

The King's School (TKS) Masterplan & STEAM Building

SSDA Acoustic Assessment - Concept and Stage 1 Masterplan

Project ID	20221414.1
Document Title	SSDA Acoustic Assessment - Concept and Stage 1
Attention To	The Council of the King's School

Revision	Date	Document Reference	Prepared By	Checked By	Approved By
0	3/03/2023	20221414.1/0303A/R0/WY	WY		WY
1	18/08/2023	20221414.1/1808A/R1/WY	WY		
2	23/10/2023	20221414.1/2310A/R2/WY	WY		WY

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1 EXECUTIVE SUMMARY

This State Significant Development Application (SSDA) seeks consent for the staged redevelopment of The King's School, including:

- **Concept Proposal for the provision of new and upgraded facilities, including:**
 - Building envelope for a new Sports Pavilion within the western sports field precinct (subject to further detailed approval).
 - Building envelope for a new Boarding House within the northern residential precinct to the north of the Doyle Sports Fields and adjacent building envelope for Staff Quarters (subject to further detailed approval).
 - Building envelope for a new Day Boy House between Dalmas House and Burkitt House, including the associated relocation of Ryrie Road (subject to further detailed approval).
 - Earthworks and the associated demolition of existing buildings and structures, and removal of trees and landscaping.
 - Staged increase in staff and student numbers.
 - Detailed Stage 1 works (as outlined below).
- **Detailed Stage 1 works, including:**
 - Earthworks and the associated demolition and existing buildings and structures.
 - Traffic upgrade works including the construction of a new vehicular entrance into the site from Masons Drive, new drop-off pick up facilities, internal access roads and increased car parking and bus parking.
 - The construction of a new Staff Residence Building comprising residences for staff and their families within the Senior School Boarding Precinct.
 - The construction of a new building for Science, Technology, Engineering, Arts and Maths (the 'STEAM building') within the Senior School and associated landscaping.
 - The staged construction of new buildings required to upgrade the Preparatory School, including:
 - Construction of a new Performing Arts and Music Centre comprising a dedicated performance space and music practice rooms to the northwest of Horrocks Road.
 - Construction of a new General Learning Unit building comprising additional classrooms / general learning spaces adjacent to the existing dam.
 - Upgrades to pedestrian access throughout the school.
 - Staged increase in staff and student numbers.
 - The removal and replacement of trees and associated landscaping.

2 ACOUSTIC INTRODUCTION

Acoustic Logic (AL) has been engaged to conduct an acoustic assessment of potential noise and vibration impacts associated with the proposed development at The King's School (TKS).

The SEARs issued for SSD-48497708 requests for a noise and vibration assessment per the below extract.

Issue and Assessment Requirements – Concept Proposal

11. Noise and Vibration

- *Provide a noise and vibration assessment prepared in accordance with the relevant NSW Environment Protection Authority (EPA) guidelines. The assessment must detail operational noise (including any public-address system, events, and out of hours use of school facilities) and vibration impacts on nearby sensitive receivers and structures, considers noise intrusion, and outline the proposed management and mitigation measures that would be implemented.*

Issue and Assessment Requirements – Stage 1 Works

7. Noise and Vibration

- *Provide a quantitative assessment of the main noise and vibration generating noise sources and activities during construction and operation of the Stage 1 works in accordance with the relevant NSW Environment Protection Authority (EPA) guidelines.*
- *Outline measures to minimise and mitigate the potential construction and operational noise impacts on nearby sensitive receivers including proposed management and mitigation measures that would be implemented.*

17. Noise and Vibration

- *Provide a noise and vibration assessment prepared in accordance with the relevant NSW Environment Protection Authority (EPA) guidelines. The assessment must detail construction and operational noise (including any public-address system, events, and out of hours use of school facilities) and vibration impacts on nearby sensitive receivers and structures, considers noise intrusion, and outline the proposed management and mitigation measures that would be implemented.*
- *Provide a quantitative assessment of the main noise and vibration generating noise sources and activities during construction in accordance with the relevant NSW Environment Protection Authority (EPA) guidelines.*
- *Outline measures to minimise and mitigate the potential construction noise impacts on nearby sensitive receivers including proposed management and mitigation measures that would be implemented.*

In accordance with the SEARs, this document addresses noise impacts associated with the following:

- Noise intrusion to project site from adjacent roadways
- Noise emissions from mechanical plant to service the project site (in principle)
- Potential noise and vibration sources during the construction and operational phases of the development, and
- Details of noise mitigation, management and monitoring measures.

AL have utilised the following documents and regulations in the noise assessment of the development:

- NSW Planning SEARs document (Ref: SSD-48497708)
- Australian Standard AS2107:2016 *Recommended Design Sound Levels and Reverberation Times for Building Interiors*
- NSW Environmental Protection Authority (EPA) *Noise Policy for Industry* (NPI) 2017
- German Standard DIN 4150-3 (2016-12), and
- NSW Environmental Protection Authority (EPA) *Assessing Vibration – A Technical Guideline*.

This assessment has been conducted using the following documentation:

- BVN architectural drawings (dated July 2023) for the Masterplan.
- BVN architectural drawings (dated July 2023) for the STEAM Building.
- BVN architectural drawings (dated September 2023) for the General Learning Unit and Performing Arts Building.
- Kennedy Associates Architects architectural drawings (dated July 2023) for the Staff Residences.
- Leaf Architecture architectural drawings (dated January and July 2023) for the Boarding House.
- Leaf Architecture architectural drawings (dated March and July 2023) for the Day Boy House.
- Leaf Architecture architectural drawings (dated April and July 2023) for the Sports Pavilion.
- TTW *School Transport Plan* (dated October 2023).
- TTW *Transport and Accessibility Impact Assessment* (dated October 2023).

3 SITE DESCRIPTION

Investigation has been carried out by this office in regards to the existing properties and noise impacts surrounding the proposed development, which is detailed below:

- Existing residential developments surrounding the site
- Existing commercial receivers scattered near residential developments surrounding the site, and
- Existing educational facilities to the south-west bounding the development envelope.

AL notes that a large majority of surrounding receivers are within the overall TKS development footprint. Noise from TKS to its own buildings is to be managed between the school and relevant consultants outside of SSDA requirements.

The nearest noise receivers around the site include:

- **R1:** Residential Receiver 1 – Residential receivers to the north-east at Camelot Crescent.
- **R2:** Residential Receiver 2 – Residential receivers to the east at Bettington Road, Gowan Crescent and Kings Place.
- **R3:** Residential Receiver 3 – Residential receivers to the south across Cumberland Highway/ Pennant Hills Road.
- **R4:** Residential Receiver 4 – Residential receivers to the west at North Rocks Road and William Place.
- **R5:** Residential Receiver 5 – Residential receivers to the far north at Camelot Crescent and Meckiff Avenue.
- **E1:** Educational Receiver 1 – Tara Anglican School for Girls and Charles Sturt University Parramatta Campus to the south-east bounding the development site at Mason Drive.

A site map, measurement description and surrounding receivers are presented in Figure 1 below. Additional details of specific stages of the proposed works within the overall TKS development envelope are also provided.

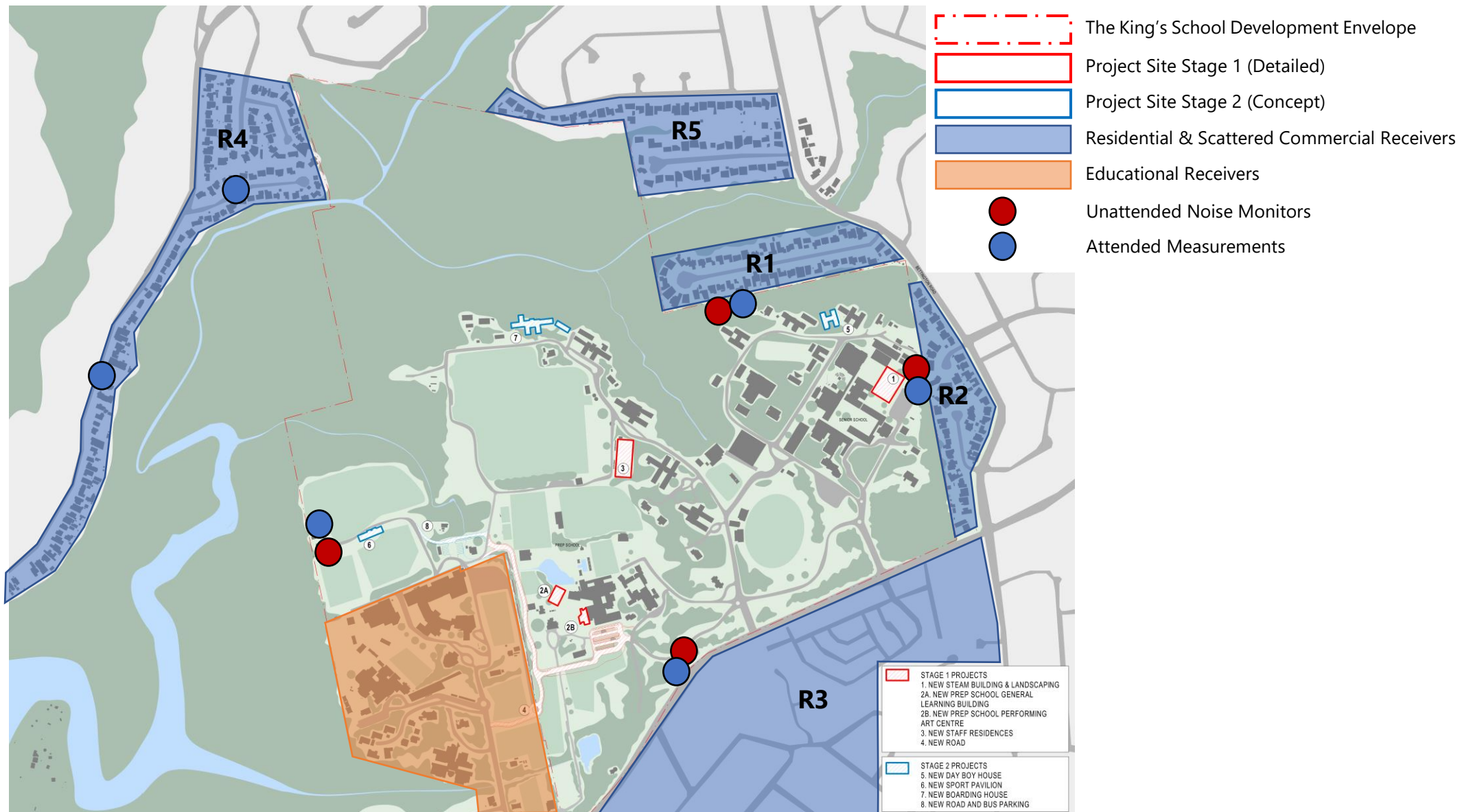


Figure 1 – Project Site
Source: NSW Six Maps

4 NOISE DESCRIPTORS

Ambient noise constantly varies in level from moment to moment, so it is not possible to accurately determine prevailing noise conditions by measuring a single, instantaneous noise level.

To quantify ambient noise, a 15-minute measurement interval is typically utilised. Noise levels are monitored continuously during this period, and then statistical and integrating techniques are used to characterise the noise being measured.

The principal measurement parameters obtained from the data are:

L_{eq} – represents the average noise energy during a measurement period. This parameter is derived by integrating the noise levels measured over the measurement period. L_{eq} is important in the assessment of noise impact as it closely corresponds with how humans perceive the loudness of time-varying noise sources (such as traffic noise).

L_{90} – This is commonly used as a measure of the background noise level as it represents the noise level heard in the typical, quiet periods during the measurement interval. The L_{90} parameter is used to set noise emission criteria for potentially intrusive noise sources since the disturbance caused by a noise source will depend on how audible it is above the pre-existing noise environment, particularly during quiet periods, as represented by the L_{90} level.

L_{10} is used in some guidelines to measure noise produced by an intrusive noise source since it represents the average of the loudest noise levels produced at the source. Typically, this is used to assess noise from licenced venues.

L_{max} is the highest noise level produced during a noise event and is typically used to assess sleep arousal impacts from short term noise events during the night. It is also used to assess internal noise levels resulting from aircraft and railway ground vibration induced noise.

L_1 is sometimes used in place of L_{max} to represent a typical noise level from a number of high-level, short-term noise events.

5 ENVIRONMENTAL NOISE SURVEY

NSW EPA's Rating Background Noise Level (RBL) assessment procedure requires determination of background noise level for each day (the ABL) then the median of the individual days as set out for the entire monitoring period.

Appendices in this report present results of unattended noise monitoring conducted at the project site. Weather affected data was excluded from the assessment. The processed RBL (lowest 10th percentile noise levels during operation time period) are presented in Table 5-1.

Measurement Position

Four unattended noise monitors were located around the potentially most noise affected residents. The noise monitors were placed within TKS development envelope as close as practicable to ascertain local noise environments as detailed below:

- One unattended noise monitor was located on the north-eastern boundary of TKS development envelope near at Ryrie Road near residents at **R1** (Camelot Crescent) and also used as a representative background noise level for **R5** Coronet Crescent and Meckiff Avenue) due to similar local environments, land zoning and the distance between TKS and **R5** being much greater than TKS and **R1**, therefore being conservative.
- One unattended noise monitor was located on the eastern boundary of TKS development envelope at Russel Road near **R2** (Gowan Crescent)
- One unattended noise monitor was located on the southern boundary of TKS development envelope at Cumberland Highway/ Pennant Hills Road near **R3**, and
- One unattended noise monitor was located on the western boundary of TKS development envelope at Massie Road near the Parramatta Lake Walk as a representative background noise level for **R4** and **E1**.

Attended short term measurements of traffic noise have been undertaken by this office to supplement the unattended noise monitoring. Refer to Figure 1 for detailed locations. All attended measurements were taken 1.5m above the local ground height.

Measurement Period

Unattended noise monitoring was conducted from Friday 10th of February 2023 to Monday 20th of February 2023. Attended noise measurements were undertaken on Friday 10th of February between the hours of 3:30pm and 4:30pm and Monday 20th of February 2023 between the hours of 4:30pm and 5:30pm.

Measurement Equipment

Equipment used consisted of Acoustic Research Laboratories Pty Ltd noise monitors. Monitors were set to A-weighted fast response and programmed to store 15-minute statistical noise levels throughout the monitoring periods. The monitors were calibrated at the start and end of the monitoring period using a Rion NC-73 calibrator. No significant drift was noted. Noise monitoring data is provided in Appendix Two – Unattended Noise Monitoring.

Attended Measurements were conducted using a Norsonic 140 Sound Analyser. The analyser was set to fast response and calibrated before and after the measurements using a Norsonic Sound Calibrator type 1251. No significant drift was noted.

5.1 SUMMARISED MEASURED NOISE LEVELS

Summarised measured rating background noise levels surrounding the proposed development are presented below. Periods of adverse weather that were determined to have affected the noise data have been eliminated when determining the rating background noise level at the site in accordance with Fact Sheets A & B of the NPI.

Table 5-1 – Measured Rating Background Noise Levels (RBL)

Monitor	Time of day	Rating Background Noise Level dB(A) _{L90(Period)}
Monitor 1 – Southern Boundary at Cumberland Highway/ Pennant Hills Road near R3	Day (7am – 6pm)	56
	Evening (6pm – 10pm)	55
	Night (10pm – 7am)	41
Monitor 2 – Western Boundary at Massie Road near R4	Day (7am – 6pm)	38
	Evening (6pm – 10pm)	38*
	Night (10pm – 7am)	34
Monitor 3 – Northern Boundary at Ryrie Road near R1/R5	Day (7am – 6pm)	41
	Evening (6pm – 10pm)	39
	Night (10pm – 7am)	36
Monitor 4 – Eastern Boundary at Russel Road near R2	Day (7am – 6pm)	43
	Evening (6pm – 10pm)	38
	Night (10pm – 7am)	33

*Adjusted down to daytime background noise level per the NSW EPA NPI 2017.

Summarised environmental noise levels from local noise sources surrounding the proposed development are presented below.

Table 5-2 – Measured Environmental Noise Levels

Location	Time of Day	Noise Level – L_{eq}
Monitor 1 – Southern Boundary at Cumberland Highway/ Pennant Hills Road near R3	Day (7am – 10pm)	68 dB(A) L_{eq} (15hr)
		68 dB(A) L_{eq} (worst 1hr)
	Night (10pm – 7am)	65 dB(A) L_{eq} (9hr)
		69 dB(A) L_{eq} (worst 1hr)
Monitor 2 – Western Boundary at Massie Road near R4	Day (7am – 10pm)	56 dB(A) L_{eq} (15hr)
	Night (10pm – 7am)	48 dB(A) L_{eq} (9hr)
Monitor 3 – Northern Boundary at Ryrie Road near R1/R5	Day (7am – 10pm)	54 dB(A) L_{eq} (15hr)
	Night (10pm – 7am)	45 dB(A) L_{eq} (9hr)
Monitor 4 – Eastern Boundary at Russel Road near R2	Day (7am – 10pm)	53 dB(A) L_{eq} (15hr)
	Night (10pm – 7am)	44 dB(A) L_{eq} (9hr)

5.2 PREDICTED FAÇADE NOISE LEVELS

Based on the attended noise measurements and unattended noise monitoring conducted for the site, the below noise levels are predicted at the façade of the concept stage and phase 1 buildings. CoRTN road traffic modelling was used to calculate traffic noise levels resultant on the façades of the future development. Predicted traffic noise levels at the worst affected façades of the proposed dwellings are detailed below.

Table 5-3 – Predicted Façade Noise Levels

Stage	Location	Time of Day	Noise Level – L _{eq}
Concept Proposal	Day Boy House	Day (7am – 10pm)	54 dB(A) L _{eq} (15hr)
		Night (10pm – 7am)	45 dB(A) L _{eq} (9hr)
	Sports Pavilion	Day (7am – 10pm)	56 dB(A) L _{eq} (15hr)
	Boarding House	Day (7am – 10pm)	56 dB(A) L _{eq} (15hr)
		Night (10pm – 7am)	48 dB(A) L _{eq} (9hr)
Detailed Stage 1	STEAM Building	Day (7am – 10pm)	53 dB(A) L _{eq} (15hr)
	Prep School Performing Arts Centre	Day (7am – 10pm)	58 dB(A) L _{eq} (15hr)
	Prep School General Learning Building	Day (7am – 10pm)	59 dB(A) L _{eq} (15hr)
	Staff Residences	Day (7am – 10pm)	54 dB(A) L _{eq} (15hr)
		Night (10pm – 7am)	45 dB(A) L _{eq} (9hr)

It is noted that the above predictions take into account predictions based on distance attenuation from measured noise levels of Cumberland Highway/ Pennant Hills Road. Predicted noise levels were compared to localised noise measurements around the unattended noise monitors.

6 EXTERNAL NOISE INTRUSION ASSESSMENT

Site investigation indicates that the major external noise sources around project site are from traffic movements along Cumberland Highway/ Pennant Hills Road to the southern boundary of the site. Measured and CoRTN road traffic modelling prediction noise levels indicate that internal noise levels are readily achievable for the proposed usages and is supported from an acoustic perspective.

6.1 NOISE INTRUSION CRITERIA

A noise intrusion assessment has been conducted based on the requirements of Australian Standard AS2107:2016 *Recommended Design Sound Levels and Reverberation Times for Building Interiors* for Detailed Stage 1 works, mainly on the GLU, PAB and STEAM buildings. TKS may choose to design to more stringent noise levels as part of an internal set of principal project requirements, however the following noise level criteria is presented for authority approval purposes.

As Stage 2 works are in concept stage a noise intrusion assessment is to be conducted following concept approval based on the requirements of Australian Standard AS2107:2016.

6.1.1 AS2107:2016 *Recommended Design Sound Levels and Reverberation Times for Building Interiors*

AS2107:2016: *Recommended Design Sound Levels and Reverberation Times for Building Interiors* specifies allowable internal noise levels for internal spaces within educational buildings. Table 1, in Section 5 of AS2107:2016, gives the following maximum internal noise levels for specific relevant spaces. Differentiation between buildings and stages has been provided for readability.

Table 6-1 – Concept Stage 2 Recommended Design Sound Levels

Building	Space /Activity Type	Recommended Design Sound Level Range
Day Boy House & Boarding House	Residential Living Areas (Study)	35-45 dB(A) _{Leq(anytime)}
	Foyer & Recreation Areas	45-50 dB(A) _{Leq(when in use)}

Table 6-2 – Detailed Stage 1 Recommended Design Sound Levels

Building	Space /Activity Type	Recommended Design Sound Level Range
Prep Performing Arts Building & General Learning Units	Music Practice Rooms	40-45 dB(A) _{Leq(when in use)}
	Music Studios (Small Performance Space)*	30-35 dB(A) _{Leq(when in use)}
	Foyer	45-50 dB(A) _{Leq(when in use)}
	Professional and Administrative Offices	35-40 dB(A) _{Leq(when in use)}
	Office Areas	40-45 dB(A) _{Leq(when in use)}
	Teaching Spaces (Primary)	35-45 dB(A) _{Leq(when in use)}
	Open Plan Teaching Spaces/ Breakout	35-45 dB(A) _{Leq(when in use)}
	Quiet Rooms (Withdrawal Rooms)	40-45 dB(A) _{Leq(when in use)}
STEAM Building	Video Editing/ Video Production/ Sound Studio	30-35 dB(A) _{Leq(when in use)}
	Robotics Assembly	<45 dB(A) _{Leq(when in use)}
	Maker Space	40-45 dB(A) _{Leq(when in use)}
	Shared/ VA/ CSL Learning/ Computer Suite	35-45 dB(A) _{Leq(when in use)}
	Incubator Project/ Print & Sculpt Workshop	<45 dB(A) _{Leq(when in use)}
	Senior Work/ Informal Shared Learning Area	35-45 dB(A) _{Leq(when in use)}
	Staff Lounge/ Meeting Small	40-45 dB(A) _{Leq(when in use)}
	Photography Studio/ Darkroom	40-45 dB(A) _{Leq(when in use)}
	WC	<55 dB(A) _{Leq(when in use)}
	Robotics Fabrication	<60 dB(A) _{Leq(when in use)}
Staff Residences	Residential Living Areas	35-45 dB(A) _{Leq(anytime)}
	Residential Sleeping Areas (Night Time)	35-40 dB(A) _{Leq(7am-10pm)}
	Residential Common Rooms	40-45 dB(A) _{Leq(when in use)}
	Foyer & Recreation Areas (Games & Breakout Space)	45-50 dB(A) _{Leq(when in use)}

*The documented space is marked as a small performance space which is to be designed with specialist advice for internal noise levels as opposed to the assembly hall or music studio recommendation of AS2107. Iteration of this criteria appropriate for usage by TKS is to be further iterated in CC Stage based on any project requirements above and beyond AS2107:2016.

6.1.2 Summarised External Noise Intrusion Criteria

The internal noise criteria adopted for each internal space is therefore summarised below based on the relevant State, Council and Australian Standard requirements.

Table 6-3 – Adopted Internal Noise Levels

Building	Space /Activity Type	Recommended Design Sound Level Range
Detailed Stage 1: Prep Performing Arts Building & General Learning Units	Music Practice Rooms	45 dB(A) _{Leq(when in use)}
	Music Studios (Small Performance Space)*	35 dB(A) _{Leq(when in use)}
	Foyer	45 dB(A) _{Leq(when in use)}
	Professional and Administrative Offices	40 dB(A) _{Leq(when in use)}
	Office Areas	45 dB(A) _{Leq(when in use)}
	Teaching Spaces (Primary)	45 dB(A) _{Leq(when in use)}
	Open Plan Teaching Spaces/ Breakout	45 dB(A) _{Leq(when in use)}
	Quiet Rooms (Withdrawal Rooms)	45 dB(A) _{Leq(when in use)}
Detailed Stage 1: STEAM Building	Video Editing/ Video Production/ Sound Studio	35 dB(A) _{Leq(when in use)}
	Robotics Assembly	45 dB(A) _{Leq(when in use)}
	Maker Space	45 dB(A) _{Leq(when in use)}
	Shared/ VA/ CSL Learning/ Computer Suite	45 dB(A) _{Leq(when in use)}
	Incubator Project/ Print & Sculpt Workshop	45 dB(A) _{Leq(when in use)}
	Senior Work/ Informal Shared Learning Area	45 dB(A) _{Leq(when in use)}
	Staff Lounge/ Meeting Small	45 dB(A) _{Leq(when in use)}
	Photography Studio/ Darkroom	45 dB(A) _{Leq(when in use)}
	WC	55 dB(A) _{Leq(when in use)}
	Robotics Fabrication	60 dB(A) _{Leq(when in use)}
Detailed Stage 1: Staff Residences	Residential Living Areas	40 dB(A) _{Leq(anytime)}
	Residential Sleeping Areas (Night Time)	35 dB(A) _{Leq(7am-10pm)}
	Residential Common Rooms	45 dB(A) _{Leq(when in use)}
	Foyer & Recreation Areas (Games & Breakout Space)	45 dB(A) _{Leq(when in use)}
Concept Stage 2: Day Boy House & Boarding House	Residential Living Areas (Study)	40 dB(A) _{Leq(anytime)}
	Foyer & Recreation Areas	45 dB(A) _{Leq(when in use)}

*The documented space is marked as a small performance space which is to be designed with specialist advice for internal noise levels as opposed to the assembly hall or music studio recommendation of AS2107. Iteration of this criteria appropriate for usage by TKS is to be further reviewed following concept approval.

6.2 INDICATIVE COMPLYING CONSTRUCTIONS

An indicative assessment of façade requirements to achieve required indoor noise levels has been undertaken. Dimensions of rooms, setbacks from roadways, window openings and floor areas have been used. It is noted that the below complying constructions are for authority approval purposes only and careful selection of materiality and acoustic performance will be conducted at CC Stage with requirements appropriate for usage by TKS.

6.2.1 Glazed Windows and Doors

The following constructions comply with the project noise objectives. Aluminium framed/sliding glass doors and windows will be satisfactory provided they meet the following criteria. All external windows and doors listed are required to be fitted with Q-Ion type acoustic seals. **(Mohair Seals are unacceptable).**

Thicker glazing may be required for structural, safety or other purposes. Where it is required to use thicker glazing than scheduled, this will also be acoustically acceptable. The complying constructions are detailed in Table 6-4.

Table 6-4 – Complying Glazing Constructions

Space	Room	Glazing Thickness	Acoustic Seals
GLU	All Spaces (external façade)	6.38mm Laminated	Yes
PAB	All Tuition Rooms, Offices and Meeting Rooms	10.38mm Laminated	Yes
	Performing Arts Space	12.5mm VLam Hush	Yes
	All Other Spaces (external façade)	6.38mm Laminated	Yes
STEAM Building	Sound Studio, Video Editing and Video Production Studio	10.38mm Laminated	Yes
	Rooftop Skylights	10.38mm Laminated	Yes
	All Other Spaces (external façade)	6.38mm Laminated	Yes
All other buildings and façades (including concept stage buildings)	Bedrooms	6.38mm Laminated	Yes
	Living rooms	6mm Float	Yes
	High noise emissions spaces (performance halls, music practice rooms, engineering workshops etc)	10.38mm Laminated*	Yes
	All other glazing	4mm Float	Yes

*This has also taken into account noise emissions from operational usage of the space.

It is recommended that only window systems having test results indicating compliance with the required ratings obtained in a certified laboratory be used where windows with acoustic seals have been recommended.

In addition to complying with the minimum scheduled glazing thickness, the R_w rating of the glazing fitted into open-able frames and fixed into the building opening should not be lower than the values listed in Table 6-5 for all areas. Where nominated, this will require the use of acoustic seals around the full perimeter of open-able frames and the frame will need to be sealed into the building opening using a flexible sealant.

Table 6-5 – Minimum R_w of Glazing Assembly (with Acoustic Seals)

Glazing Assembly	Minimum R_w of Installed Window
4mm Float	27
6mm Float	29
6.38mm Laminated	31
10.38mm Laminated	35
12.5mm Vlam Hush	40

Note: Façade constructions to be reviewed at CC stage based on construction drawings. The glazing types listed above are indicative and for authority approvals purposes only.

6.2.2 External Wall Construction

External wall construction constructed from concrete/masonry elements will not require acoustic upgrades. Lightweight walls can utilise standard constructions to achieve internal noise levels pending further review in CC Stage.

There should not be vents on the internal skin of external walls. In the event that any penetrations are required thru the external skin, an acoustic sealant should be used to minimise all gaps.

6.2.3 Entry Doors

All doors shall have glazing thicknesses equal to those recommended in Section 6.2.1 and are to have Raven RP10 to the top and sides and Raven RP38 to the underside of a swing door.

Note that mohair seals in windows and doors are not acceptable where acoustic seals are required.

