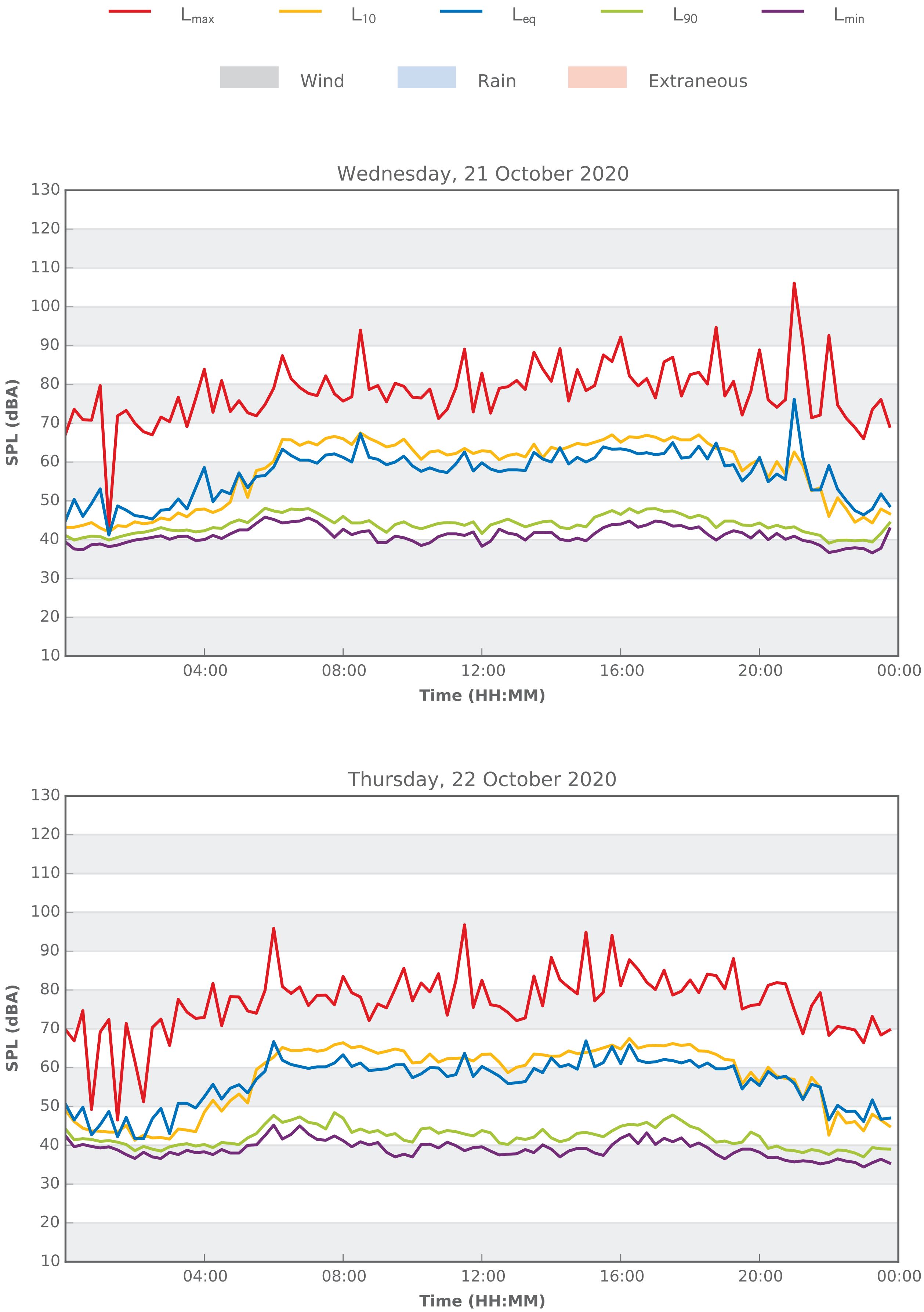

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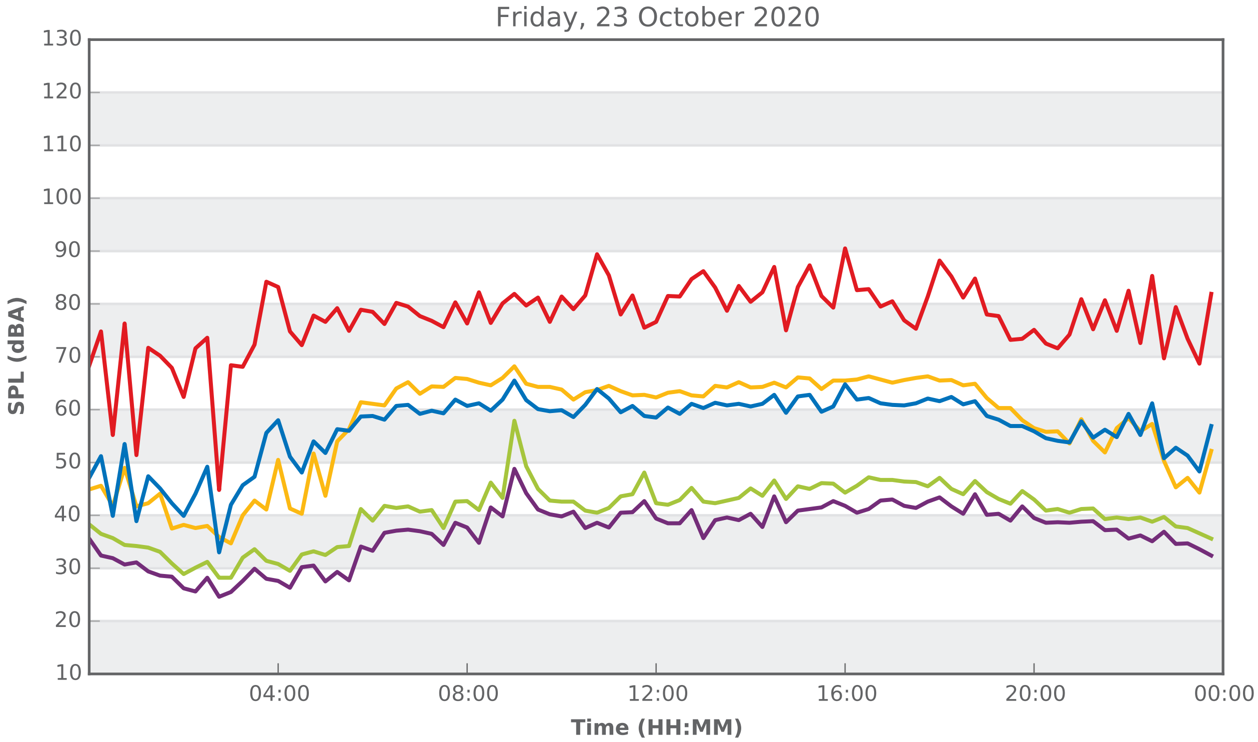

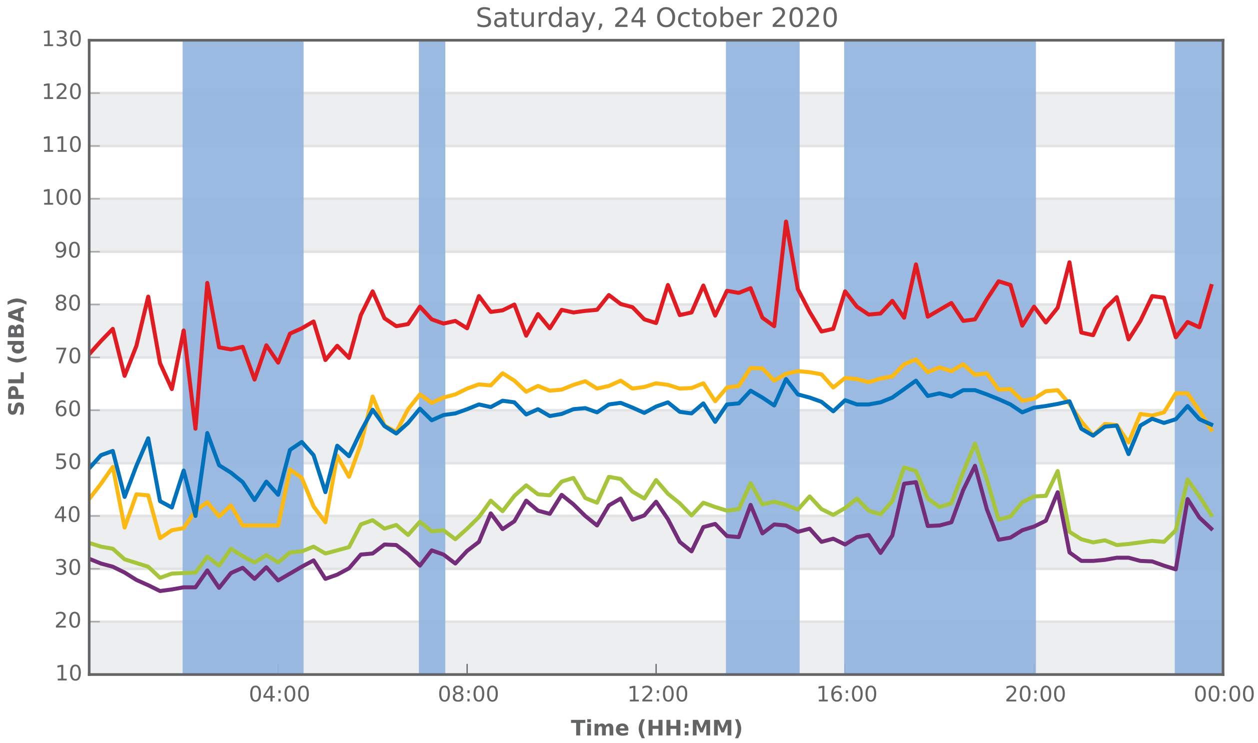

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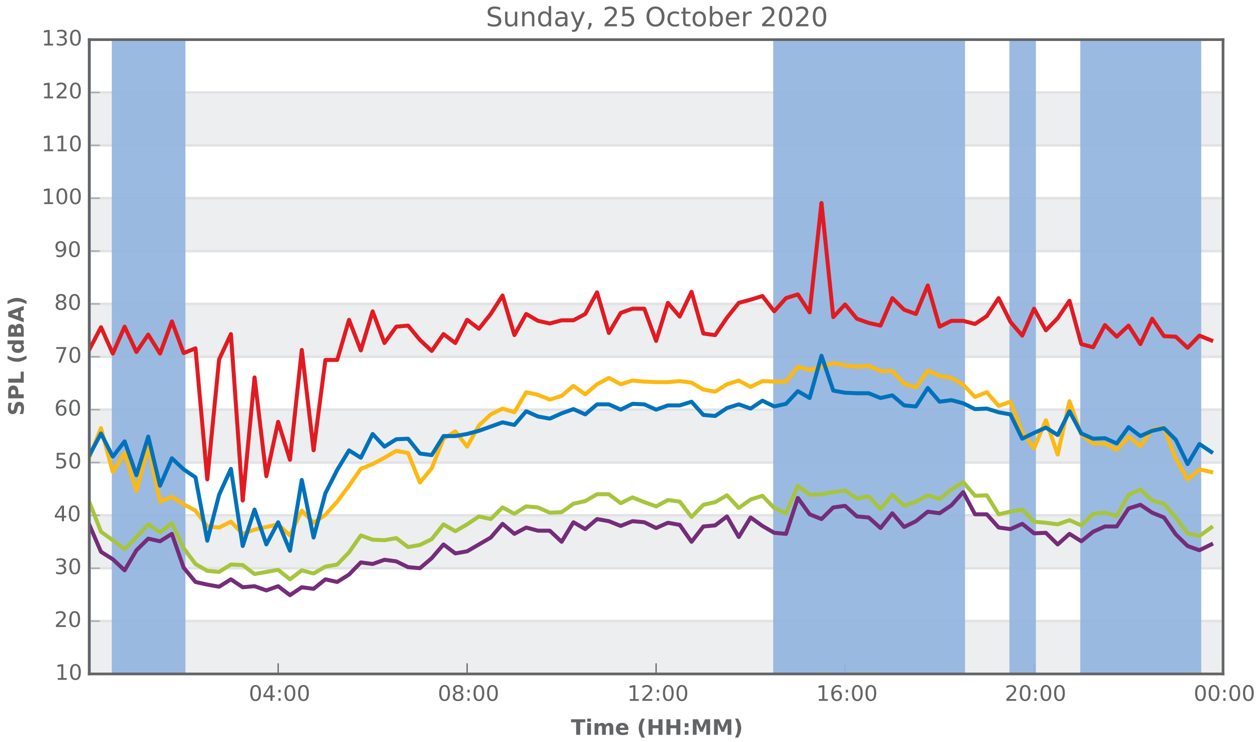

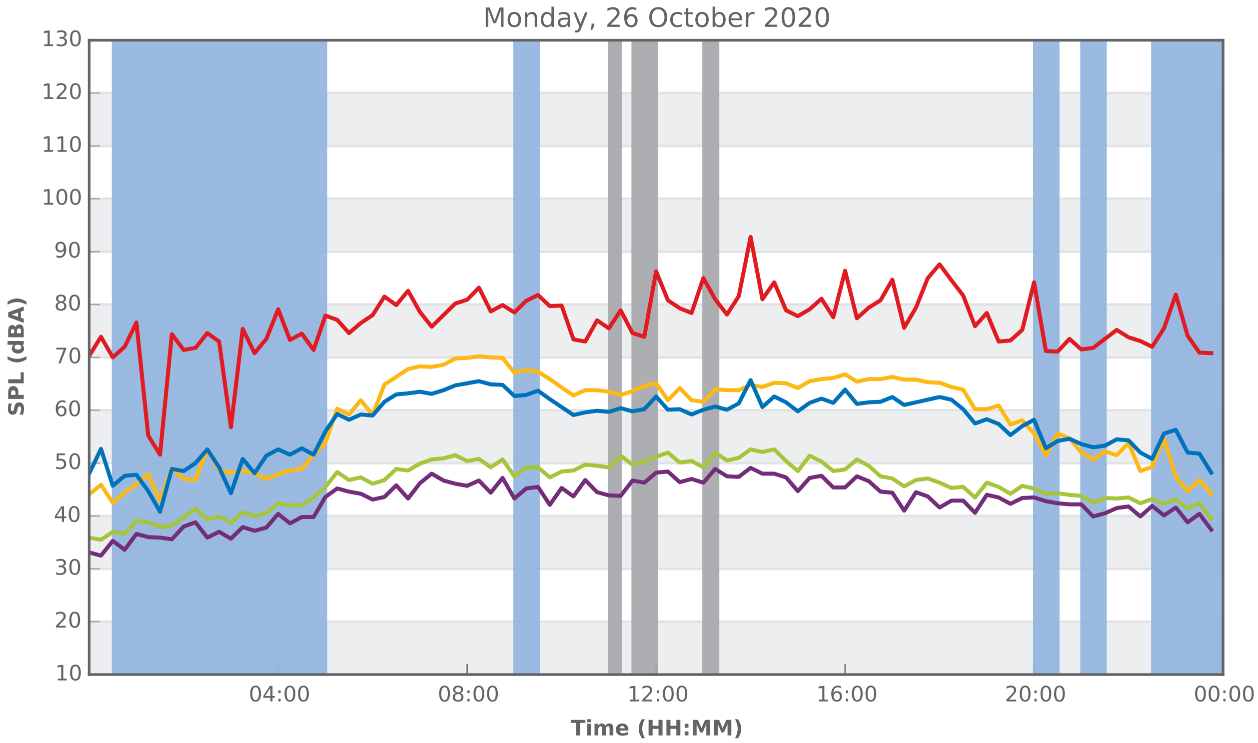

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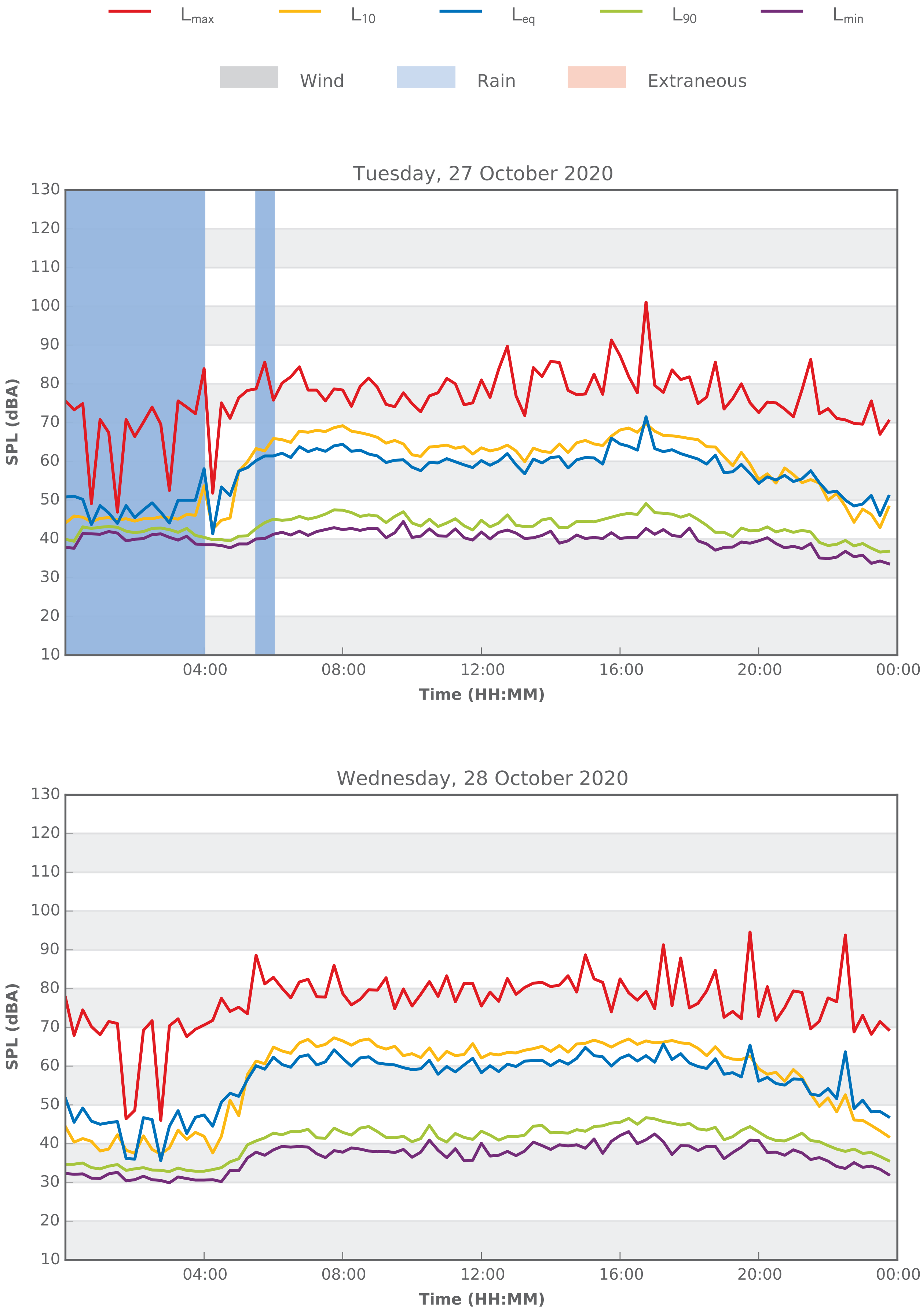

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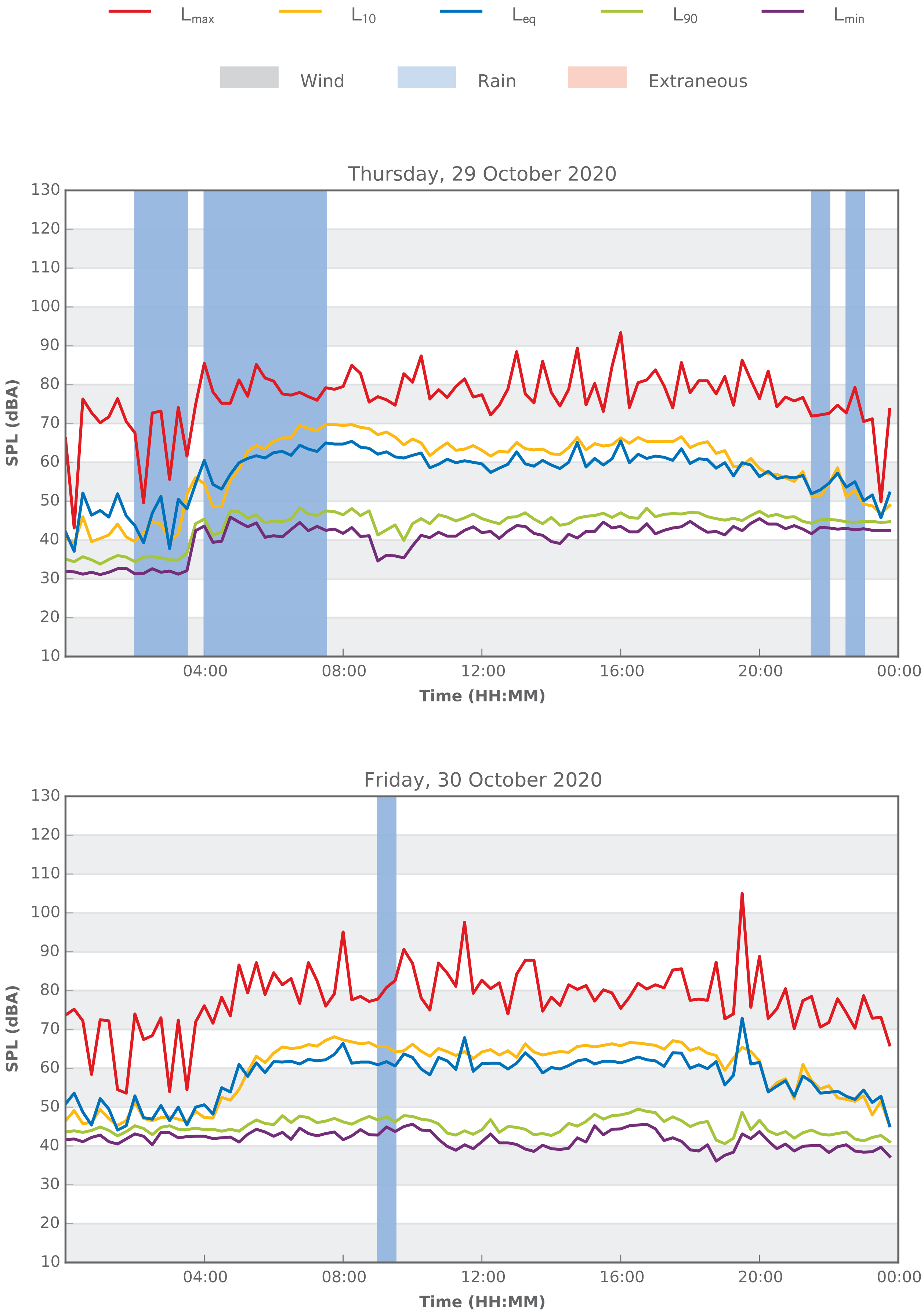

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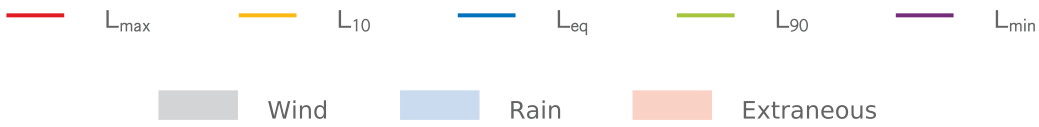