6.2.4 External Roof/Ceiling Construction

External wall construction constructed from concrete/masonry elements will not require acoustic upgrades. Lightweight roofs can utilise standard constructions to achieve internal noise levels pending further review in CC Stage.

In the event that any penetrations are required thru the external skin, an acoustic sealant should be used to minimise all gaps.

7 NOISE EMISSION CRITERIA

The noise emission from the project site shall comply with the requirements of the following documents:

- NSW Planning SEARs document (Ref: SSD-48497708)
- NSW EPA Road Noise Policy (RNP) 2011, and
- NSW EPA Noise Policy for Industry (NPI) 2017.

7.1 NSW PLANNING SEARS DOCUMENT (REF: SSD-48497708)

The NSW Planning Secretary's Environmental Assessment Requirements (Application SSD-48497708) states the following in regard to noise emissions from the proposed site:

Issue and Assessment Requirements – Concept Proposal

11. Noise and Vibration

- *Provide a noise and vibration assessment prepared in accordance with the relevant NSW Environment Protection Authority (EPA) guidelines. The assessment must detail operational noise (including any public-address system, events, and out of hours use of school facilities) and vibration impacts on nearby sensitive receivers and structures, considers noise intrusion, and outline the proposed management and mitigation measures that would be implemented.*

17. Noise and Vibration

- *Provide a noise and vibration assessment prepared in accordance with the relevant NSW Environment Protection Authority (EPA) guidelines. The assessment must detail construction and operational noise (including any public-address system, events, and out of hours use of school facilities) and vibration impacts on nearby sensitive receivers and structures, considers noise intrusion, and outline the proposed management and mitigation measures that would be implemented.*

7.2 NSW EPA ROAD NOISE POLICY 2011

For land use developments with the potential to create additional traffic on public streets the development should comply with the EPA Road Noise Policy.

Noise levels generated by traffic should not exceed the noise levels set out in the table below when measured at a nearby property.

Table 7-1 – Criteria for Traffic Noise Generated by New Developments

Road Type	Time of day	Permissible Noise Generation
Freeways/Arterial/Sub-arterial Roads	Day (7am to 10pm)	60 dB(A) $L_{eq}(1hr)$
	Night (10pm to 7am)	55 dB(A) $L_{eq}(1hr)$

However, if existing noise levels exceed those in the table above, Section 3.4 of the Road Noise Policy is applicable, which requires noise impacts are reduced through feasible and reasonable measures. However, in determining what is feasible/reasonable, the Policy notes that an increase of less than 2dB(A) is a minor impact and would be barely perceptible. The following table therefore presents the adopted criteria based on unattended noise monitoring.

Table 7-2 – Criteria for Traffic Noise Generated by New Developments

Road Type	Time of day	Permissible Noise Generation
Residents along Cumberland Highway/ Pennant Hills Road	Day (7am to 10pm)	70 dB(A) $L_{eq}(1hr)$
	Night (10pm to 7am)	71 dB(A) $L_{eq}(1hr)$

7.3 NSW EPA NOISE POLICY FOR INDUSTRY (NPI) 2017

The EPA NPI has two criteria which both are required to be satisfied, namely Intrusiveness and amenity. The NPI sets out acceptable noise levels for various localities. The policy indicates four categories to assess the appropriate noise level at a site. They are rural, suburban, urban and urban/industrial interface. Under the policy the nearest residential receivers would be assessed against the urban criteria.

Noise levels are to be assessed at the property boundary or nearby dwelling, or at the balcony or façade of an apartment.

7.3.1 Intrusiveness Level

The guideline is intended to limit the audibility of noise emissions at residential receivers and requires that noise emissions measured using the L_{eq} descriptor not exceed the background noise level by more than 5dB(A). Where applicable, the intrusive noise level should be penalised (increased) to account for any annoying characteristics such as tonality.

Background noise levels adopted are presented in Table 5-1. Noise emissions from the site should comply with the noise levels presented below when measured at nearby property boundary.

7.3.2 Project Amenity Level

The guideline is intended to limit the absolute noise level from all noise sources to a level that is consistent with the general environment.

The EPA's NPI sets out acceptable noise levels for various localities. The recommended noise amenity area is based upon the measured background noise levels at the sensitive receiver. Based on the measured background noise levels detailed in Table 5-1, the Noise Policy for Industry suggests the adoption of the 'urban' categorisation.

The NPI requires project amenity noise levels to be calculated in the following manner:

$$L_{Aeq,15min} = \text{Recommended Amenity Noise Level} + 3 \text{ dB(A)}$$

The amenity levels appropriate for the receivers surrounding the site are presented in Table 7-3 and Table 7-4.

Table 7-3 – EPA Amenity Noise Levels

Type of Receiver	Time of day	Amenity Noise Level dB(A) $L_{eq}(\text{period})$	Project Amenity Noise Level dB(A) $L_{eq}(15 \text{ minute})$
Residential – urban R3	Day	60	58
	Evening	50	48
	Night	45	43
Residential – suburban R1, R2, R4, R5	Day	55	53
	Evening	45	43
	Night	40	38

Table 2.2 of the NPI also details the recommended amenity noise level for non-residential receivers as shown below.

Table 7-4 – EPA NPI Noise Emission Criteria (Non-Residences Surrounding Project Site)

Type of Receiver	Time of day	Recommended Noise Level dB(A) $L_{eq}(\text{period})$	Recommended Noise Level dB(A) $L_{eq}(15 \text{ min})$
Commercial premises	When in use	65	63
School classroom – internal	Worst 1 Hour When in use	35 (internal)	35 (internal)

The NSW EPA Noise Policy for Industry (2017) defines:

- Day as the period from 7am to 6pm Monday to Saturday and 8am to 6pm Sundays and Public Holidays.
- Evening as the period from 6pm to 10pm.
- Night as the period from 10pm to 7am Monday to Saturday and 10pm to 8am Sundays and Public Holidays

7.3.3 Sleep Arousal Criteria

The Noise Policy for Industry recommends the following noise limits to mitigate sleeping disturbance:

Where the subject development / premises night -time noise levels at a residential location exceed:

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

a detailed maximum noise level even assessment should be undertaken.

Table 7-5 – Sleep Arousal Criteria for Residential Receivers

Receiver	Rating Background Noise Level (Night) dB(A) L_{90}	Emergence Level
R1/R5	36 dB(A) L_{90}	41 dB(A) $L_{eq, 15min}$; 52 dB(A) L_{Fmax}
R2	33 dB(A) L_{90}	40 dB(A) $L_{eq, 15min}$; 52 dB(A) L_{Fmax}
R3	41 dB(A) L_{90}	46 dB(A) $L_{eq, 15min}$; 56 dB(A) L_{Fmax}
R4	34 dB(A) L_{90}	40 dB(A) $L_{eq, 15min}$; 52 dB(A) L_{Fmax}

7.4 SUMMARISED NOISE EMISSION CRITERIA

Table 7-6 – EPA NPI Noise Emission Criteria (Residents Surrounding Project Site)

Residential Receiver	Time of day	Rating Background Noise Level (RBL) dB(A) $L_{eq}(\text{period})$	Intrusiveness Noise Level dB(A) $L_{eq}(\text{period})$	Project Amenity Noise Level dB(A) $L_{eq}(15 \text{ minute})$	NPI Criteria for Sleep Disturbance
R1/R5	Day (7am – 6pm)	41	46	53	N/A
	Evening (6pm – 10pm)	39	44	43	N/A
	Night (10pm – 7am)	36	41	38	41 dB(A)$L_{eq, 15min}$; 52 dB(A)L_{Fmax}
R2	Day (7am – 6pm)	43	48	53	N/A
	Evening (6pm – 10pm)	38	46	43	N/A
	Night (10pm – 7am)	33	38	38	40 dB(A)$L_{eq, 15min}$; 52 dB(A)L_{Fmax}
R3	Day (7am – 6pm)	56	61	58	N/A
	Evening (6pm – 10pm)	55	60	48	N/A
	Night (10pm – 7am)	41	46	43	46 dB(A)$L_{eq, 15min}$; 56 dB(A)L_{Fmax}
R4	Day (7am – 6pm)	38	43	53	N/A
	Evening (6pm – 10pm)	38	43	43	N/A
	Night (10pm – 7am)	34	39	38	40 dB(A)$L_{eq, 15min}$; 52 dB(A)L_{Fmax}

The project noise trigger levels are indicated by the bolded values in the table above.

Table 7-7 – EPA NPI Noise Emission Criteria (Non-Residences Surrounding Project Site)

Type of Receiver	Time of day	Recommended Noise Level dB(A) $L_{eq}(15 \text{ min})$
Commercial premises	When in use	63
School classroom – internal	Worst 1 Hour When in use	35 (internal)

8 NOISE EMISSION ASSESSMENT

8.1 NOISE FROM MECHANICAL PLANT WITHIN PROPOSED SITE GENERALLY

Detailed plant selection and location has not been undertaken at this stage, however mechanical designs have been proposed for the PAB, GLU and STEAM buildings (Detailed Stage 1 works). AL has provided indicative design advice for mechanical plant treatments in the design package outside of this SSDA, noting that final equipment selections are yet to be made. Noise levels will be able to achieve the noise emissions criteria through appropriate plant selection, location and if necessary, standard acoustic treatments such as duct lining, acoustic silencers and enclosures.

Noise emissions from all mechanical services to the closest residential and commercial receivers should comply with the requirements of Section 7.4. Preliminary mechanical treatment advice has been provided below to provide confidence to any indicative plant uses and locations.

8.1.1 Preliminary Mechanical Treatment Advice

An indicative assessment of initial design of primary plant items is presented below.

- Generators may be used for standby power, these may require attenuation to radiators and air intakes, as well as silencers/mufflers to the exhaust.
- Major fans (typically with a sound power over 80dB(A) – such as kitchen exhaust, major toilet exhaust and major relief air fans) may require acoustic treatment if located externally near sensitive receivers. It is recommended that axial (as opposed to roof mounted fans) are to be used as this will enable acoustic treatment to be incorporated within ductwork running to atmosphere and with attenuators if necessary. Indicatively a one diameter long attenuator or with 2m of internally lined ductwork.
- **Detailed Stage 1 works:**
 - **STEAM Building:** Detailed noise emissions of the STEAM Building have been conducted with specific recommendations for fan selections implemented into the currently ongoing design of the project. No additional barriers are required based on the current documentation.
 - **GLU Building:** Detailed noise emissions of the GLU Building have been conducted with specific recommendations for fan selections implemented into the currently ongoing design of the project. No additional barriers are required based on the current documentation.
 - **PAB Building:** Detailed noise emissions of the PAB Building have been conducted with specific recommendations for fan selections implemented into the currently ongoing design of the project. No additional barriers are required based on the current documentation.
 - **Staff Residences:** Indicative calculations have been conducted for typical residential sized condensers servicing each staff residence either being located in the lower ground floor or on ground floor yards. Based on the current architectural documentation, no additional barrier constructions are required subject to final mechanical plant selections and placements. Condensers may require usage of night mode cards.

- **Concept Stage 2 works:**

- **Day Boy House:** Indicative calculations have been conducted for typical residential sized condensers servicing the day boy house with an indicative location along the northern side of the development to provide conservative assessment to the nearest residential receivers. No additional barrier constructions are required subject to final mechanical plant selections and placements. Condensers may require usage of night mode cards.
- **Sports Pavilion:** Indicative calculations have been conducted for a small kitchen exhaust fan for the canteen and toilet exhaust fans for the change rooms and toilets. Axial fans are recommended to allow for acoustic treatment through lined ducting.
- **Boarding House:** Indicative calculations have been conducted for typical residential sized condensers servicing the boarding house with an indicative location along the north-eastern corner to provide conservative assessment to the nearest residential receivers. No additional barrier constructions are required subject to final mechanical plant selections and placements. Condensers may require usage of night mode cards. A kitchen exhaust fan is also feasible with axial fans allowing for acoustic treatment through lined ducting.

Cumulative assessment of plant noise with other noise sources is recommended when conducting acoustic design of plant items.

Compliance with EPA acoustic criteria (as set out in Section 7.4) will be achievable, provided that detailed acoustic review of plant items is undertaken once plant is selected, and acoustic treatments similar to those outlined above are adopted. Additional detailed acoustic review should be undertaken at CC stage once mechanical plant selections have been made to determine final acoustic treatments to control noise emissions to satisfactory levels.

8.2 NOISE GENERATED BY ADDITIONAL TRAFFIC ON PUBLIC ROADS

Assessment of noise generated by additional traffic on public roads has been undertaken based on the traffic trip generation information provided in the traffic report for the development prepared by TTW (Ref: 221272, dated October 2023).

8.2.1 Pennant Hills Road

The existing peak hour trip generation rate was measured by TTW. The total volume of movements as measured was used to in comparison with the cumulative traffic volume from additional peak hour traffic associated with the proposed development as shown in Table 2.3 and Table 4.6 of the report and replicated in Table 8-1 below.

Table 8-1 – Additional Peak Hour School Traffic Generation Estimate (Pennant Hills Road)

Element	Morning Quantities	Afternoon Quantities
Additional Students	56	
% Travel by car	80%	68%
Additional students travelling by car	45	38
Estimated vehicle occupancy	1.2	1.2
Additional vehicles	37	32
% Travel during peak hour	100%	100%
Additional vehicles during peak hour	37	32
Measured peak hour volume at Pennant Hills Road & Wade Road (school access give-way intersection)	2,479	2,666
Future peak hour volume with additional vehicles included	2,516	2,698

Predictions of traffic noise generation have been made with a modelling assumption that cars are travelling at 40 km/h along all roads due to school zone restrictions with a sound power level of 94 dB(A). The AM Peak volumes have been utilised for conservative assessment.

8.2.2 Masons Drive

The existing peak hour trip generation rate was measured by TTW. The total volume of movements as measured was used to in comparison with the cumulative traffic volume from additional peak hour traffic and any changes from transferred traffic due to the new road structure. The existing and future peak traffic volumes provided by TTW have been replicated in Table 8-2 below.

Table 8-2 – Additional Peak Hour School Traffic Generation Estimate (Masons Drive)

Element	Morning Quantities	Afternoon Quantities
Measured existing peak hour movements by TTW	780	518
Additional traffic generation	25	22
Transferred additional traffic	64	33
Future peak hour volume with additional vehicles included	870	573

8.2.3 Bettington Road

The existing peak hour trip generation rate was measured by TTW. The total volume of movements as measured was used to in comparison with the cumulative traffic volume from additional peak hour traffic and any changes from transferred traffic due to the new road structure. The existing and future peak traffic volumes provided by TTW have been replicated in Table 8-3 below.

Table 8-3 – Additional Peak Hour School Traffic Generation Estimate (Bettington Road)

Element	Morning Quantities	Afternoon Quantities
Measured existing peak hour movements by TTW	878	972
Additional traffic generation	13	11
Transferred additional traffic	0	0
Future peak hour volume with additional vehicles included	891	983

8.2.4 Traffic Noise Generation Predictions

Noise emissions have been predicted at the worst affected residential receivers and compared against the acoustic criteria set out in Section 7.2. Noise levels have been predicted based on the relative increase of traffic volumes as presented in the table above with an assumption that residents are at minimum 10m from the kerb.

Table 8-4 – Cumulative Traffic Noise Including Additional Traffic Generation

Movement Direction	Base Traffic Noise Level – dB(A) L_{eq}	Future Development Noise Level – dB(A) L_{eq}	Compliance
Pennant Hills Road	Day: 68.1 dB(A) $L_{eq(1hr)}$	Day: 68.1 dB(A) $L_{eq(1hr)}$	Complies (≤ 70.1 dB(A) $L_{eq(1hr)}$ day time criteria)
Masons Drive	*Day: 61.3 dB(A) $L_{eq(1hr)}$	Day: 61.7 dB(A) $L_{eq(1hr)}$	Complies (≤ 63.3 dB(A) $L_{eq(1hr)}$ day time criteria)
Bettington Road	*Day: 62.0 dB(A) $L_{eq(1hr)}$	Day: 62.0 dB(A) $L_{eq(1hr)}$	Complies (≤ 64.0 dB(A) $L_{eq(1hr)}$ day time criteria)

*Predicted traffic noise level based on the measured existing peak hour movements travelling at 40km/h.

The potential for additional traffic noise generation from the site is negligible in the context of the existing traffic noise along Pennant Hills Road, Masons Drive and Bettington Road.

8.3 OPERATIONAL NOISE SOURCES – DISCUSSION

An in-principle assessment of operational noise emissions can be discussed to provide insight into potential acoustic concerns with the Detailed Stage 1 proposal of the PAB, GLU, STEAM building and Staff Residences. An in-principle approach has been taken as specific operational noise conditions will be highly dependent on classroom management and variables in school operations.

The sources of noise generation from these additional buildings will typically be noise from indoor classrooms, noise from indoor common and games areas, outdoor playing areas and traffic noise.

The additional noise increase from indoor activities and outdoor playing areas can be controlled to be <1dB(A) based on typical school management controls (such as closing windows when high noise generating activities are occurring internally, staff supervision and limiting common area usage to day and evening time only) which is considered negligible in the context of the existing use of the site as an educational establishment.

AL note that an increase of 1-2dB(A) is imperceptible and is considered negligible. This is consistent with the NSW EPA NPI 2017, where increases of up to 2dB(A) are considered acceptable (Section 11.1.3) and the NSW EPA RNP 2011. The predicted noise increases will be less than 1 dB(A) and will not be noticeable.

Our assessment indicates that the proposed additions will have no adverse impact on neighbouring properties. Therefore, no additional architectural acoustic treatment is required to prevent any adverse noise impact on adjacent residential developments.

8.3.1 Detailed Stage 1 Works

- Noise emissions from the GLU and STEAM building will be primarily dominated by classroom noise and workshops.
 - It is noted that the classrooms and workshops are enclosed, therefore noise emissions will be readily controlled through the appropriate selection of construction materials. Based on an assessment of a typical internal sound pressure level of 85dB(A) within a typical classroom space, noise emissions are adequately treated with the proposed façade treatments.
 - Proposed mechanical plant for the GLU and STEAM building has been reviewed separately with TKS in design, with the STEAM building being the closest to affected residential buildings. No additional barriers are required based on the current mechanical design, therefore noise emissions from the other smaller buildings can be seen to be easily controlled.
 - Proposed operating hours of the centre may include the early morning period of 6am-7am through to 10pm. Due to the far proximity of nearby residents, operation of these spaces during off-peak times will comply with the noise emissions criteria for each specific receiver.
- Noise emissions from the Prep Performing Arts building will be primarily dominated by usage of the tuition rooms and the small performance space.
 - It is noted that the music hall is enclosed and located far from the overall development envelope, therefore noise emissions will be readily controlled through multiple layers of building construction through the appropriate selection of construction materials.
 - Tuition rooms shall be designed to provide flexibility in usage of the space. It is noted that music practise rooms can emit high noise levels, therefore thicker glazed elements shall be explored to mitigate any loss of acoustic amenity to local residents. In any case, a typical internal sound pressure level of up to 95dB(A) within a typical tuition room, noise emissions are adequately treated with the proposed façade treatments.
 - Proposed operating hours of the centre may include the early morning period of 6am-7am through to 10pm.

- Staff residences are unlikely to contribute to noise emissions as per typical residential accommodation. Any noise from mechanical plant servicing the staff residences can be adequately controlled.
- No PA's are proposed for the buildings above.
- Traffic noise generation from pick up and drop off locations will be negligible to the context of the proposal as traffic trip generation numbers are minimal. Minimal noise impacts is predicted to local receivers based on the traffic numbers provided by TTW.

On this basis, noise from the use of the facilities can be justified, noting the following recommendations:

- With current detailed design documentation being procured for the PAB, GLU and STEAM buildings, a detailed review of noise emissions associated with all facilities has been undertaken. Recommendations have already been made and integrated into the architectural and mechanical design. Further iterations to this design post approval will be required based on final plant selections to incorporate acoustic mitigation measures into the architectural design prior to the issue of a construction certificate to ensure operational noise levels meet the noise emission requirements detailed in Section 7.4 as is typical for construction stage.
- External façade and glazing requirements shall be per Section 6.2 subject to further detailed iterations.

8.3.2 Concept Proposal Stage 2 Works

Given the conceptual nature of Stage 2 works, the following comments are provided for perceived operational noise.

- The sports pavilion may increase local noise emissions from patrons supporting any sport played on the existing fields which the pavilion is to service. Given that the nearest resident is over 500m away, the following comments are provided:
 - Internal noise emissions can be adequately controlled through glazing thickness and appropriate architectural constructions.
 - External noise emissions from sources such as patrons shouting have been reviewed. Cumulative sound power levels of up to 100 dB(A) at the sports pavilion are predicted to comply with the night time noise criteria at the nearest resident at **R4**. This correlates to over 200 patrons with 1 in 2 speaking at any given time. This is unlikely to occur, and is only provided as context to assure that operational noise emissions are readily compliant.
- The day boy house and boarding house will have low noise emissions provided adequate management controls are put in place for student etiquette. This can be managed by TKS through allowances such as site managers or supervisors as well as student education.
- General mechanical treatments have been provided in the above sections of this report, however it is recommended that a review and detailed design of all mechanical plant associated with the site be undertaken prior to the issue of a construction certificate to ensure plant noise levels meet the noise emission requirements detailed in Section 7.4. Specific mechanical recommendations can be made at a future detailed application stage, however it is typical to provide final acoustic advice at construction stage. Any review of mechanical plant noise should take into consideration the operational noise levels from the site, such that the cumulative noise does not exceed the PNTL's.
- External façade and glazing requirements shall be per Section 6.2 subject to further detailed iterations.

9 CONSTRUCTION NOISE AND VIBRATION OBJECTIVES

All construction noise and vibration objectives presented below relate to both Stage 1 works and future construction associated with future stages.

9.1 NSW PLANNING SEARS DOCUMENT (REF: SSD-48497708)

The NSW Planning Secretary's Environmental Assessment Requirements (Application SSD-48497708) states the following in regard to construction noise emissions from the proposed site:

Issue and Assessment Requirements – Concept Proposal

11. Noise and Vibration

- *Provide a noise and vibration assessment prepared in accordance with the relevant NSW Environment Protection Authority (EPA) guidelines. The assessment must detail operational noise (including any public-address system, events, and out of hours use of school facilities) and vibration impacts on nearby sensitive receivers and structures, considers noise intrusion, and outline the proposed management and mitigation measures that would be implemented.*

Issue and Assessment Requirements – Stage 1 Works

7. Noise and Vibration

- *Provide a quantitative assessment of the main noise and vibration generating noise sources and activities during construction and operation of the Stage 1 works in accordance with the relevant NSW Environment Protection Authority (EPA) guidelines.*
- *Outline measures to minimise and mitigate the potential construction and operational noise impacts on nearby sensitive receivers including proposed management and mitigation measures that would be implemented.*

17. Noise and Vibration

- *Provide a noise and vibration assessment prepared in accordance with the relevant NSW Environment Protection Authority (EPA) guidelines. The assessment must detail construction and operational noise (including any public-address system, events, and out of hours use of school facilities) and vibration impacts on nearby sensitive receivers and structures, considers noise intrusion, and outline the proposed management and mitigation measures that would be implemented.*
- *Provide a quantitative assessment of the main noise and vibration generating noise sources and activities during construction in accordance with the relevant NSW Environment Protection Authority (EPA) guidelines.*
- *Outline measures to minimise and mitigate the potential construction noise impacts on nearby sensitive receivers including proposed management and mitigation measures that would be implemented.*

9.2 TYPICAL CONSTRUCTION HOURS

The following standard construction hours are proposed based on the NSW DECC *Interim Construction Noise Guideline*. Works proposed outside this time period shall be further assessed.

- Monday to Friday: 7:00am-6:00pm, and
- Saturday 8:00am-1:00pm.

9.3 NOISE OBJECTIVES

Noise associated with construction activities on the site will be assessed in conjunction with the following documents and guidelines:

- NSW DECC *Interim Construction Noise Guideline* (ICNG) 2009 and
- Australian Standard 2436-2010 *"Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites"*.

9.3.1 NSW DECC Interim Construction Noise Guideline 2009

The EPA Interim Construction Noise Guideline (ICNG) assessment requires:

- Determination of noise management levels (based on ambient noise monitoring);
- Review of operational noise levels at nearby development; and
- If necessary, recommendation of noise controls strategies in the event that compliance with noise emission management levels is not possible.

EPA guidelines adopt differing strategies for noise control depending on the predicted noise level at the nearest residences:

- *"Noise affected" level. Where construction noise is predicted to exceed the "noise affected" level at a nearby residence, the proponent should take reasonable/feasible work practices to ensure compliance with the "noise affected level". For residential properties, the "noise affected" level occurs when construction noise exceeds ambient levels by more than 10dB(A)Leq(15min).*
- *"Highly noise affected level". Where noise emissions are such that nearby properties are "highly noise affected", noise controls such as respite periods should be considered. For residential properties, the "highly noise affected" level occurs when construction noise exceeds 75dB(A)Leq(15min) at nearby residences.*

In addition to the above management levels for residential receivers, the ICNG nominates a Management Level of 70dB(A) $L_{eq(15min)}$ at commercial receiver facades (typical office, retail). And a Management Level of RBL + 5 dB(A) for any work done outside of standard hours.

A summary of the above recommended noise levels from the ICNG is presented below.

Table 9-1 – Noise Emission Goal at Residential Property Boundaries

Location	"Noise Affected" Level - dB(A) $L_{eq(15min)}$ Standard Hours	"Highly Noise Affected" Level - dB(A) $L_{eq(15min)}$
R1/R5	51, externally at façade	75
R2	53, externally at façade	75
R3	66, externally at façade	75
R4	48, externally at façade	75

Where noise from the construction works is above the “noise affected” level, the proponent shall apply any feasible and reasonable work practices to minimise noise. The “noise affected level is representative of a level where there may be some community reaction to noise.

If noise emissions are likely to exceed 75 dB(A)_{Leq(15min)} “highly noise affected” at the boundary of surrounding affected residential receivers, the receiver is deemed to be “highly noise affected”. The “highly noise affected” level is representative of a level where strong community reaction to noise is expected. Introduction of management controls such as scheduling of noisy periods, or respite periods is then recommended.

Section 4.1.2 and 4.1.3 of the EPA Interim Construction Noise Guideline also nominates management levels for other sensitive land uses (other than residences). Criteria relevant to this assessment is detailed below.

Table 9-2 – Noise Emission Goal at Commercial/Sensitive Property Boundaries

Location	“Noise Affected” Level – dB(A)_{Leq(15min)} Standard Hours
Surrounding Commercial Receivers	70 externally at façade
Classrooms at schools and other educational institutions	45 internally

It is noted that the ICNG noise management levels apply to receivers outside the development. As the closest buildings within TKS development envelope are owned by the proponent, any management of noise and vibration with these buildings will be liaised directly with representatives of the proponent.

9.3.2 Australian Standard AS2436:2010 “Guide to Noise Control on Construction, Maintenance and Demolition Sites”

The Australian Standard AS2436 states that where all reasonable and available measures have been taken to reduce construction noise, mitigation strategies may be put in place to reduce levels noise levels to within a reasonable and acceptable level.

For the control and regulation of noise from construction sites, AS2436:1981 nominates the following:

- a. *That reasonable suitable noise criterion is established,*
- b. *That all practicable measures be taken on the building site to regulate noise emissions, including the siting of noisy static processes to locations of the site where they can be shielded, selecting less noisy processes, and if required regulating construction hours, and*
- c. *The undertaking of noise monitoring where non-compliance occurs to assist in the management and control of noise emission from the construction site.*

The guideline reflects on feasible and reasonable mitigation strategies, management controls and public liaising in the effort to reach realistic compromises between construction sites and potential noise affected receivers.

Based on these criteria the following procedure will be used to assess noise emissions:

- Predict noise levels produced by typical construction activities at the sensitive receivers.
- Adopt management conditions as per AS2436 in the event of a non-compliance.

9.4 VIBRATION OBJECTIVES

Vibration caused by construction at any residence or structure outside the subject site will be assessed with reference to the following:

- For structural damage vibration, German Standard DIN 4150-3 *Structural Vibration: Effects of Vibration on Structures*; and
- For human exposure to vibration, Department of Environment and Conservation NSW "Assessing Vibration: A Technical Guideline" (Feb 2006) is based on the guidelines contained in BS 6472:1992 *Guide to Evaluate Human Exposure to Vibration in Buildings (1Hz to 80Hz)* for low probability of adverse comment.

The criteria and the application of this standard are discussed in separate sections below.

9.4.1 Structure Borne Vibrations

German Standard DIN 4150-3 (2016-12) provides a guideline for acceptable levels of vibration velocity in building foundations, to assess the effects of vibration on structures. The table give guidance on the maximum accepted values of velocity at the foundation and in the plane of the highest floor of various types of buildings, to prevent any structural damage.

The table below lists the peak particle velocity, which is the maximum absolute value of the velocity signals for the three orthogonal components. This is measured as a maximum value of any of the three orthogonal component particle velocities when measured at the foundation, and the maximum levels measured in the x- and y-horizontal directions in the plane of the floor of the uppermost storey.

Table 9-3 – DIN 4150-3 (2016-12) Safe Limits for Building Vibration

TYPE OF STRUCTURE		PEAK PARTICLE VELOCITY (mms ⁻¹)				
		At Foundation at a Frequency of			Plane of Floor of Uppermost Storey	Floor Slabs, Vertical Direction
		<10Hz	10Hz to 50Hz	50Hz to 100Hz	All Frequencies	All Frequencies
1	Buildings used in commercial purposes, industrial buildings, and buildings of similar design	20	20 to 40	40 to 50	40	20
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15	20
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Lines 1 or 2 and have intrinsic value (e.g., buildings that are under a preservation order)	3	3 to 8	8 to 10	8	20

9.4.2 Assessing Amenity

The NSW EPA's *Assessing Vibration – A Technical Guideline* is based on the guidelines contained in British Standard BS 6472-1992 *Guide to Evaluate Human Exposure to Vibration Buildings (1Hz to 80Hz)*. This guideline provides procedures for assessing tactile vibration and regenerated noise within potentially affected buildings.

The recommendations of this guideline should be adopted to assess and manage vibration from the site. Where vibration exceeds, or is likely to exceed, the recommended levels then an assessment of reasonable and feasible methods for the management of vibration should be undertaken.

Table 9-4 – BS 6472 Vibration Criteria

		RMS acceleration (m/s ²)		RMS velocity (mm/s)		Peak velocity (mm/s)	
Place	Time	Preferred	Maximum	Preferred	Maximum	Preferred	Maximum
Continuous Vibration							
Residences	Daytime	0.01	0.02	0.2	0.4	0.28	0.56
Offices	Day or night-time	0.02	0.04	0.4	0.8	0.56	1.1
Workshops		0.04	0.08	0.8	1.6	1.1	2.2
Impulsive Vibration							
Residences	Daytime	0.3	0.6	6.0	12.0	8.6	17.0
Offices	Day or night-time	0.64	1.28	13	26	18	36
Workshops		0.64	1.23	13	26	18	36

Note 1: Continuous vibration relates to vibration that continues uninterrupted for a defined period (usually throughout the daytime or night-time), e.g., continuous construction or maintenance activity. (DECC, 2006).

Note 2: Impulsive vibration relate to vibration that builds up rapidly to a peak followed by a damped decay and that may or may not involve several cycles of vibration (depending on frequency and damping), with up to three occurrences in an assessment period, e.g., occasional loading and unloading, or dropping of heavy equipment. (DECC, 2006).

9.5 PRELIMINARY CONSTRUCTION ACTIVITY ASSESSMENT

Typical equipment/processes anticipated to be used for the construction of the subject development are presented below for preliminary analysis, noting that specific processes will be selected by the builder during the construction stage. Noise impacts from these activities on the amenity of the surrounding identified sensitive receivers, will be predicted in this section. Typically, the most significant sources of noise or vibration generated during a construction project will be demolition, excavation, civil works (compaction, asphaltting) and piling.

The A-weighted sound power levels for the expected typical loudest equipment/processes for each stage of development are outlined in the table below.

Table 9-5 – Proposed Construction Activities and Associated Typical Sound Power Levels

Construction Stage	Equipment /Process	Typical Sound Power Level dB(A)
Demolition	Jackhammers	121
	Concrete Saw	117
	Machine Mounted Hydraulic Drill	113
	Excavator & Trucks	107
Excavation	Piling (bored)	111
	Vibratory Roller	108
	Excavator & Trucks	107
	Mobile Crane	104
	Powered Hand Tools (Electric)	102
Construction	Concrete Pump Truck	108
	Excavator & Trucks	107
	Mobile Crane	104
	Powered Hand Tools (Electric)	102

The noise levels presented in the above table are derived from the following sources:

1. On-site measurements
2. Table A1 of Australian Standard 2436-2010, and
3. *Data held by this office from other similar studies.

Noise levels take into account correction factors (for tonality, intermittency where necessary). These processes have been selected for indicative analysis and are subject to builder selection during construction stage.

The predicted noise levels during excavation and construction will depend on:

- The activity undertaken.
- The distance between the work site and the receiver. For many of the work areas, the distance between the noise source and the receiver will vary depending on which end of the site the work is undertaken. For this reason, the predicted noise levels will be presented as a range.

Predicted noise levels are presented below. Predictions take into account the following:

- Noise reduction as a result of distance.
- Barrier effects resulting from shielding of the surrounding buildings (where applicable).
- Demolition plan per Appendix One – Demolition Plan.

The following predictions represent a worst-case scenario for each respective item. The highest predicted noise levels assume direct line of sight with no barrier effects (such as second storey receivers with direct line of sight to the operating construction machinery). For context, noise levels above relevant noise management levels but under the highly noise affected level have been considered as medium acoustic impact on specific receivers.

Table 9-6 – Predicted Noise Generation to R1 Residential Receiver

Activity	Predicted Level – dB(A) L_{eq}(15min) (External Areas)	Comment*
Jackhammer (Demolition only)	55-66	Exceeds 51 dB(A) Noise Management Level but under 75 dB(A) Highly Noise Affected Level (medium noise impact, see Section 9.6)
Concrete Saw (Demolition only)	51-62	
Machine Mounted Hydraulic Drill (Demolition only)	47-58	Exceeds 51 dB(A) Noise Management Level when working close to the north-eastern boundary but under 75 dB(A) Highly Noise Affected Level (medium noise impact, see Section 9.6)
Piling (bored) (Excavation only)	45-63	
Vibratory Roller (Excavation) & Concrete Pump Truck (Construction)	42-59	
Excavator & Trucks	41-59	
Mobile Crane	39-57	
Powered Hand Tools (Electric)	36-54	

Table 9-7 – Predicted Noise Generation to R2 Residential Receiver

Activity	Predicted Level – dB(A) L_{eq}(15min) (External Areas)	Comment
Jackhammer (Demolition only)	51-56	Exceeds 53 dB(A) Noise Management Level when working close to the eastern boundary but under 75 dB(A) Highly Noise Affected Level (medium noise impact, see Section 9.6)
Concrete Saw (Demolition only)	47-52	Under 53 dB(A) Noise Management Level
Machine Mounted Hydraulic Drill (Demolition only)	43-48	
Piling (bored) (Excavation only)	41-69	Exceeds 53 dB(A) Noise Management Level when working close to the eastern boundary but under 75 dB(A) Highly Noise Affected Level (medium noise impact, see Section 9.6)
Vibratory Roller (Excavation) & Concrete Pump Truck (Construction)	38-66	
Excavator & Trucks	37-65	
Mobile Crane	35-63	
Powered Hand Tools (Electric)	32-60	

Table 9-8 – Predicted Noise Generation to R3 Residential Receiver

Activity	Predicted Level – dB(A) L_{eq}(15min) (External Areas)	Comment
Jackhammer (Demolition only)	55-63	Under 66 dB(A) Noise Management Level
Concrete Saw (Demolition only)	51-59	
Machine Mounted Hydraulic Drill (Demolition only)	47-55	
Piling (bored) (Excavation only)	45-59	
Vibratory Roller (Excavation) & Concrete Pump Truck (Construction)	42-56	
Excavator & Trucks	41-55	
Mobile Crane	39-53	
Powered Hand Tools (Electric)	36-50	

Table 9-9 – Predicted Noise Generation to R4 Residential Receiver

Activity	Predicted Level – dB(A) L_{eq}(15min) (External Areas)	Comment
Jackhammer (Demolition only)	49-58	Exceeds 48 dB(A) Noise Management Level but under 75 dB(A) Highly Noise Affected Level (medium noise impact, see Section 9.6)
Concrete Saw (Demolition only)	45-54	Exceeds 48 dB(A) Noise Management Level when working close to the western boundary but under 75 dB(A) Highly Noise Affected Level (medium noise impact, see Section 9.6)
Machine Mounted Hydraulic Drill (Demolition only)	41-50	
Piling (bored) (Excavation only)	39-48	Under 48 dB(A) Noise Management Level
Vibratory Roller (Excavation) & Concrete Pump Truck (Construction)	36-45	
Excavator & Trucks	35-44	
Mobile Crane	33-42	
Powered Hand Tools (Electric)	30-39	

Table 9-10 – Predicted Noise Generation to R5 Residential Receiver

Activity	Predicted Level – dB(A) L_{eq}(15min) (External Areas)	Comment
Jackhammer (Demolition only)	51-62	Exceeds 51 dB(A) Noise Management Level when working close to the northern boundary but under 75 dB(A) Highly Noise Affected Level (medium noise impact, see Section 9.6)
Concrete Saw (Demolition only)	47-58	
Machine Mounted Hydraulic Drill (Demolition only)	43-54	
Piling (bored) (Excavation only)	41-52*	Under 51 dB(A) Noise Management Level
Vibratory Roller (Excavation) & Concrete Pump Truck (Construction)	38-49	
Excavator & Trucks	37-48	
Mobile Crane	35-46	
Powered Hand Tools (Electric)	32-43	

*A 1-2 dB(A) exceedance is imperceptible to the human ear and is considered negligible.

Table 9-11 – Predicted Noise Generation to E1 Educational Receiver

Activity	Predicted Level – dB(A) L_{eq}(15min) (Internal Areas)	Comment
Jackhammer (Demolition only)	43-61	Exceeds 45 dB(A) Noise Management Level when working close to the south-western boundary (medium noise impact, see Section 9.6)
Concrete Saw (Demolition only)	39-57	
Machine Mounted Hydraulic Drill (Demolition only)	35-53	
Piling (bored) (Excavation only)	33-51	
Vibratory Roller (Excavation) & Concrete Pump Truck (Construction)	30-48	
Excavator & Trucks	29-47	
Mobile Crane	27-45	Under 45 dB(A) Noise Management Level
Powered Hand Tools (Electric)	24-42	

*A 1-2 dB(A) exceedance is imperceptible to the human ear and is considered negligible.

Internal noise levels were predicted by taking a conservative 10dB(A) reduction through a naturally ventilated open window. Noise reduction through a closed façade is likely to be in the range of 20-30dB(A).

Exceedances of specific noise management levels are not considered high acoustic impact on receivers. When noise levels approach the highly noise affected noise management level, specific noise management controls such as respite periods can be introduced. It is noted however that introducing respite periods for lower acoustic impact noise levels may prolong the construction process excessively and provide an overall loss of amenity for local receivers. Careful management is to be maintained with TKS, surrounding receivers and the Builder.

9.6 PRELIMINARY CONSTRUCTION RECOMMENDATIONS

In light of the above, we recommend:

1. **Community Consultation/Notification:** Notification (leaflet or similar) of all residents as marked in Figure 1 is to be done prior to commencement of works.
2. **Respite Periods:** To protect the amenity of nearby residential receivers, respite periods may be implemented where construction activities exceed the 'highly noise affected level (75 dB(A) $L_{eq(15min)}$). Specific recommendations of respite periods are to be addressed in a full construction noise and vibration management plan during construction stage if requested. In general:
 - a. It is noted that the construction plant which is predicted to exceed the 'highly noise affected level' would only be in use intermittently during the demolition and excavation stage. As part of any proposed respite conditions, it is recommended to limit demolition and excavation works to not be carried out on Saturdays to reduce noise impacts outside of standard hours.
 - b. It is noted that respite periods will extend the length of demolition, excavation and construction works and may provide heavier loss of amenity compared to non-imposed excavation.
3. **Liaison with TKS:** Noise from construction processes to buildings within the greater TKS will be managed through liaison with representatives of the school and the builder directly to minimise impacts within the greater development.
4. **Vibration Monitoring (Detailed Stage 1):** In the event of ongoing complaints of excessive vibration, vibration monitoring is to be implemented along the property boundary closest to the vibration receiver who issued the complaint for a short period to ascertain whether vibration parameters have been exceeded. If exceedances are found, adjustments to the construction process exceeding the parameter must be made to reduce the vibration level at the receiver. Specific recommendations for the Concept Proposal (Stage 2) shall be made post concept approval.
5. **Noise Monitoring (Detailed Stage 1):** In the event of ongoing complaints of excessive noise, noise monitoring is to be implemented along the property boundary closest to the noise receiver who issued the complaint for a short period to ascertain whether noise parameters are above reasonable levels per the site-specific noise management levels/ highly noise affected level. If exceedances are found, adjustments to the construction process exceeding the parameter must be made to reduce the noise level at the receiver or appropriately manage time slots of usage of the process to minimise impact on the receiver in question. Specific recommendations for the Concept Proposal (Stage 2) shall be made post concept approval.
6. **Quiet Work Methods/Technologies:**
 - a. Materials handling/vehicles:
 - i. Trucks to use a non-tonal reversing beacon (subject to OH&S requirements) to minimise potential disturbance of neighbours.
 - ii. Avoid careless dropping of construction materials into empty trucks.
 - iii. Trucks, trailers and concrete trucks (if feasible) shall turn off their engines during idling to reduce noise impacts.
7. **Complaints Handling:** Procedures to handle and review complaints can be implemented.
8. **Site Induction:**
 - a. A copy of the Construction Noise and Vibration Management Plan is to be available to contractors. The location of the CNVMP shall be advised in any site induction.
 - b. Site induction shall also detail the site contact in the event of noise complaint.

10 CONCLUSION

This report presents an acoustic assessment of noise and vibration impacts associated with The King's School (TKS) Masterplan & STEAM Building.

Internal noise criteria have been established to satisfy the requirements of Australian Standard AS2107:2016 *Recommended Design Sound Levels and Reverberation Times for Building Interiors*.

External noise emissions criteria have been established in this report to satisfy the requirements from the following documents:

- NSW Planning SEARs document (Ref: SSD-48497708)
- NSW EPA *Road Noise Policy* (RNP) 2011, and
- NSW EPA *Noise Policy for Industry* (NPI) 2017.

Construction noise and vibration objectives have been established in this report to satisfy the requirements of the following documents:

- NSW DECC *Interim Construction Noise Guideline* (ICNG) 2009
- Australian Standard 2436-2010 *Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites*
- German Standard DIN 4150-3 (2016-12), and
- NSW EPA *Assessing Vibration – A Technical Guideline*.

Preliminary assessment and mitigation techniques have been recommended. A full construction noise and vibration management plan can be conducted during construction stage if required.

AL confirms that if the proposed development is undertaken in accordance with this plan, the development is supported for approval.

We trust this information is satisfactory. Please contact us should you have any further queries.

Yours faithfully,



Acoustic Logic Pty Ltd
Weber Yeh

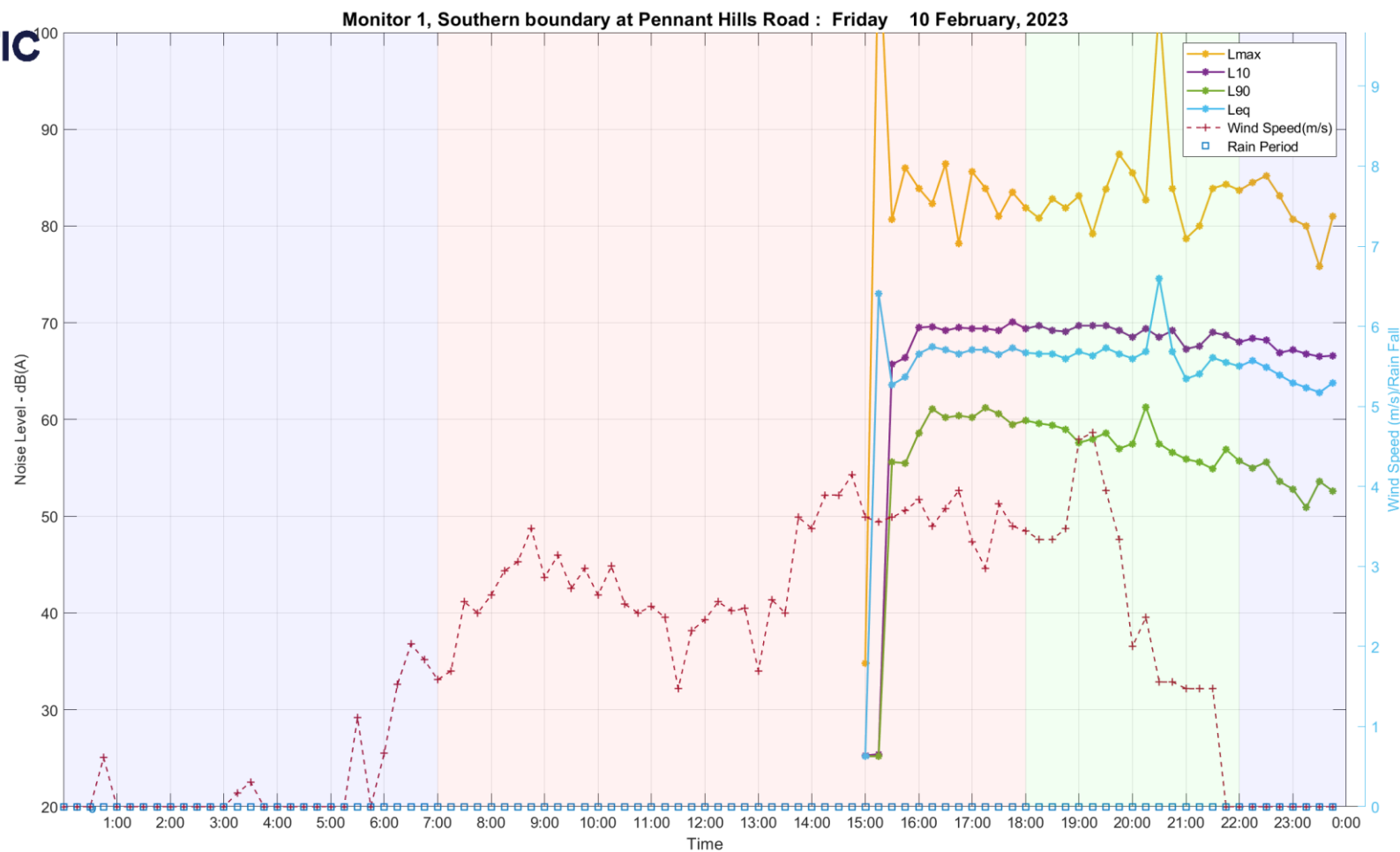
APPENDIX ONE – DEMOLITION PLAN

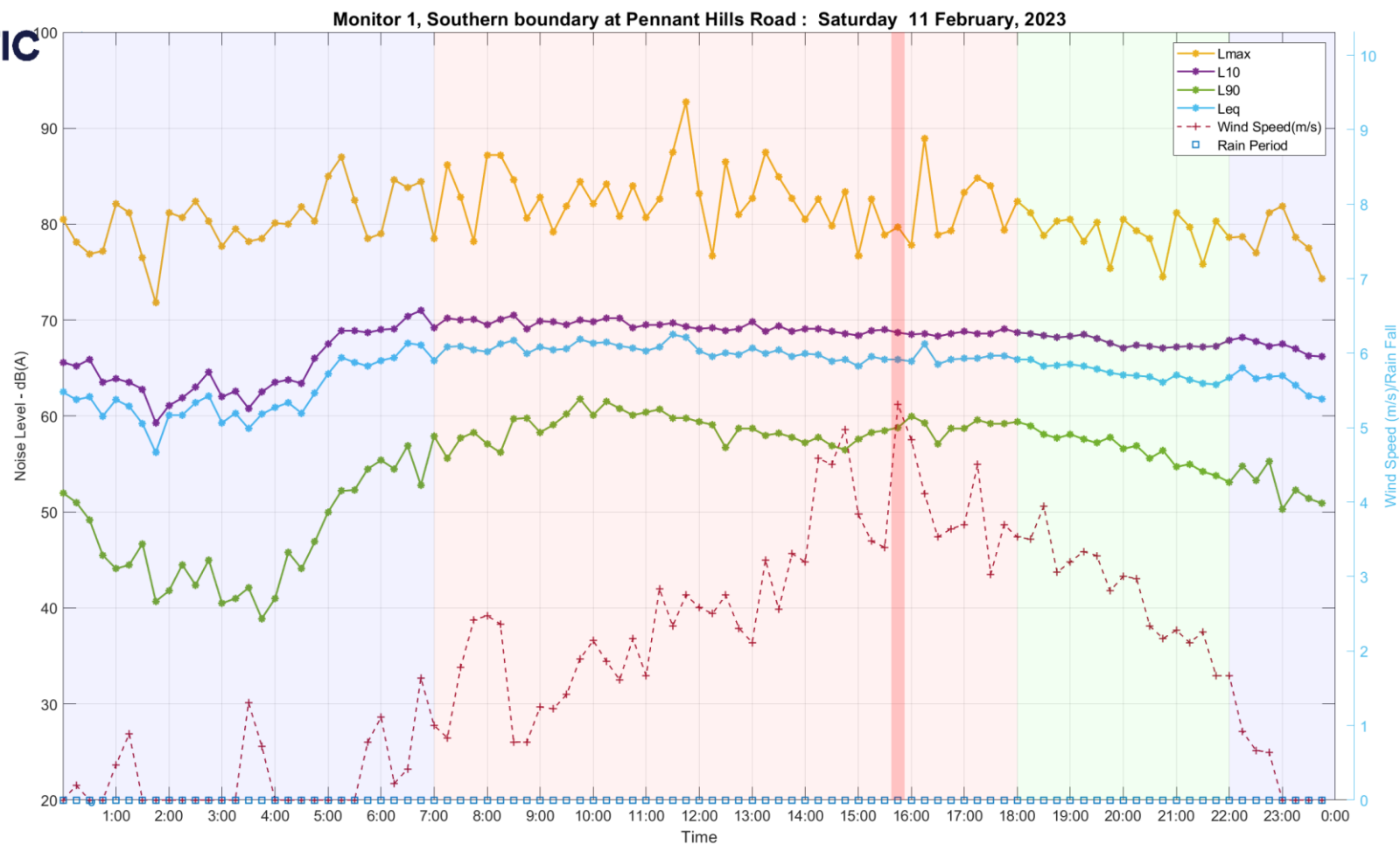


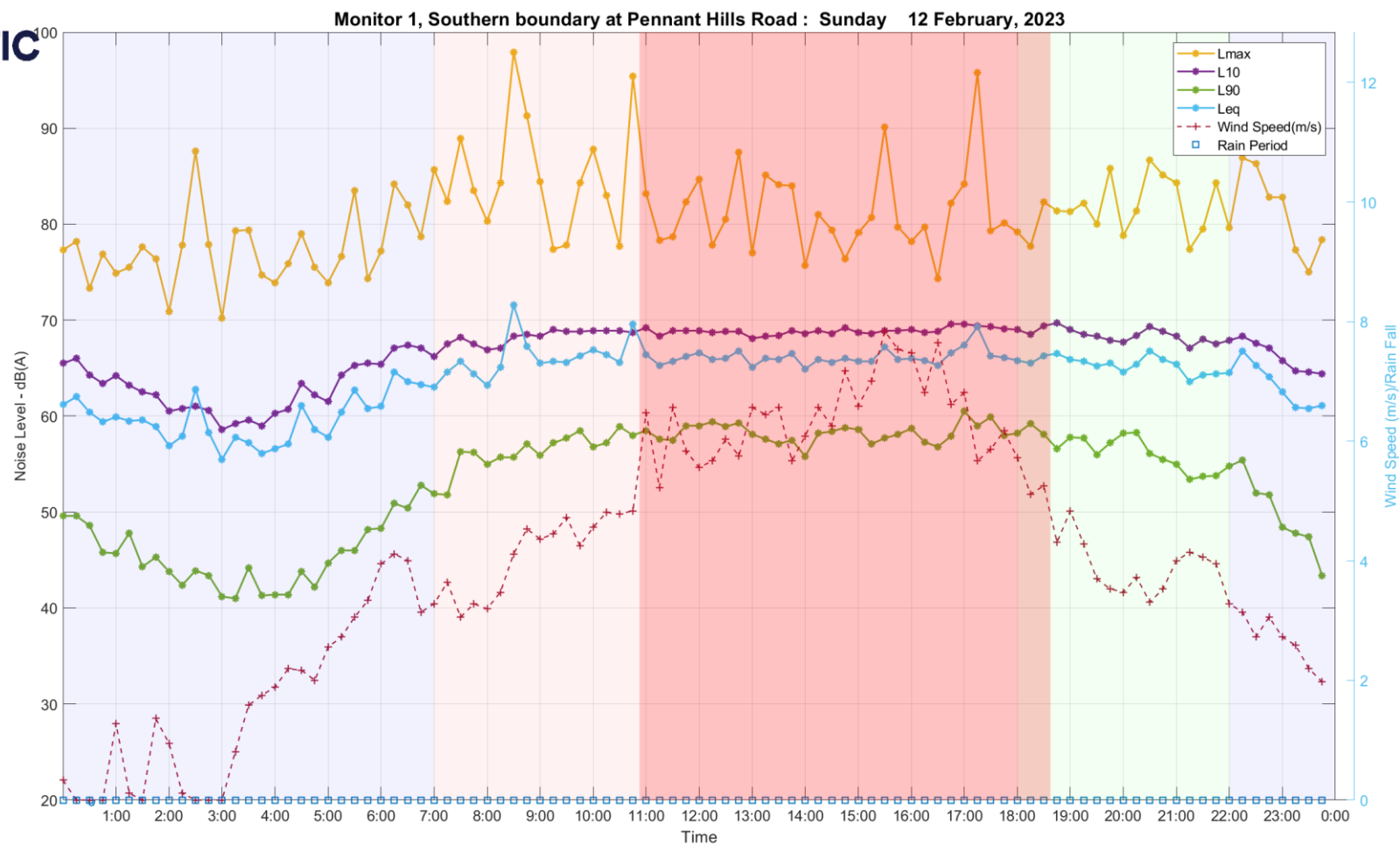


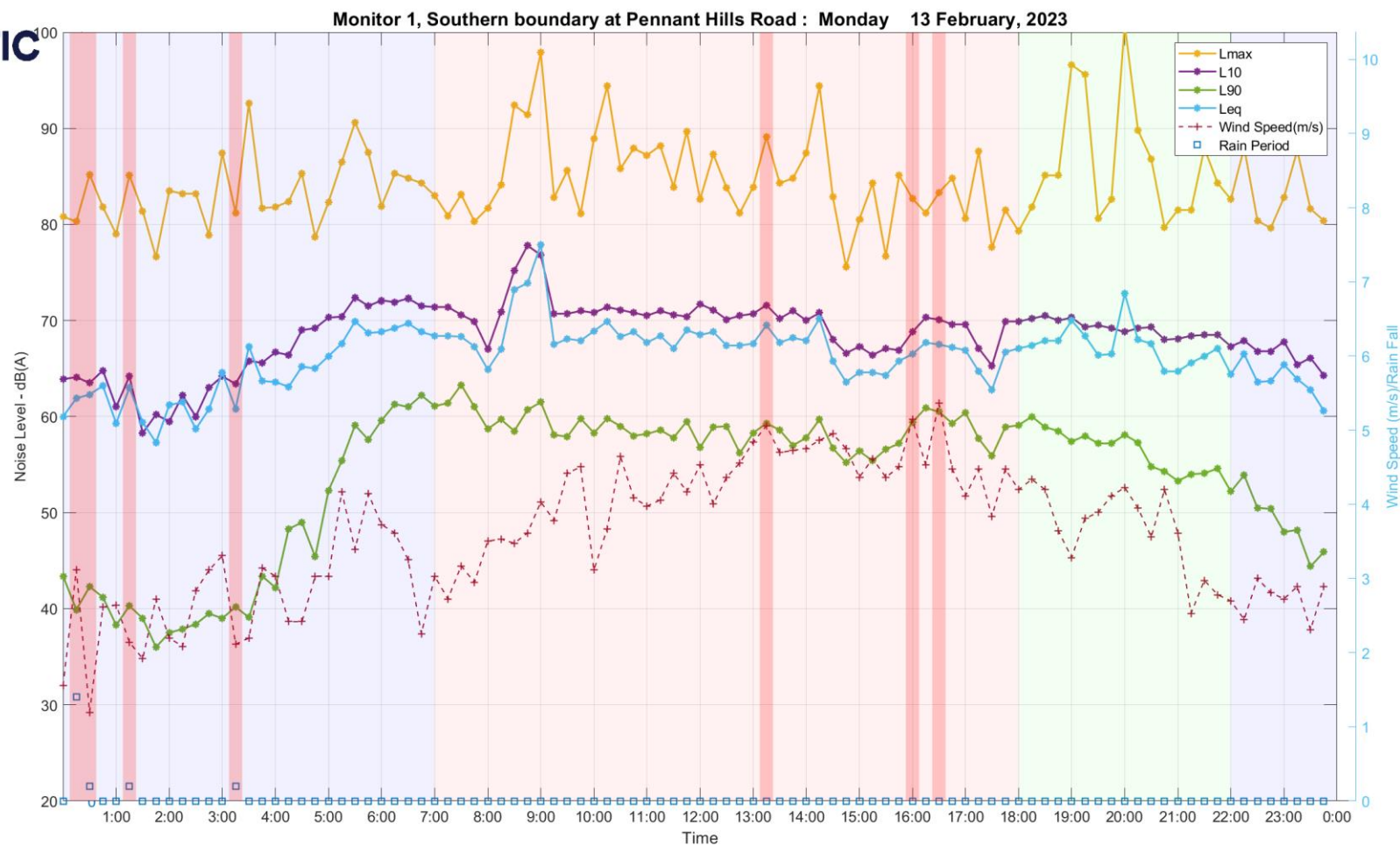
APPENDIX TWO – UNATTENDED NOISE MONITORING