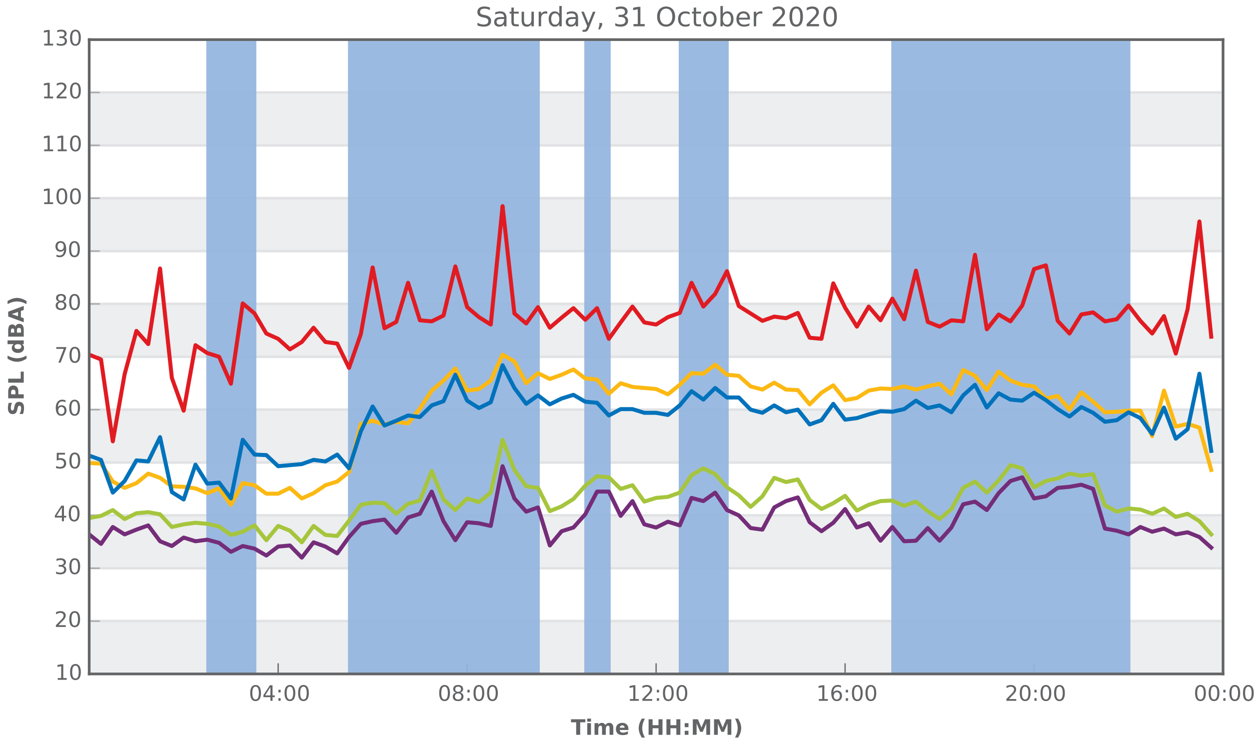

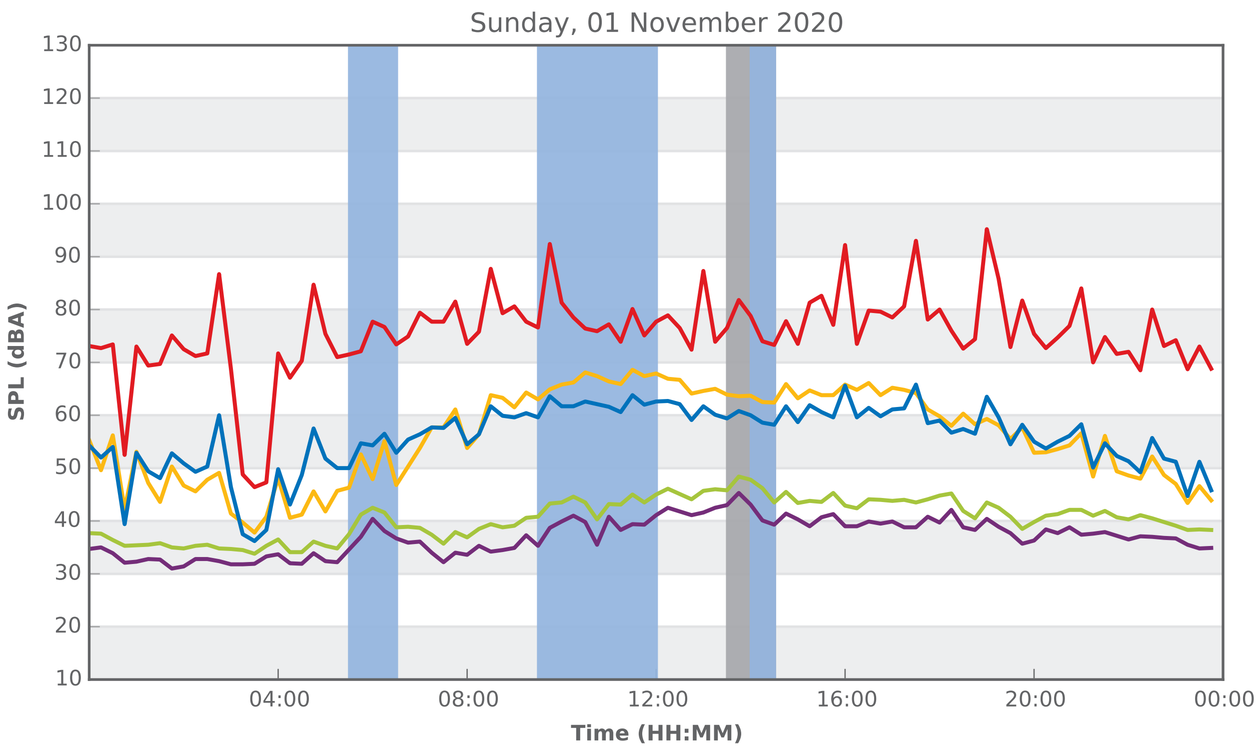

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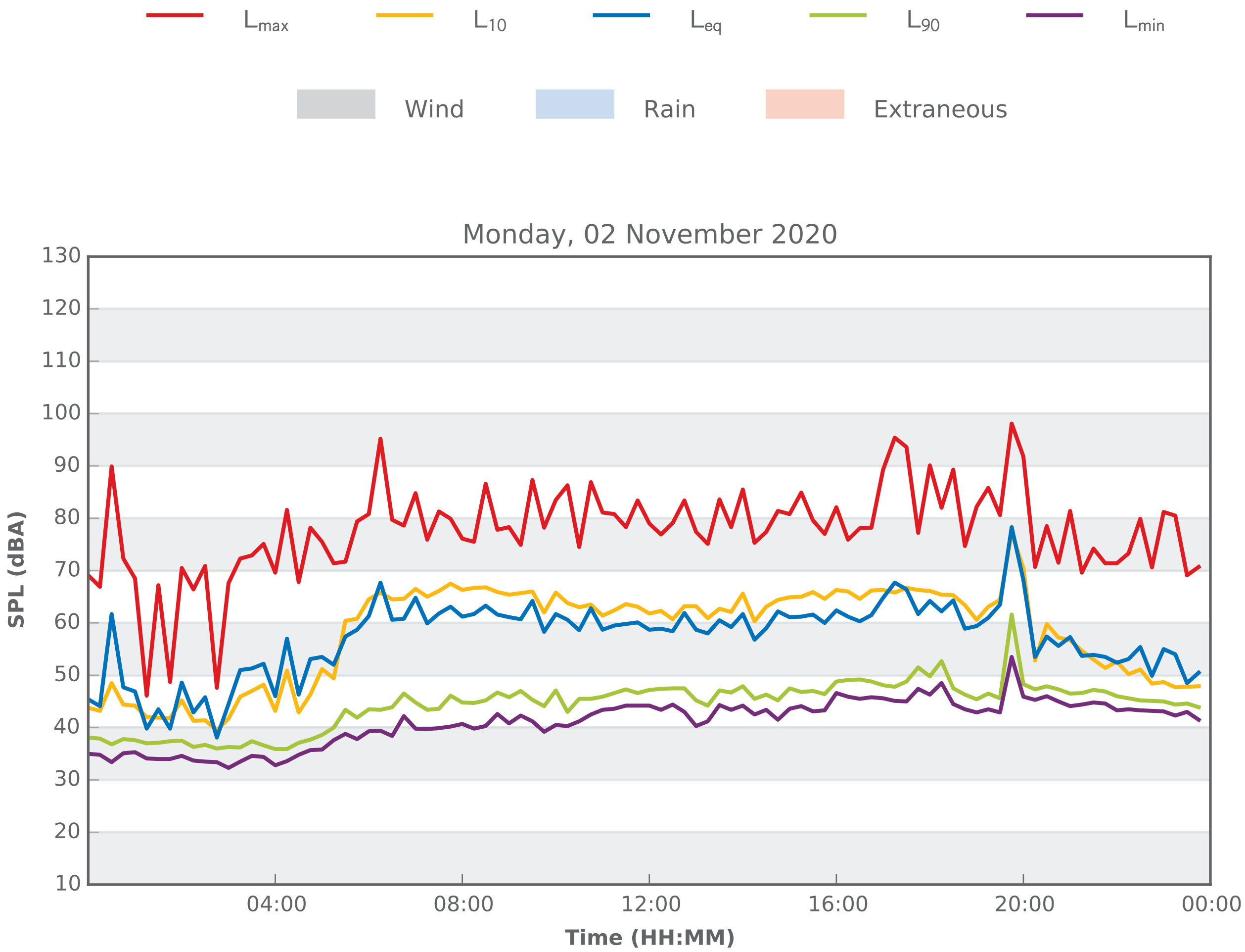

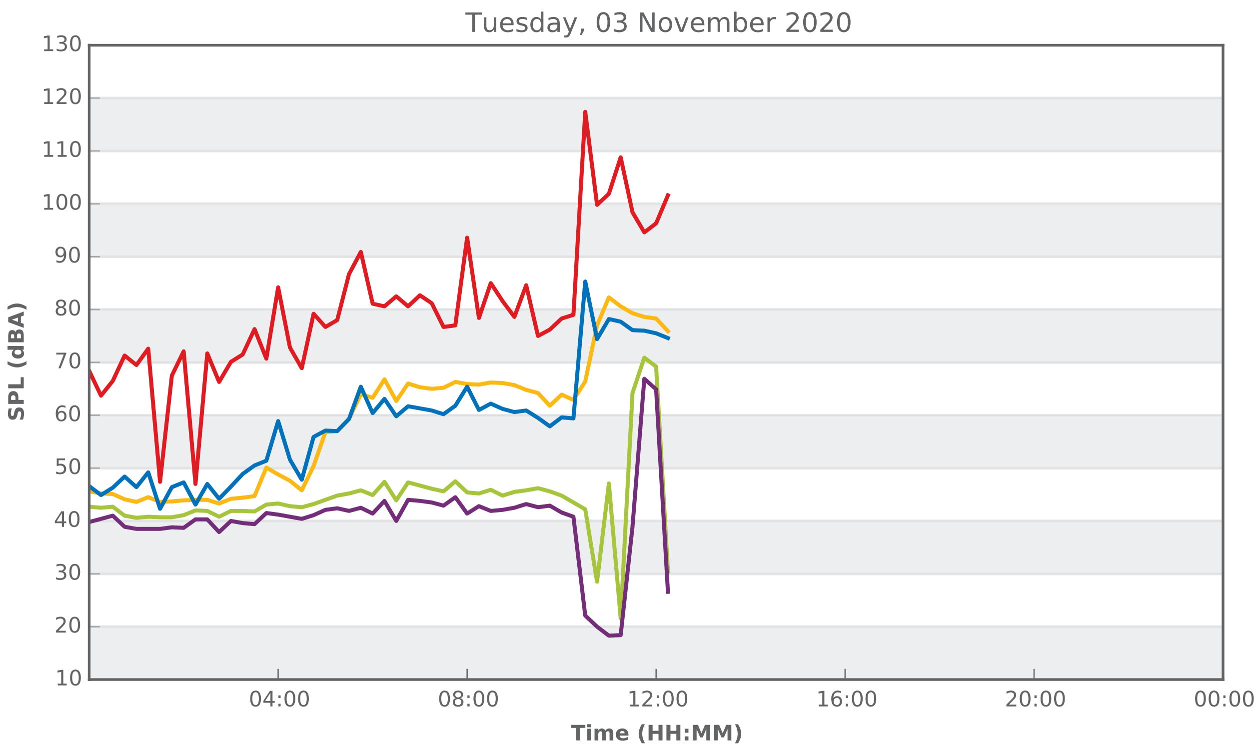

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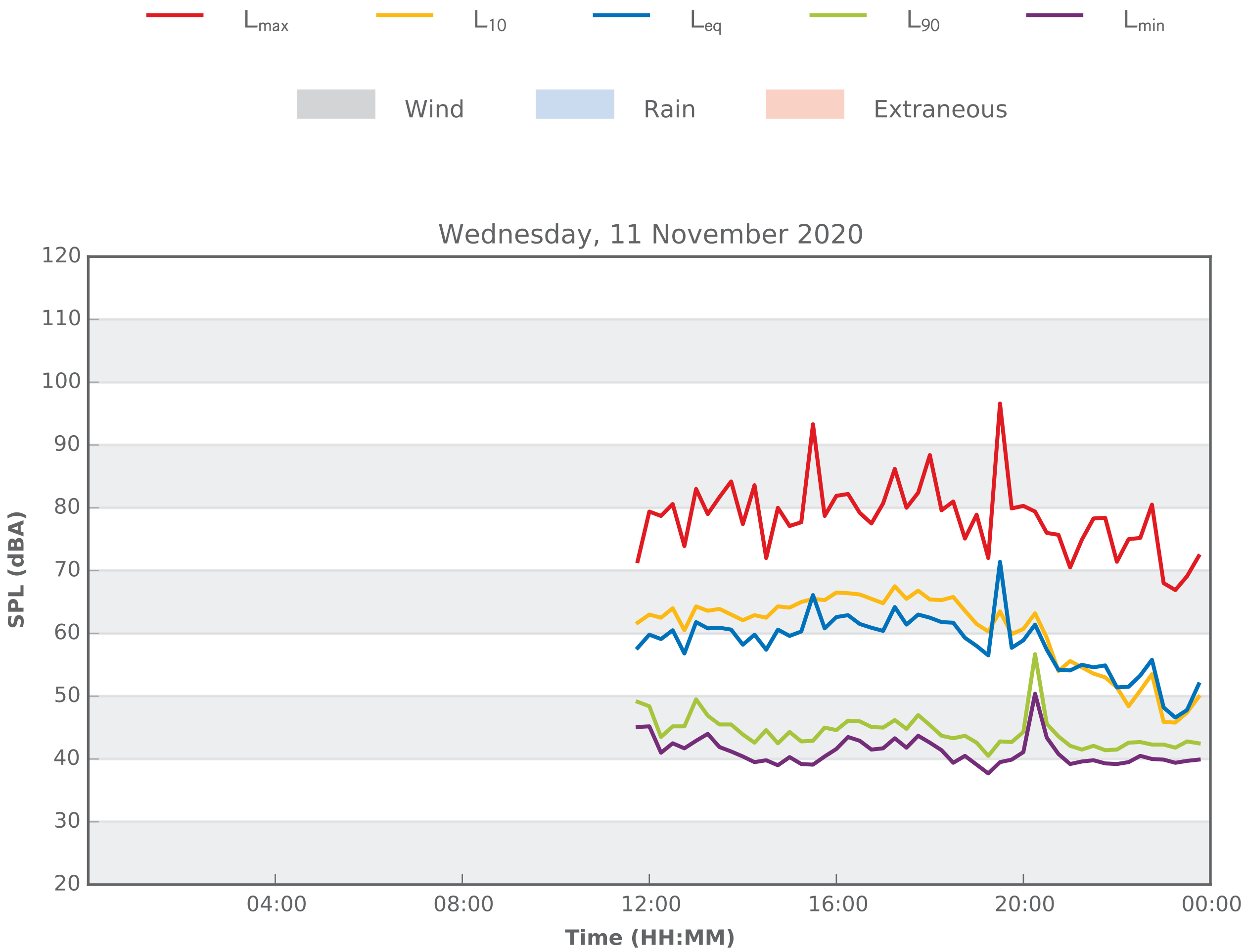
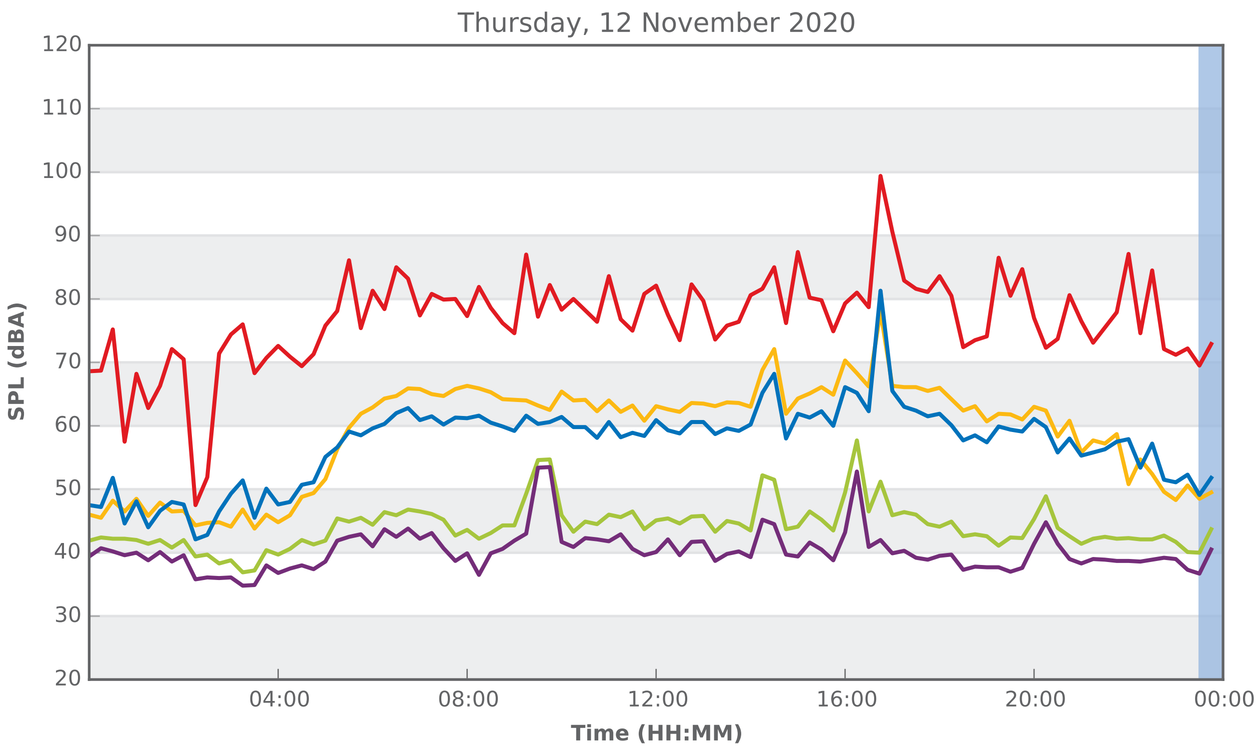
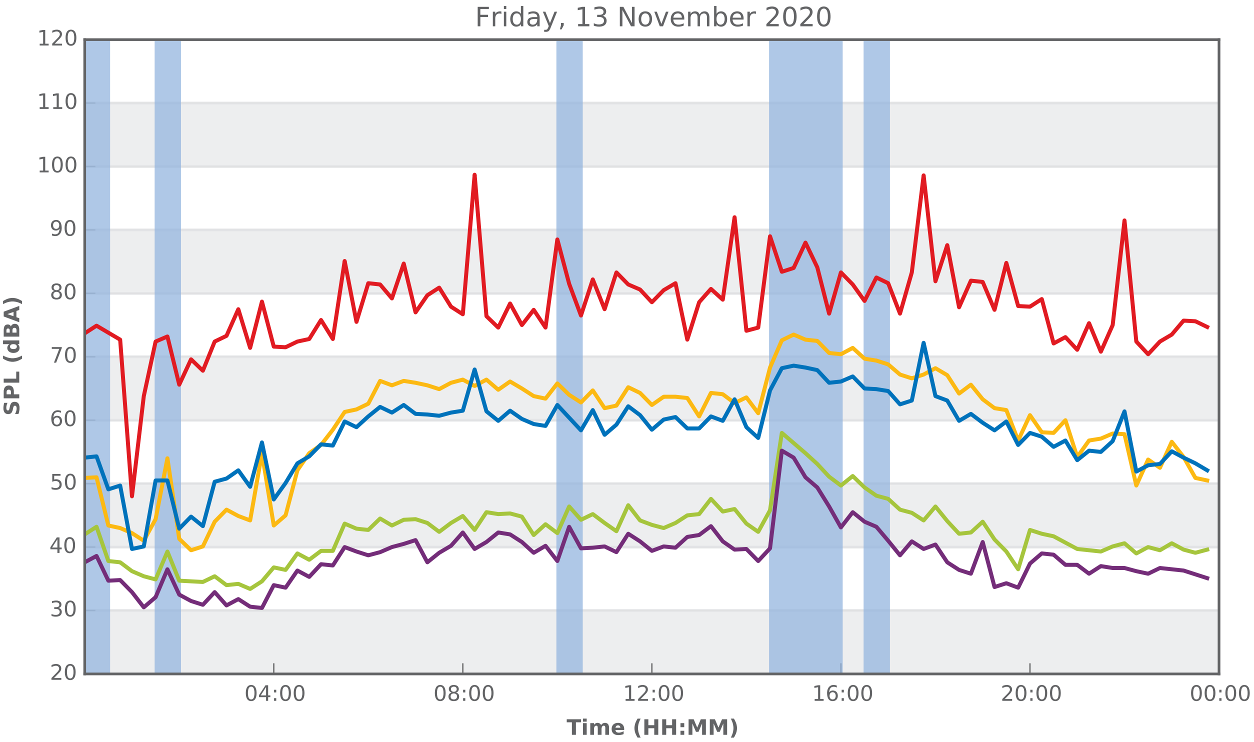