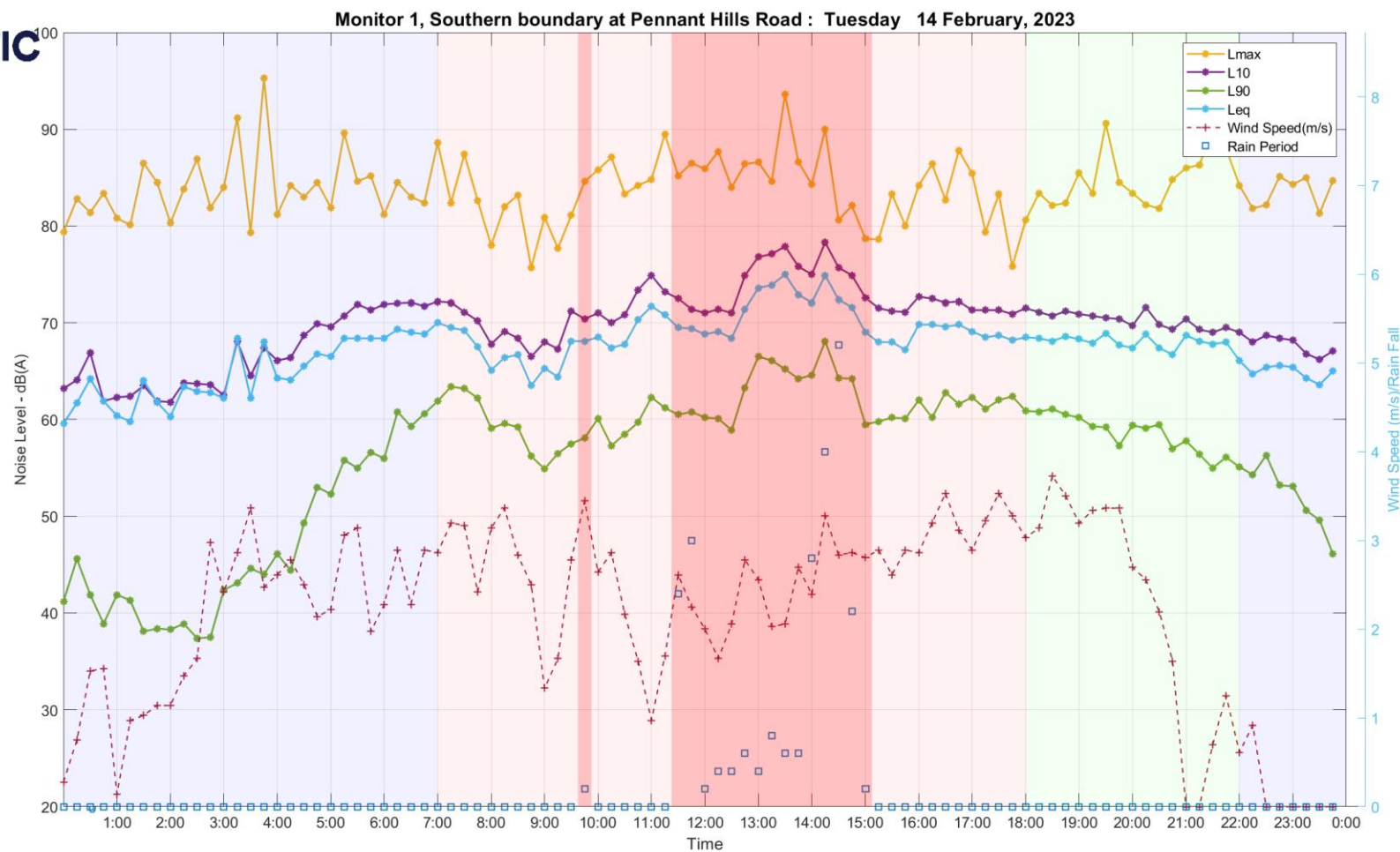
MONITOR 1 – SOUTHERN BOUNDARY AT PENNANT HILLS ROAD

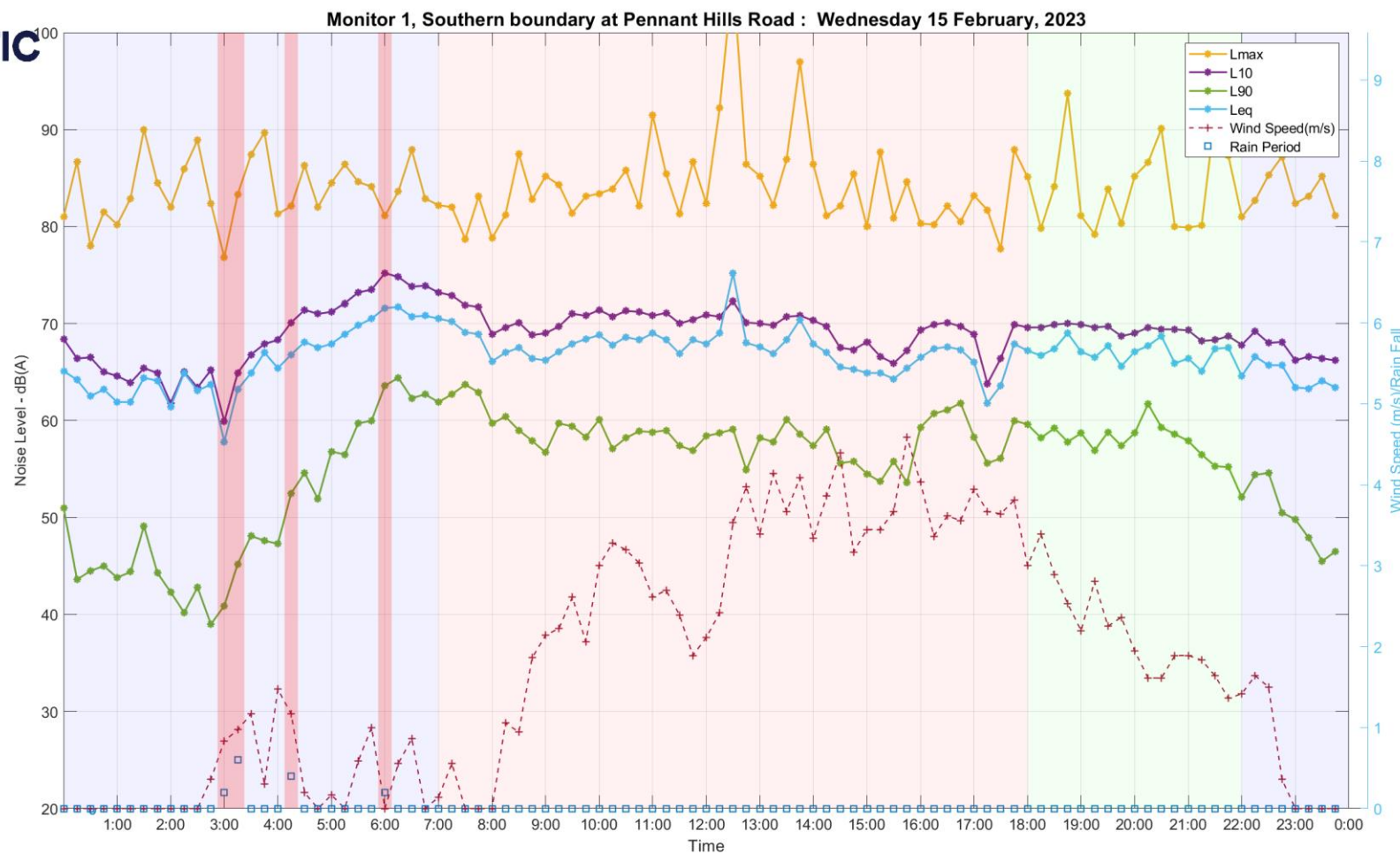


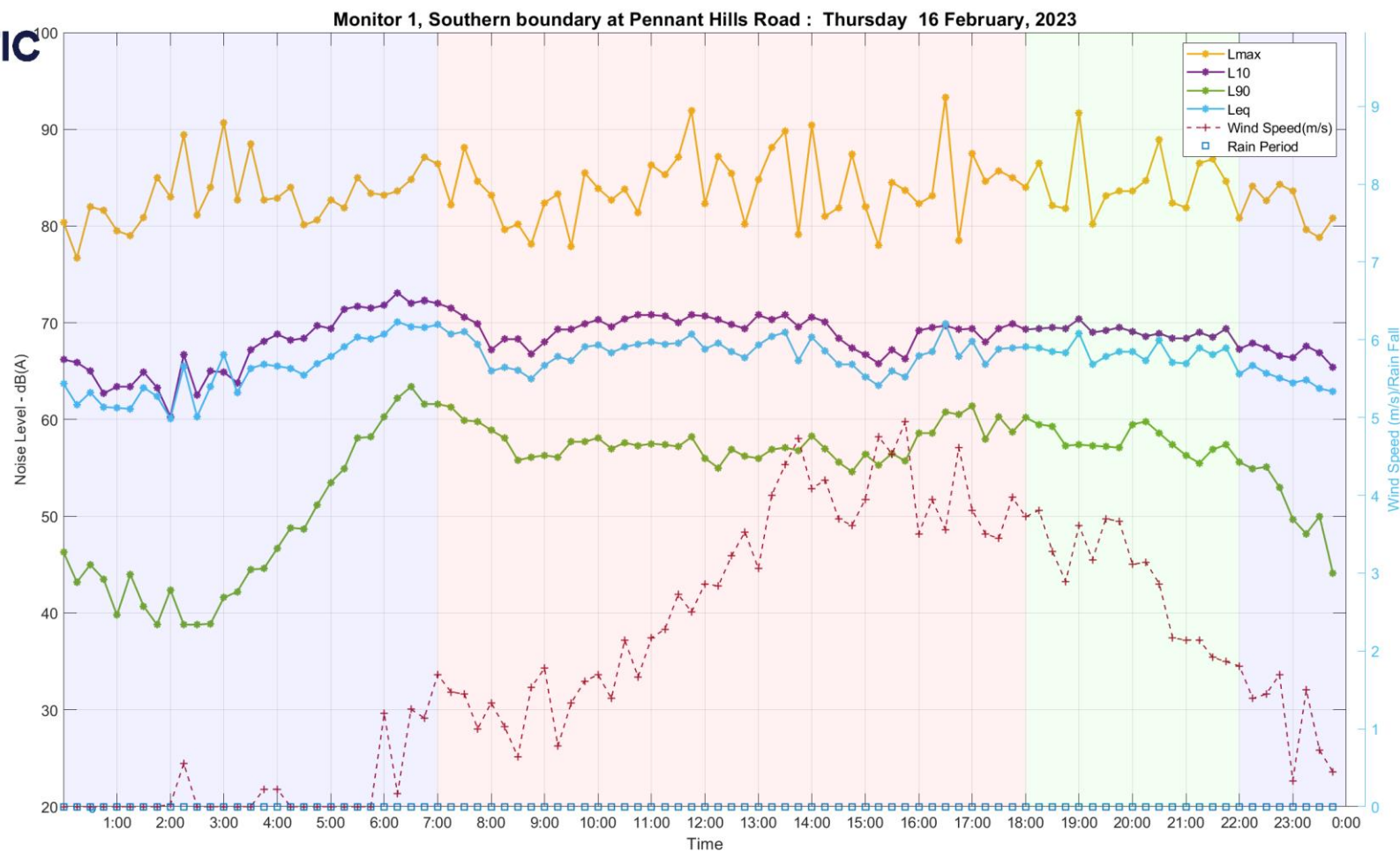


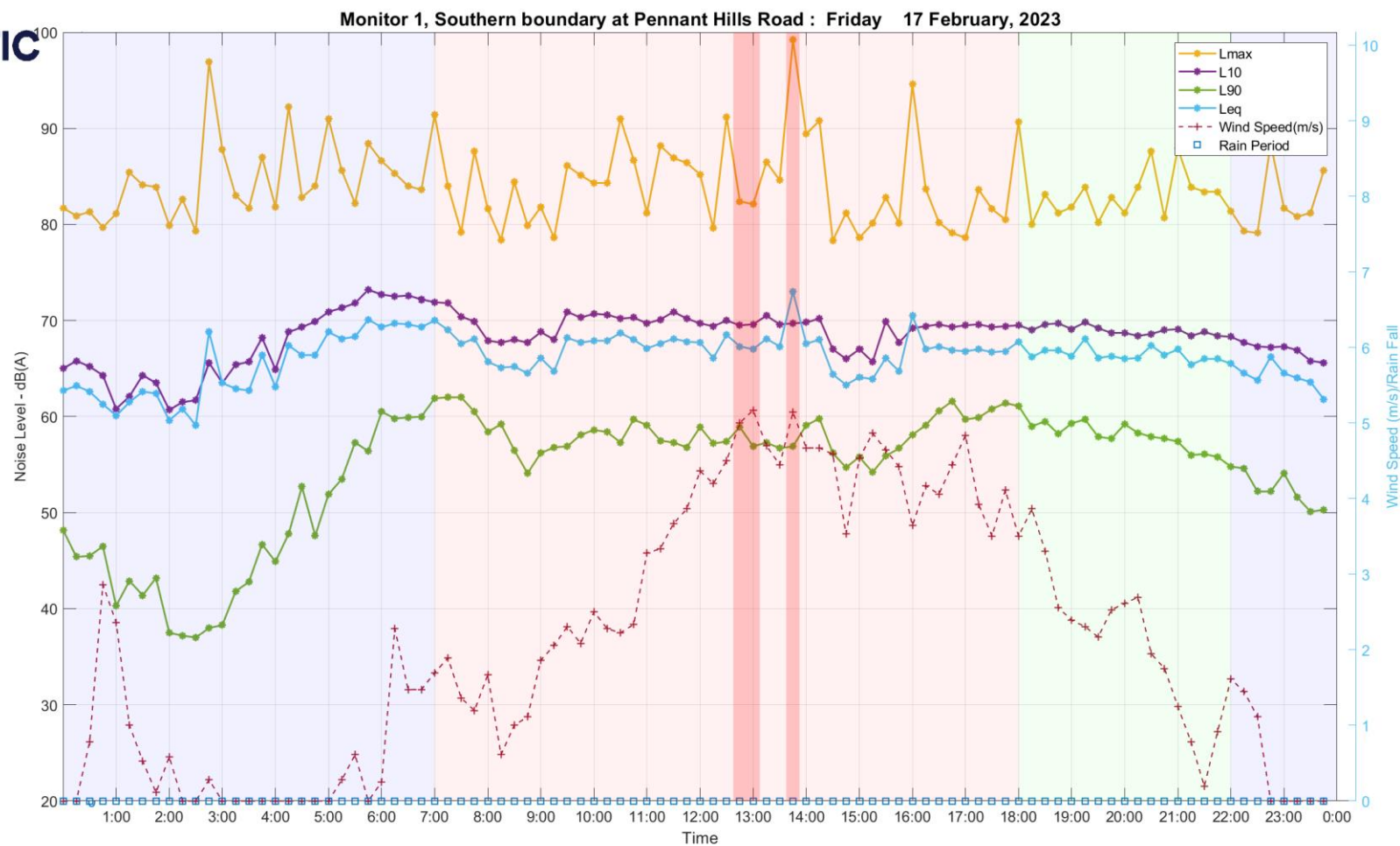


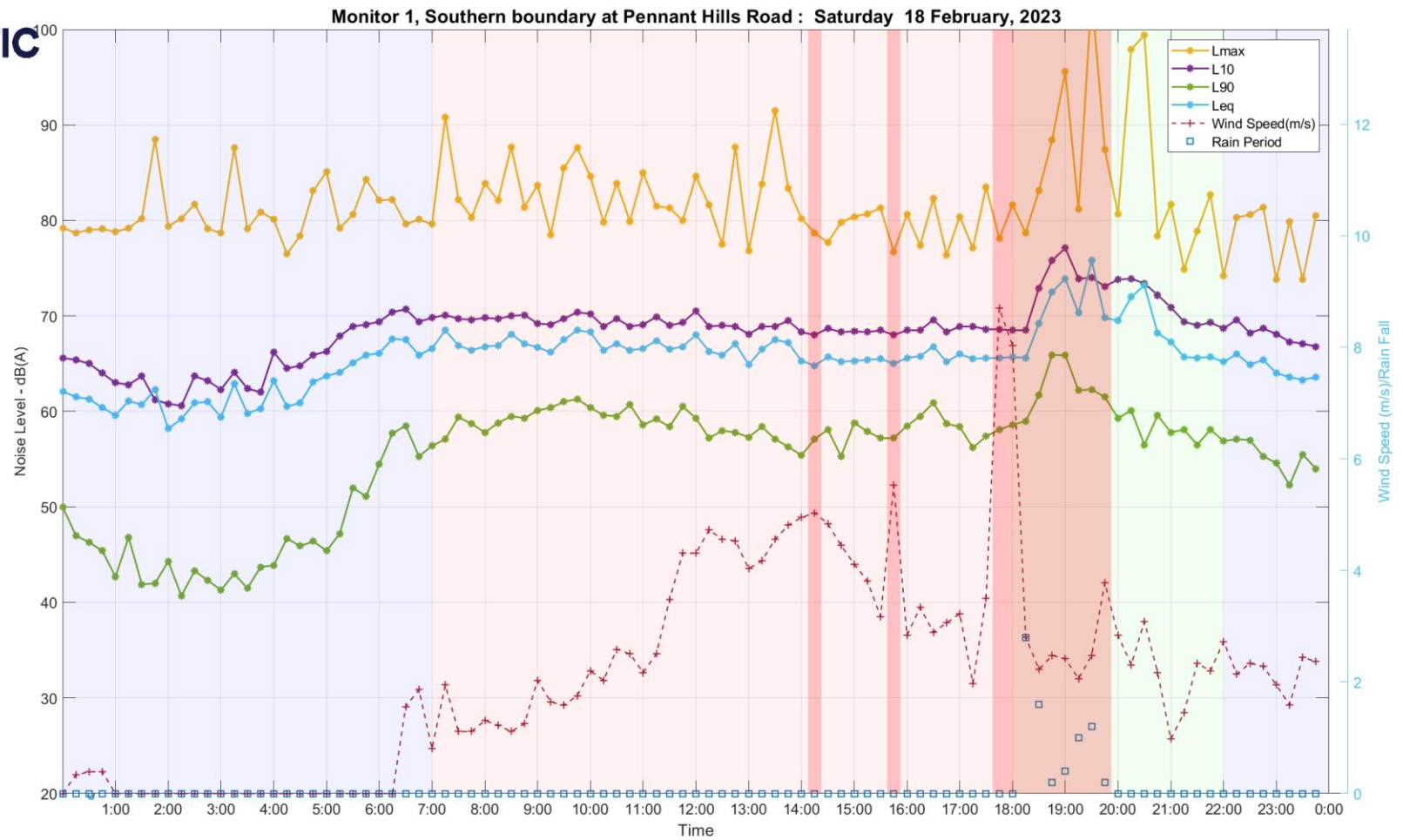


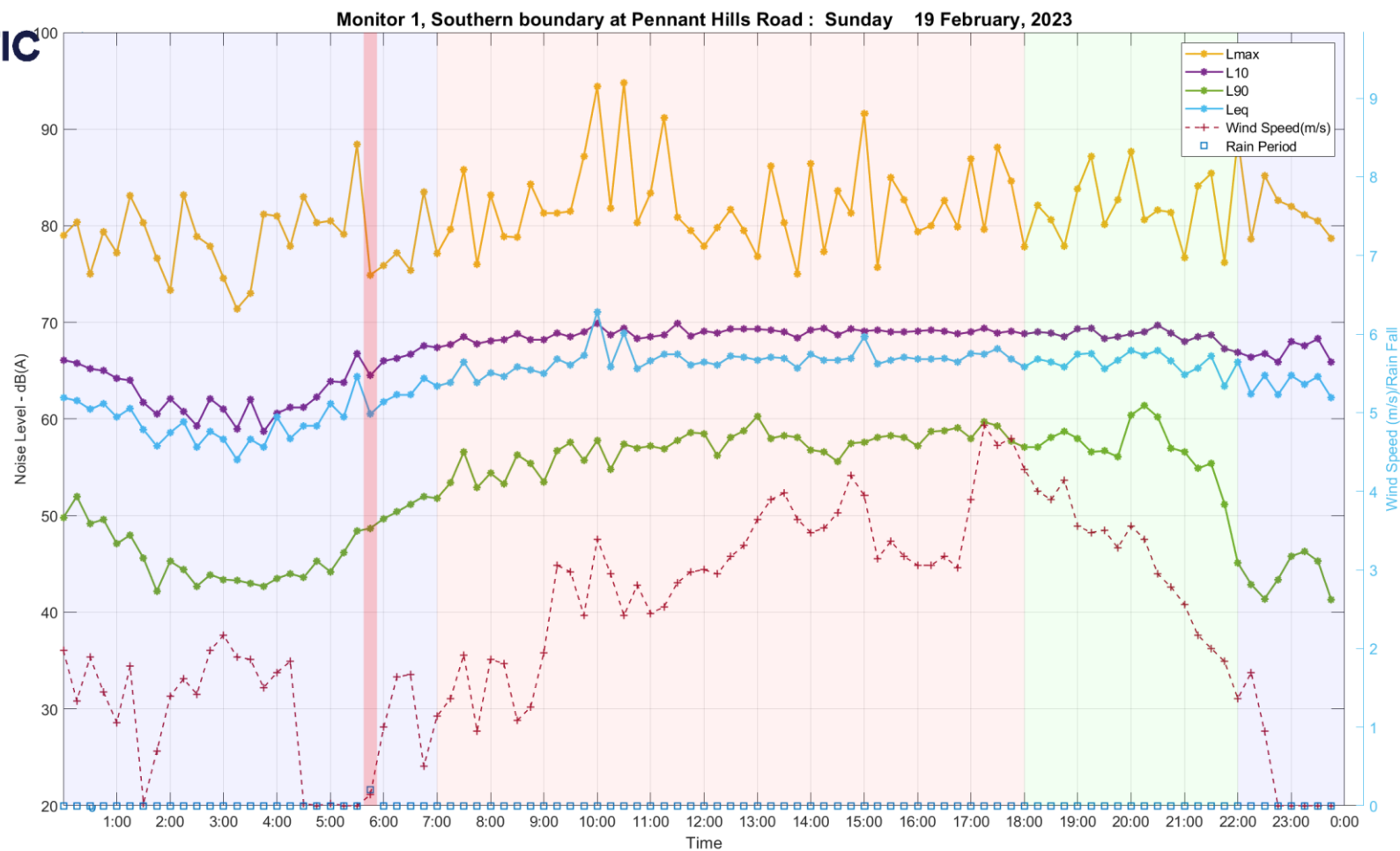


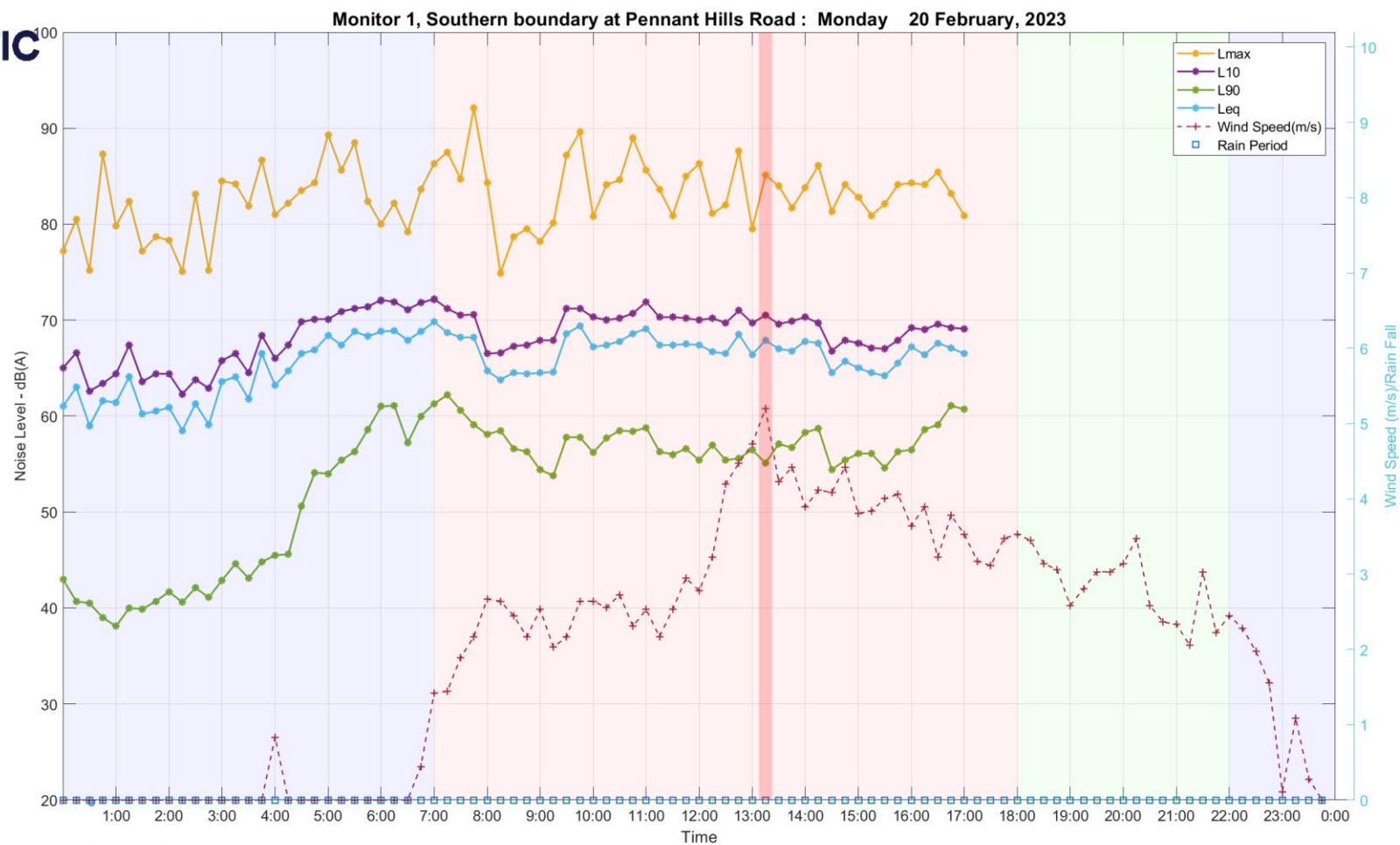






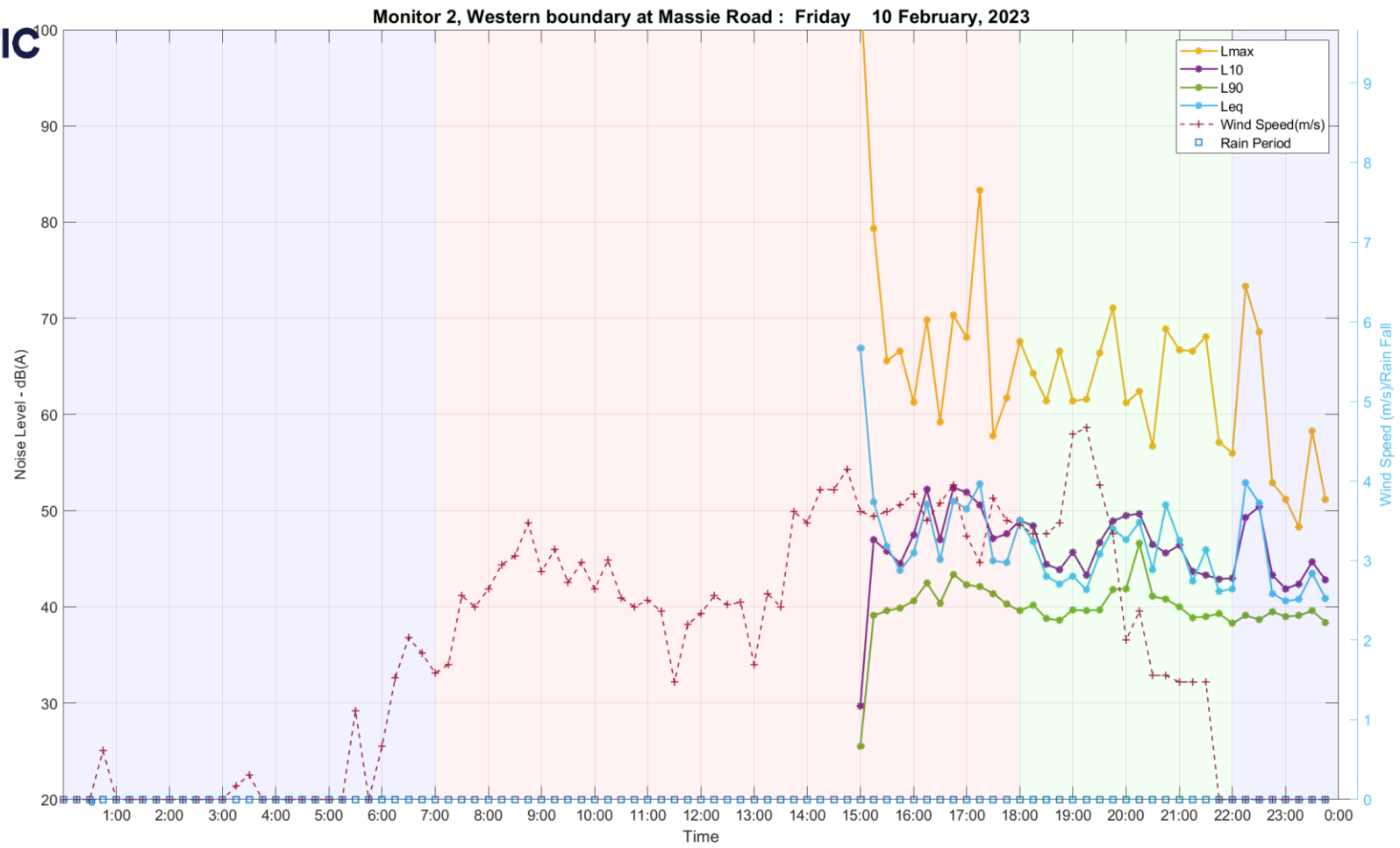


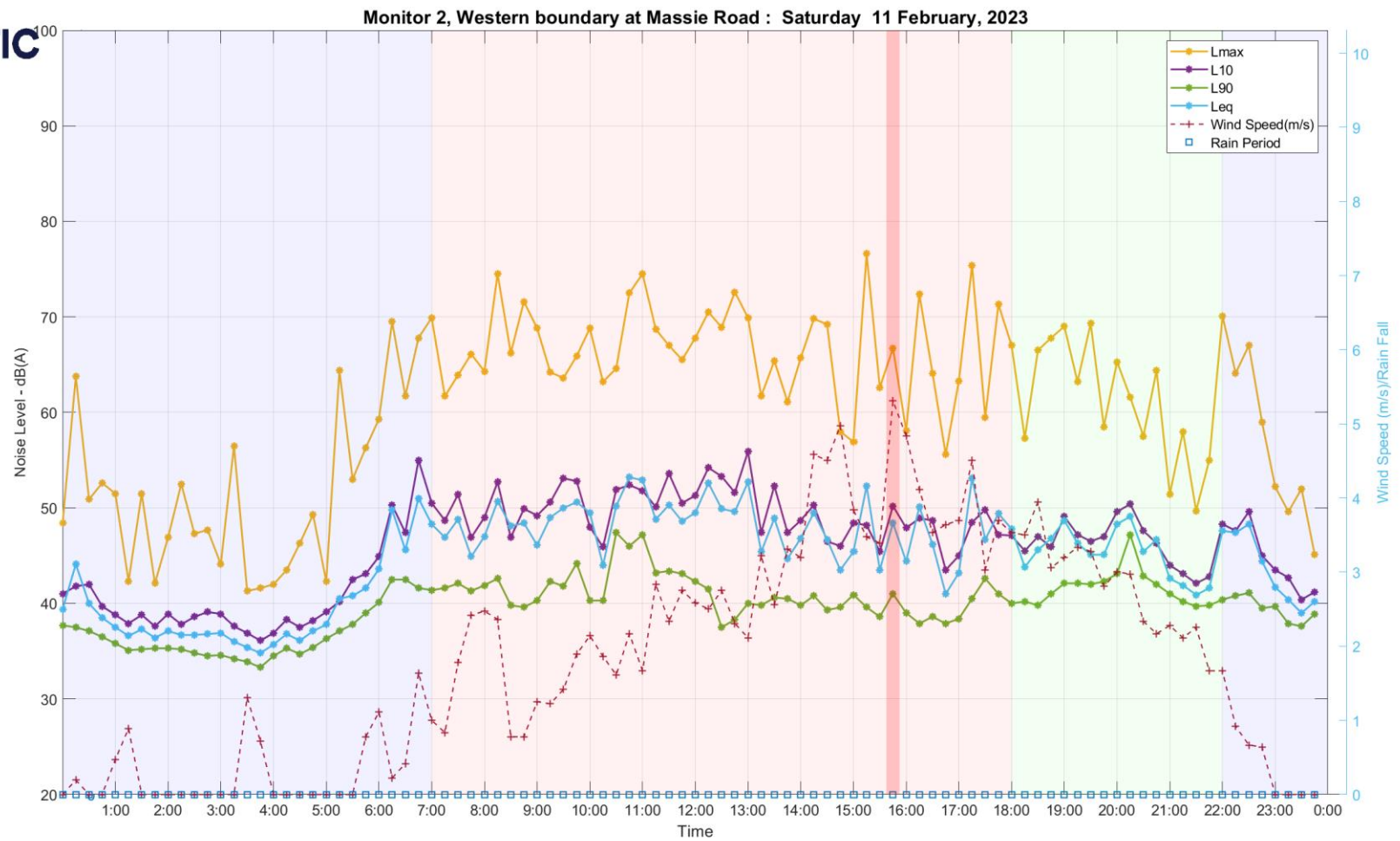


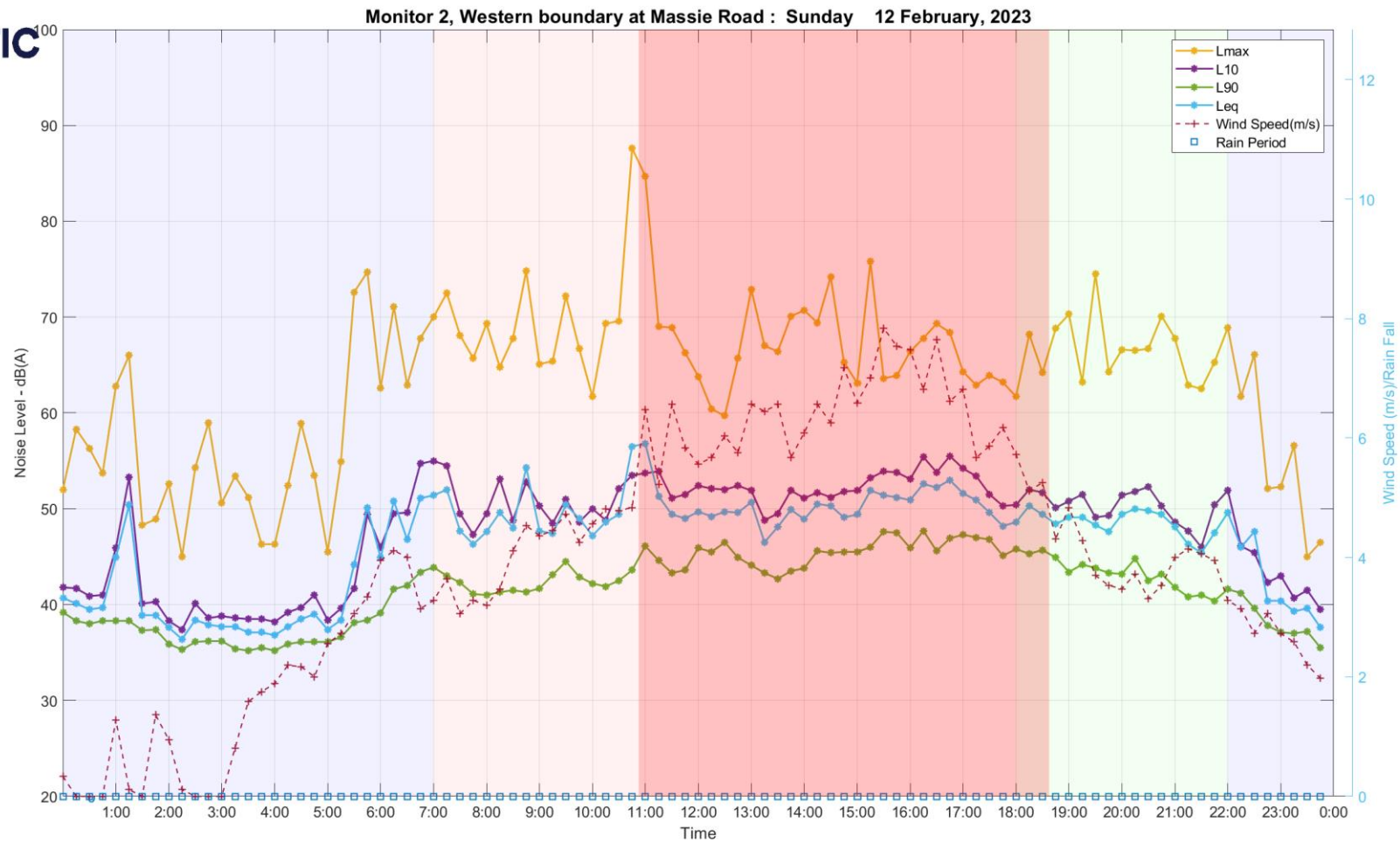


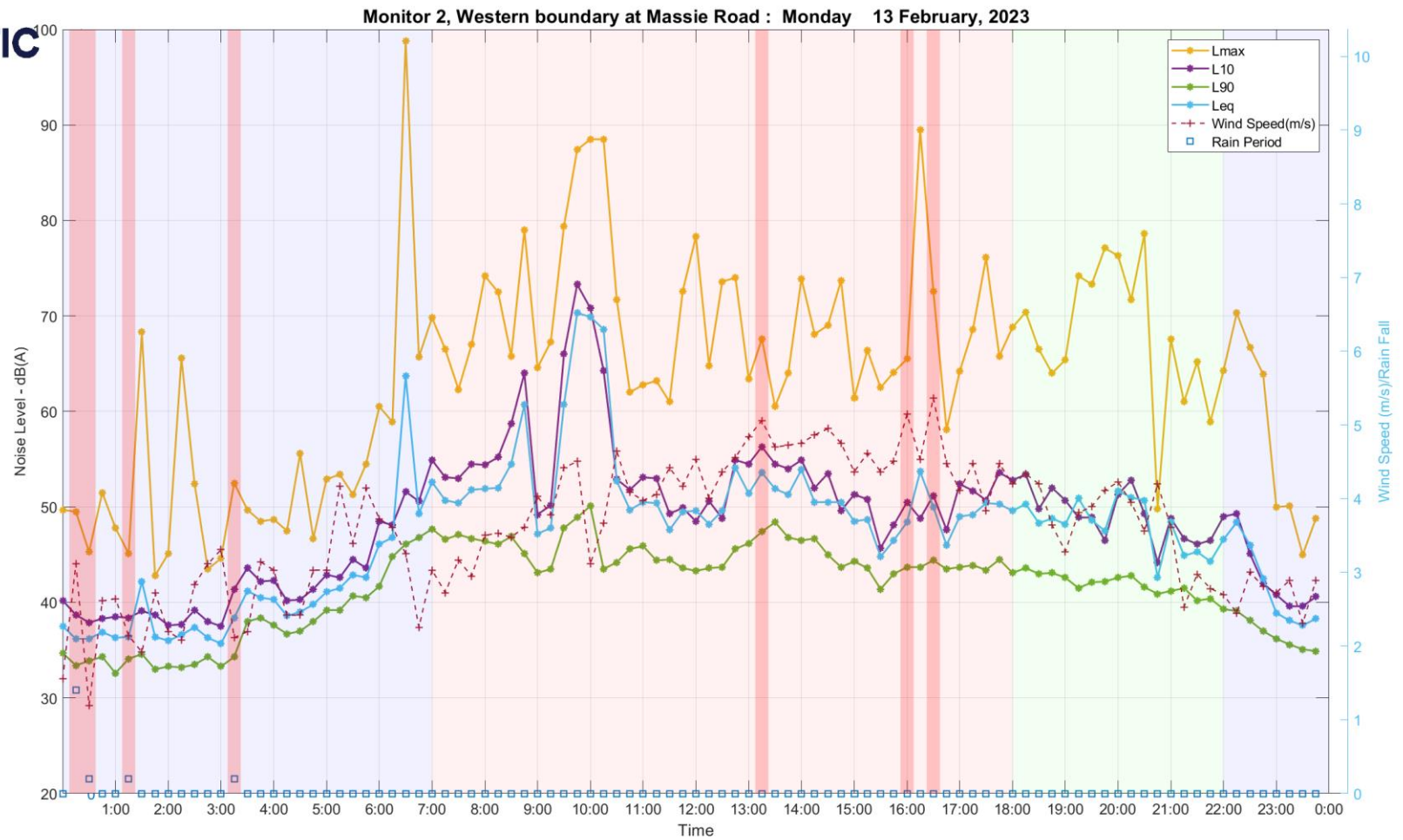
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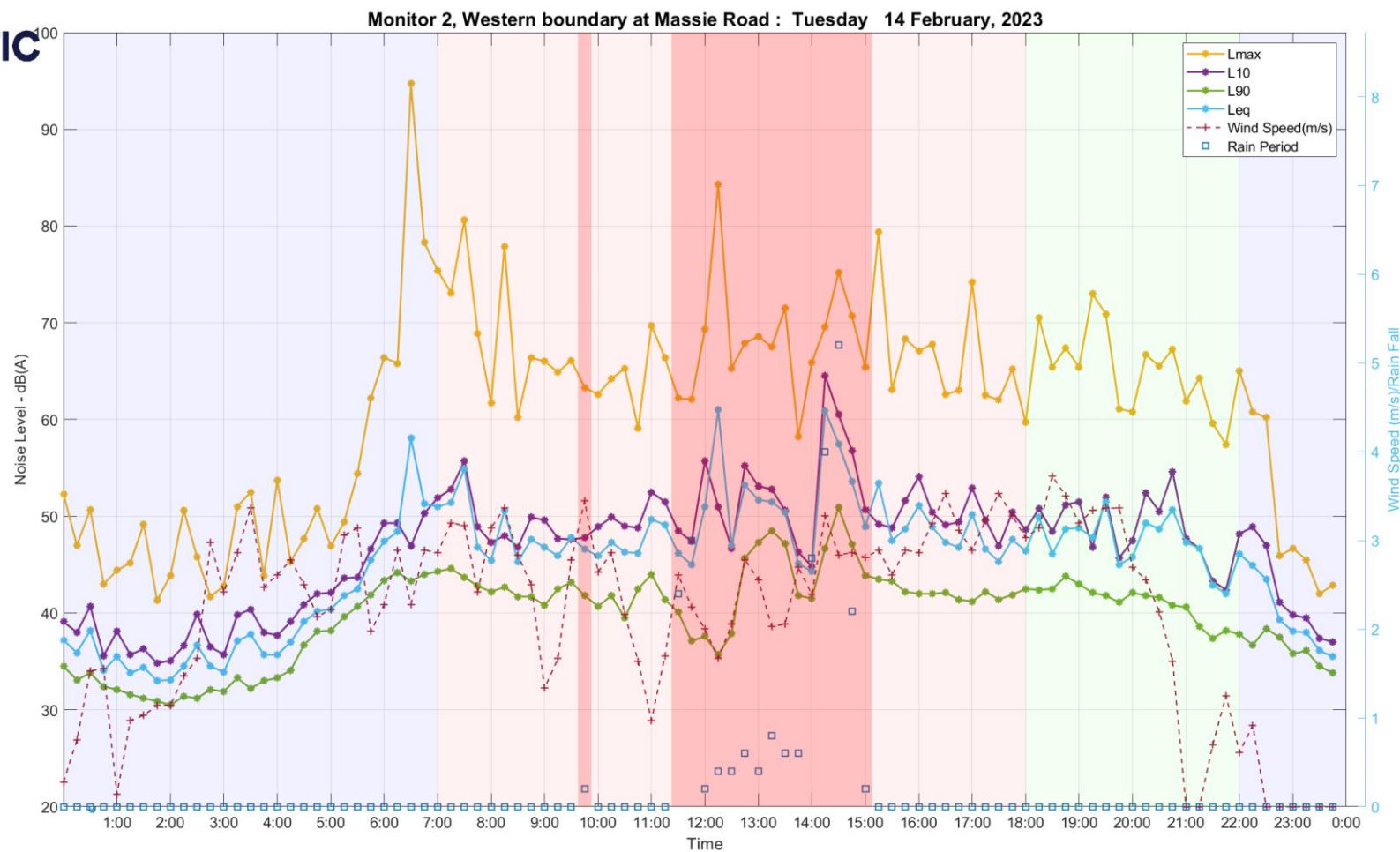
MONITOR 2 – WESTERN BOUNDARY AT MASSIE ROAD