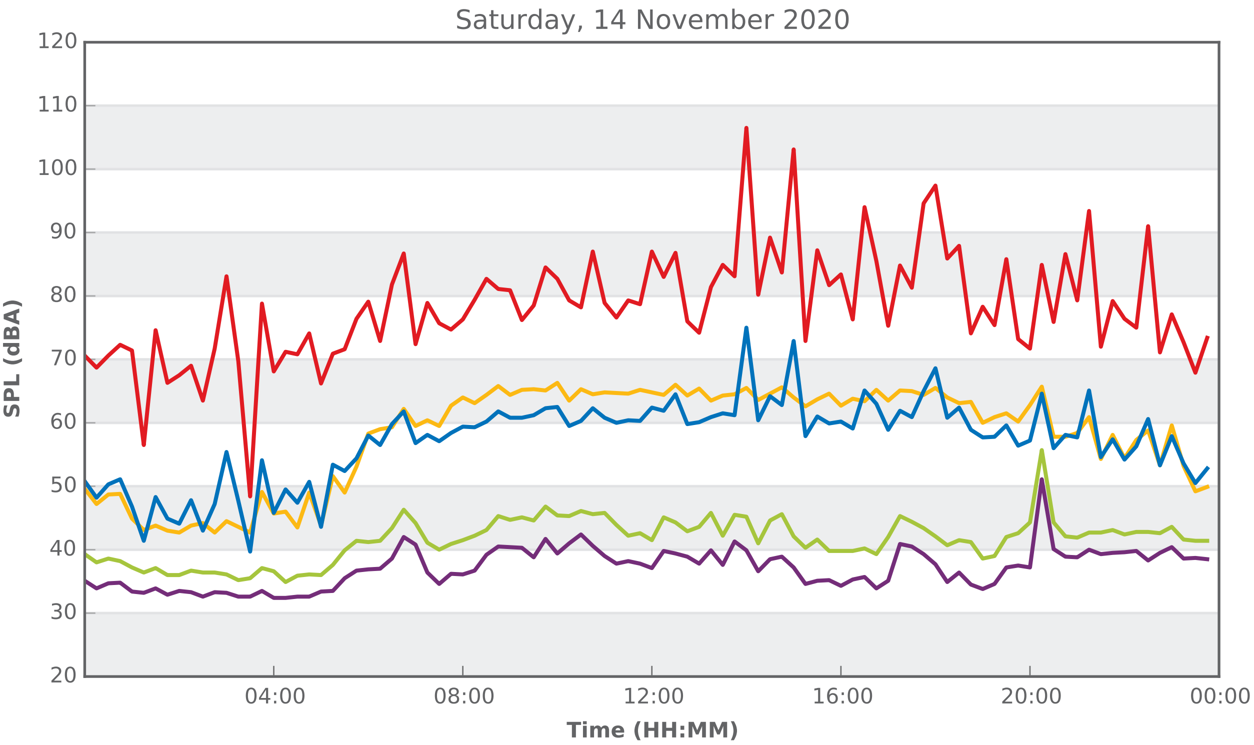


15 Finns Road, Menangle

L_{max} L_{10} L_{eq} L_{90} L_{min}

Wind Rain Extraneous





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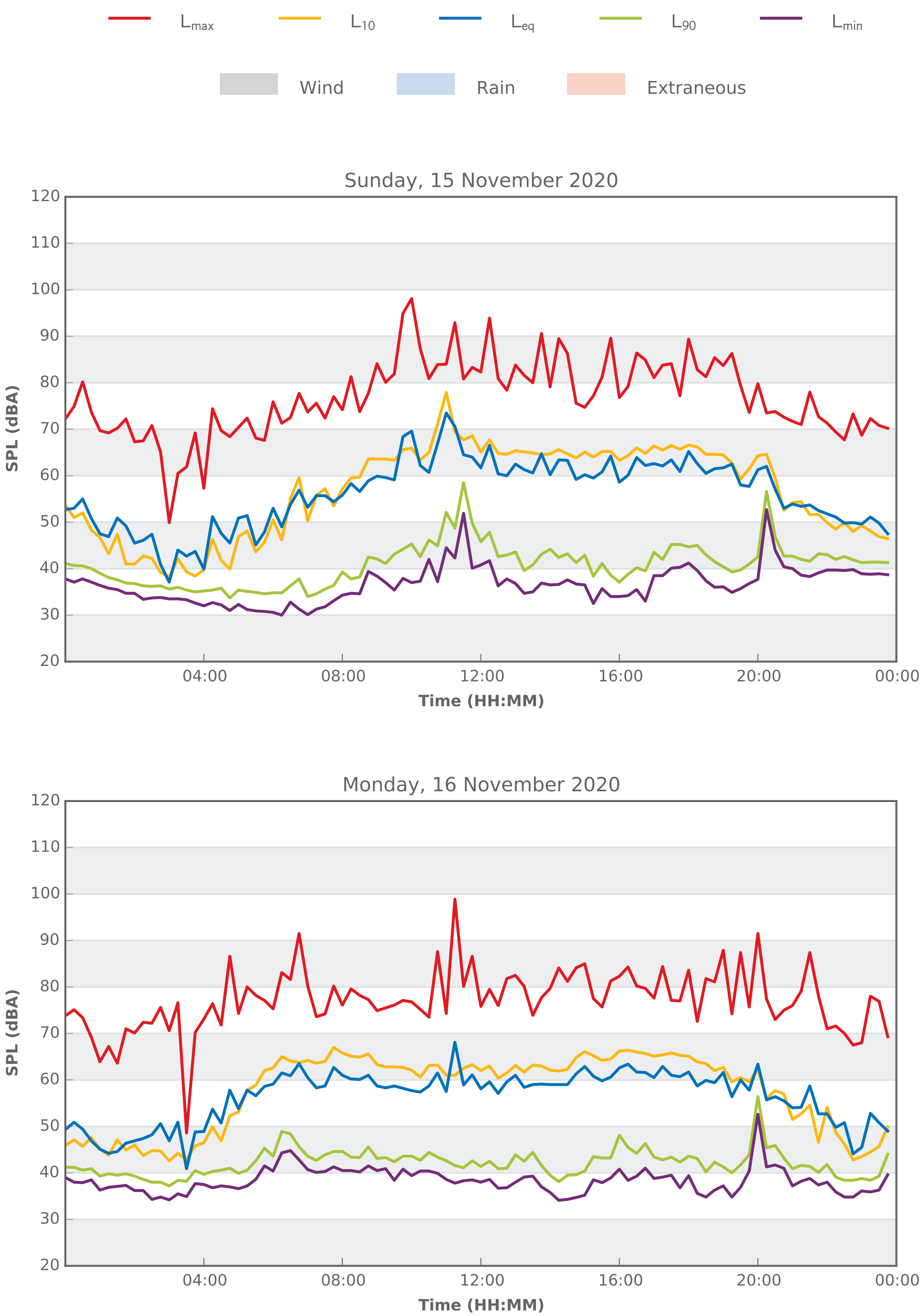
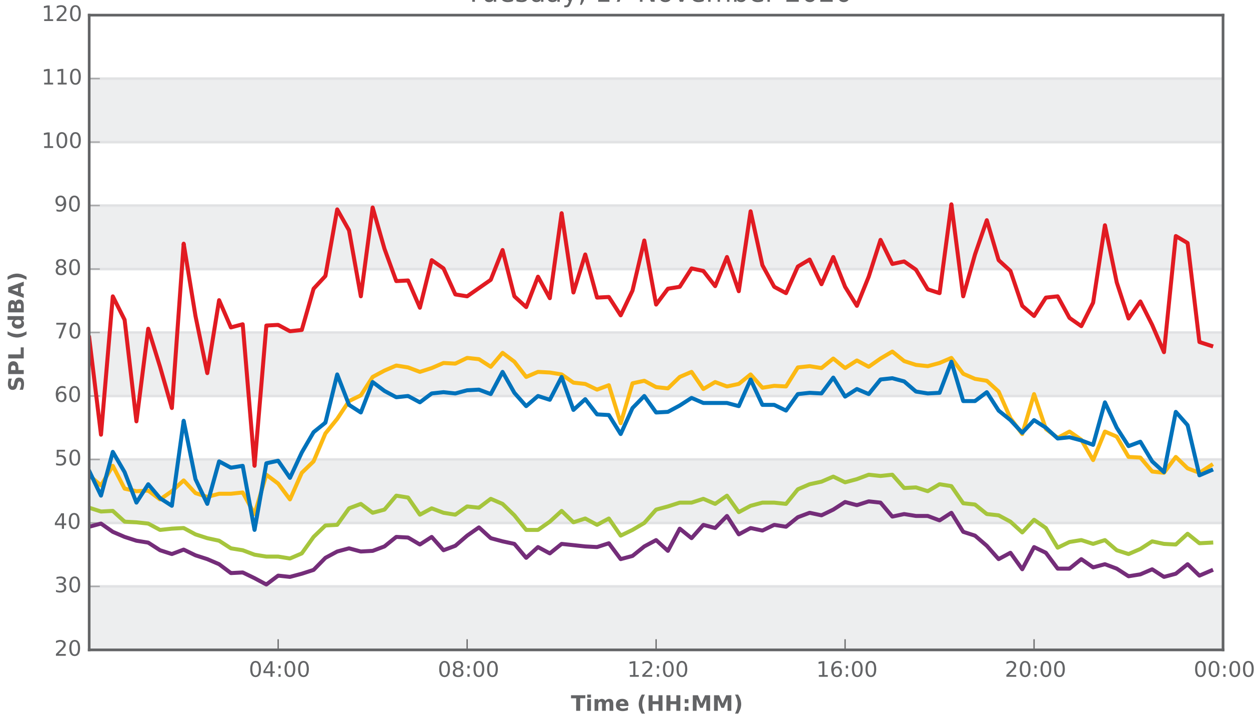


15 Finns Road, Menangle

Tuesday, 17 November 2020



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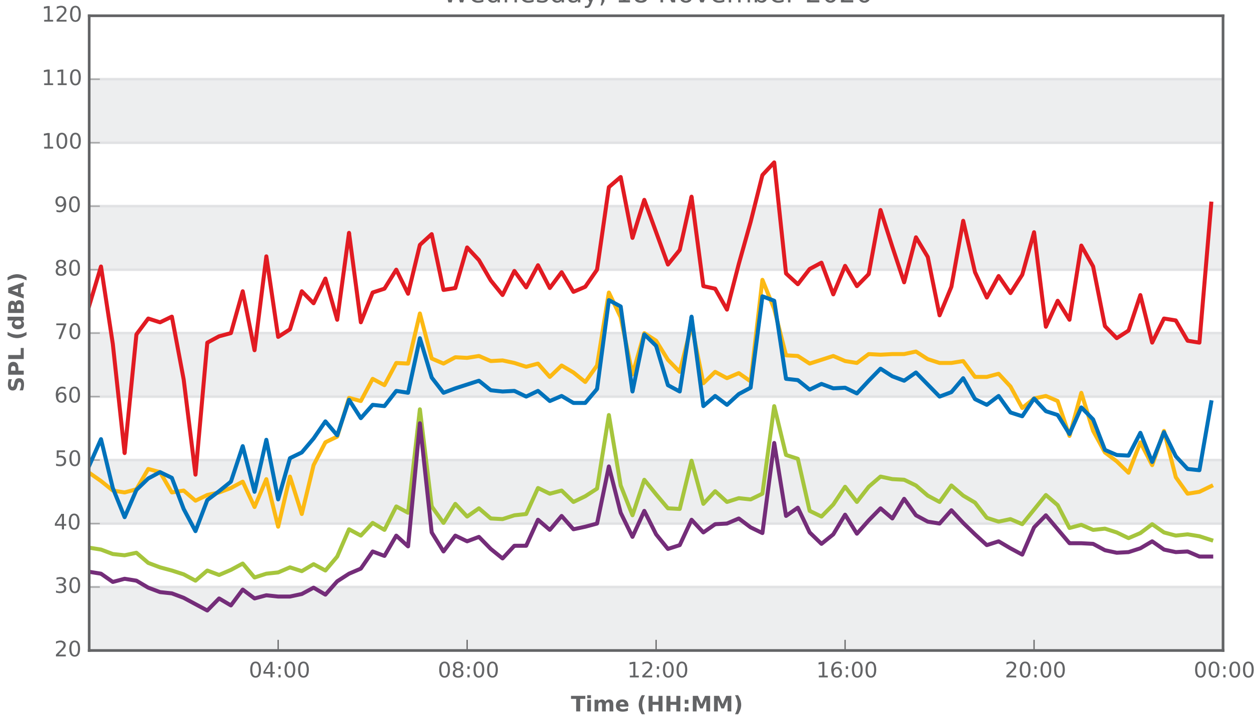

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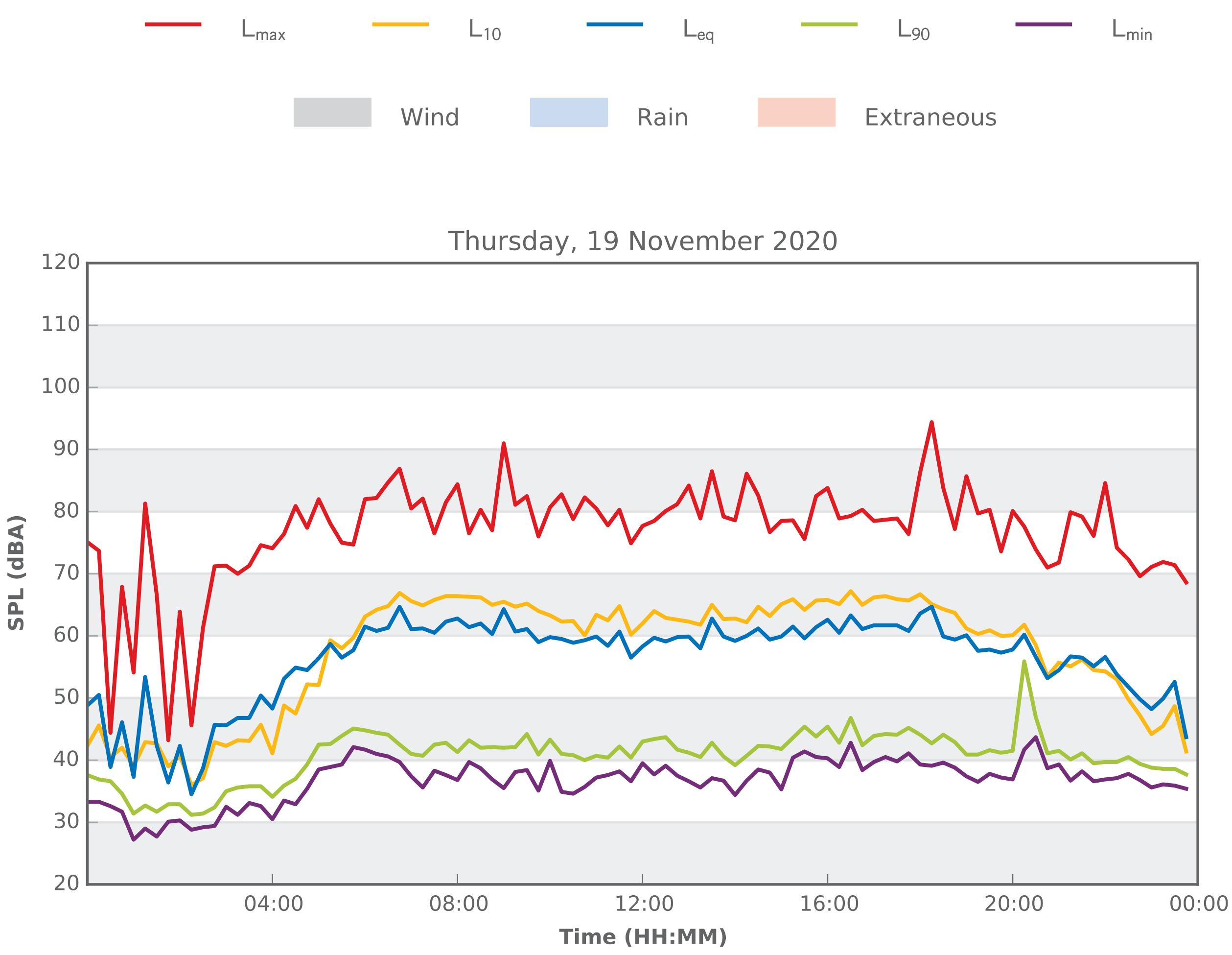

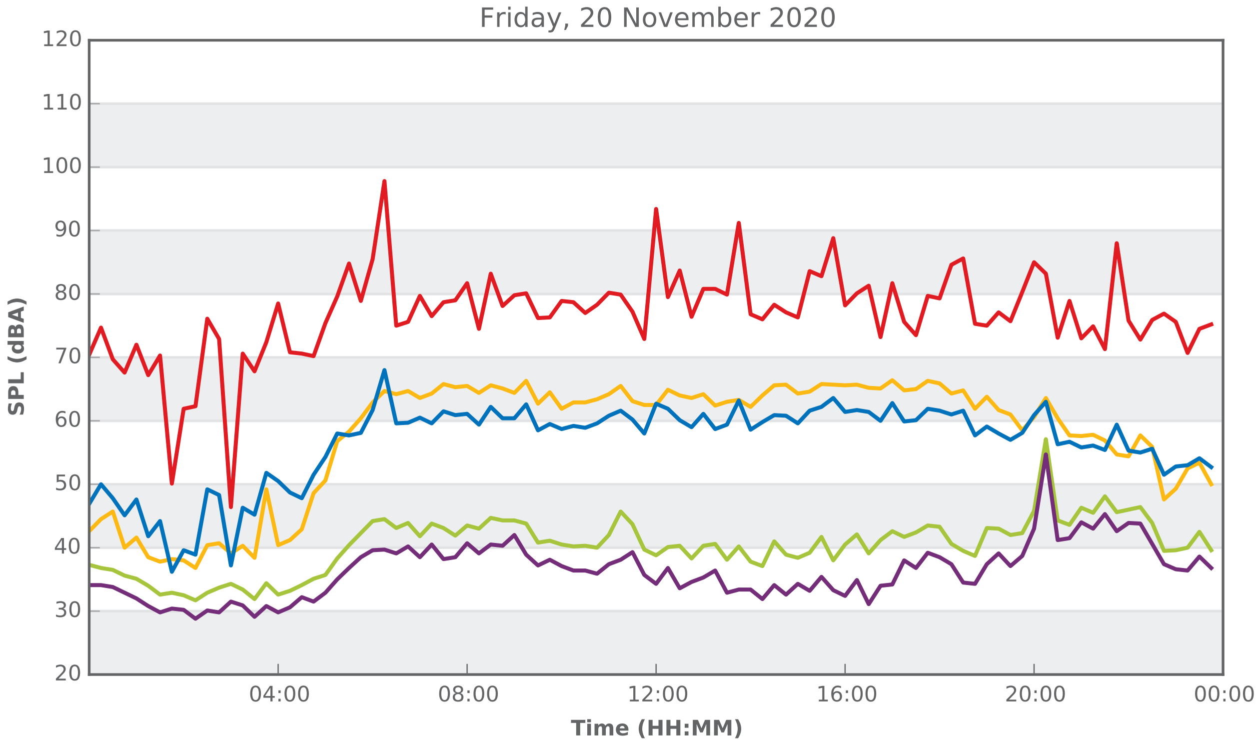

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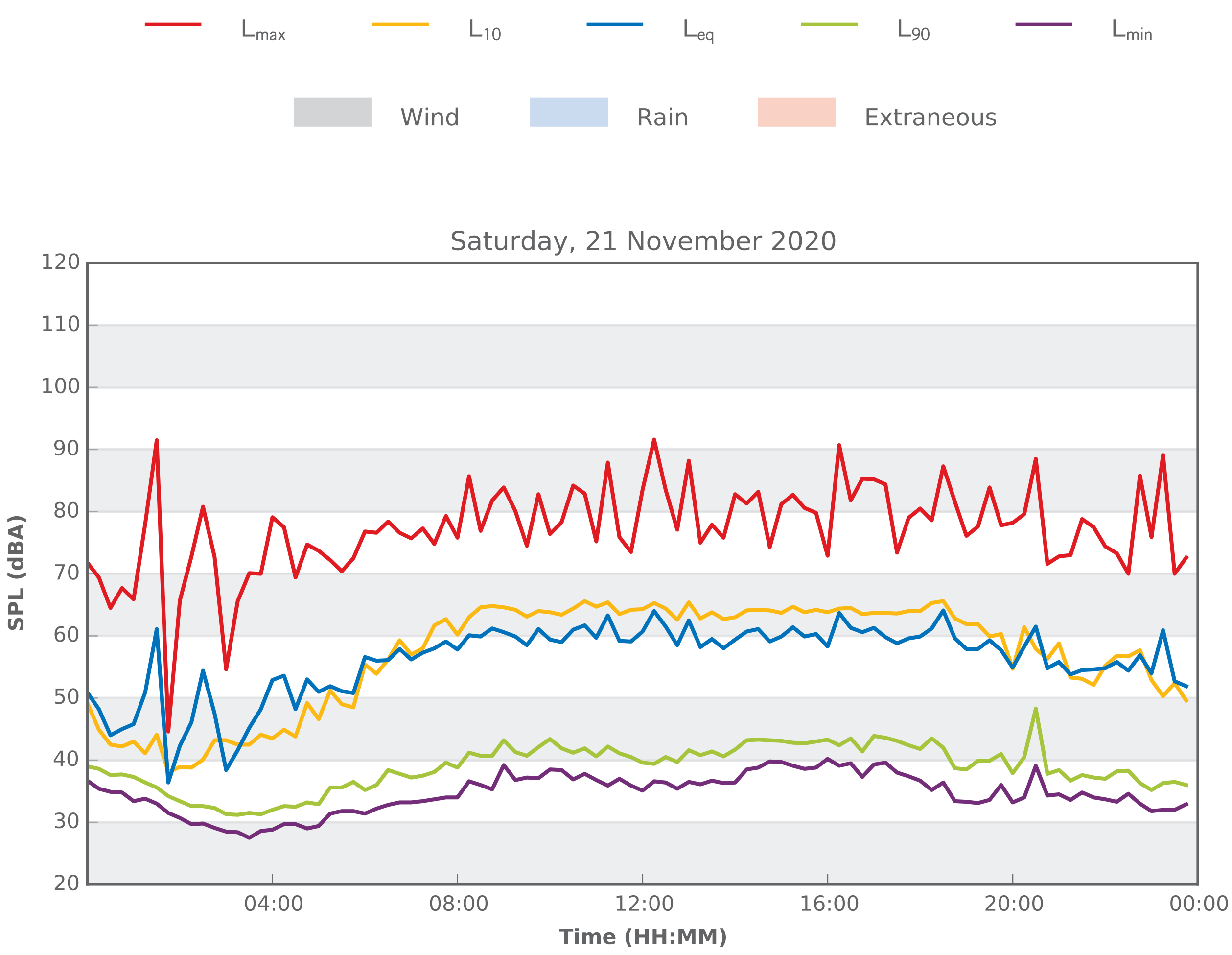