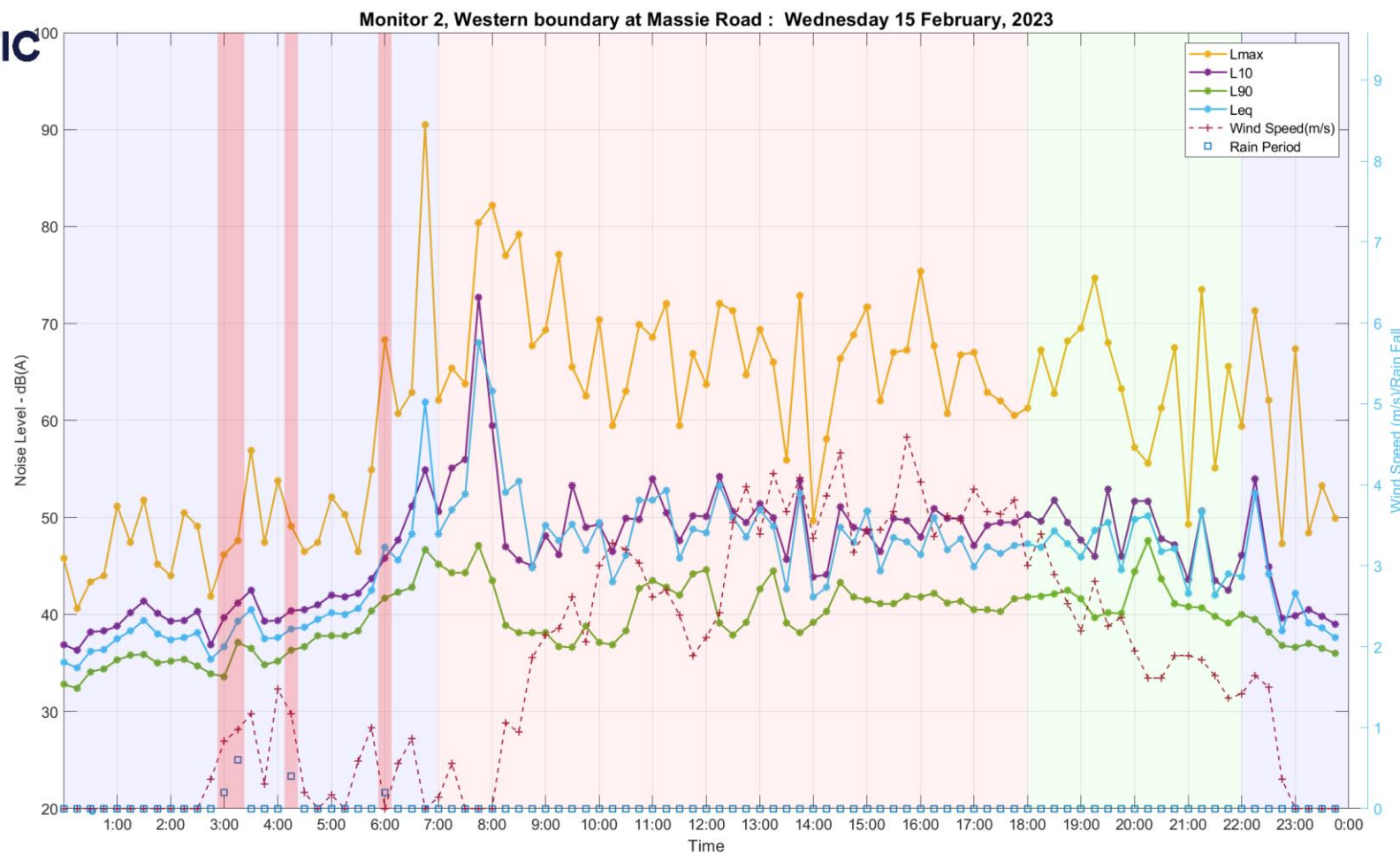


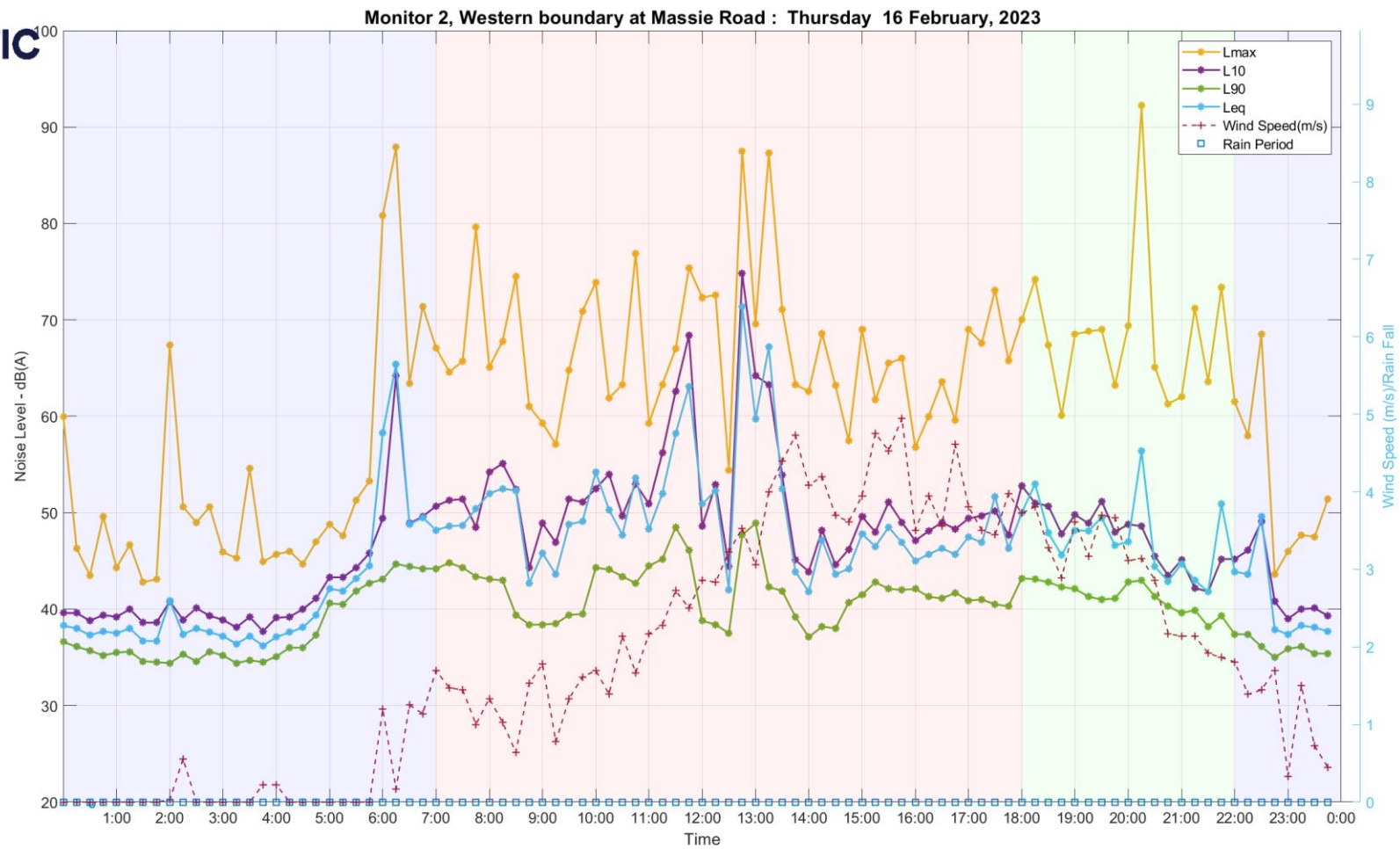


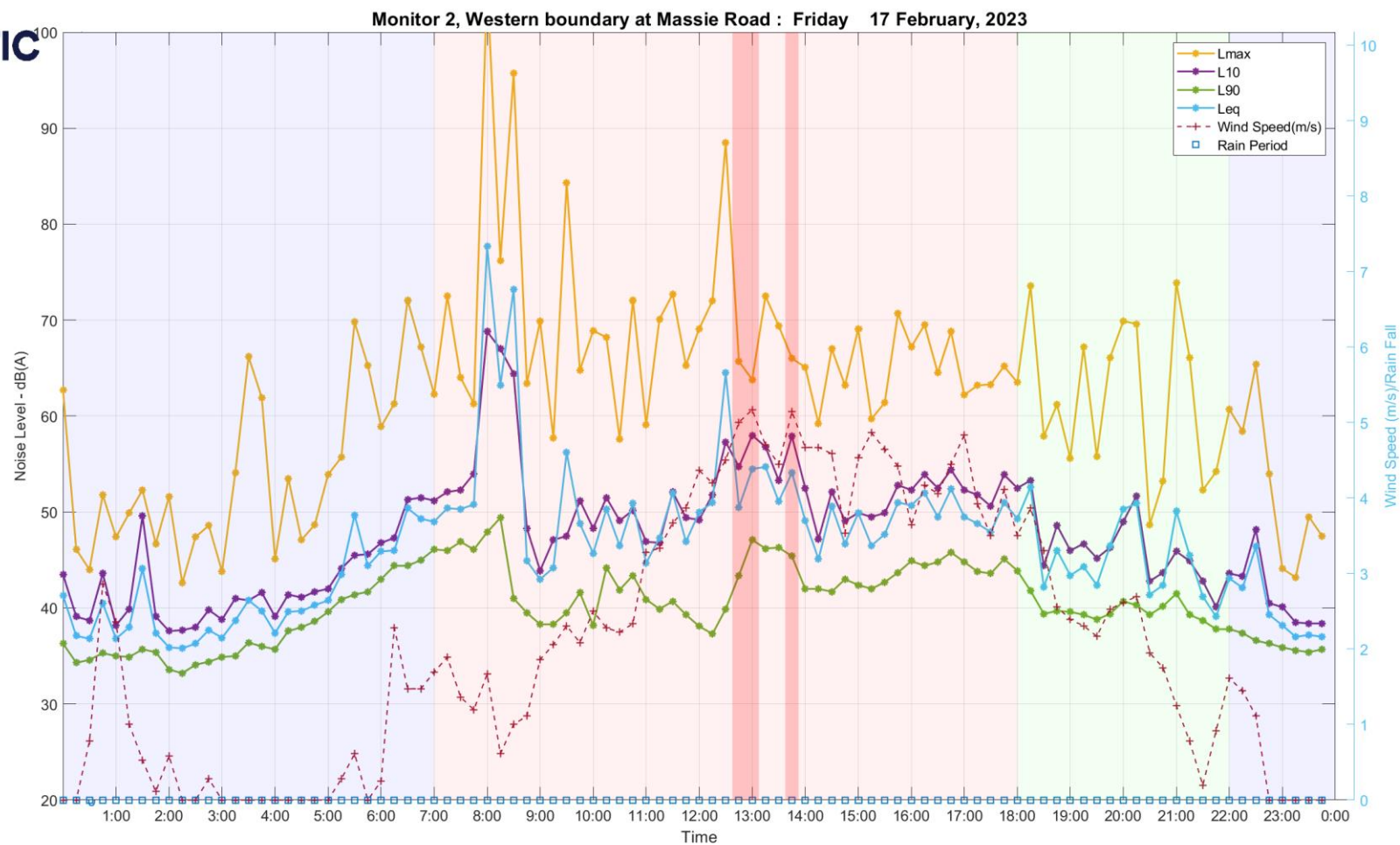


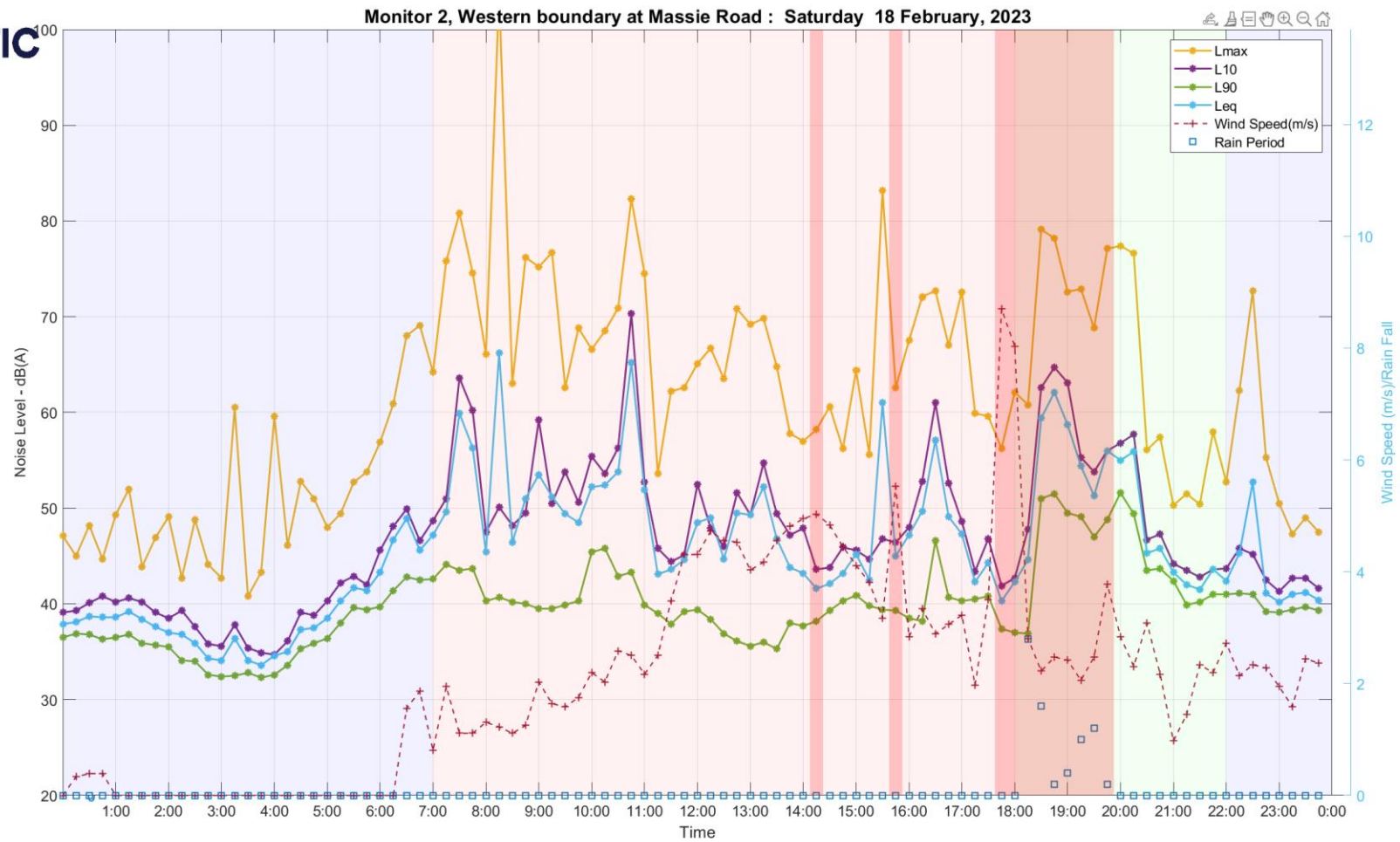


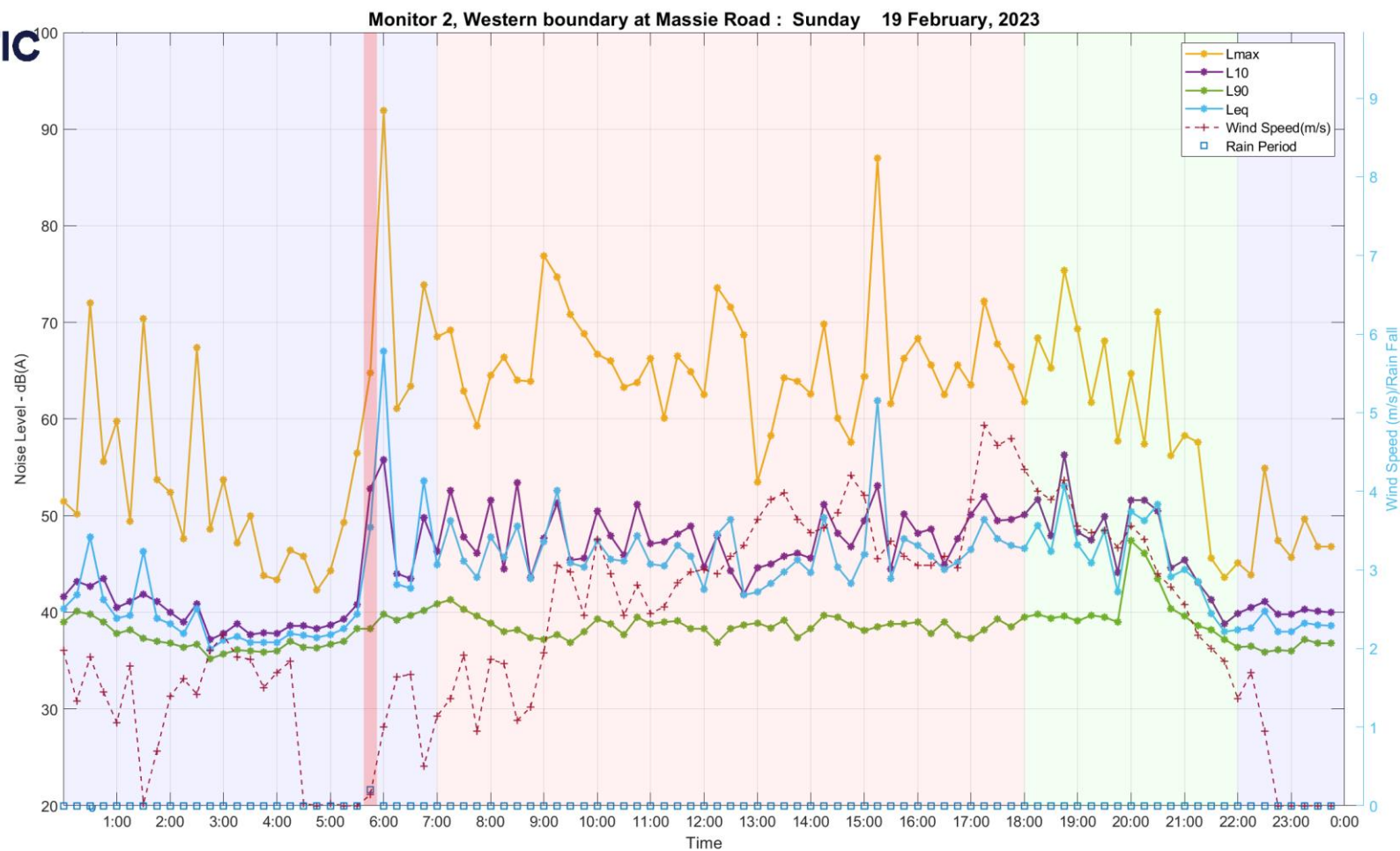


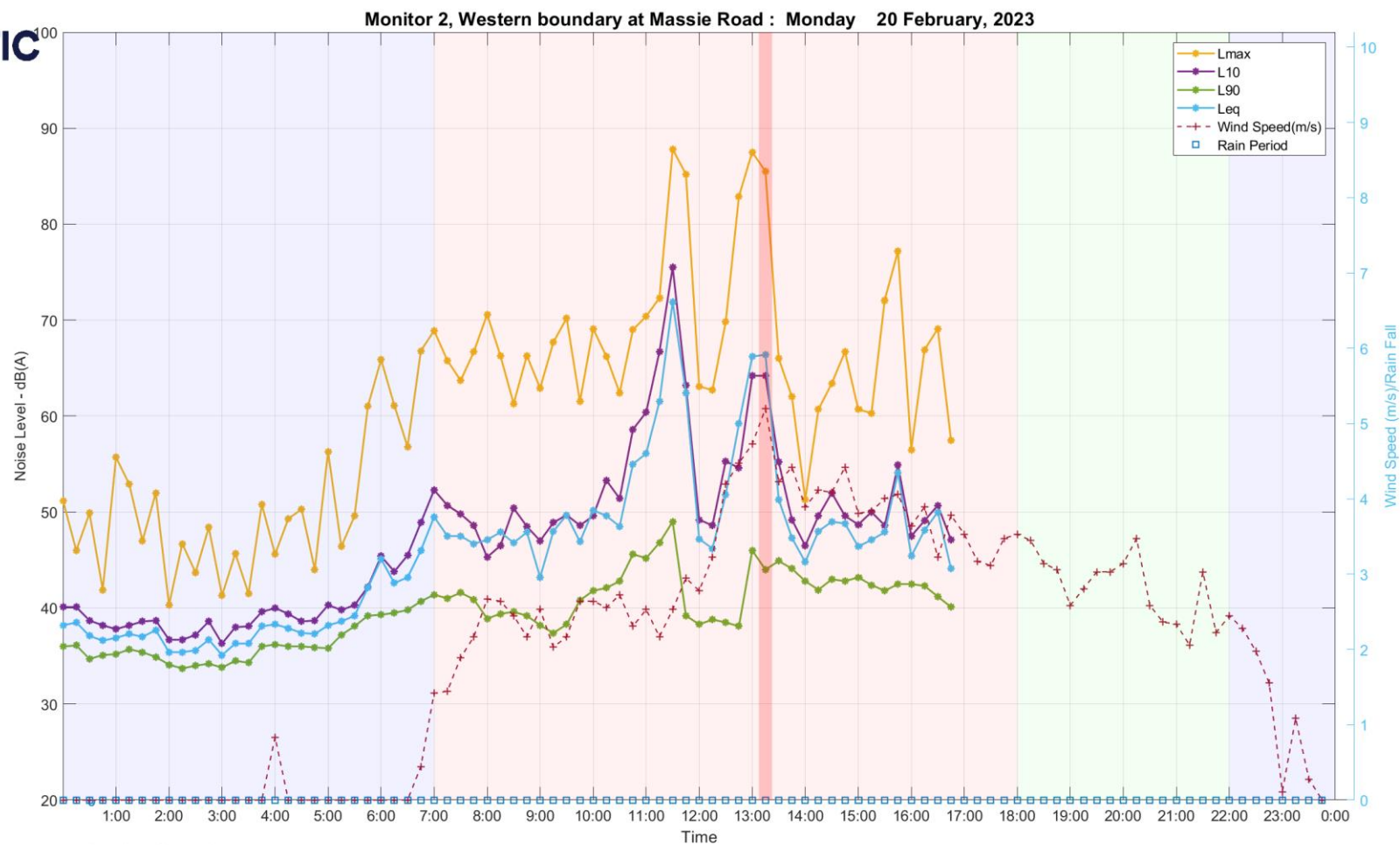






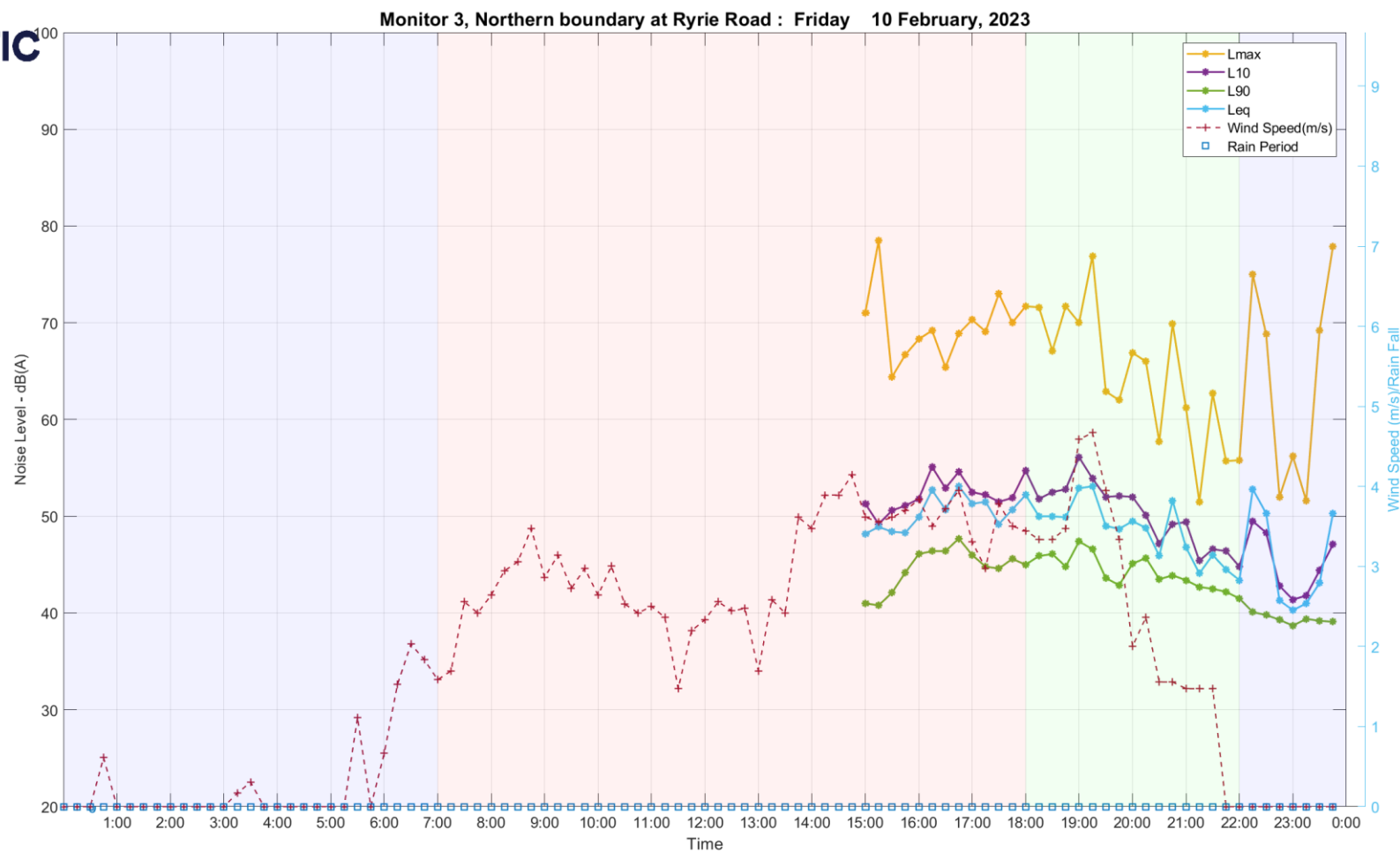


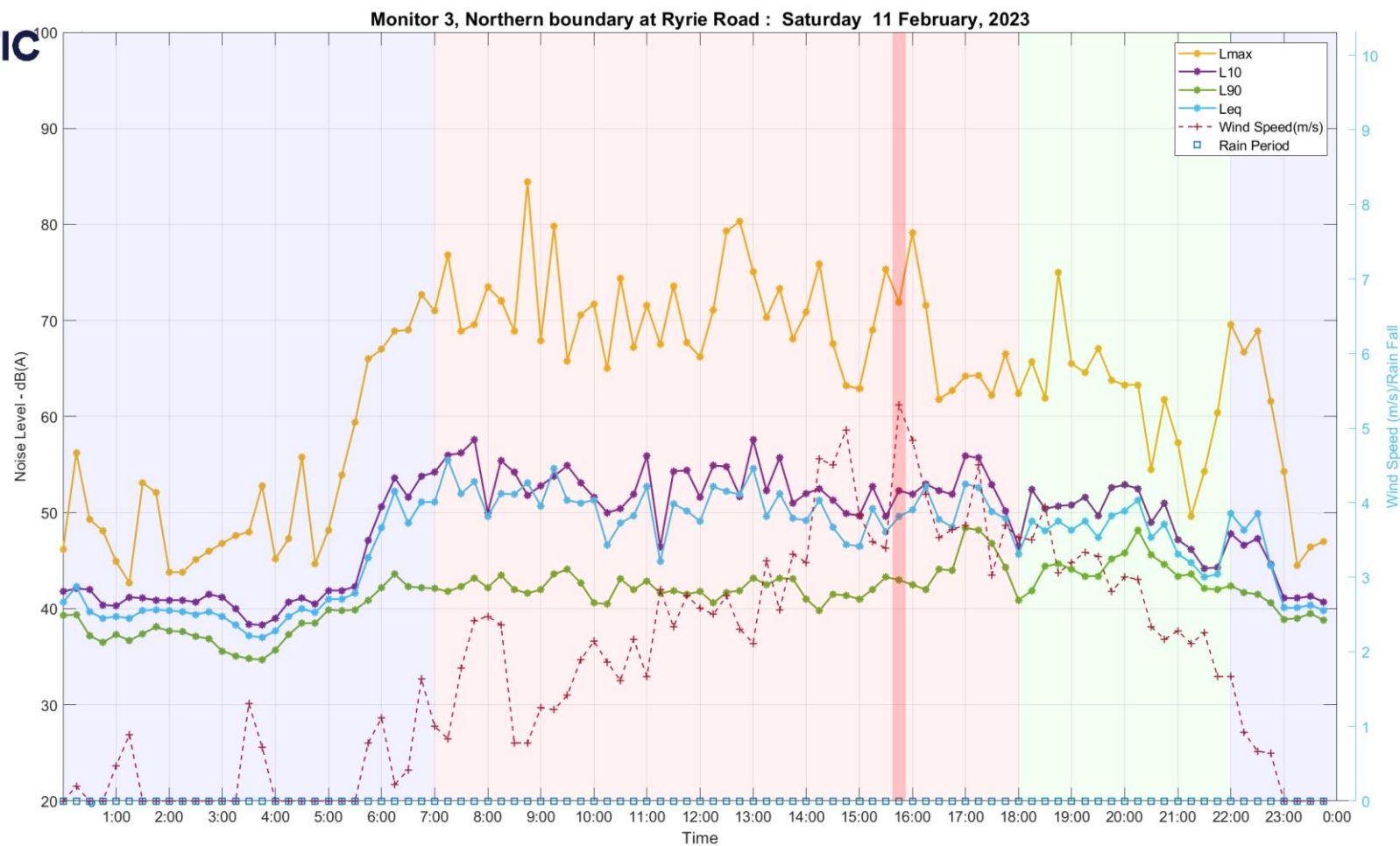


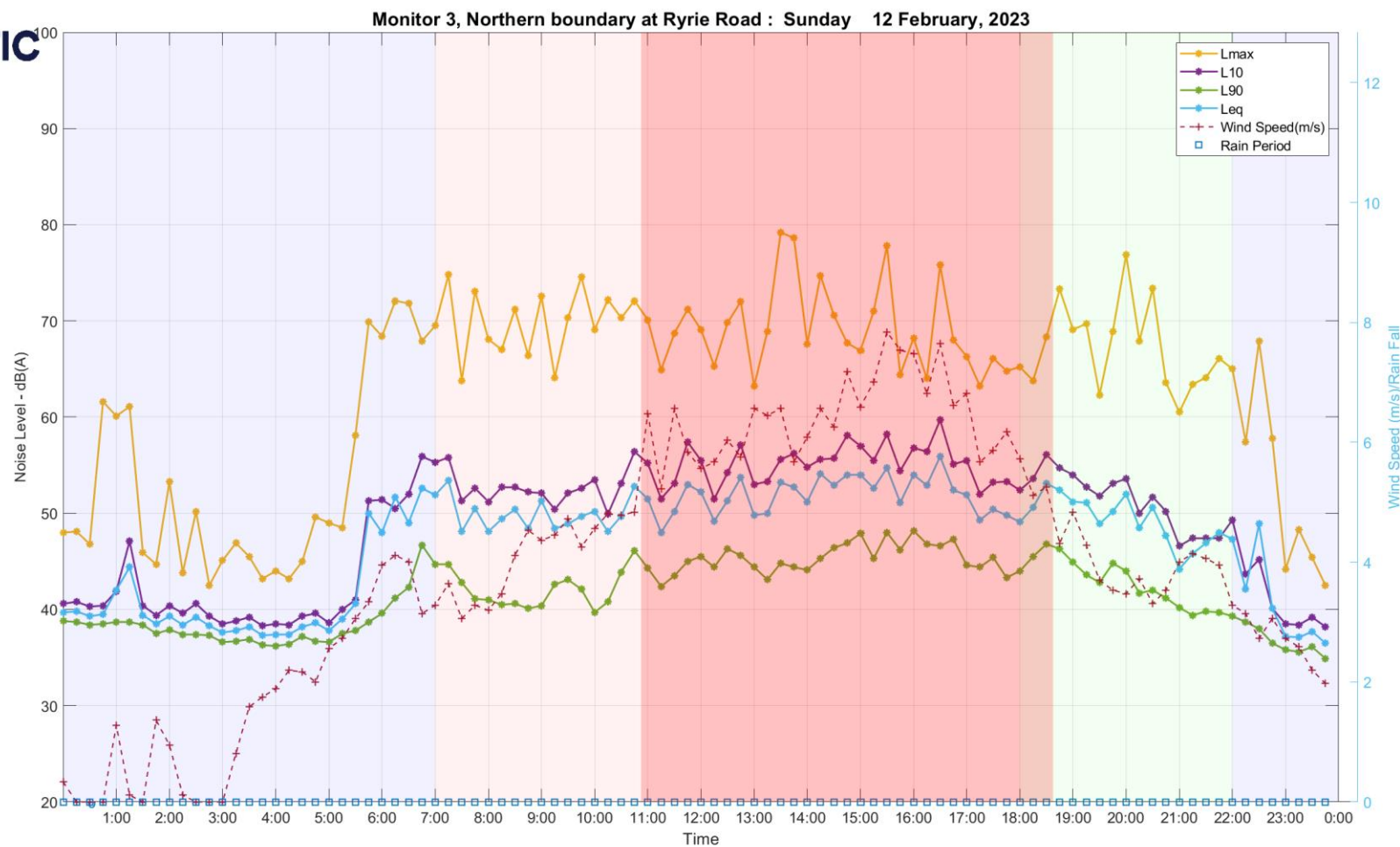


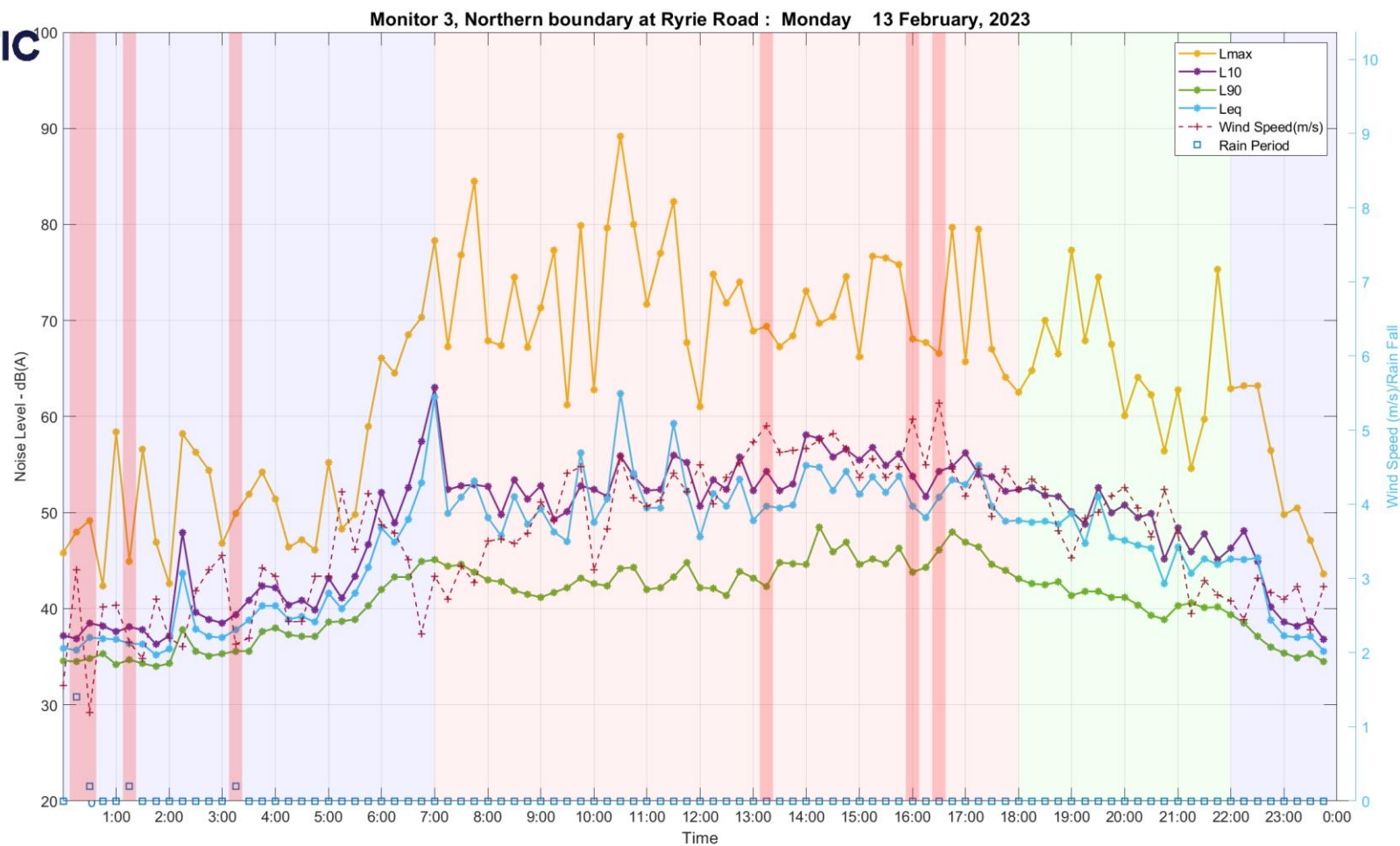
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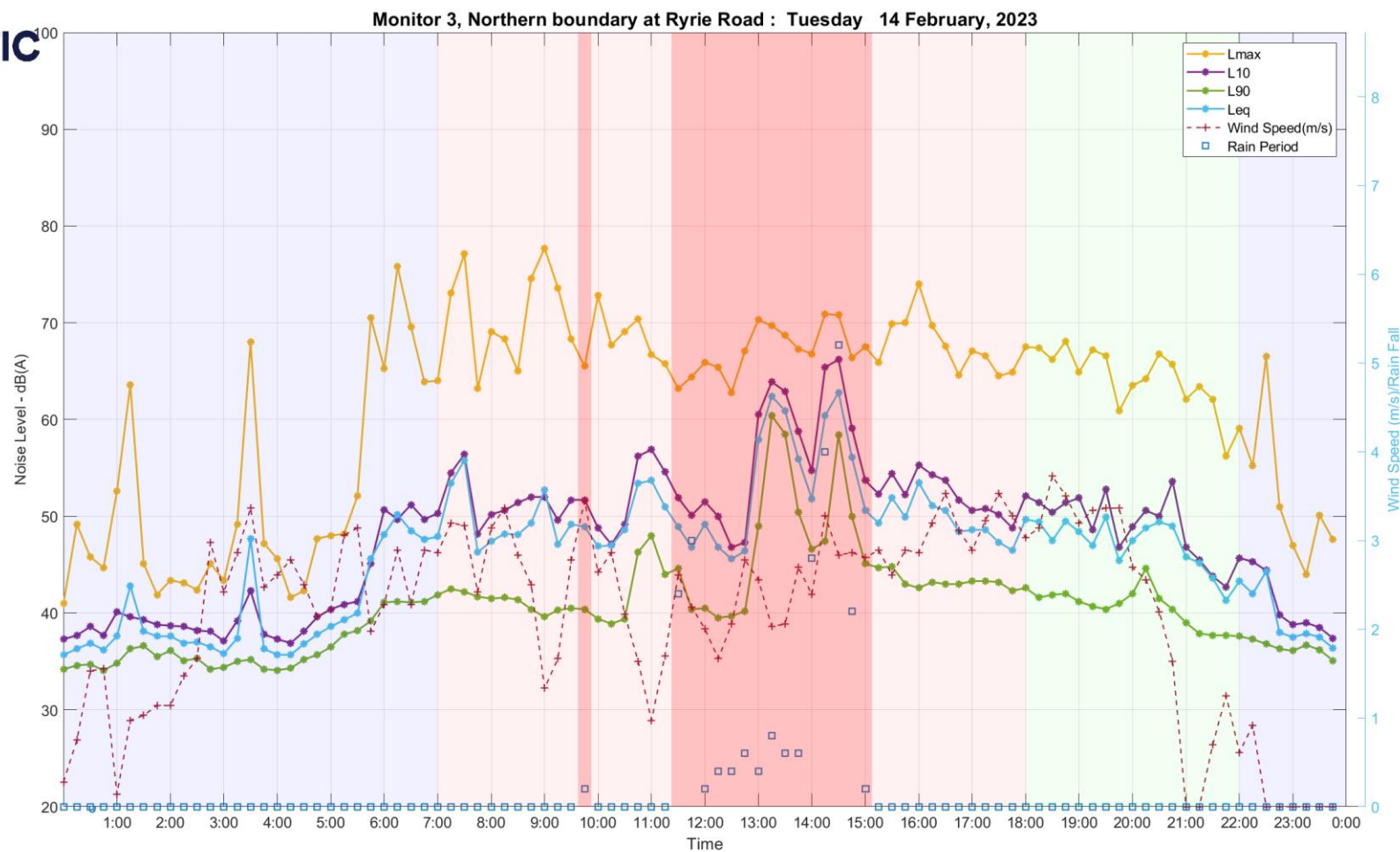
MONITOR 3 – NORTH-EASTERN BOUNDARY AT RYRIE ROAD