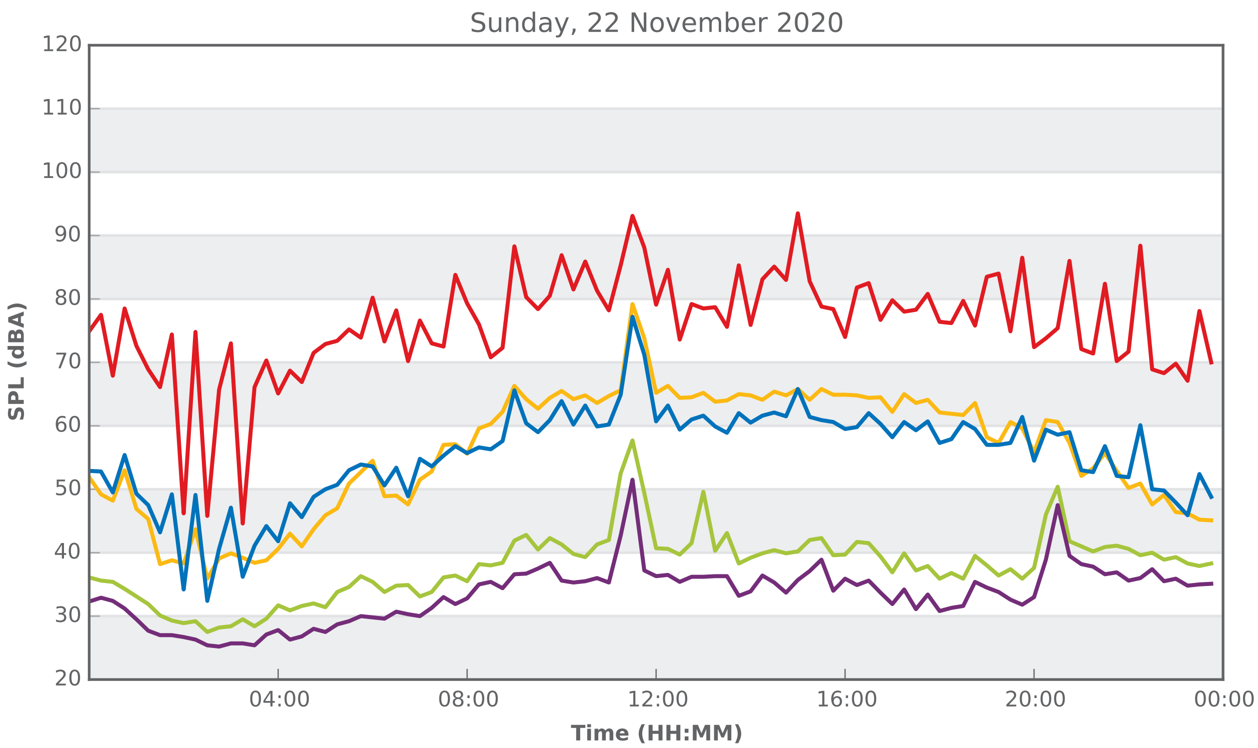

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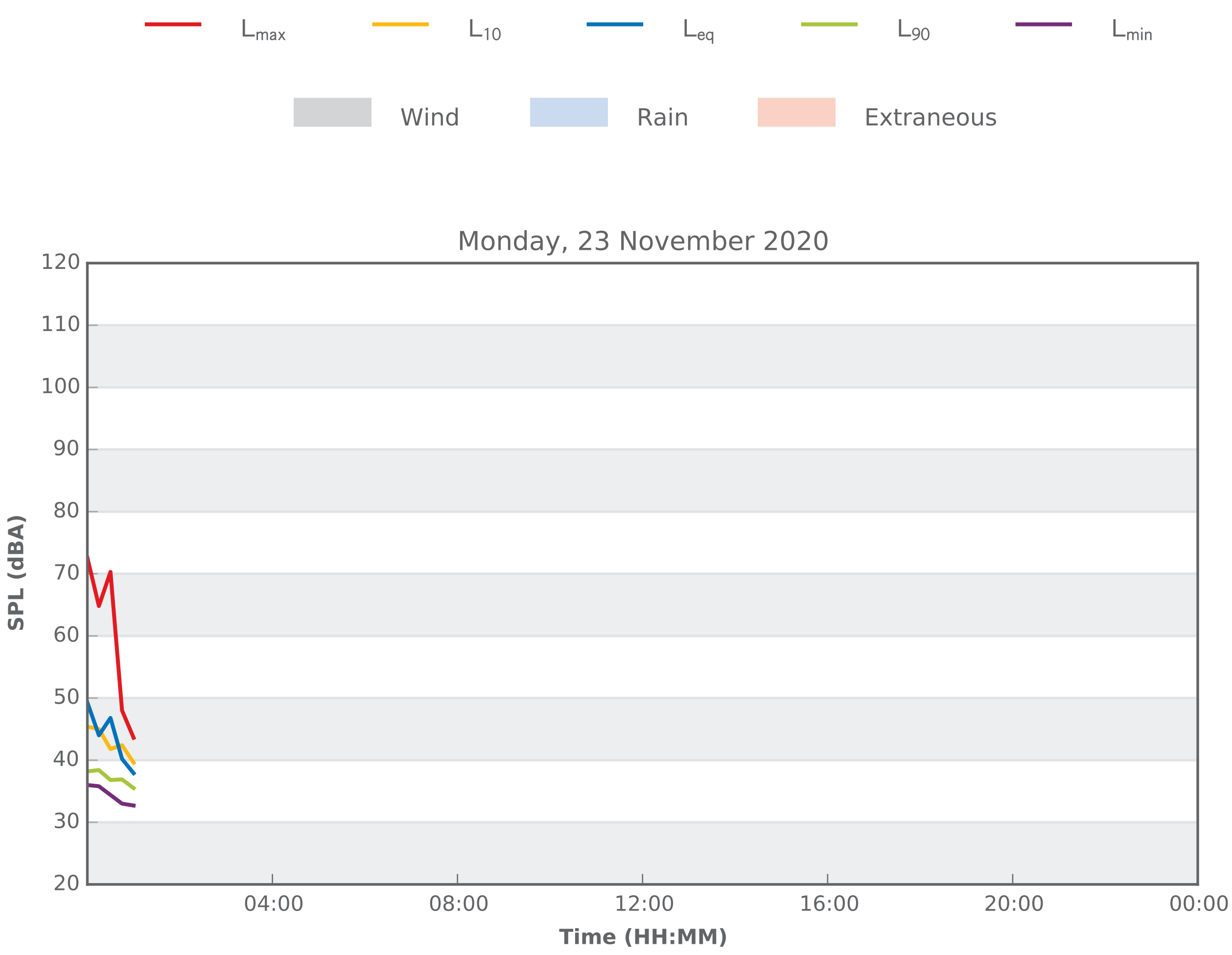
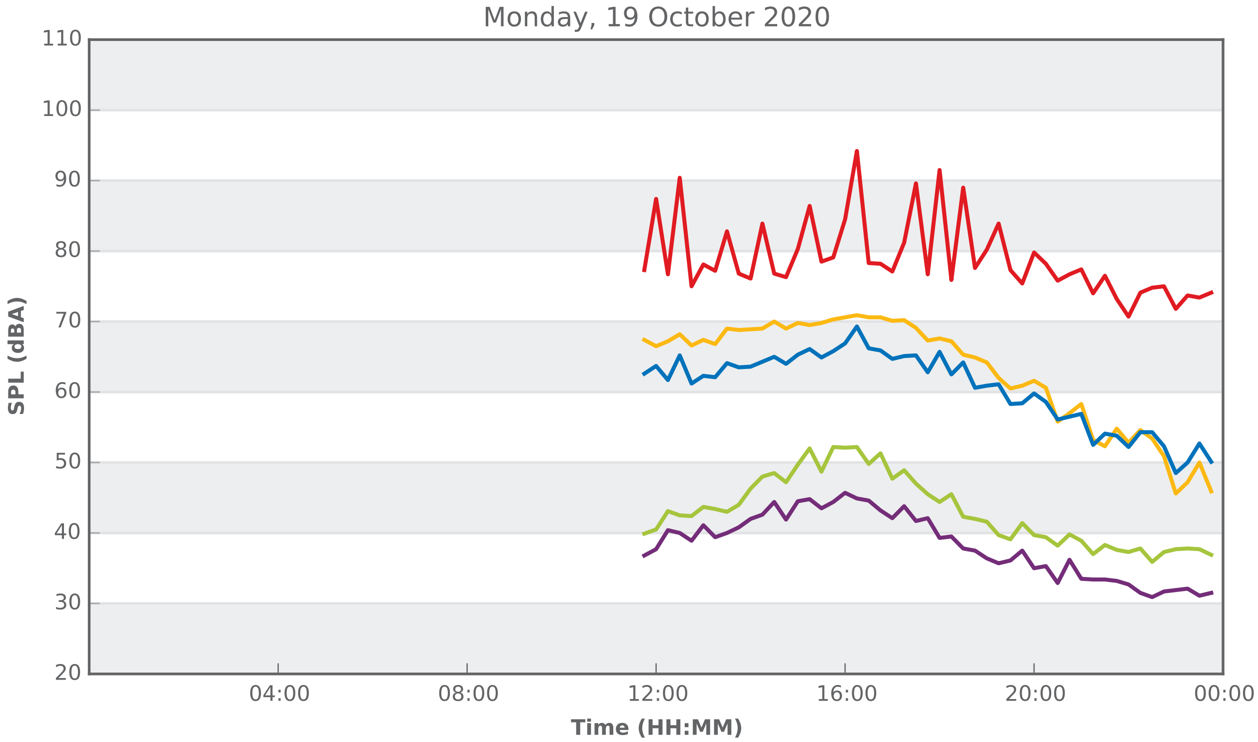
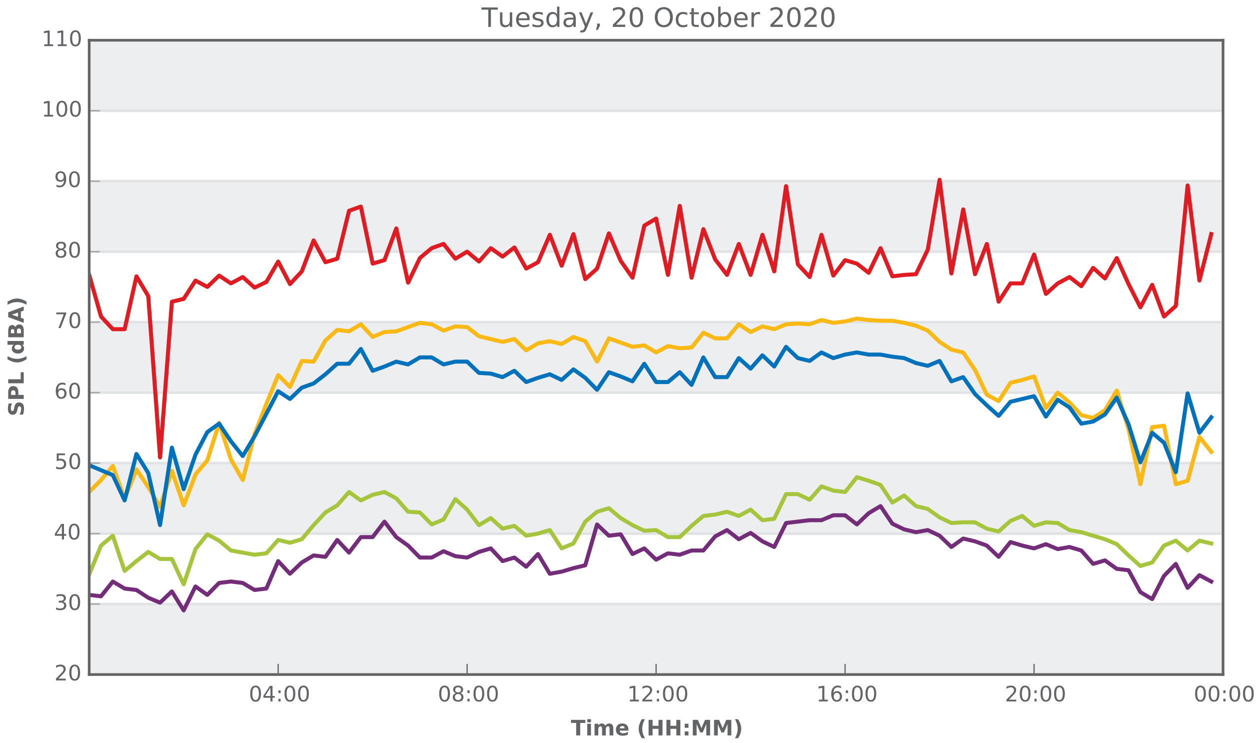


436 Menangle Road, Menangle

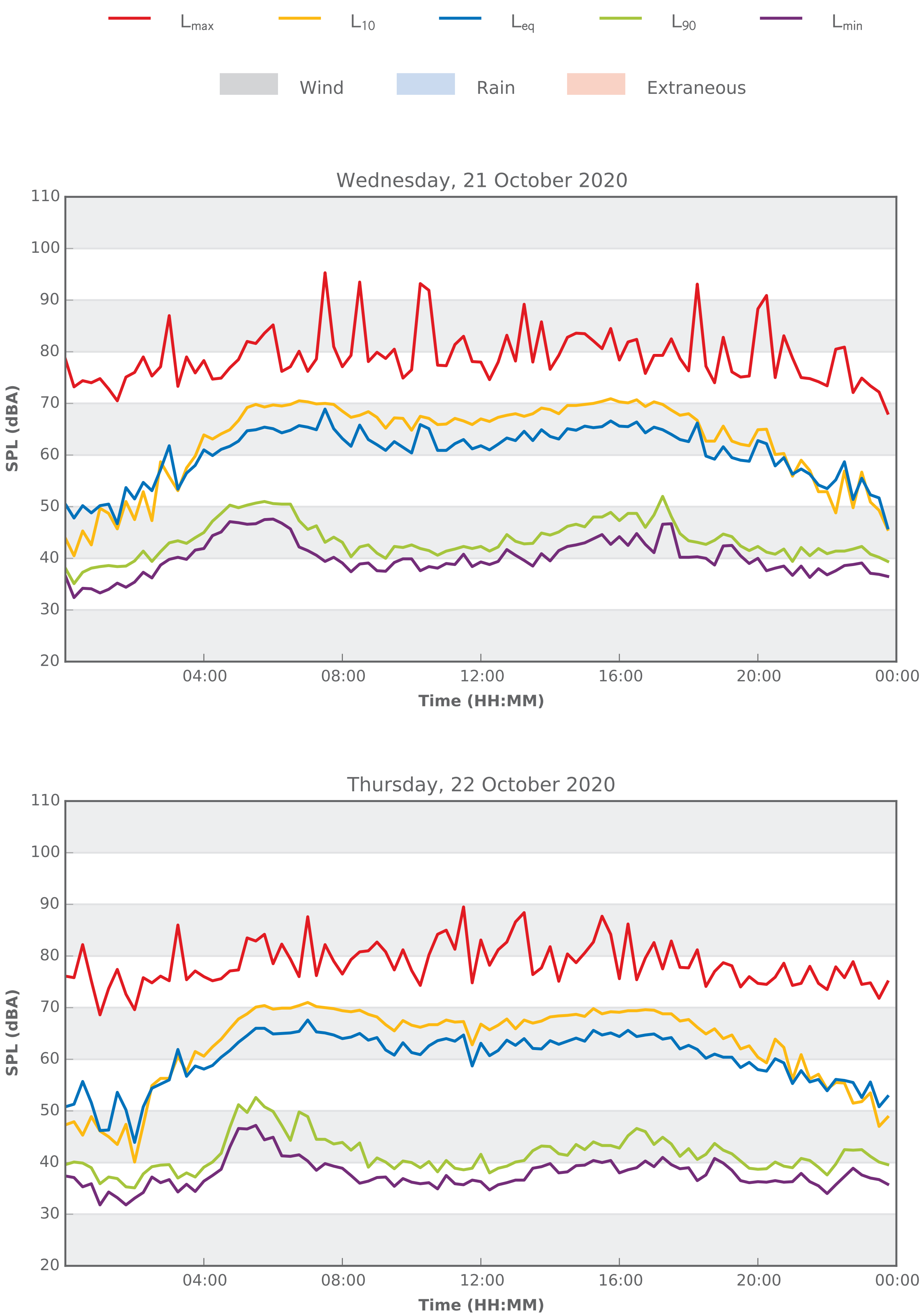
Lmax — L10 — Leq — L90 — Lmin

Wind — Rain — Extraneous





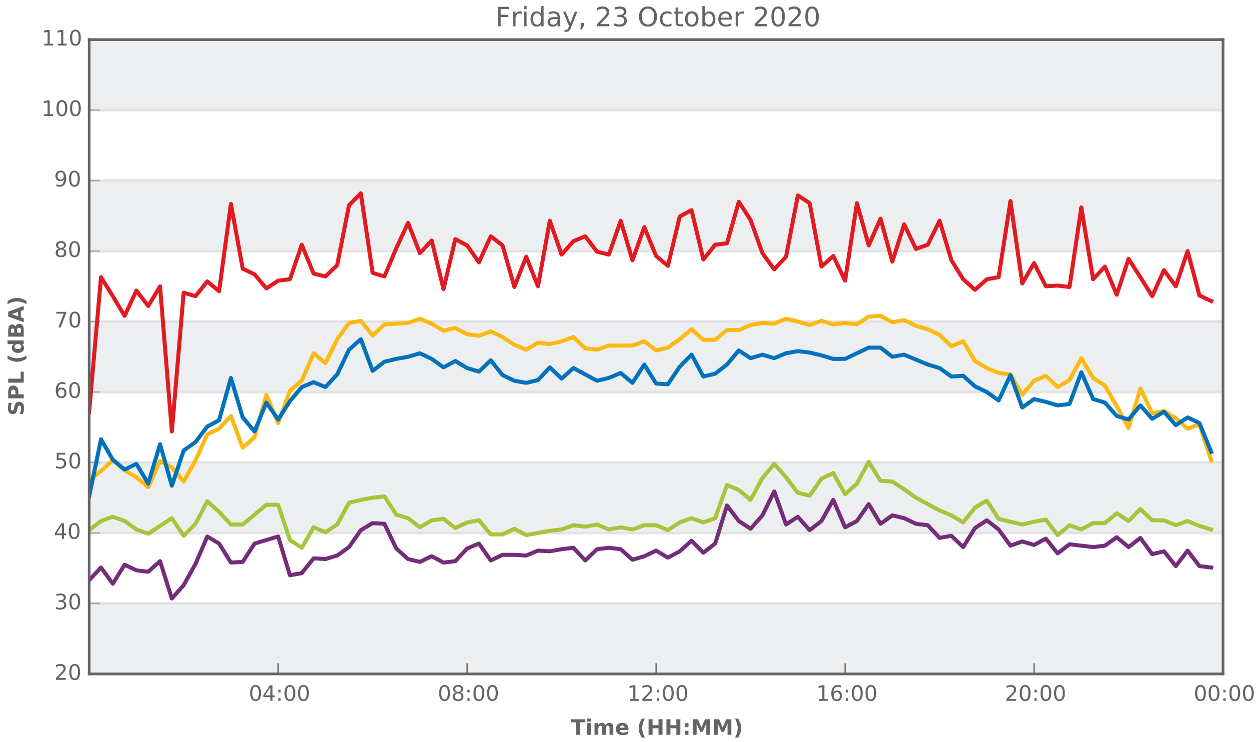
436 Menangle Road, Menangle

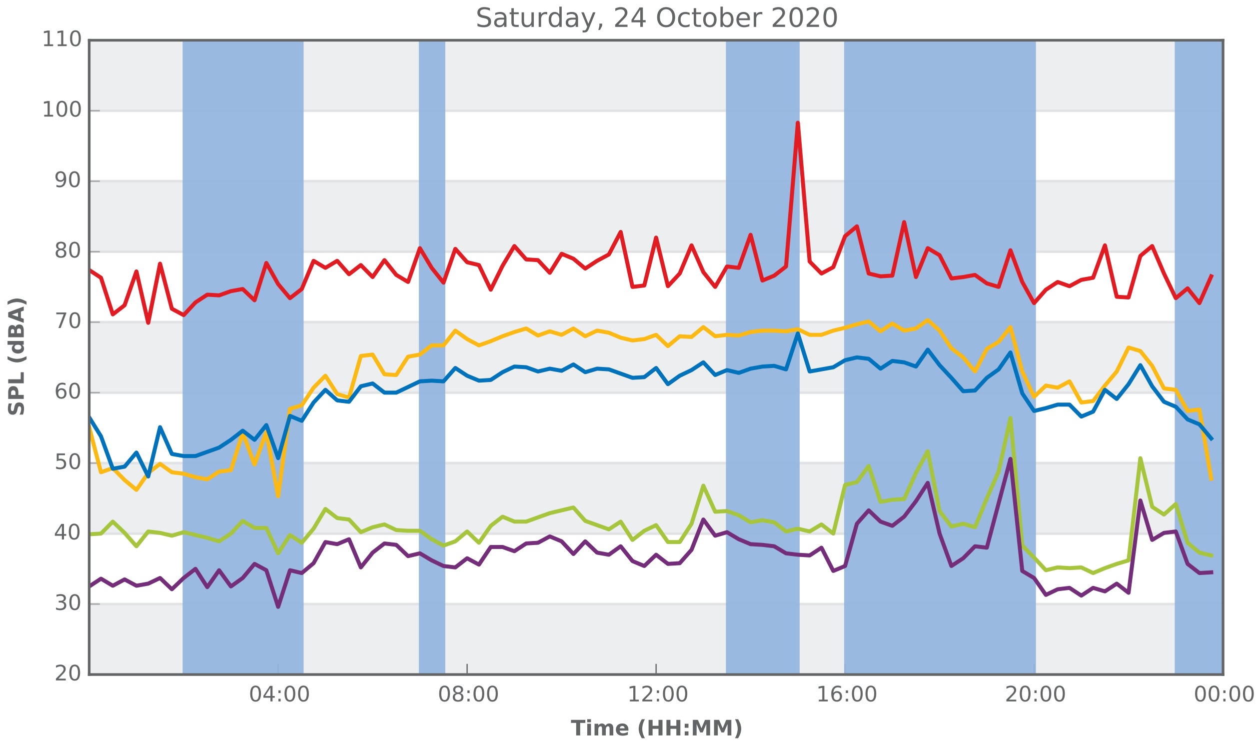


436 Menangle Road, Menangle

L_{max} L_{10} L_{eq} L_{90} L_{min}

Wind Rain Extraneous

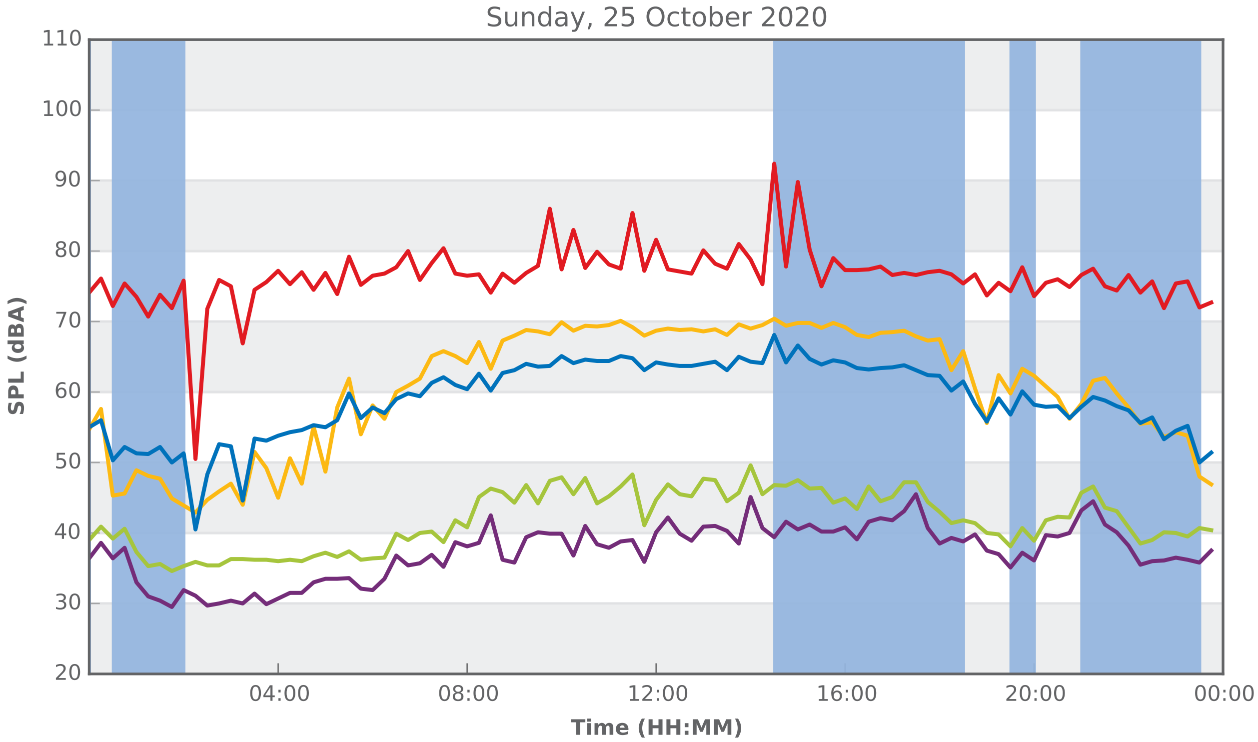


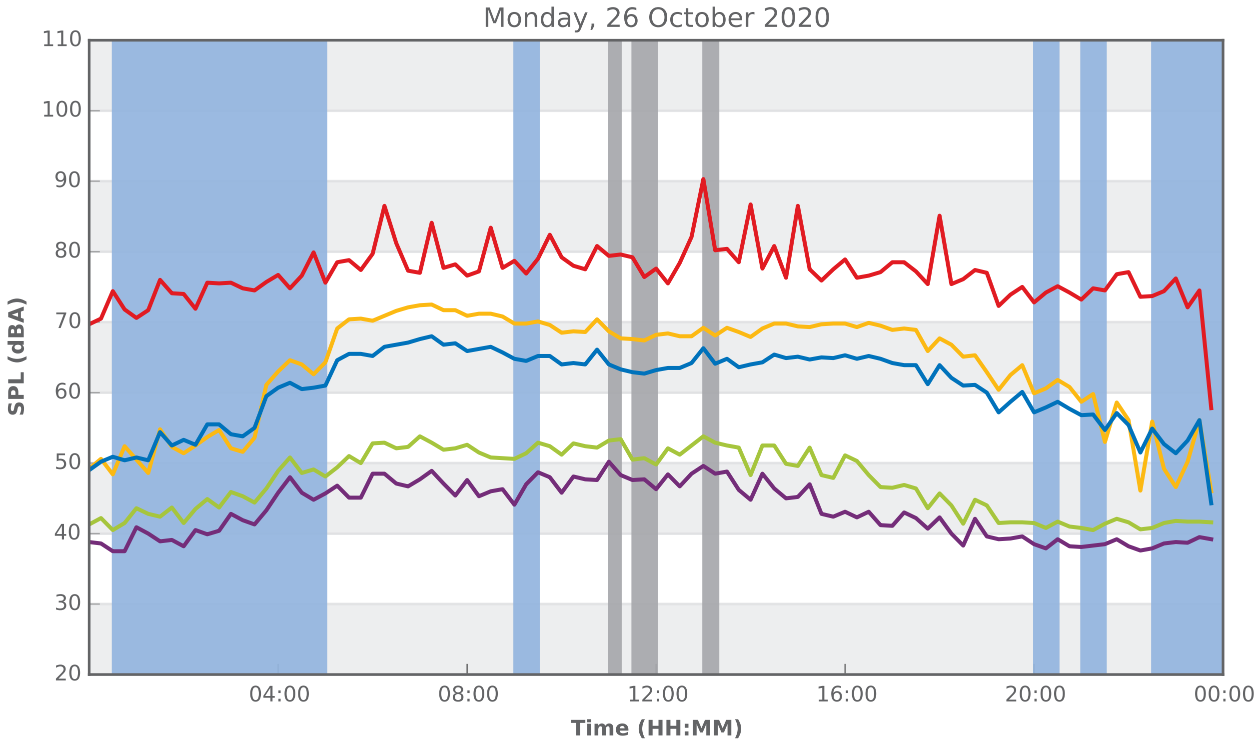


436 Menangle Road, Menangle

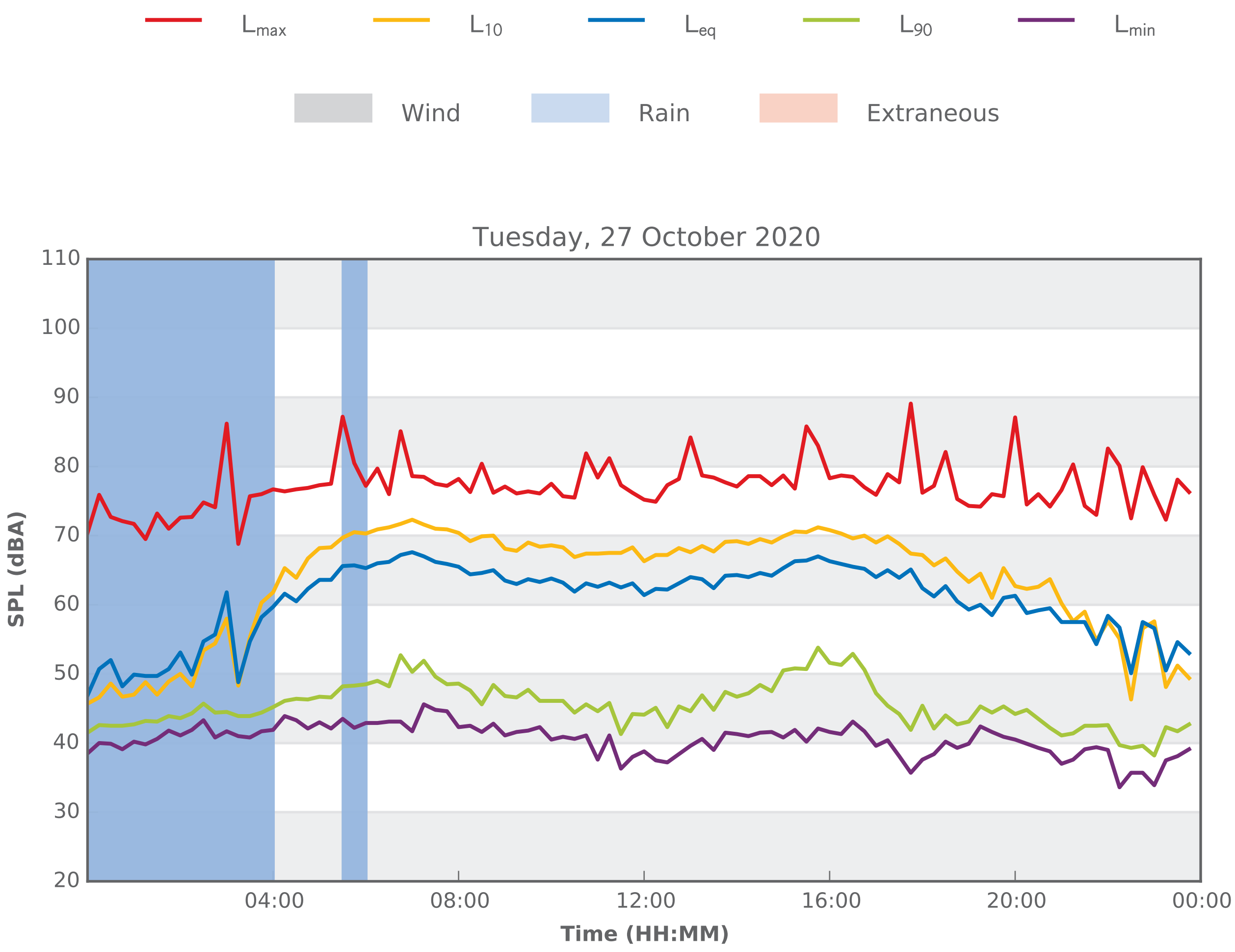
Lmax L10 Leq L90 Lmin

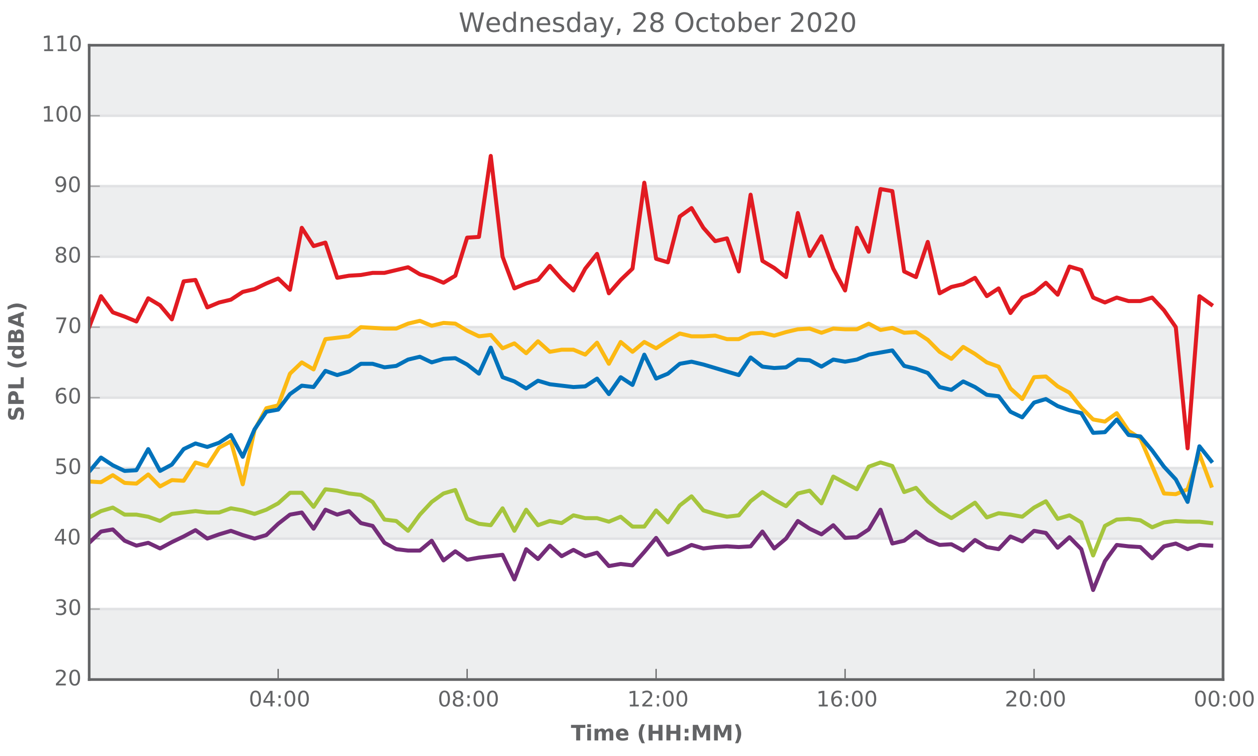
Wind Rain Extraneous



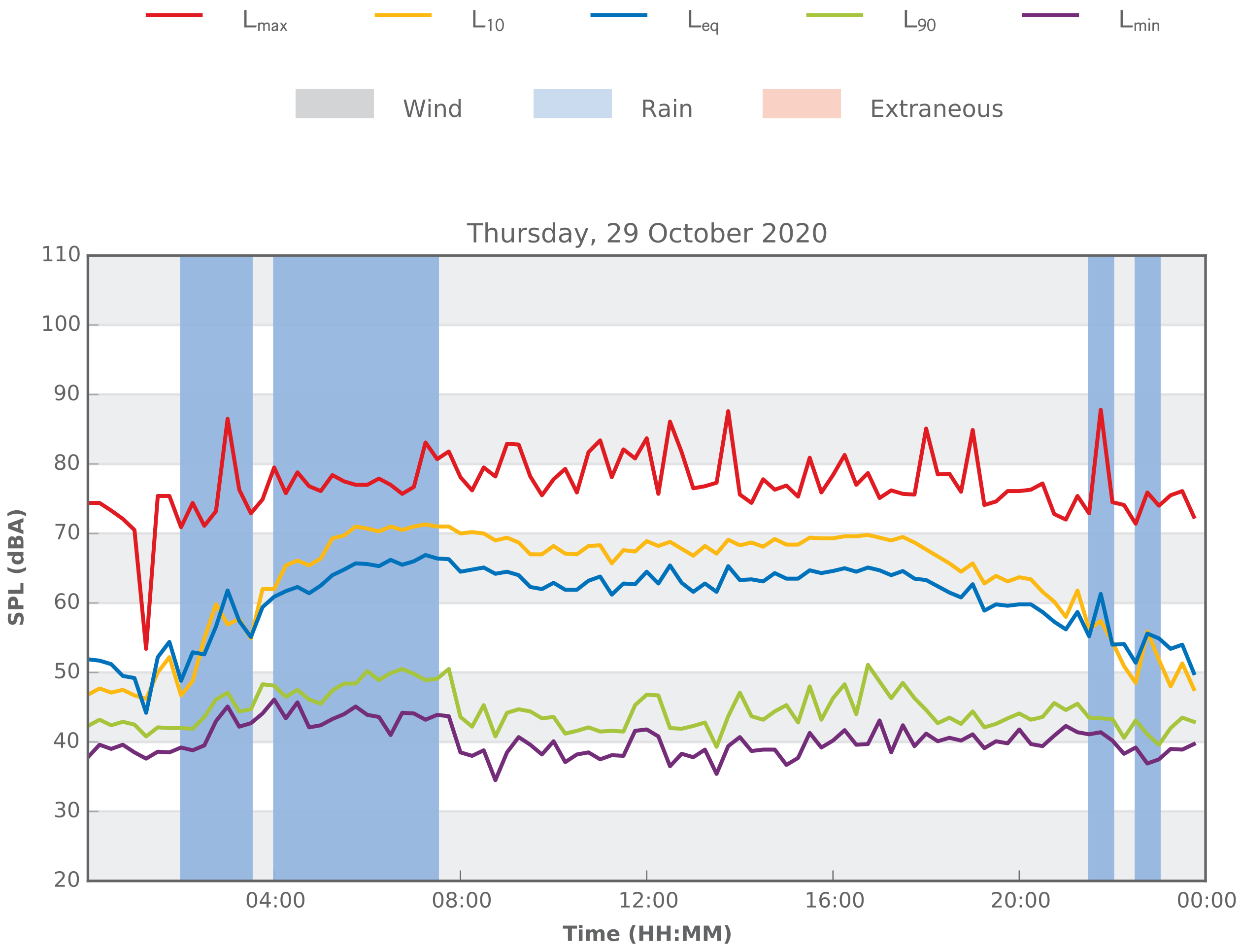


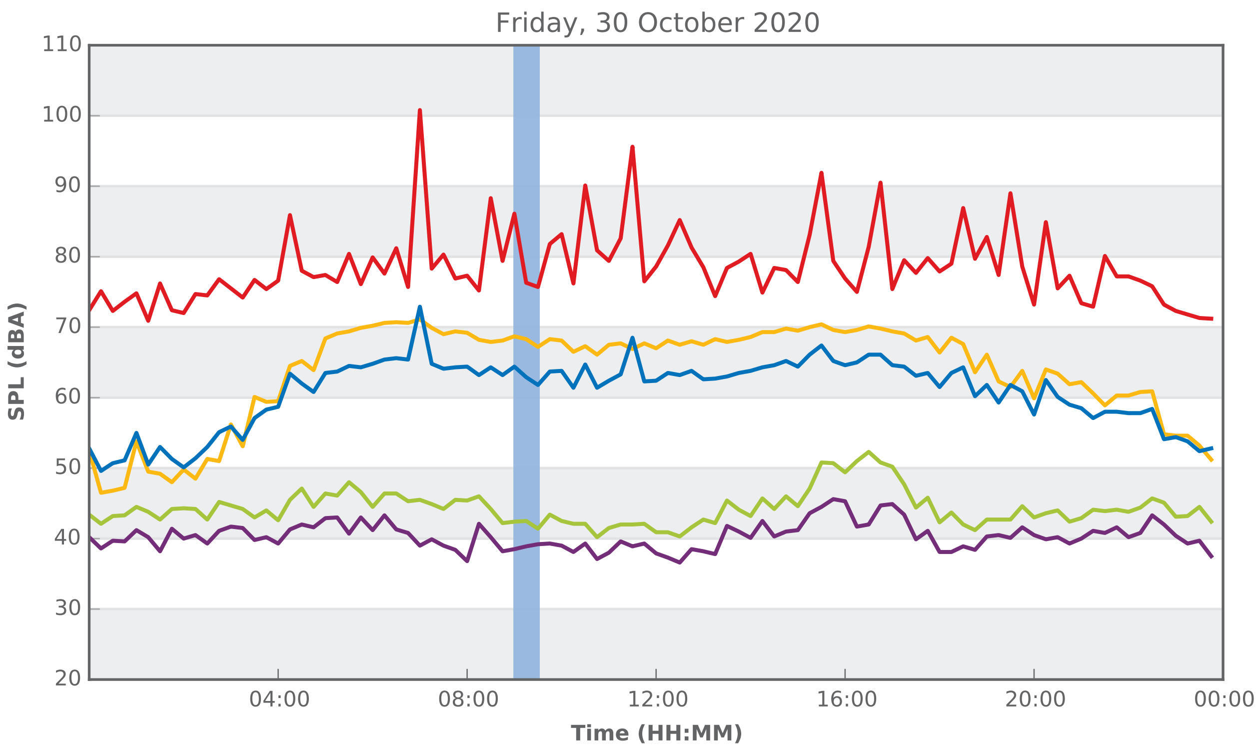
436 Menangle Road, Menangle