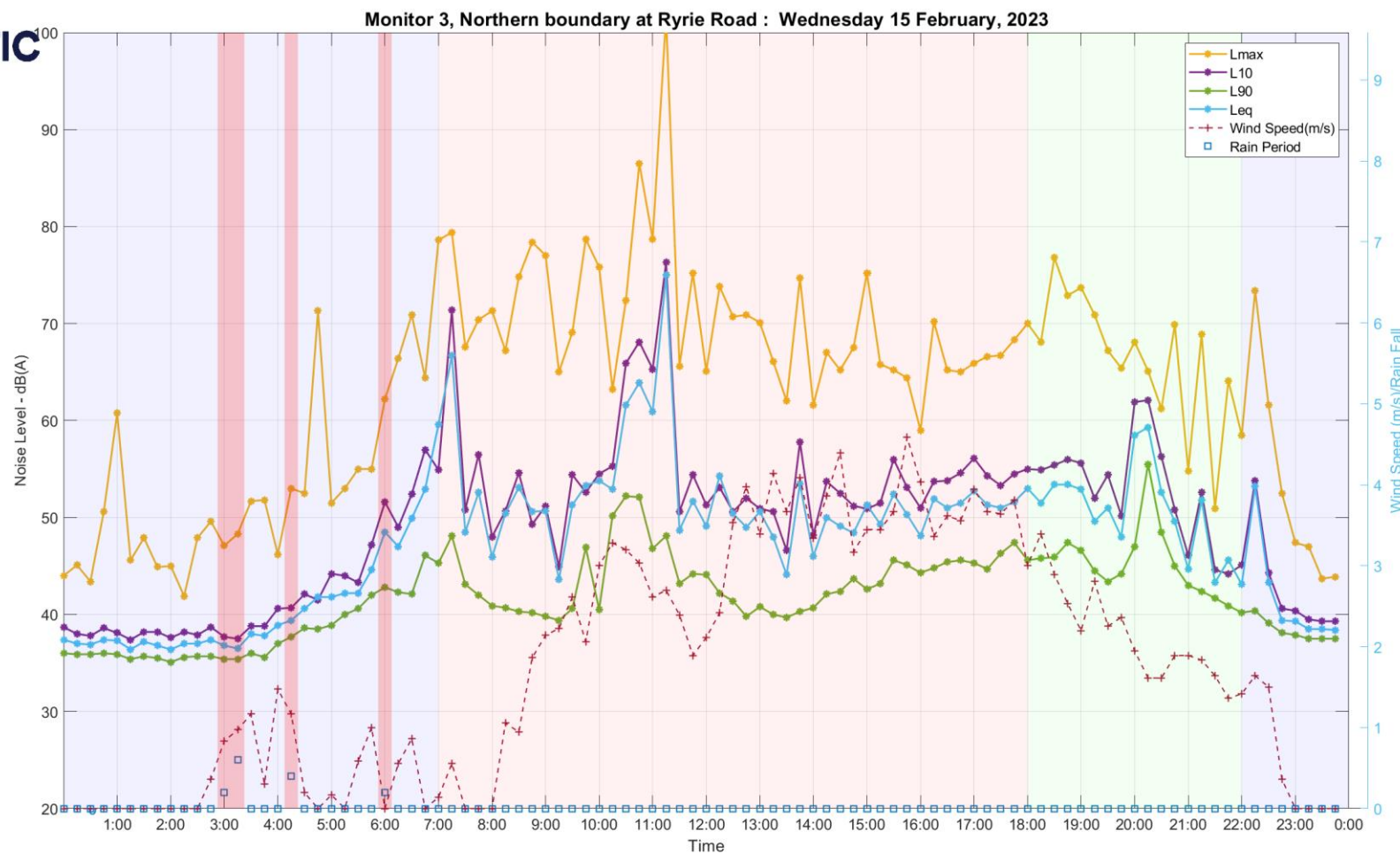






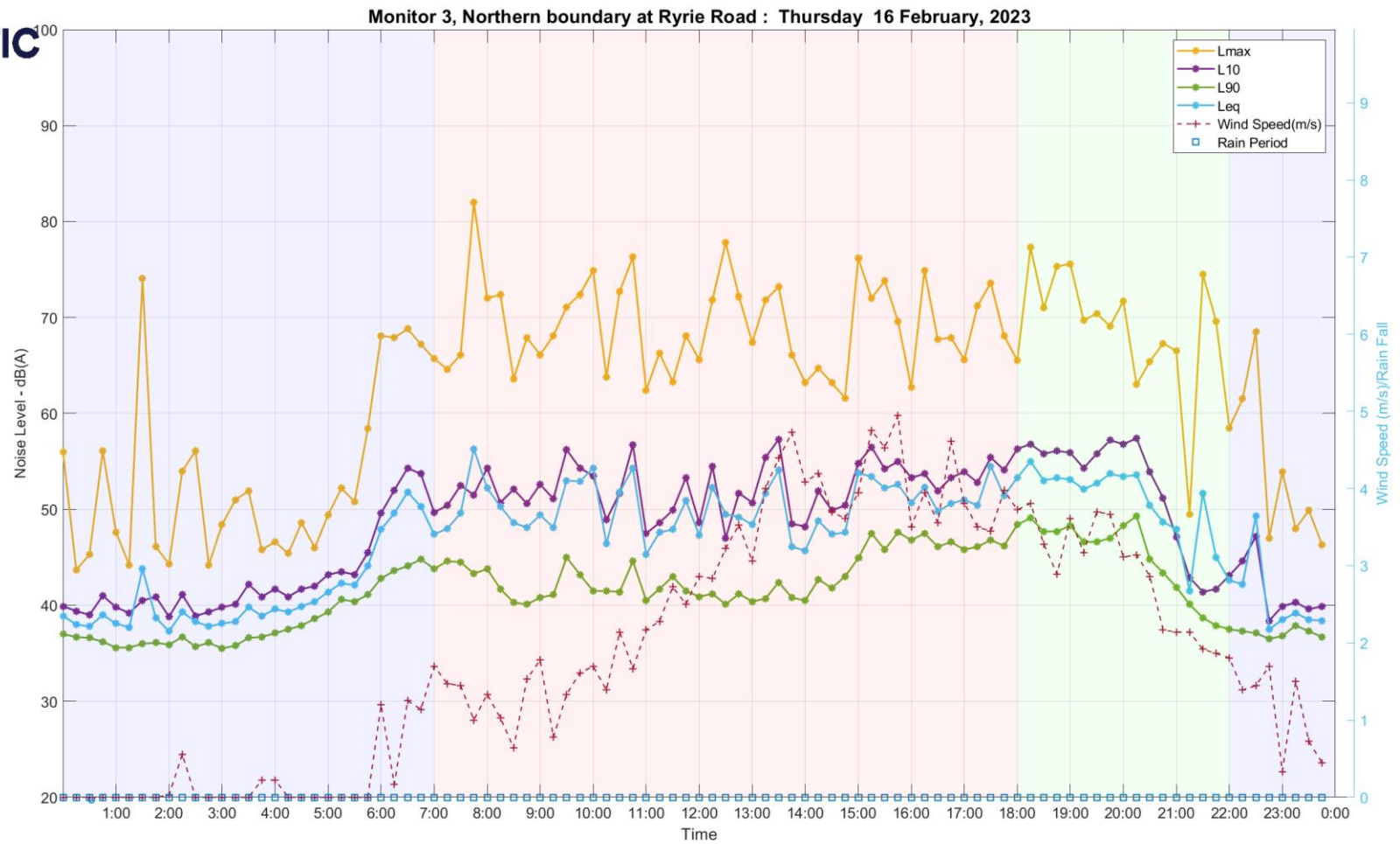






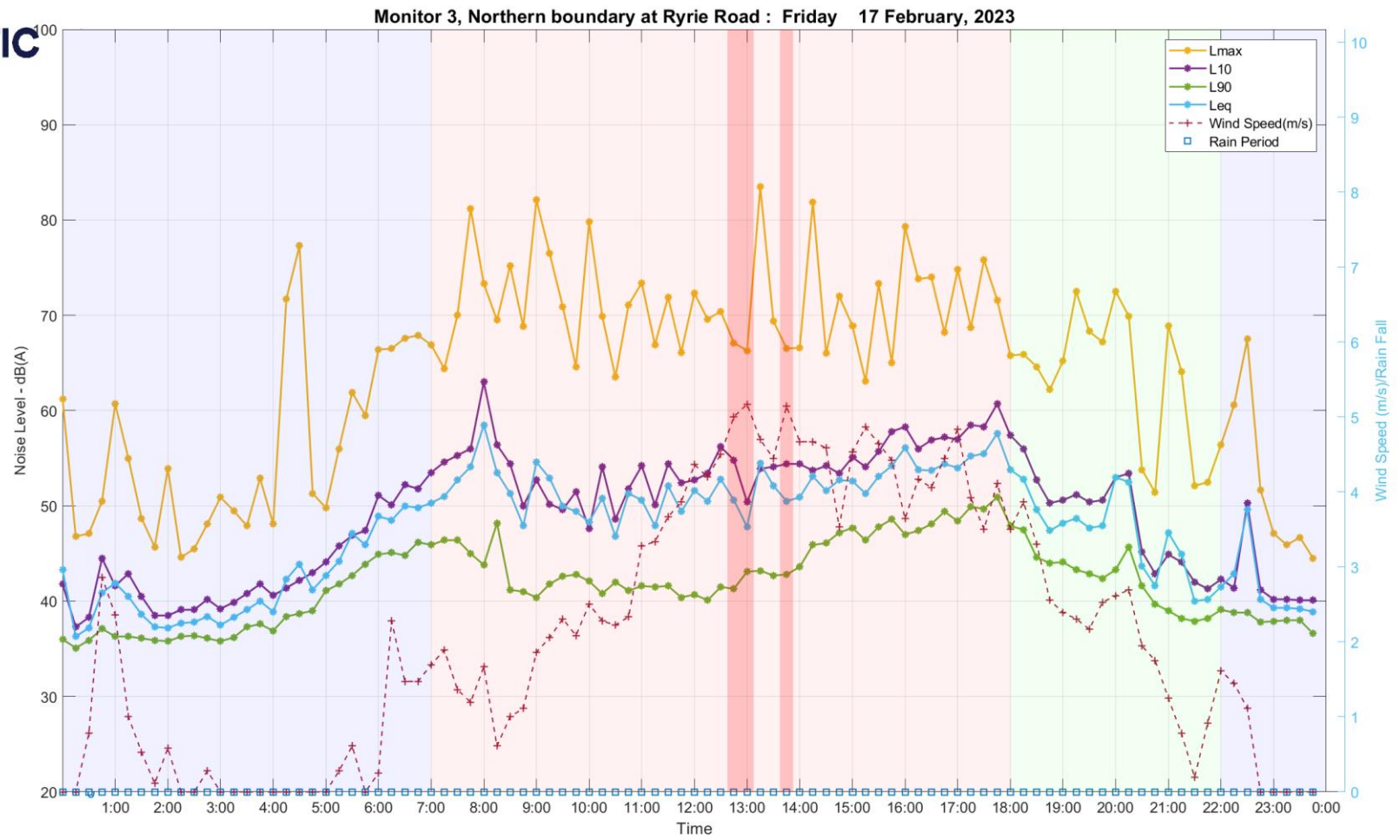


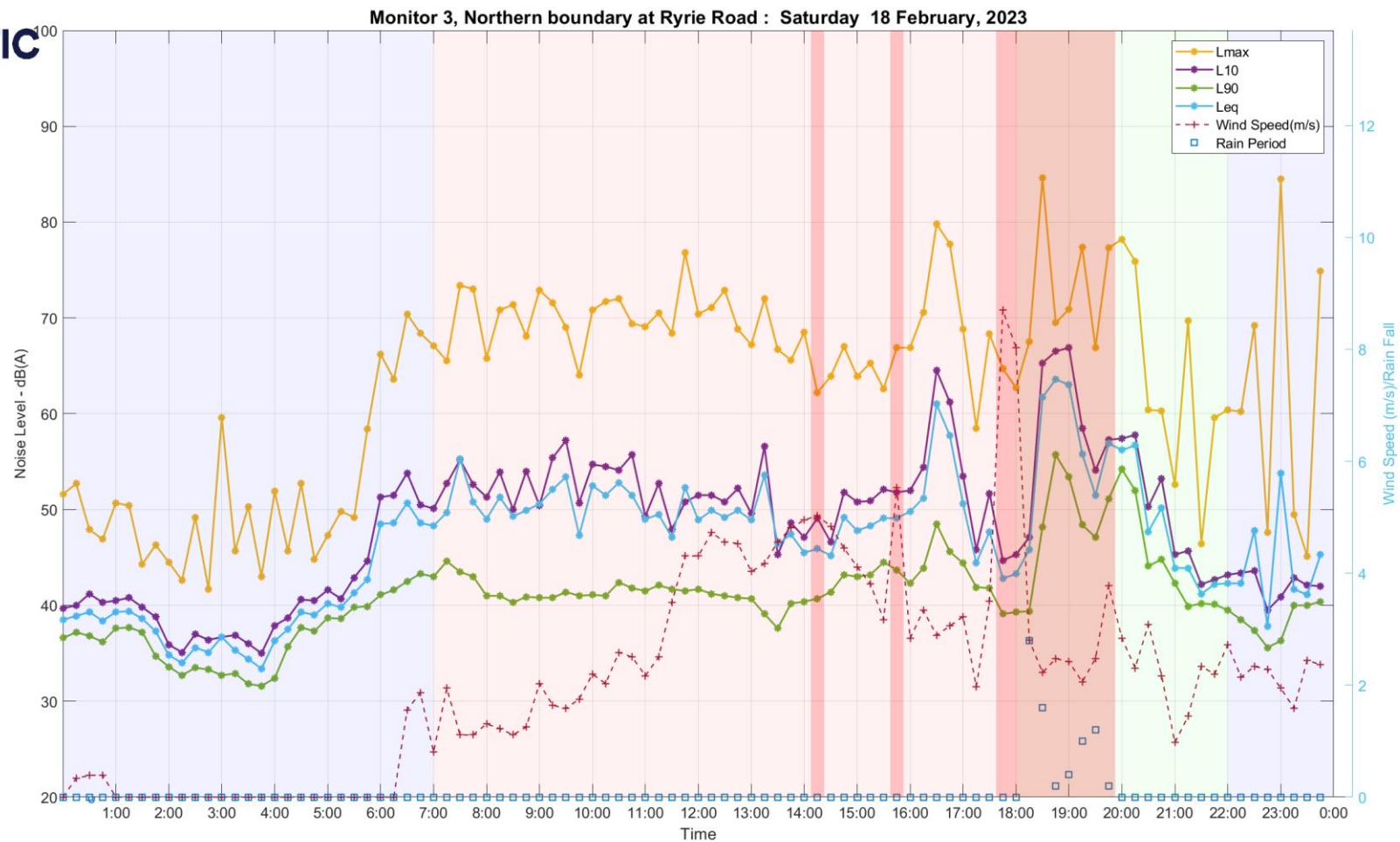
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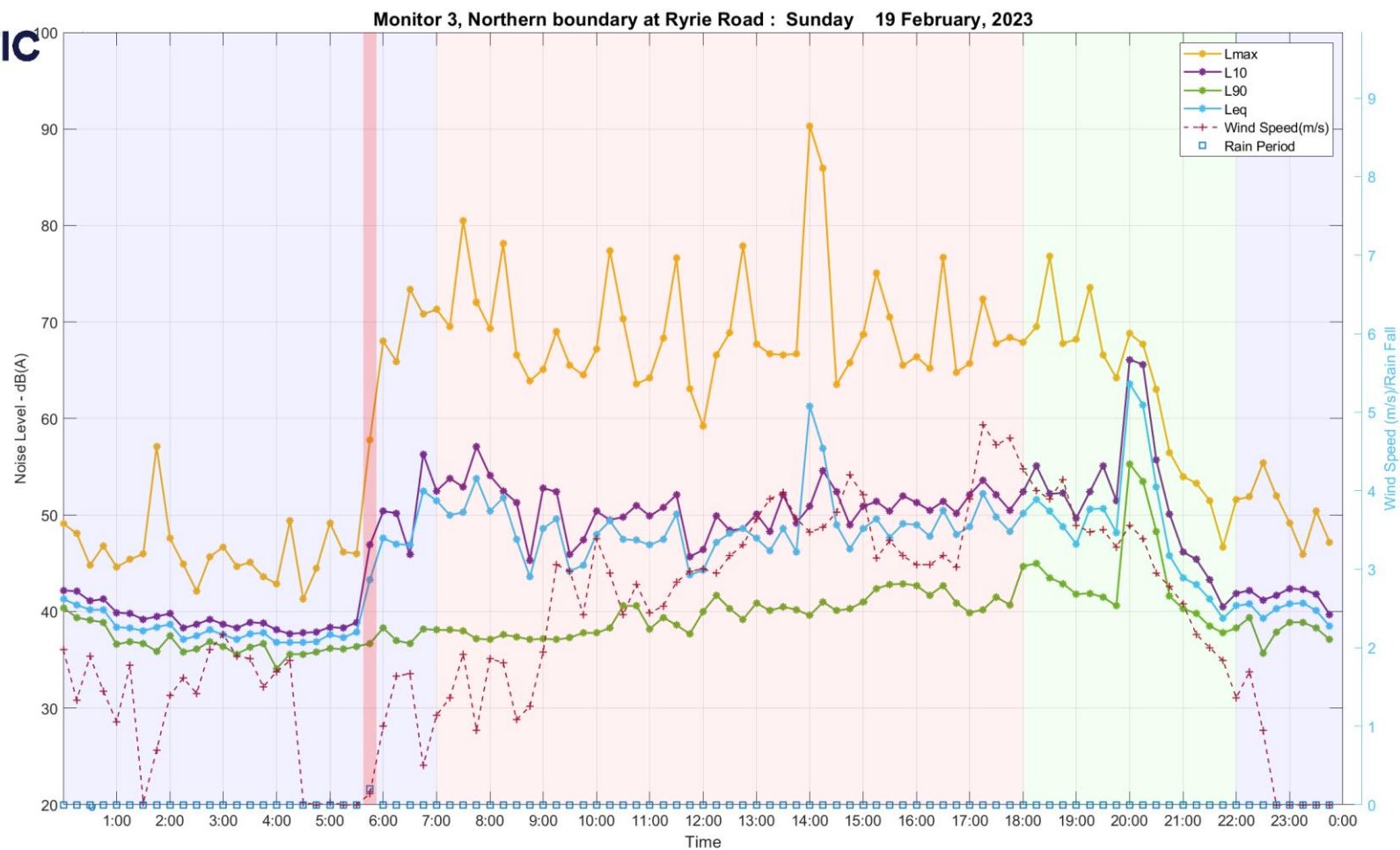


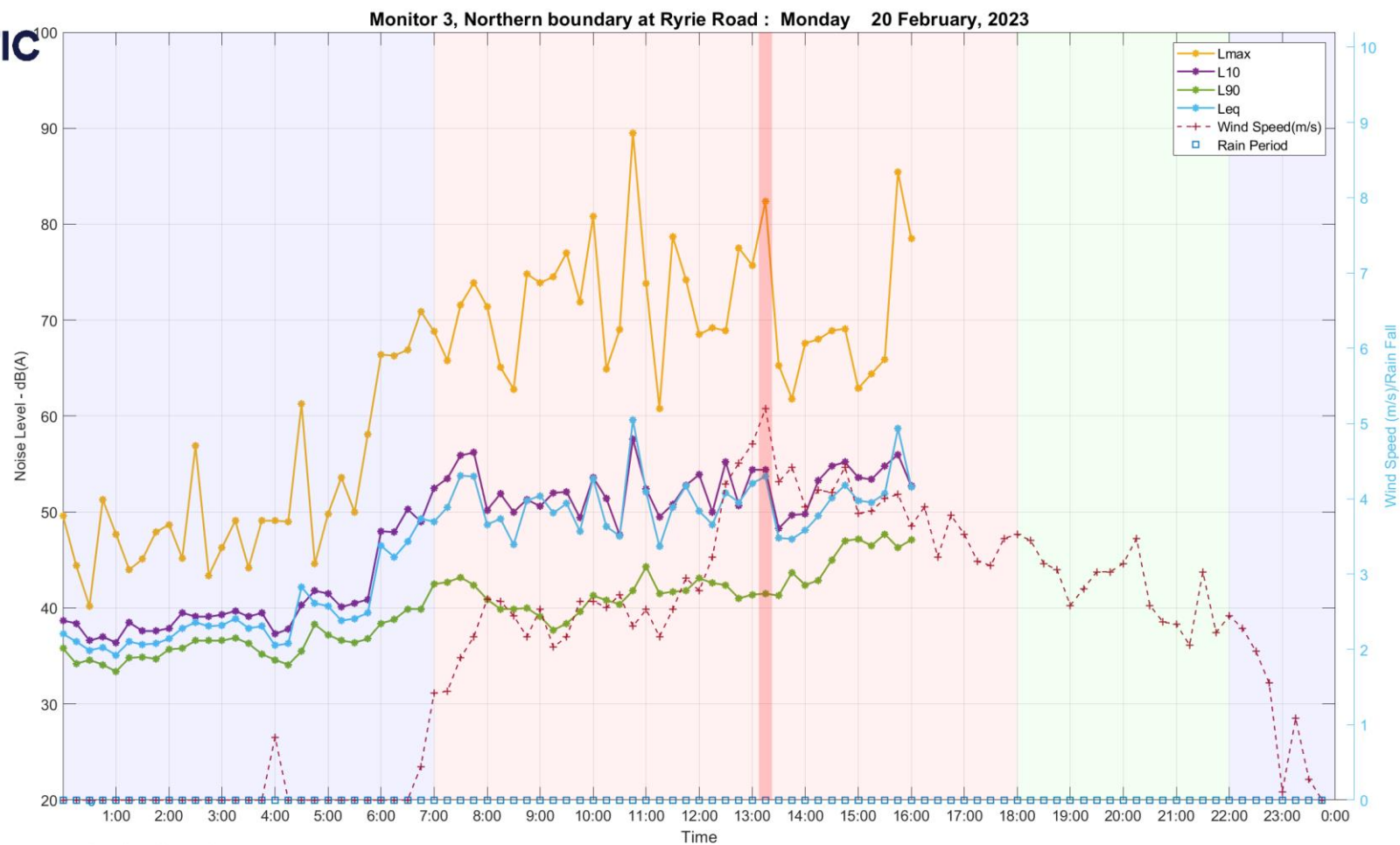


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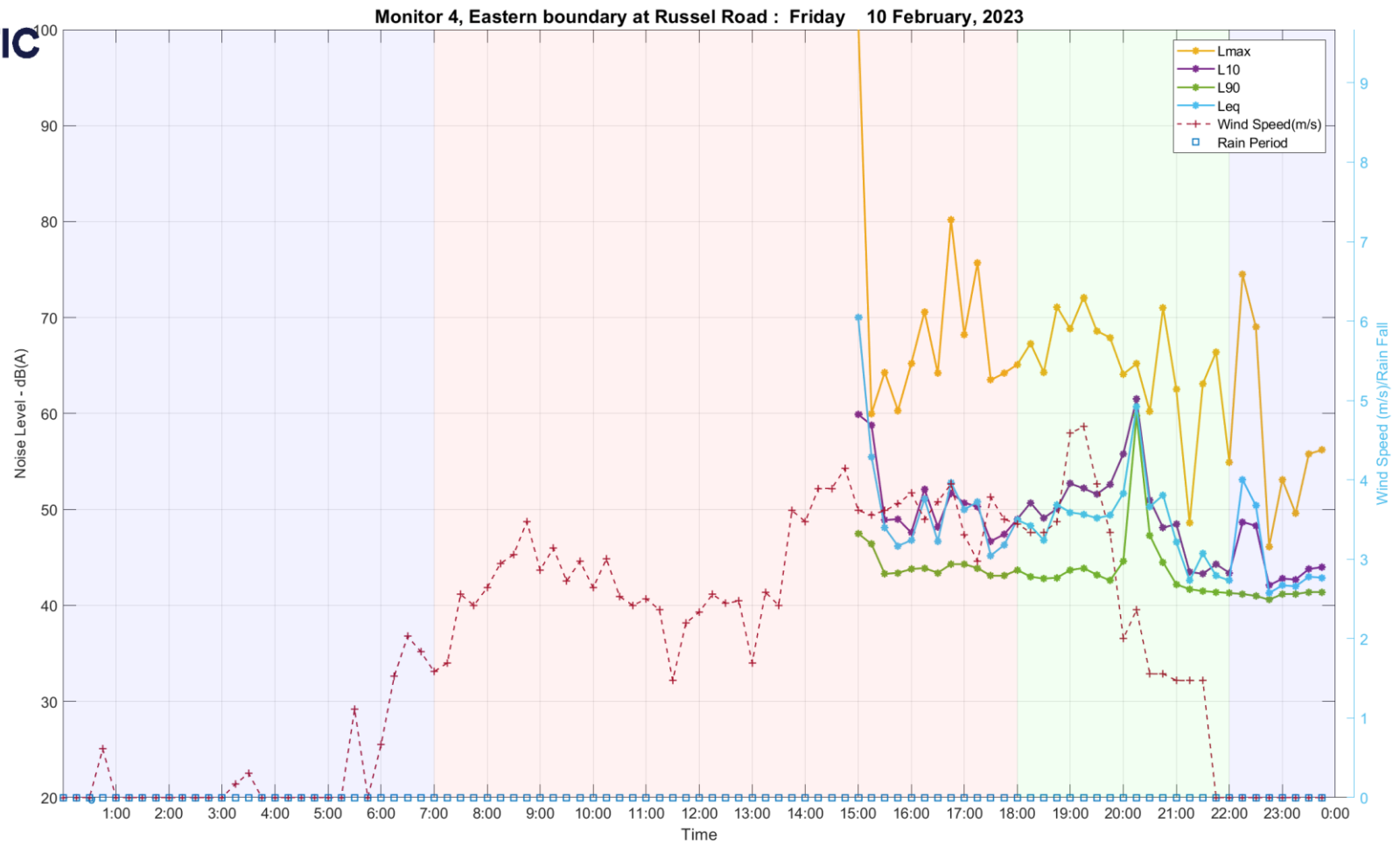