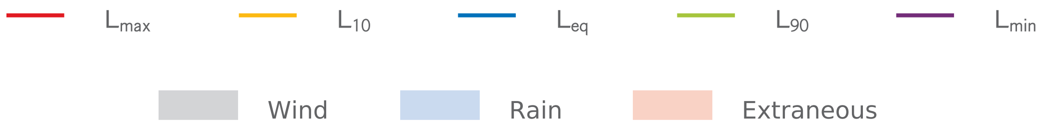


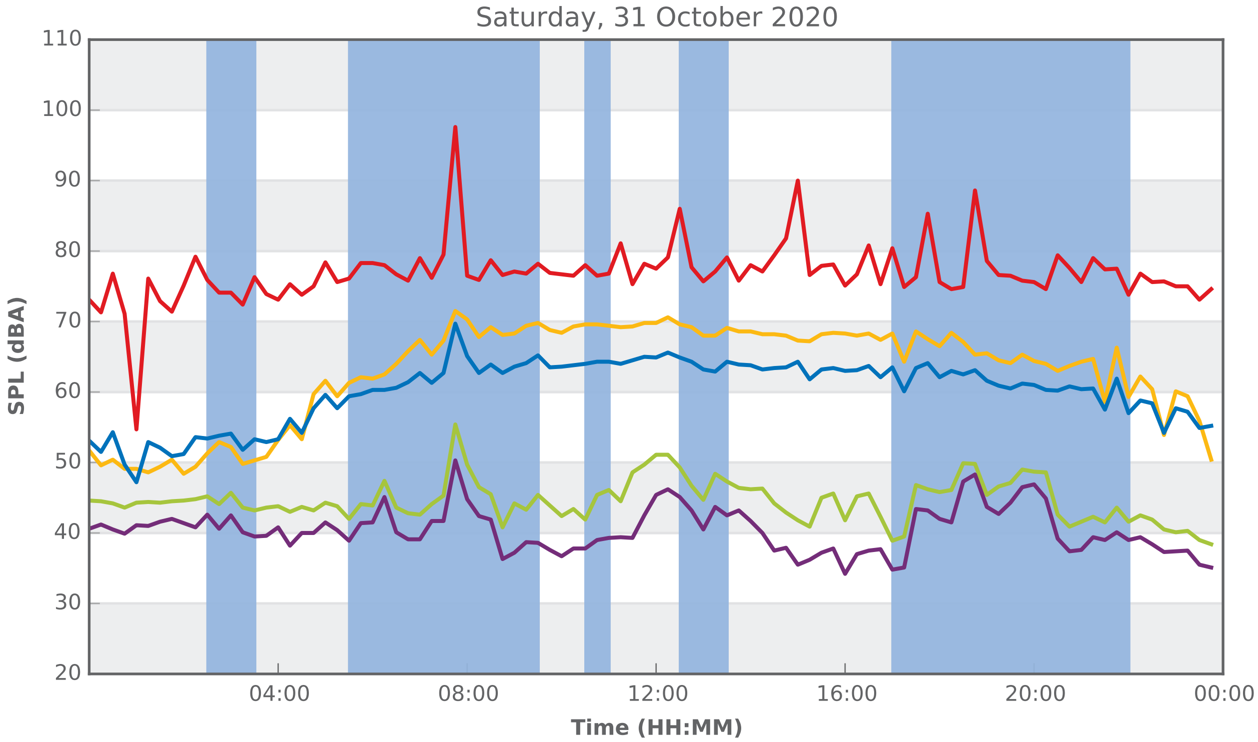
436 Menangle Road, Menangle

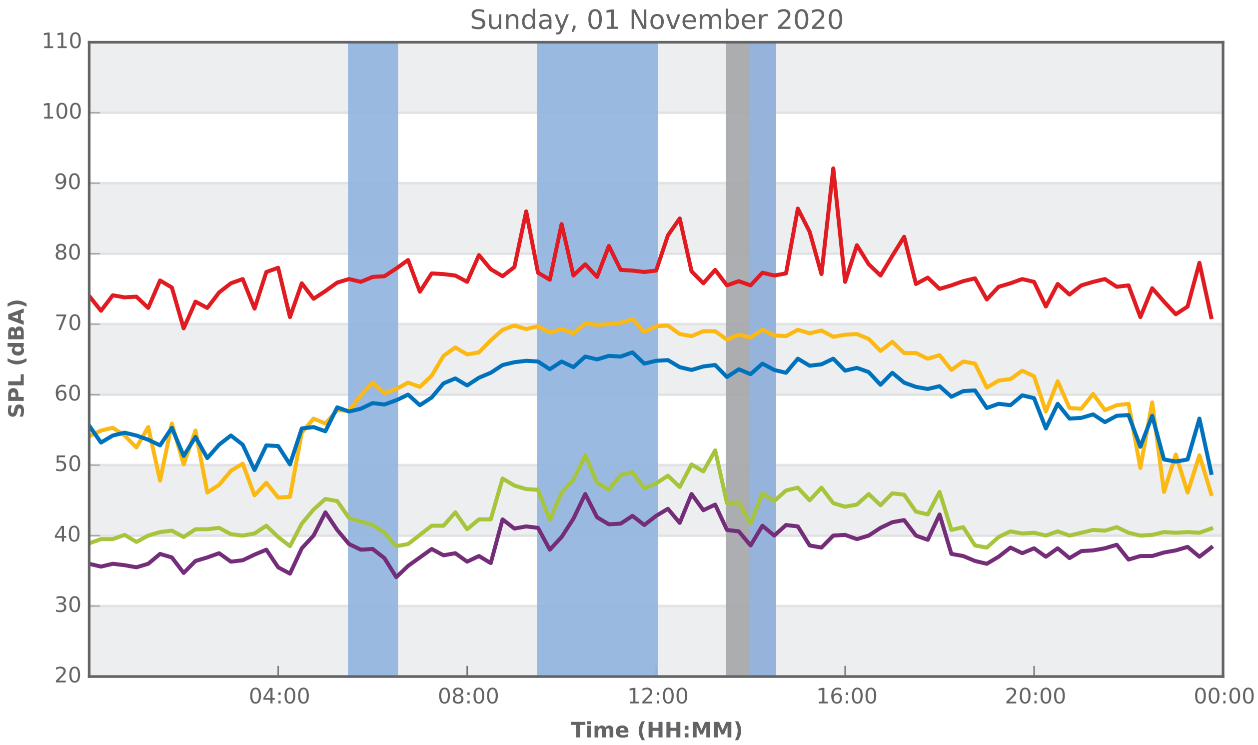




436 Menangle Road, Menangle



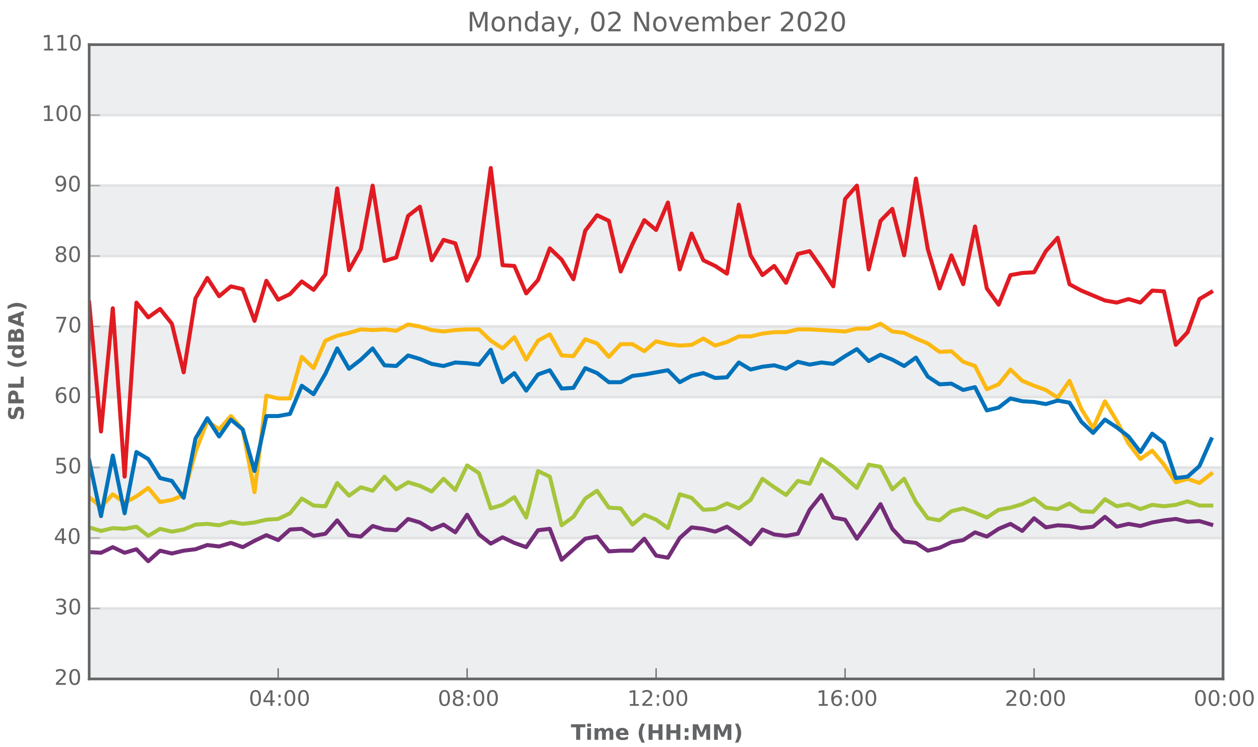


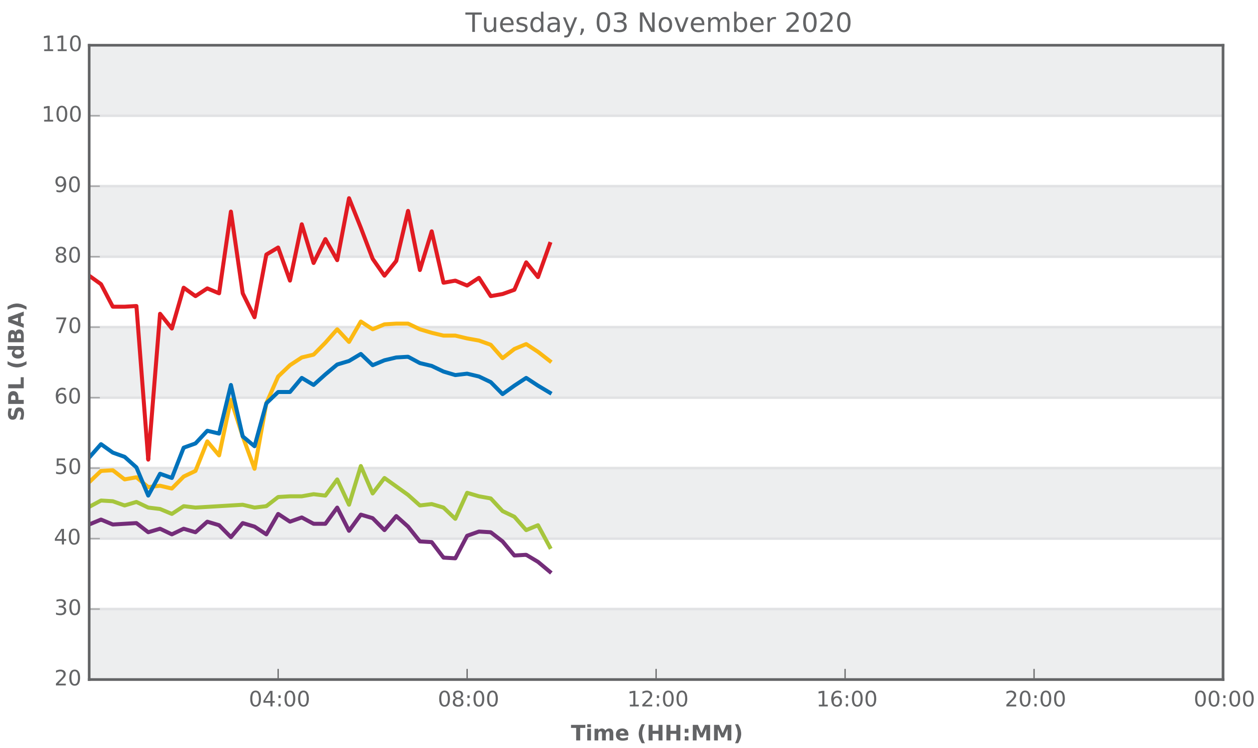


436 Menangle Road, Menangle

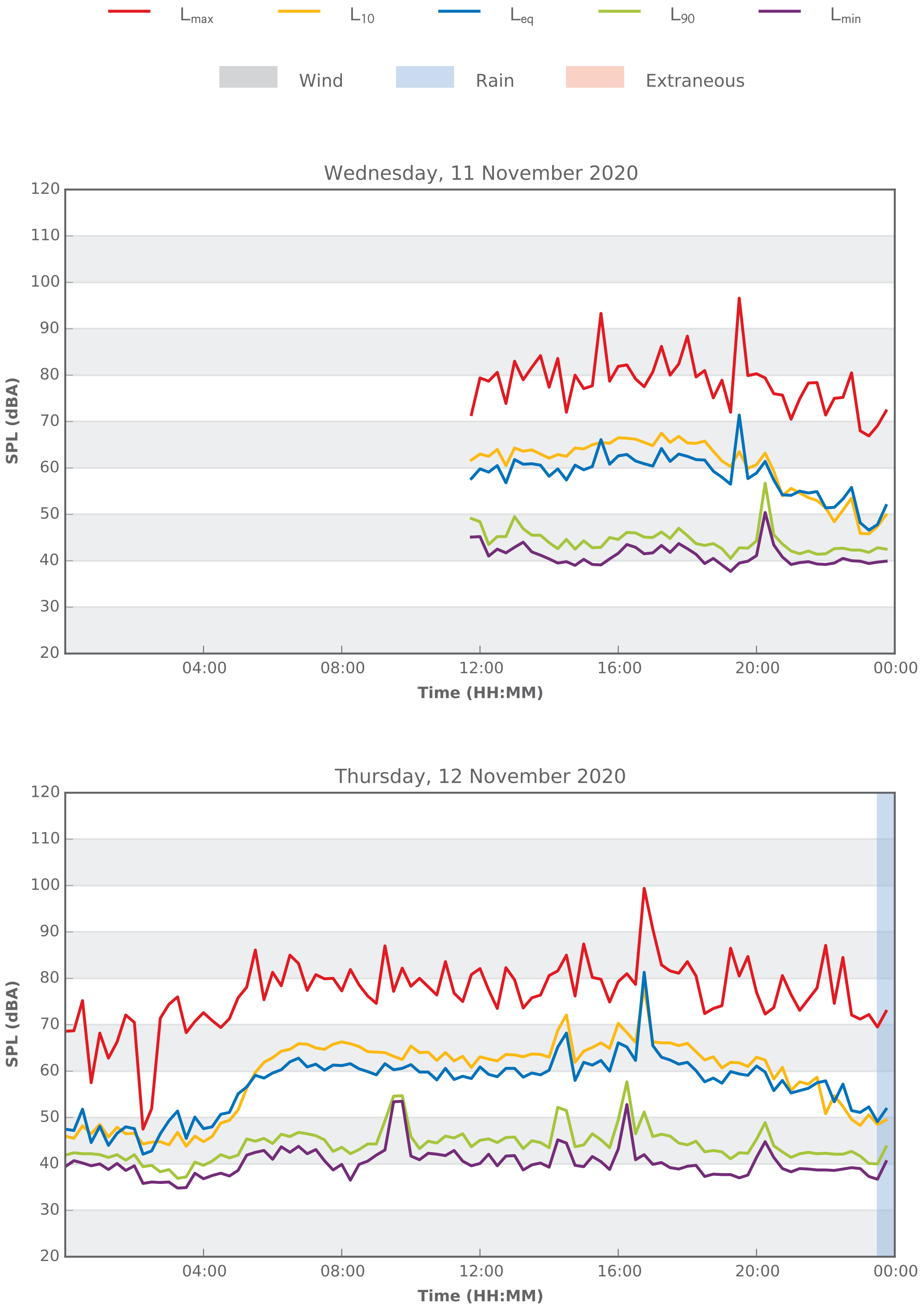
Lmax   L10   Leq   L90   Lmin

Wind   Rain   Extraneous

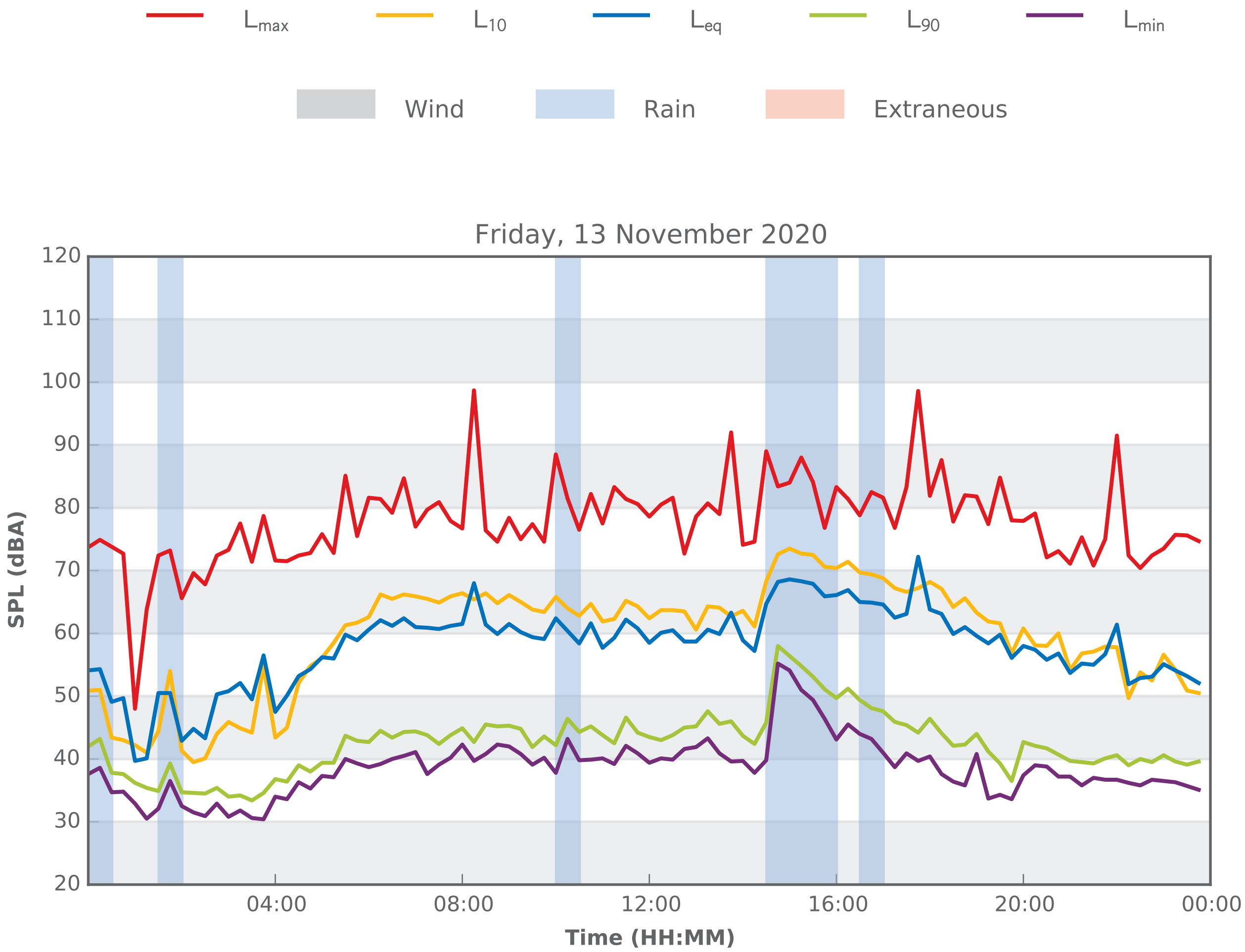


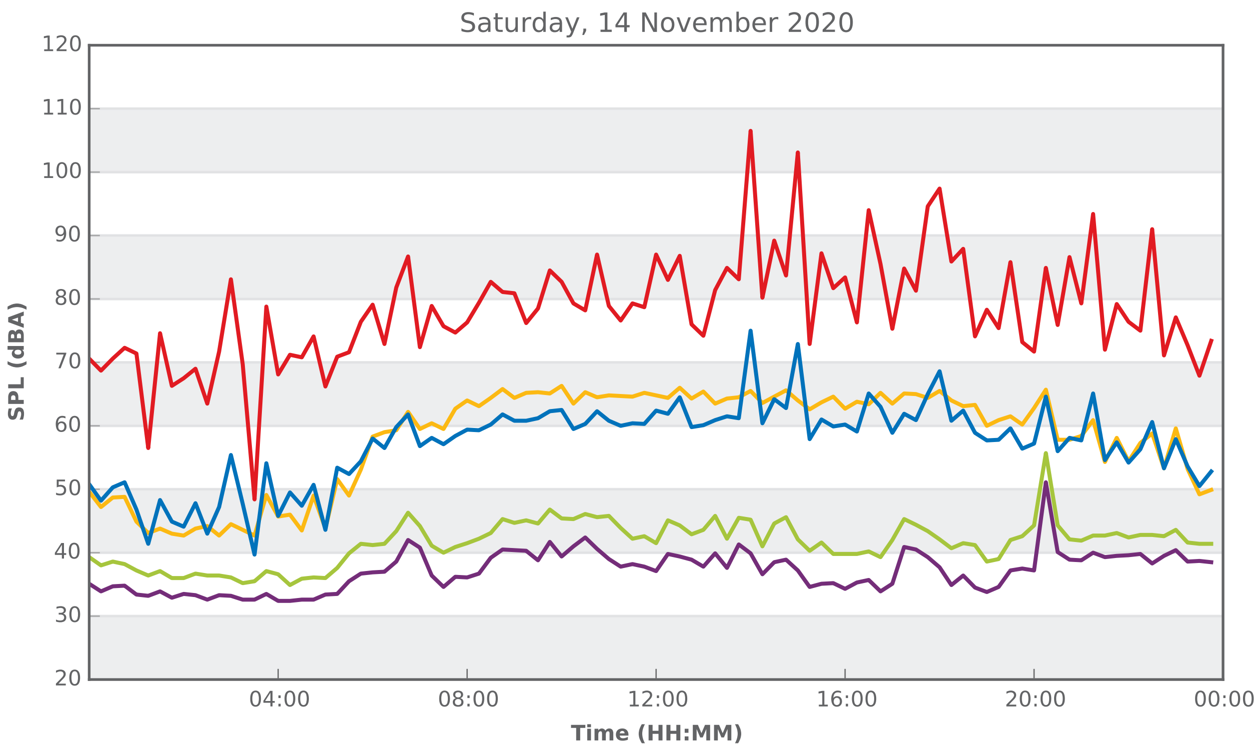


436 Menangle Road, Menangle

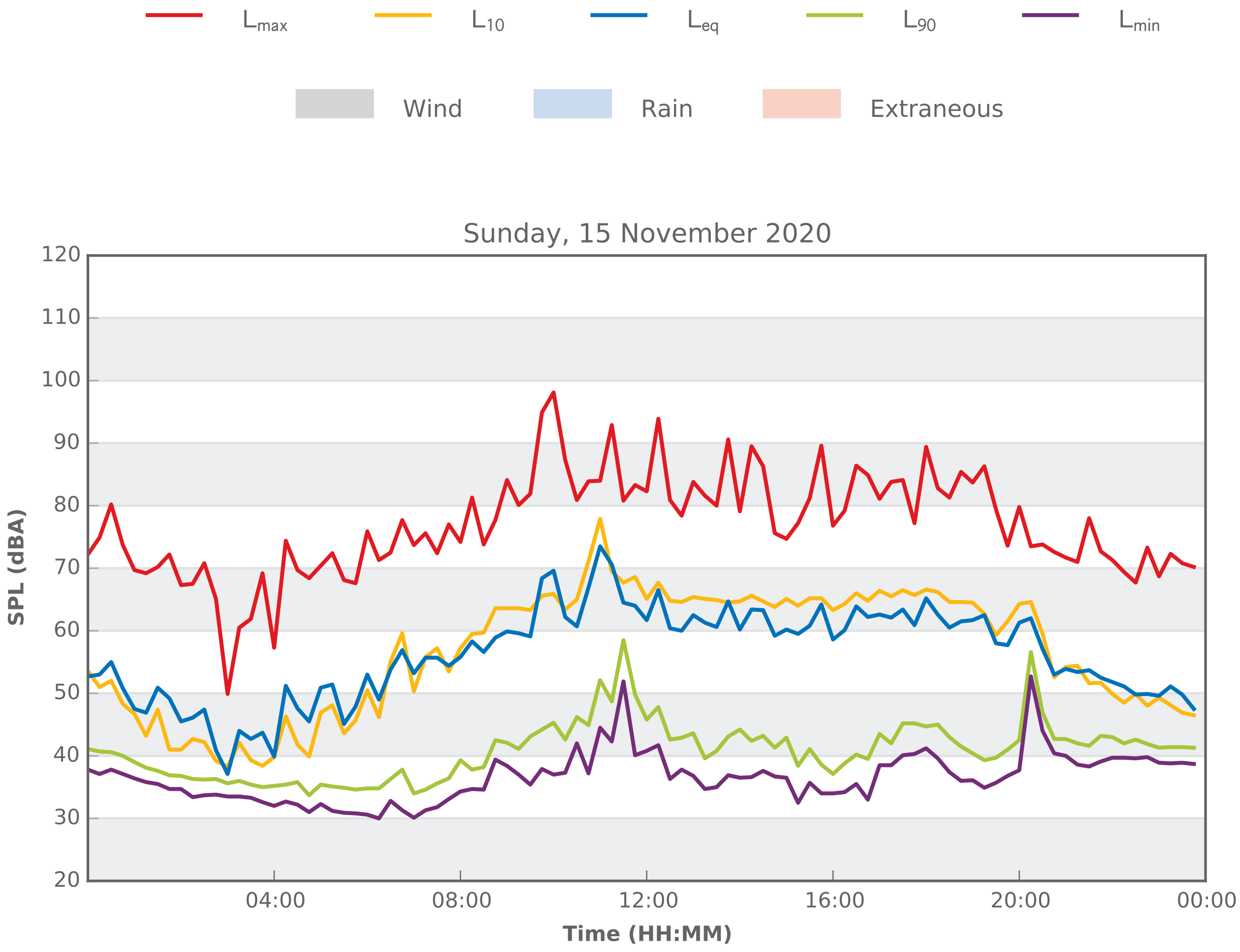


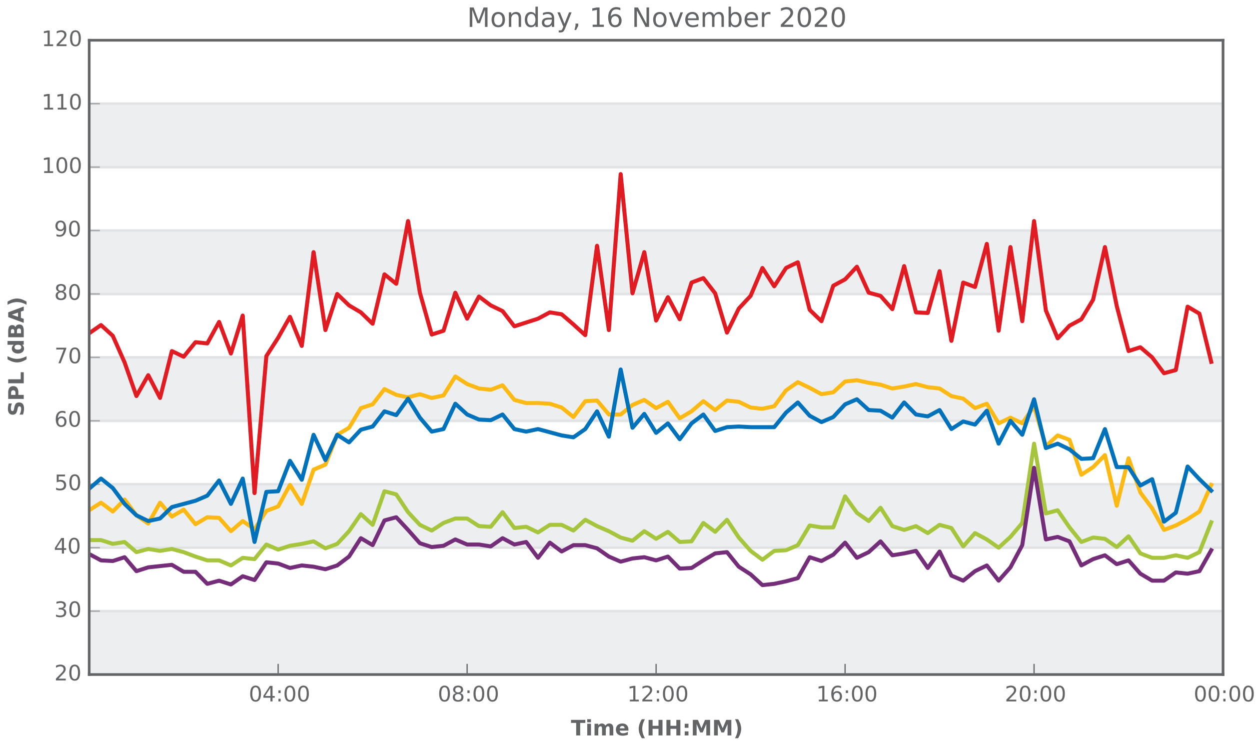
436 Menangle Road, Menangle



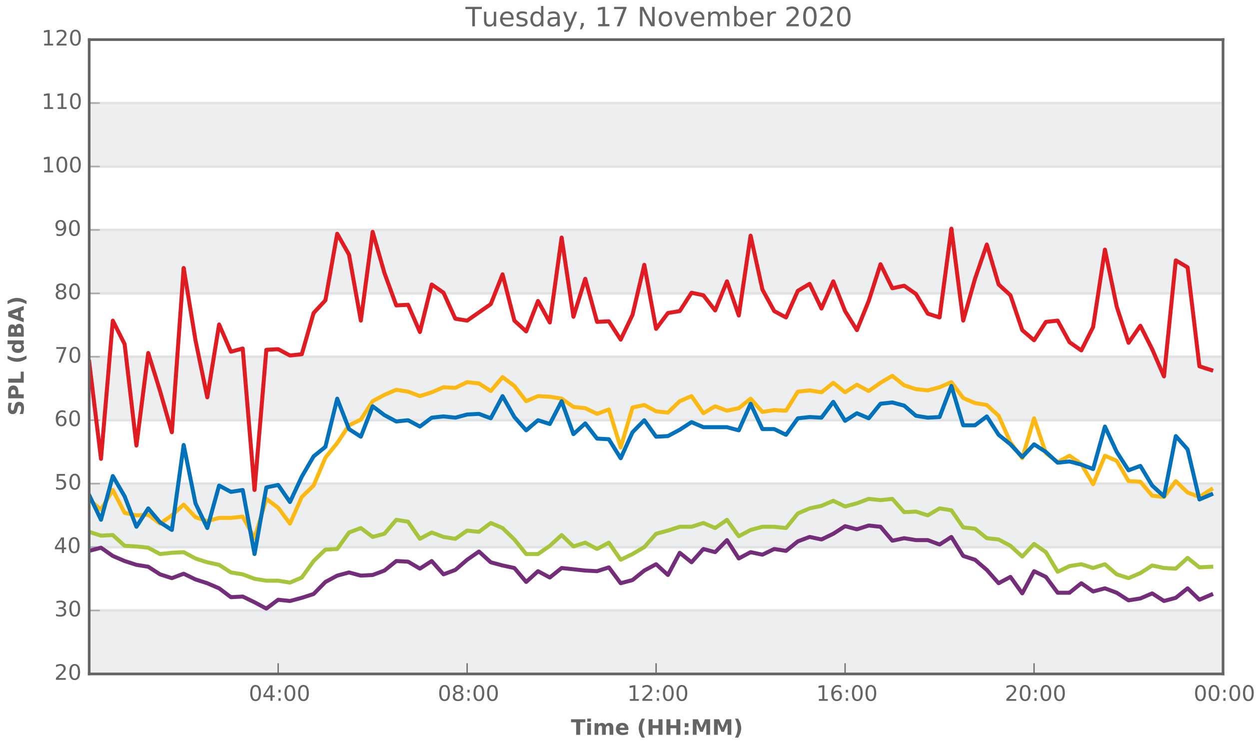


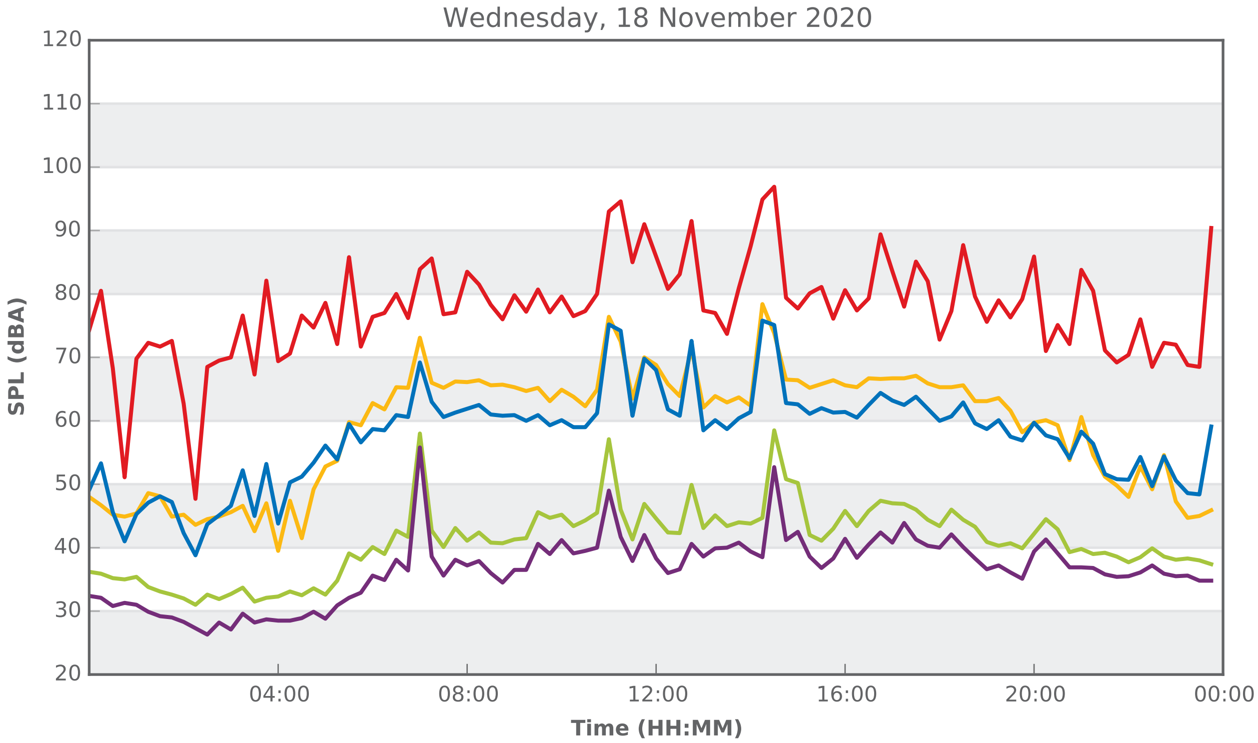
436 Menangle Road, Menangle





436 Menangle Road, Menangle

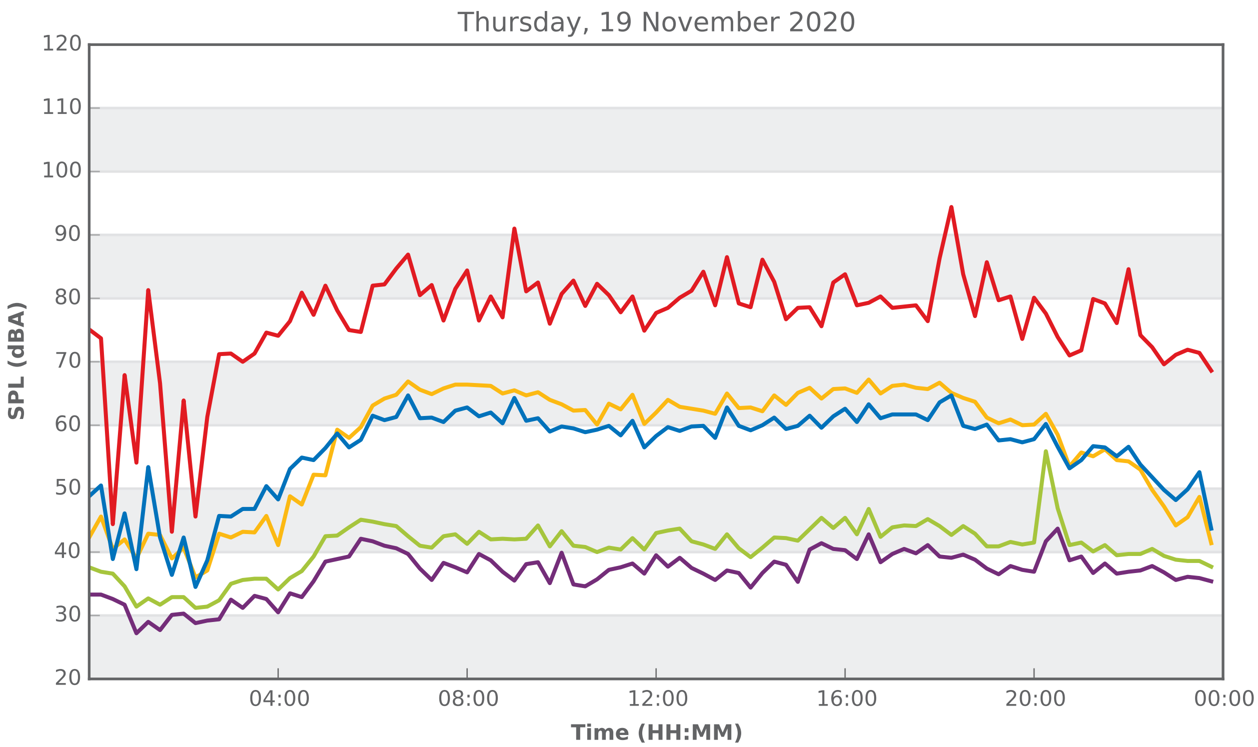


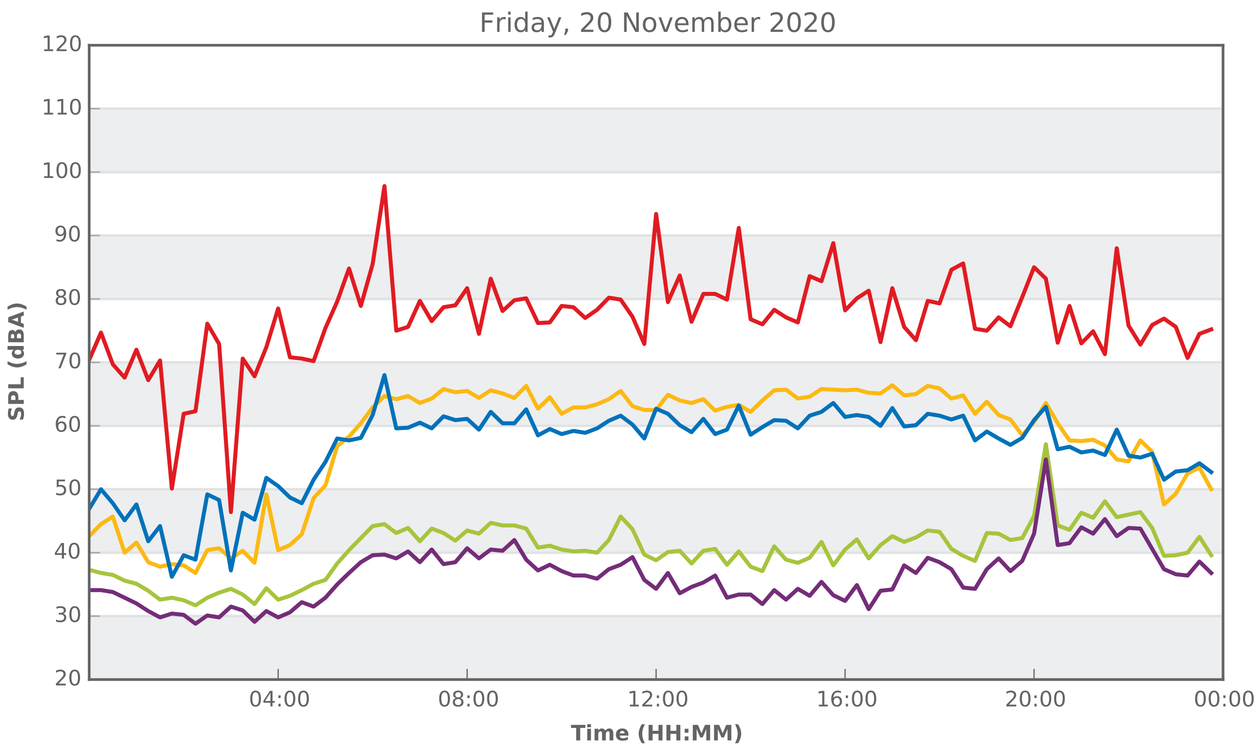


436 Menangle Road, Menangle

Lmax — L10 — Leq — L90 — Lmin

Wind — Rain — Extraneous



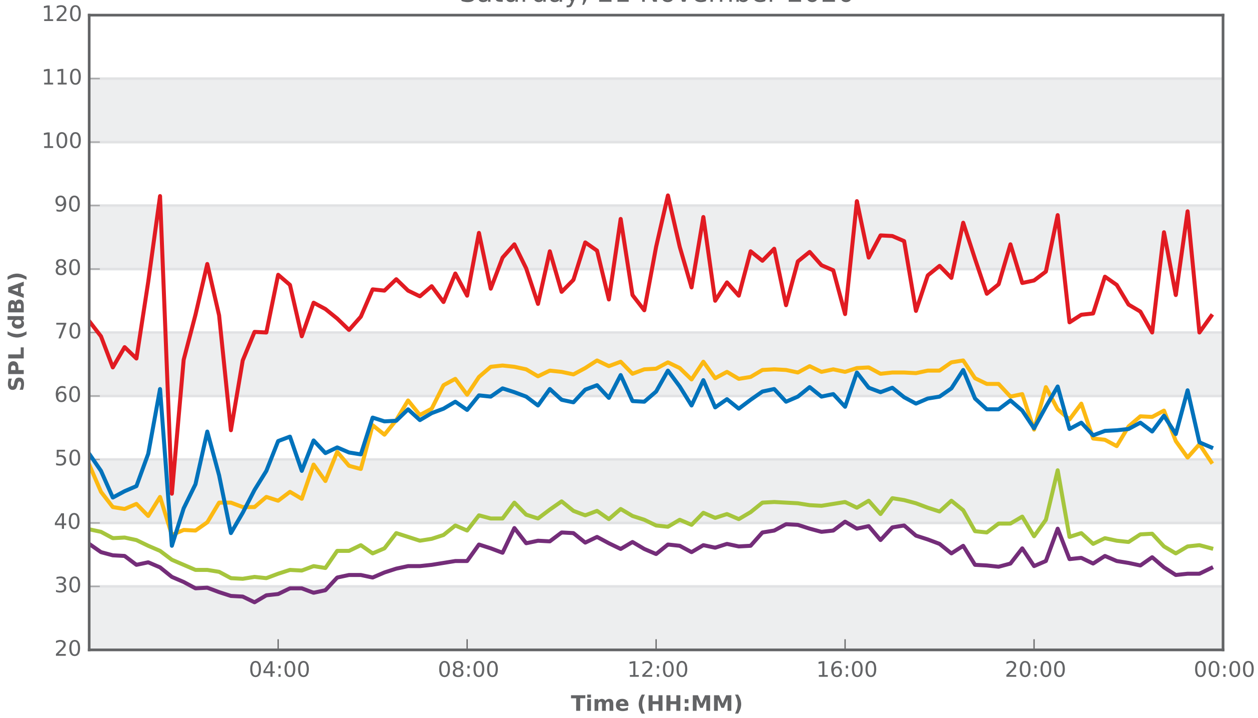


436 Menangle Road, Menangle

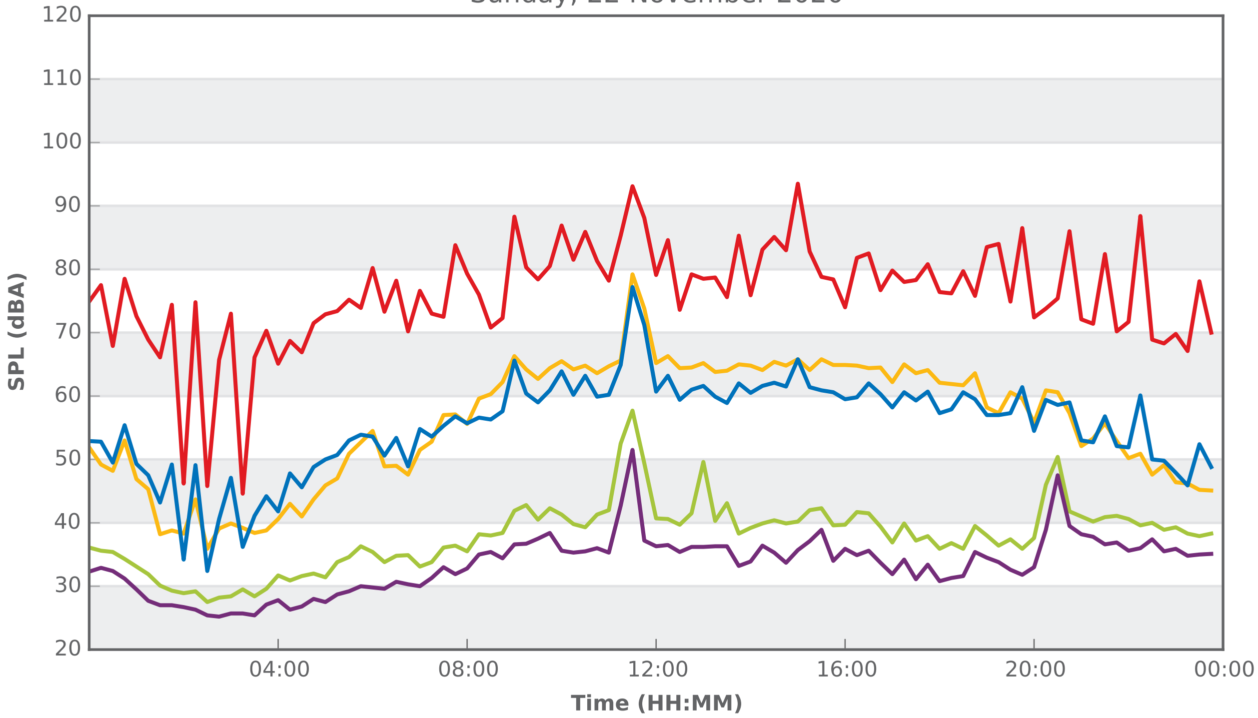
L_{max} L_{10} L_{eq} L_{90} L_{min}

Wind Rain Extraneous

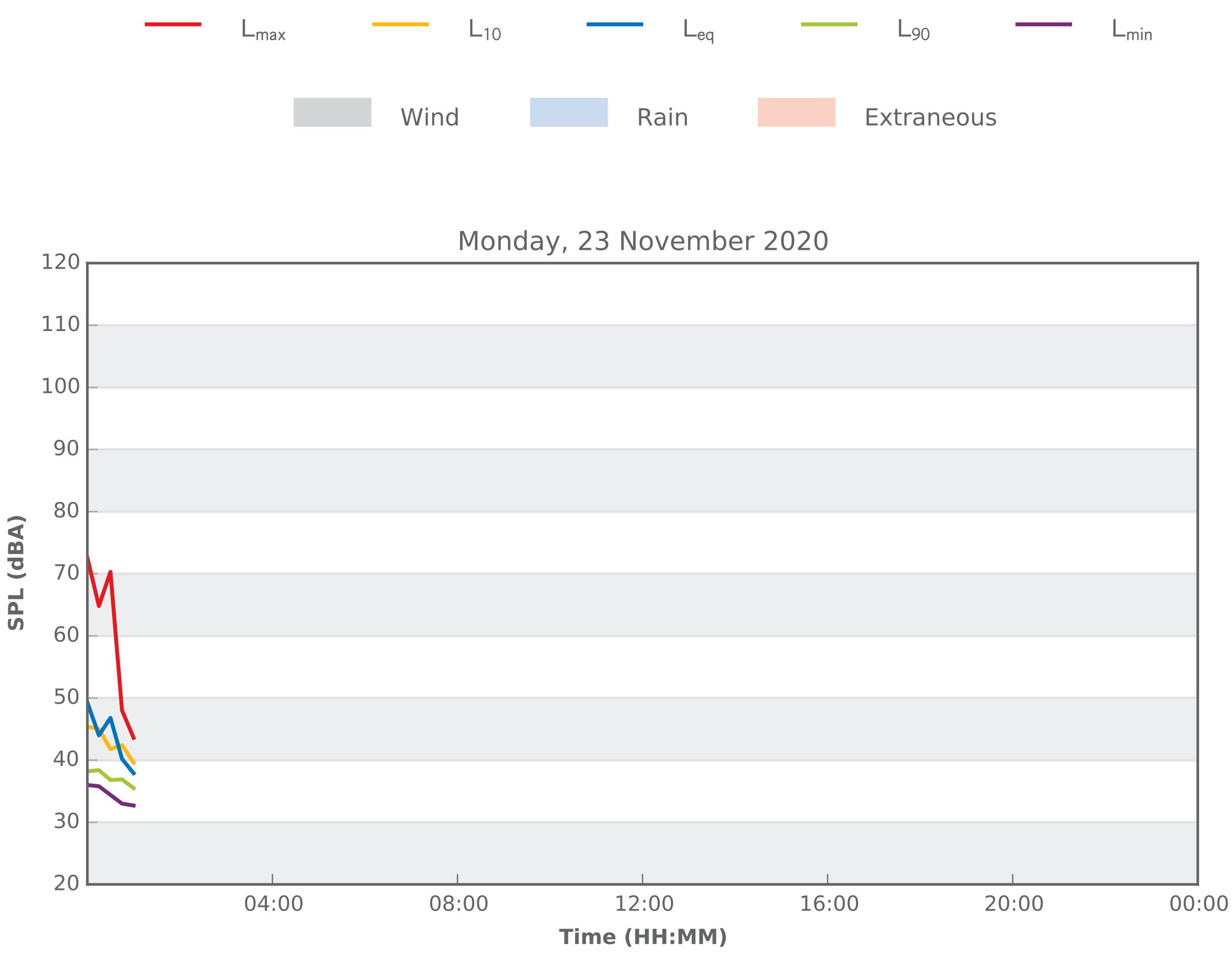
Saturday, 21 November 2020



Sunday, 22 November 2020



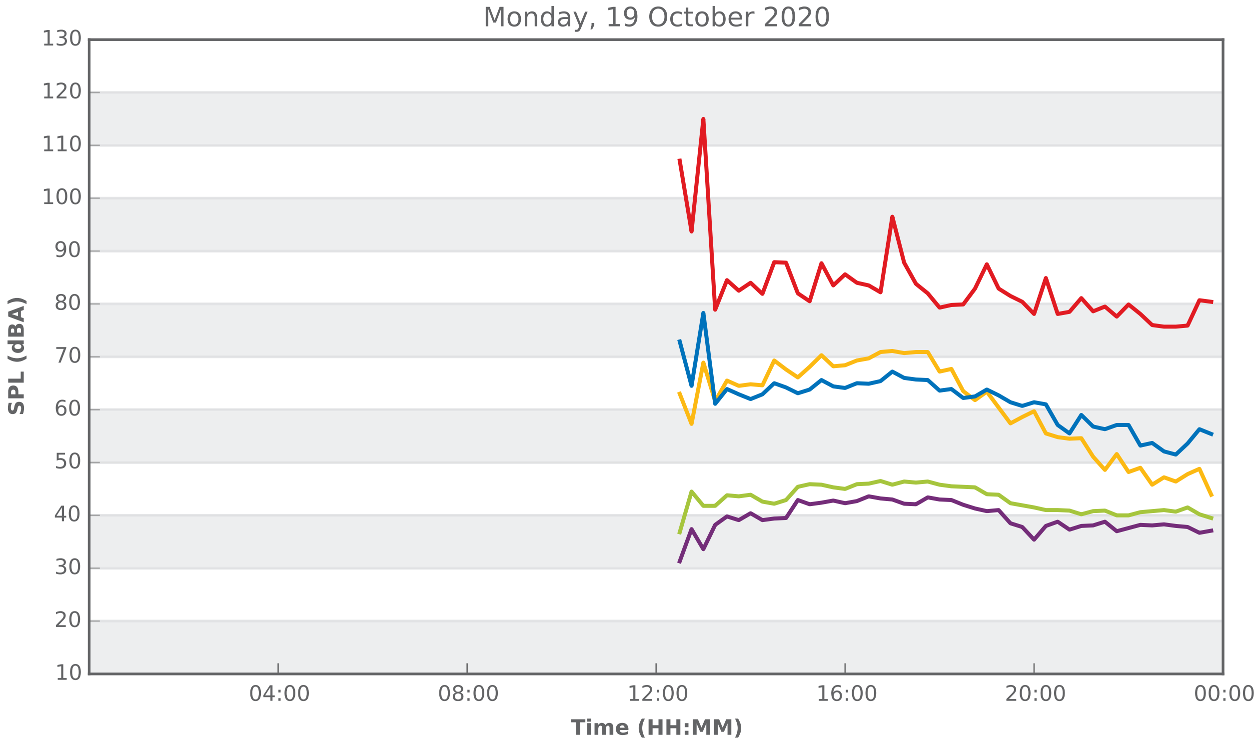
436 Menangle Road, Menangle

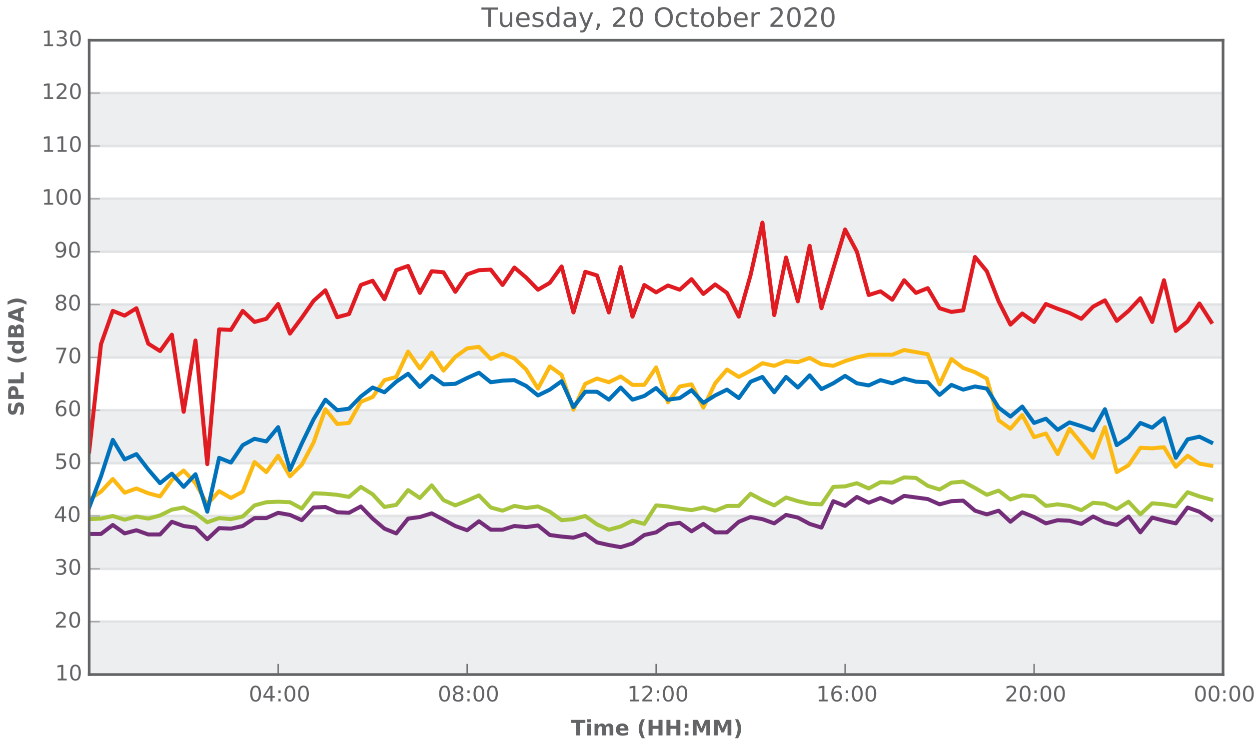


775 Moreton Park Road, Menangle

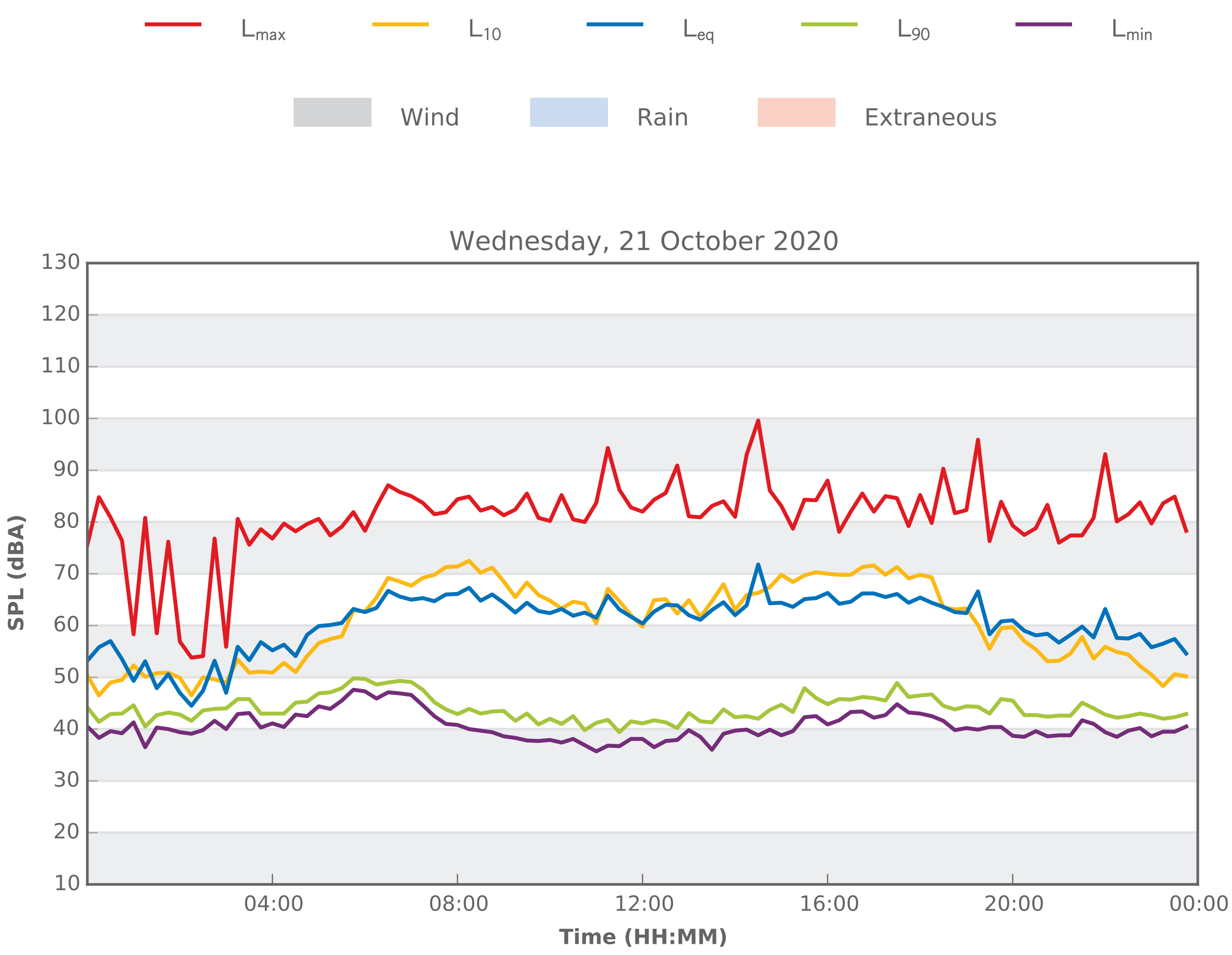
L_{max} L_{10} L_{eq} L_{90} L_{min}

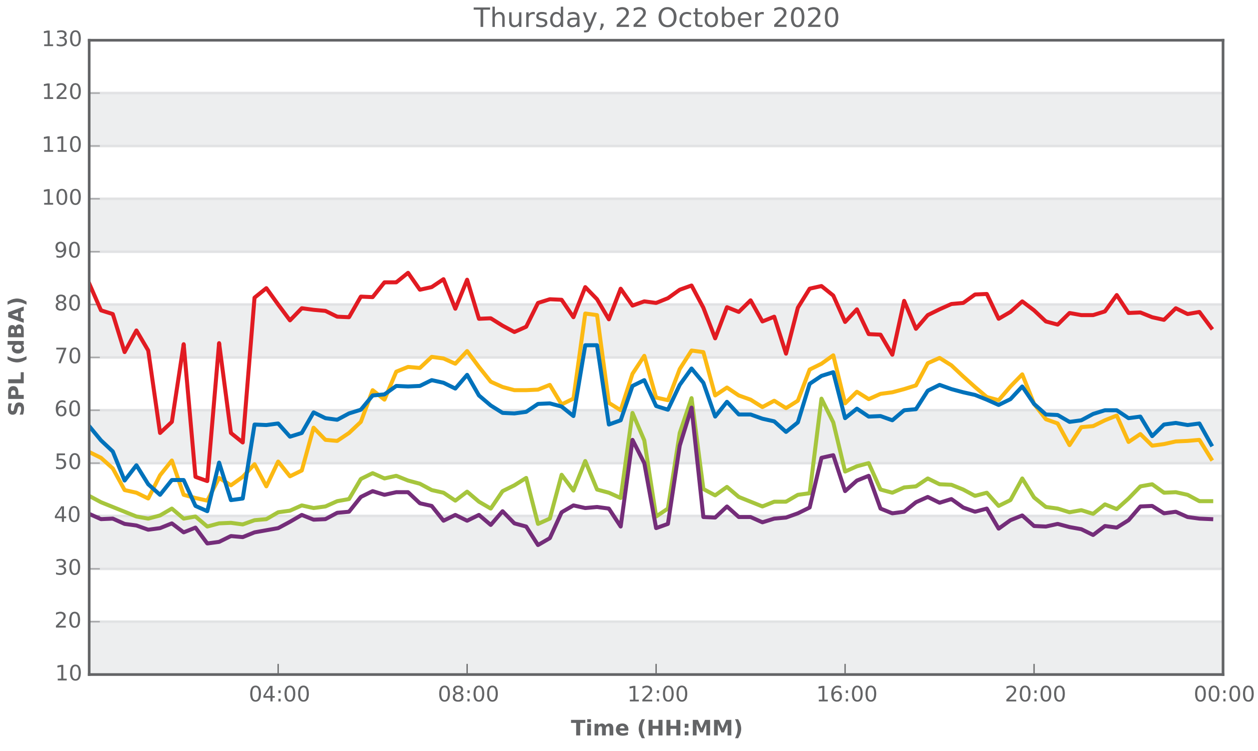
Wind Rain Extraneous



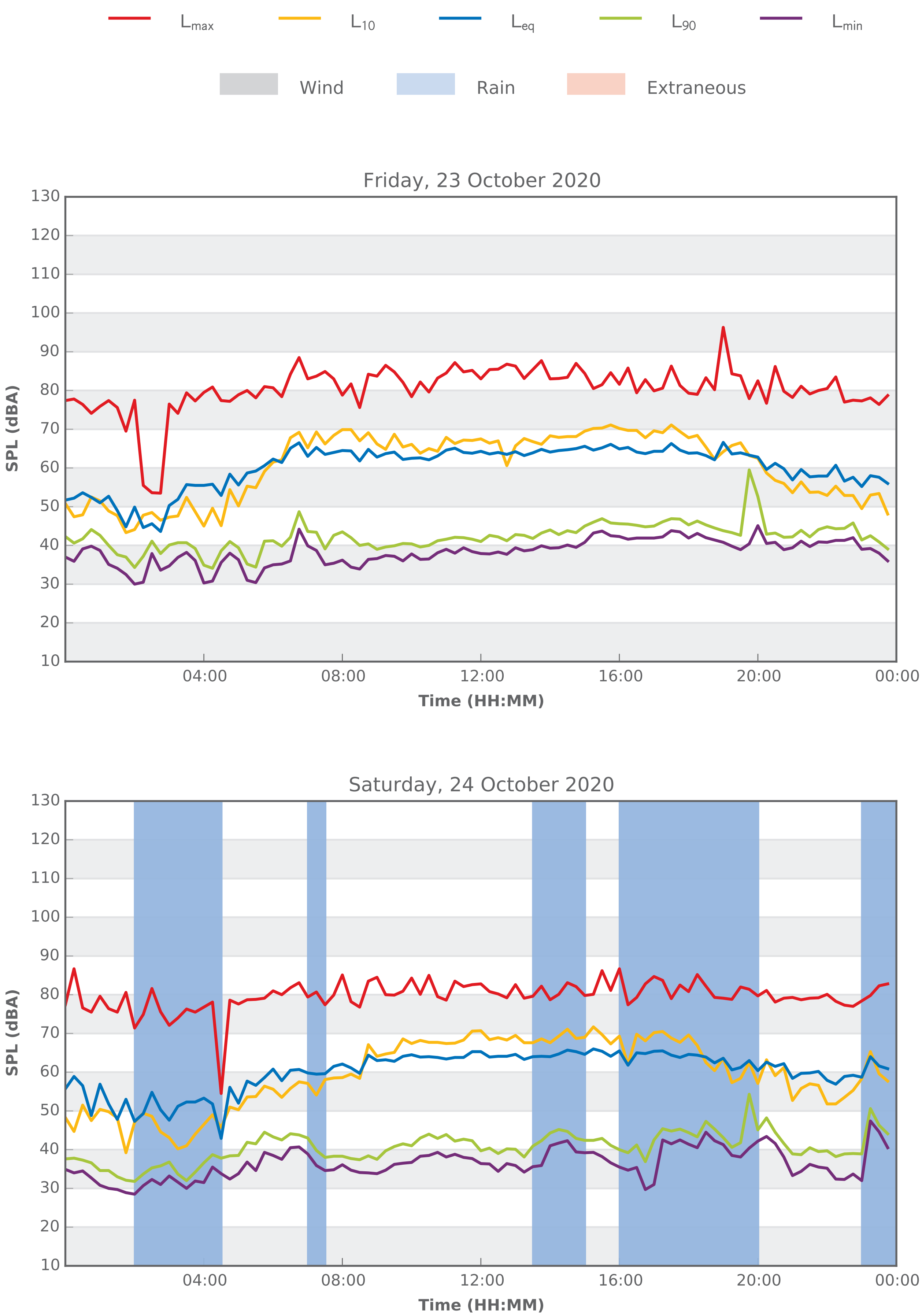


775 Moreton Park Road, Menangle

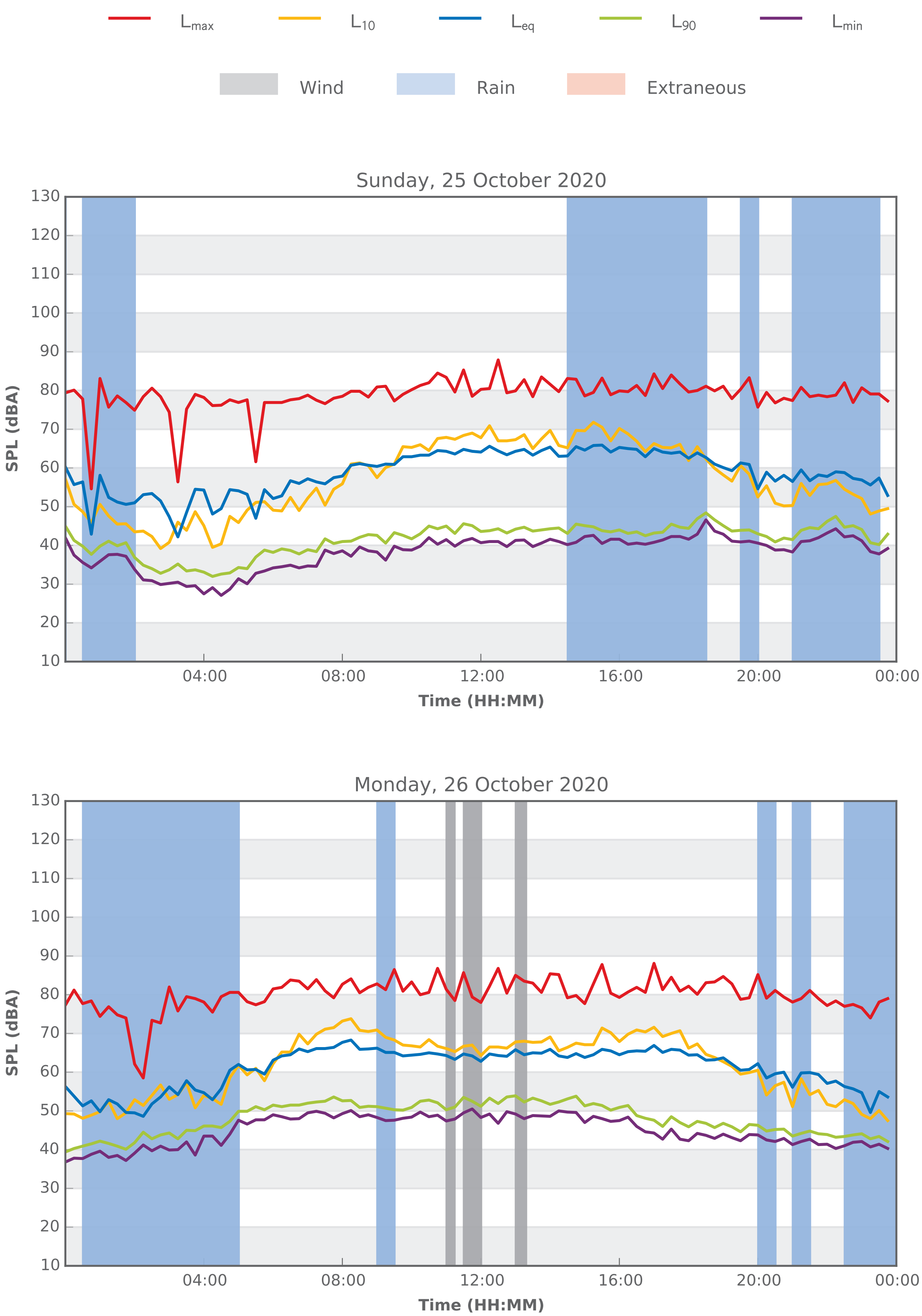




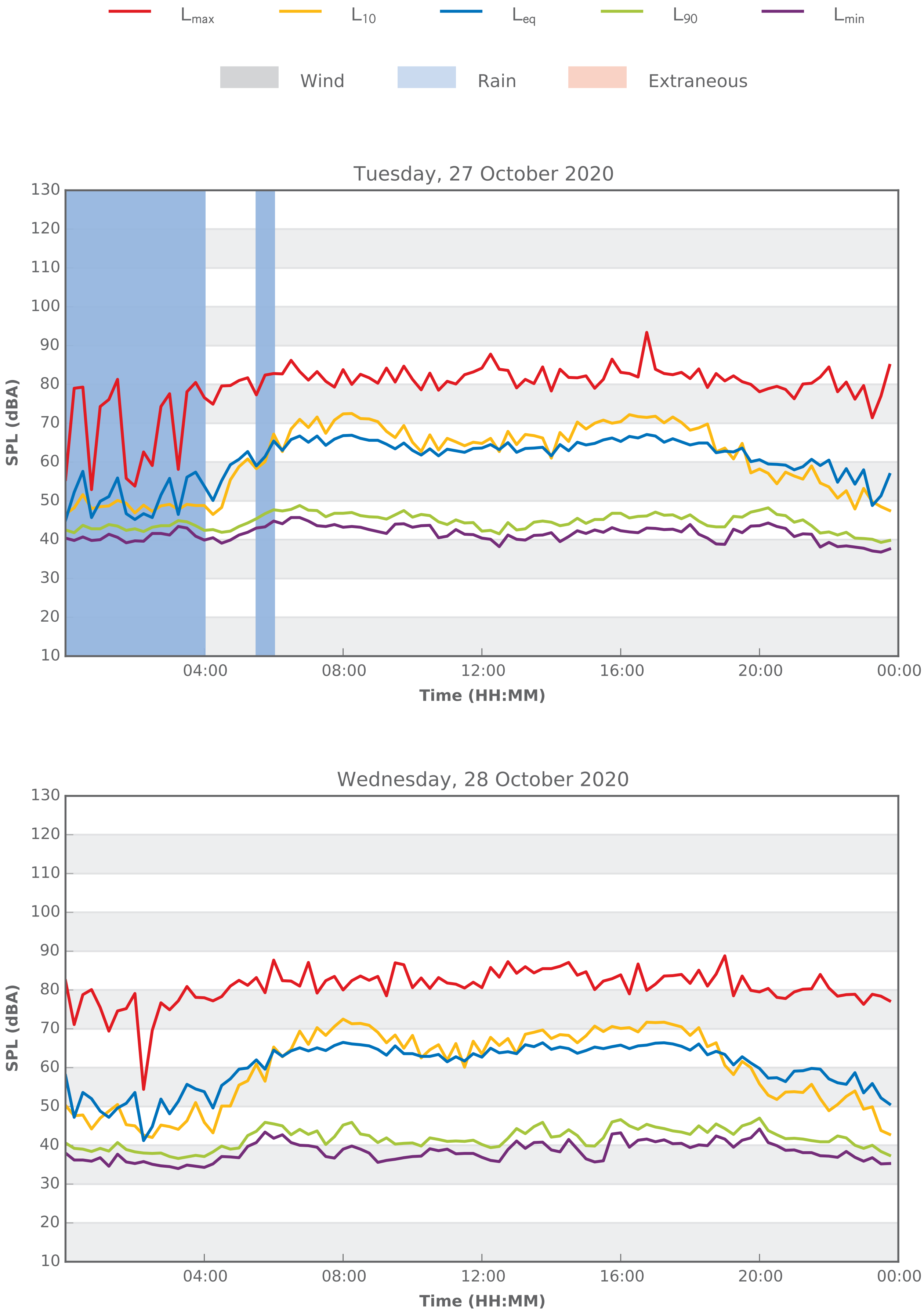
775 Moreton Park Road, Menangle



775 Moreton Park Road, Menangle



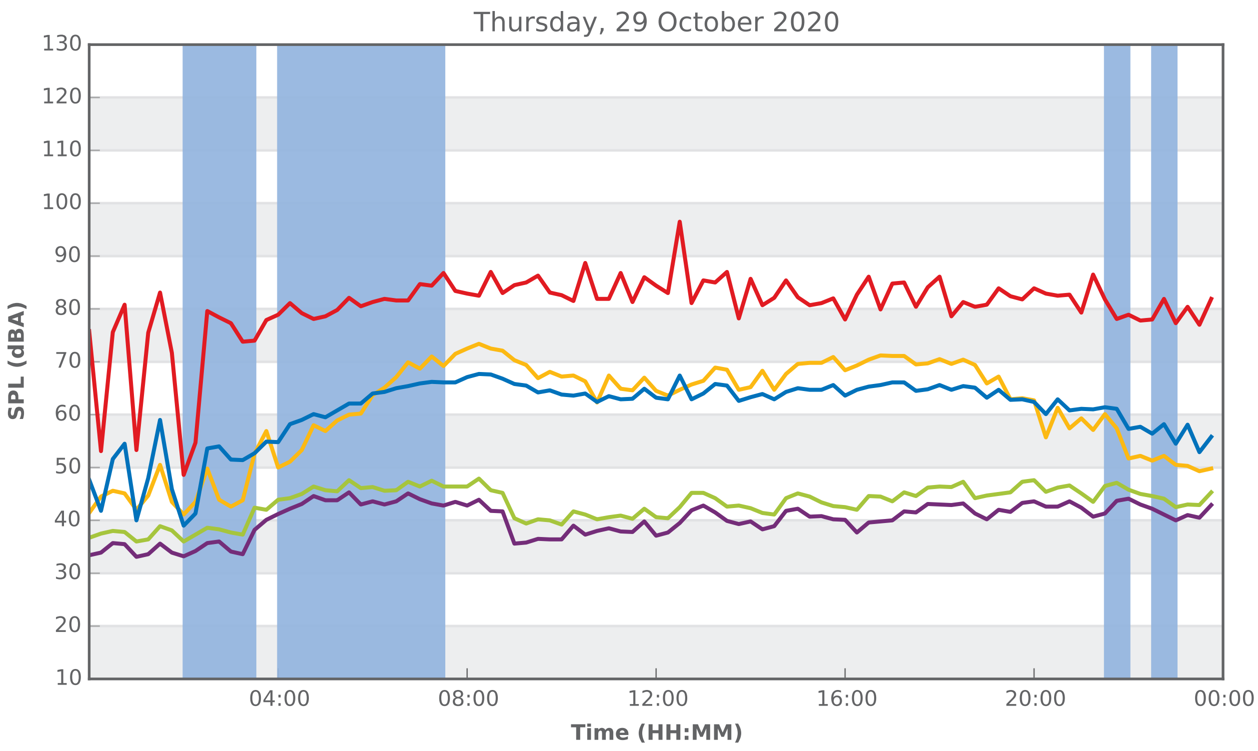
775 Moreton Park Road, Menangle

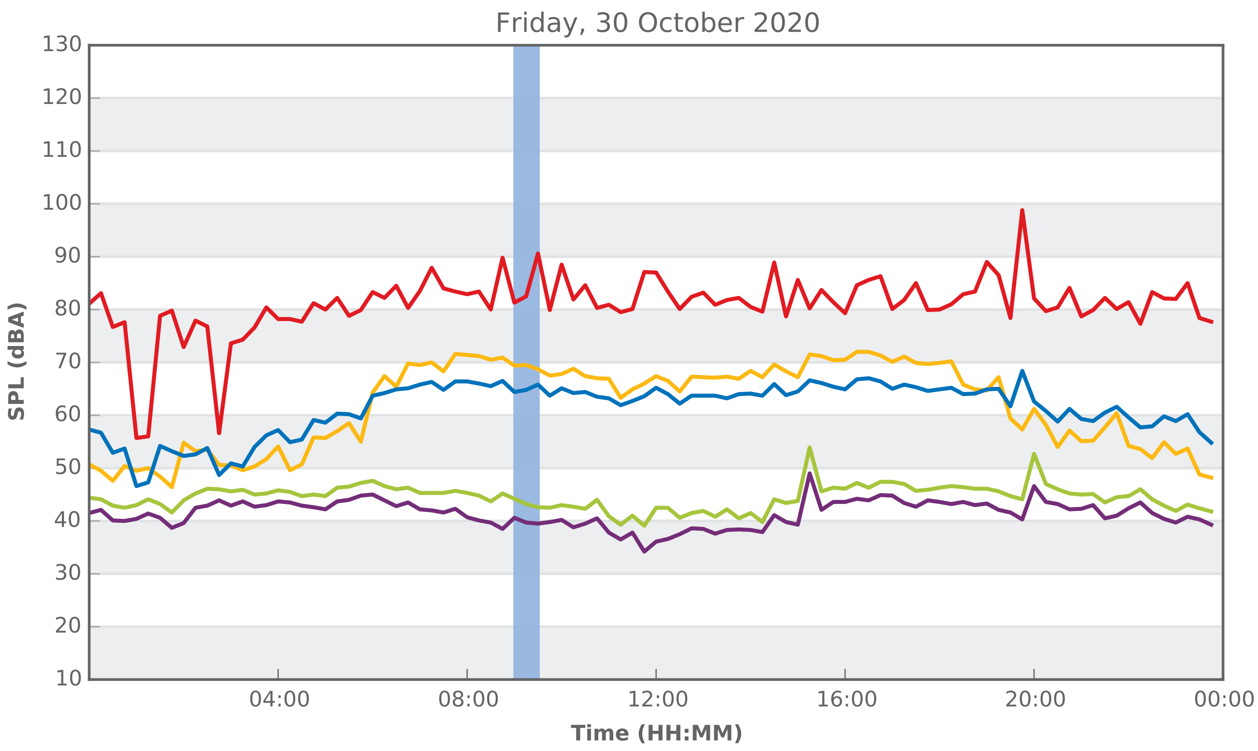


775 Moreton Park Road, Menangle

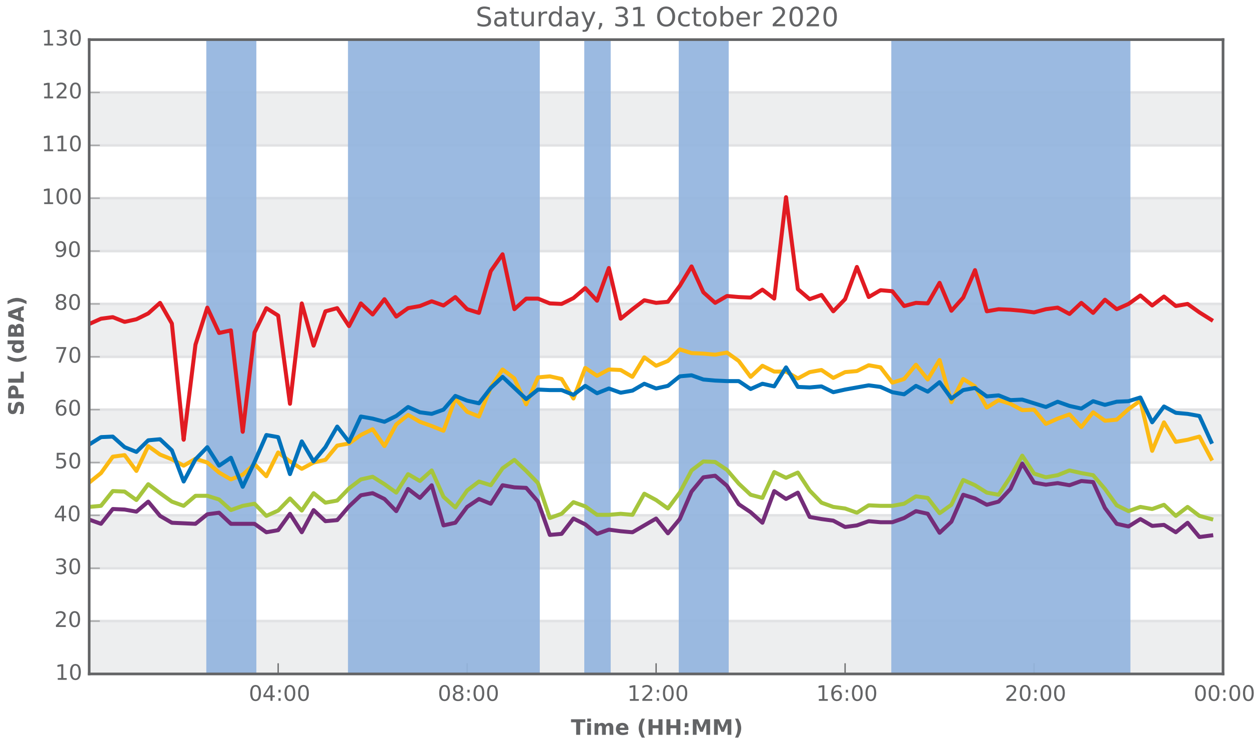
L_{max} L_{10} L_{eq} L_{90} L_{min}

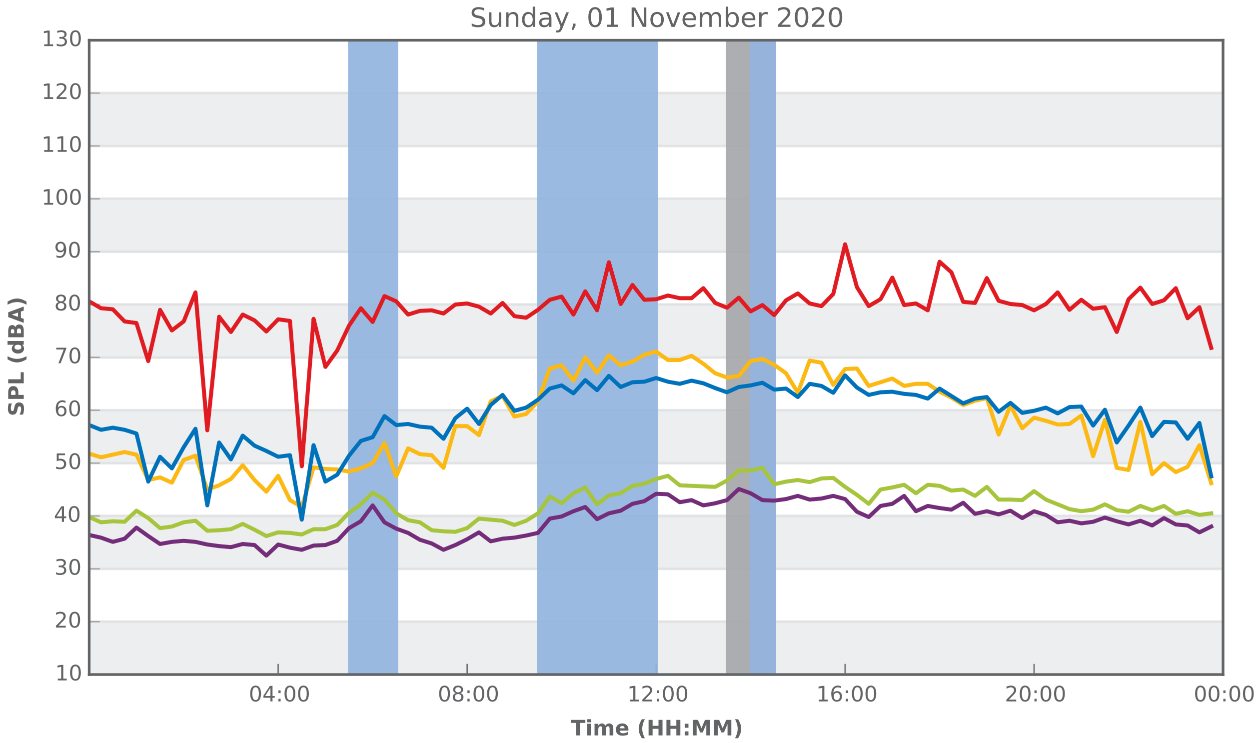
Wind Rain Extraneous





775 Moreton Park Road, Menangle





775 Moreton Park Road, Menangle