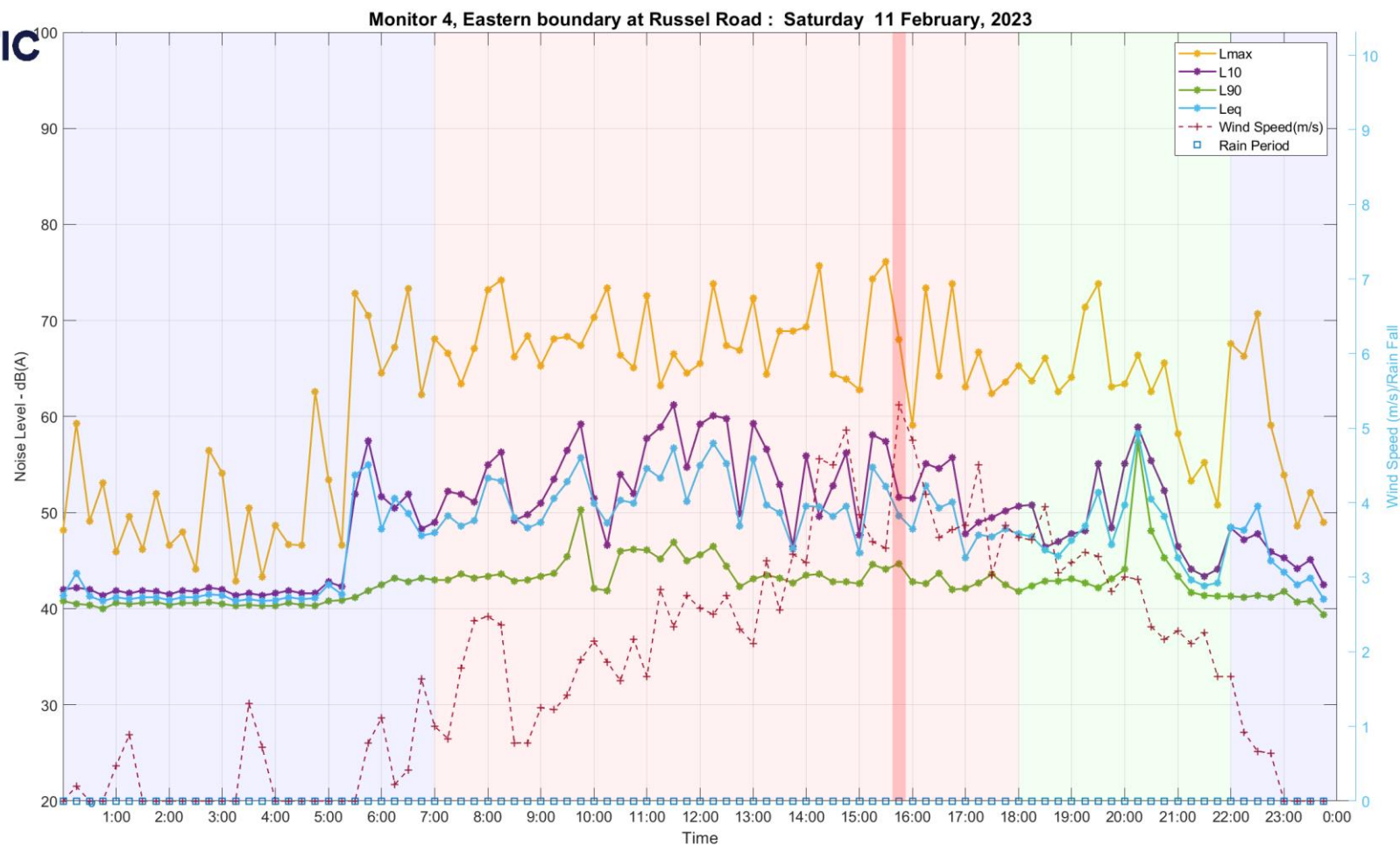
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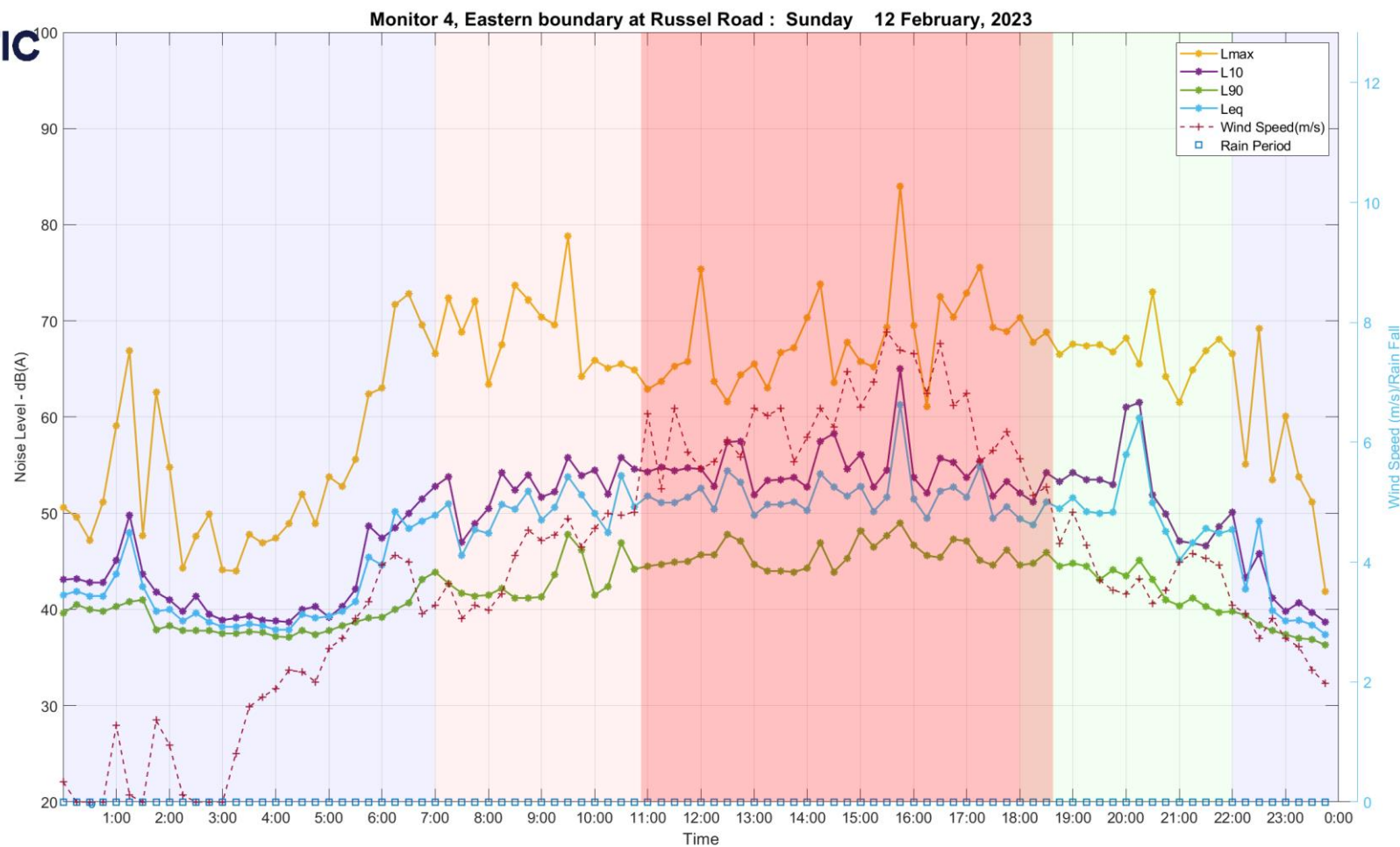
MONITOR 4 – EASTERN BOUNDARY AT RUSSEL ROAD

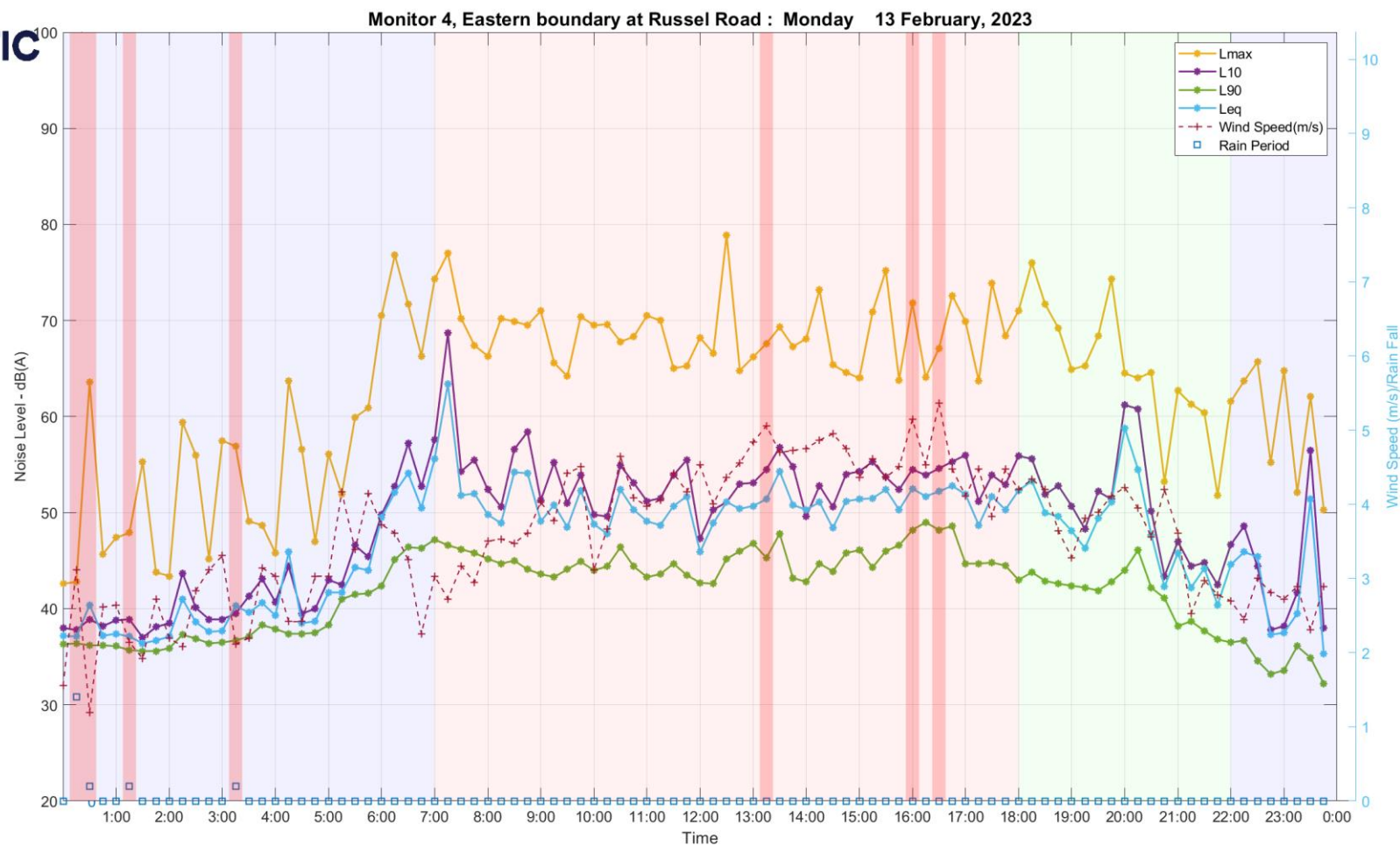


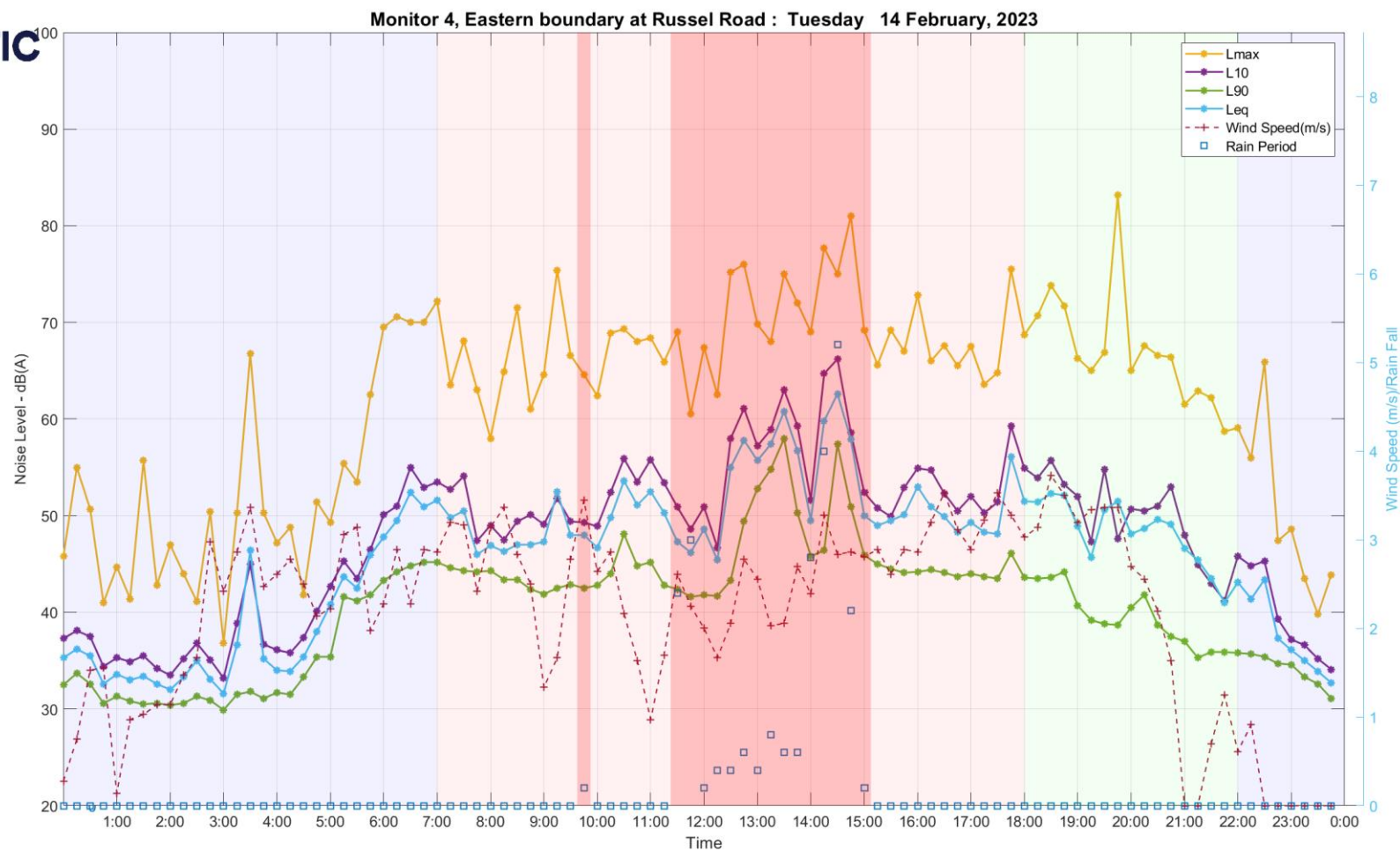
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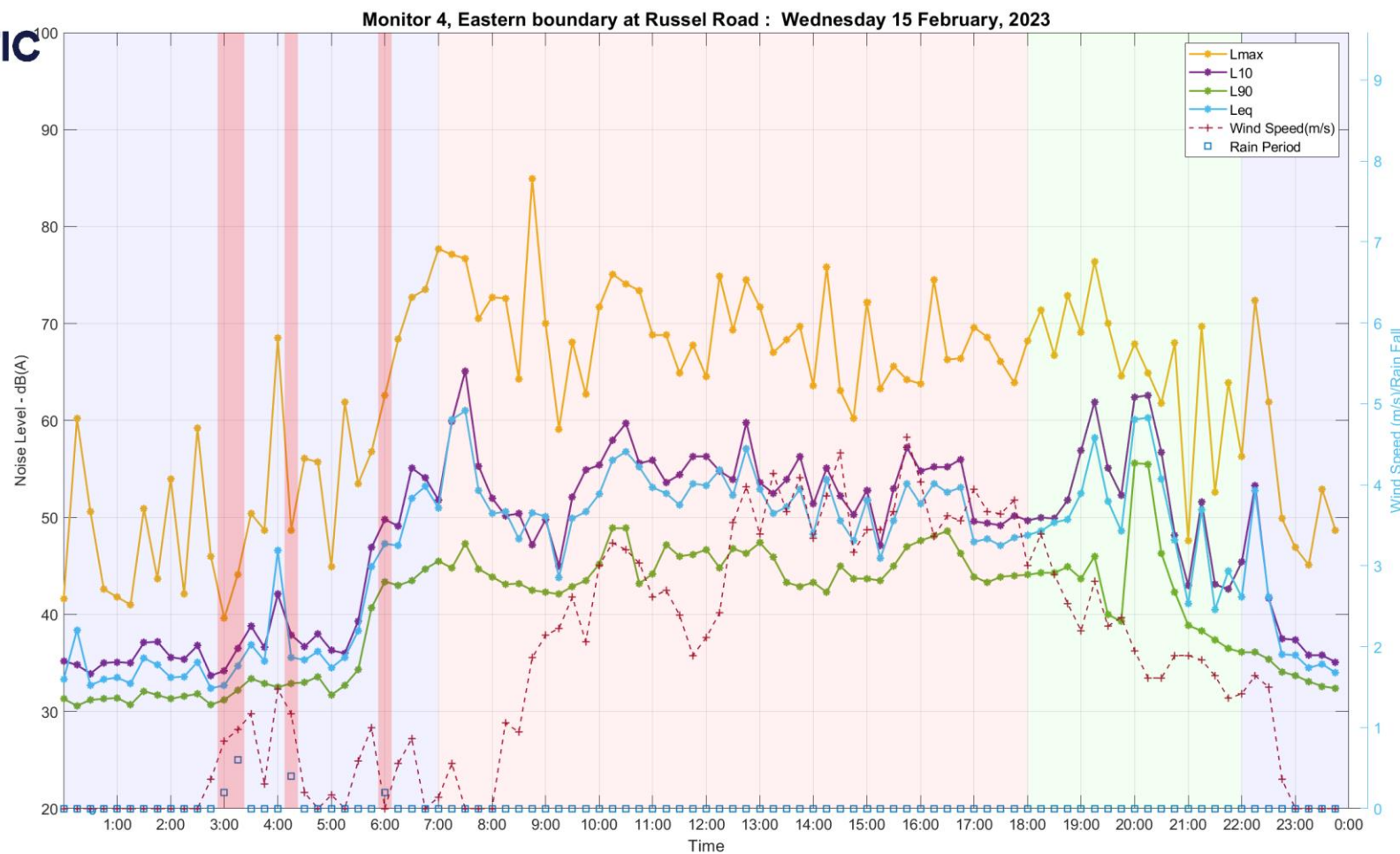


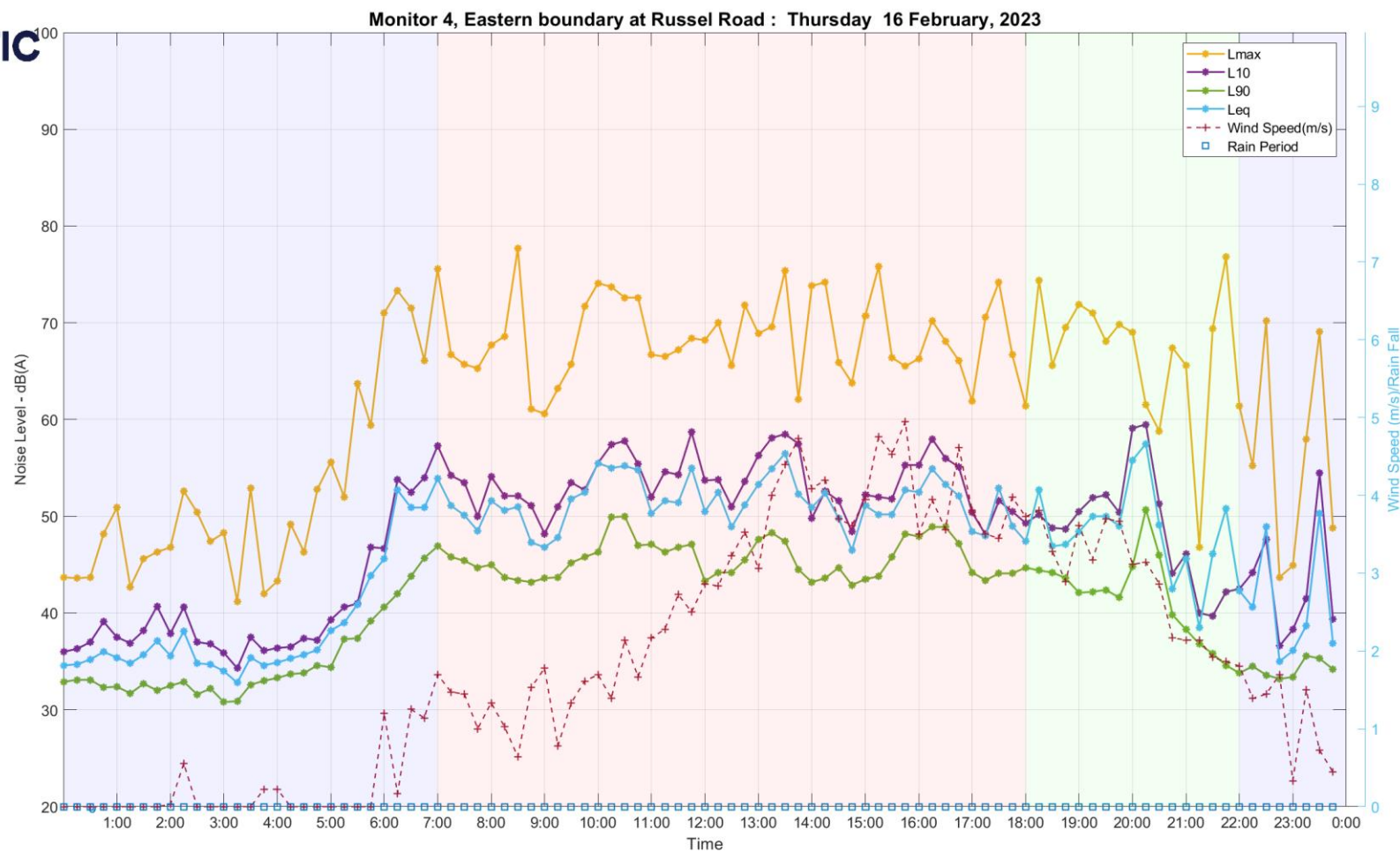


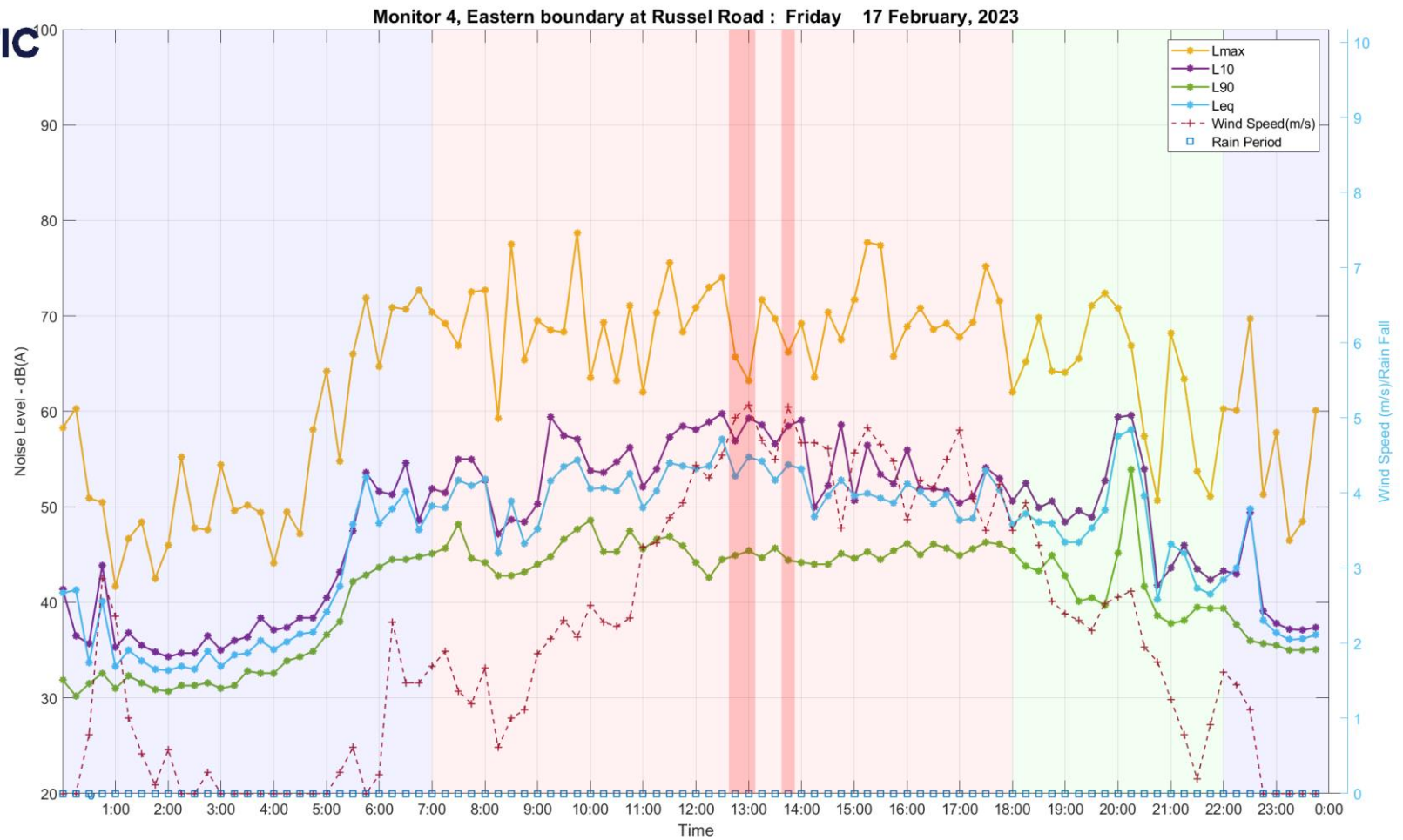


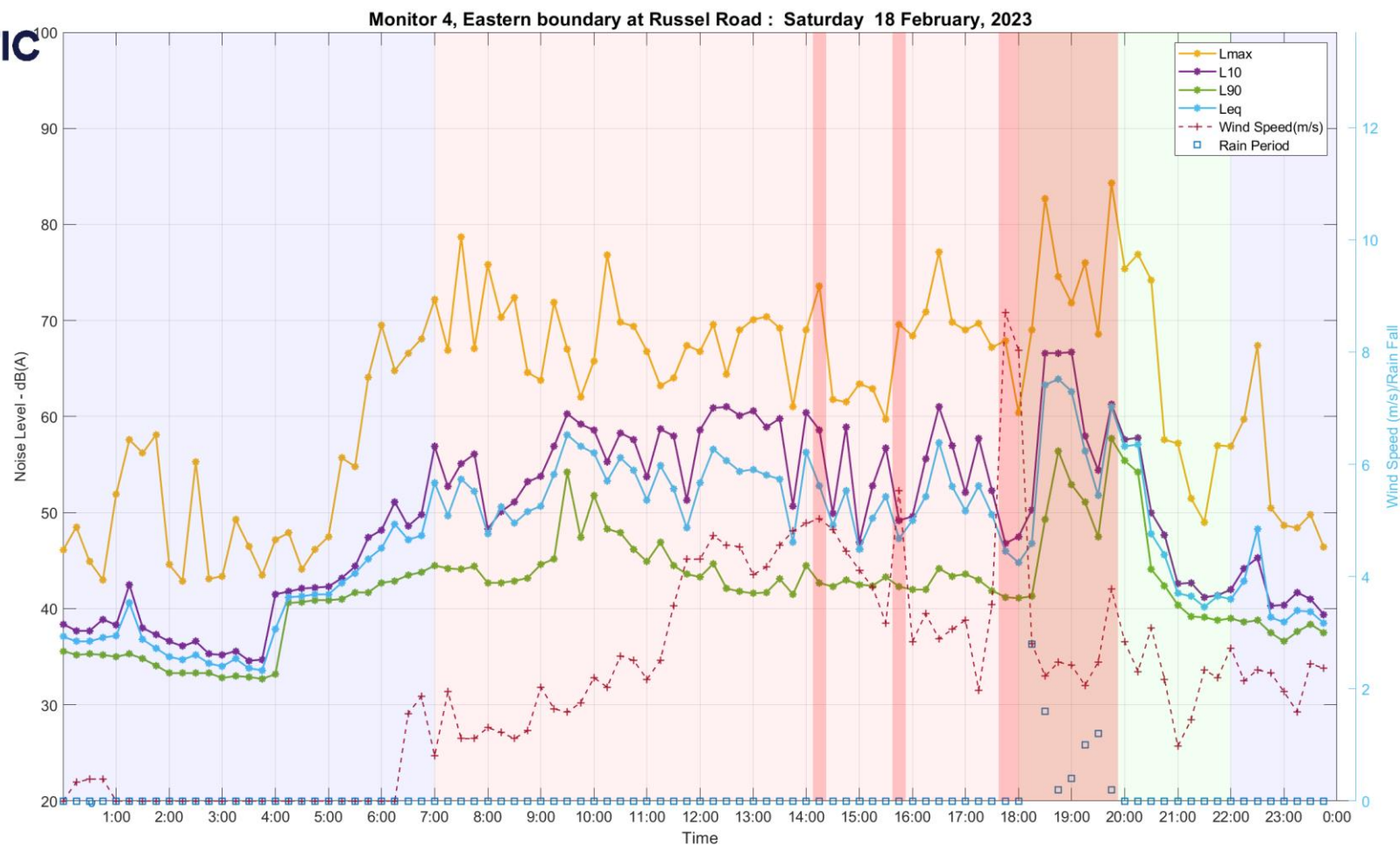


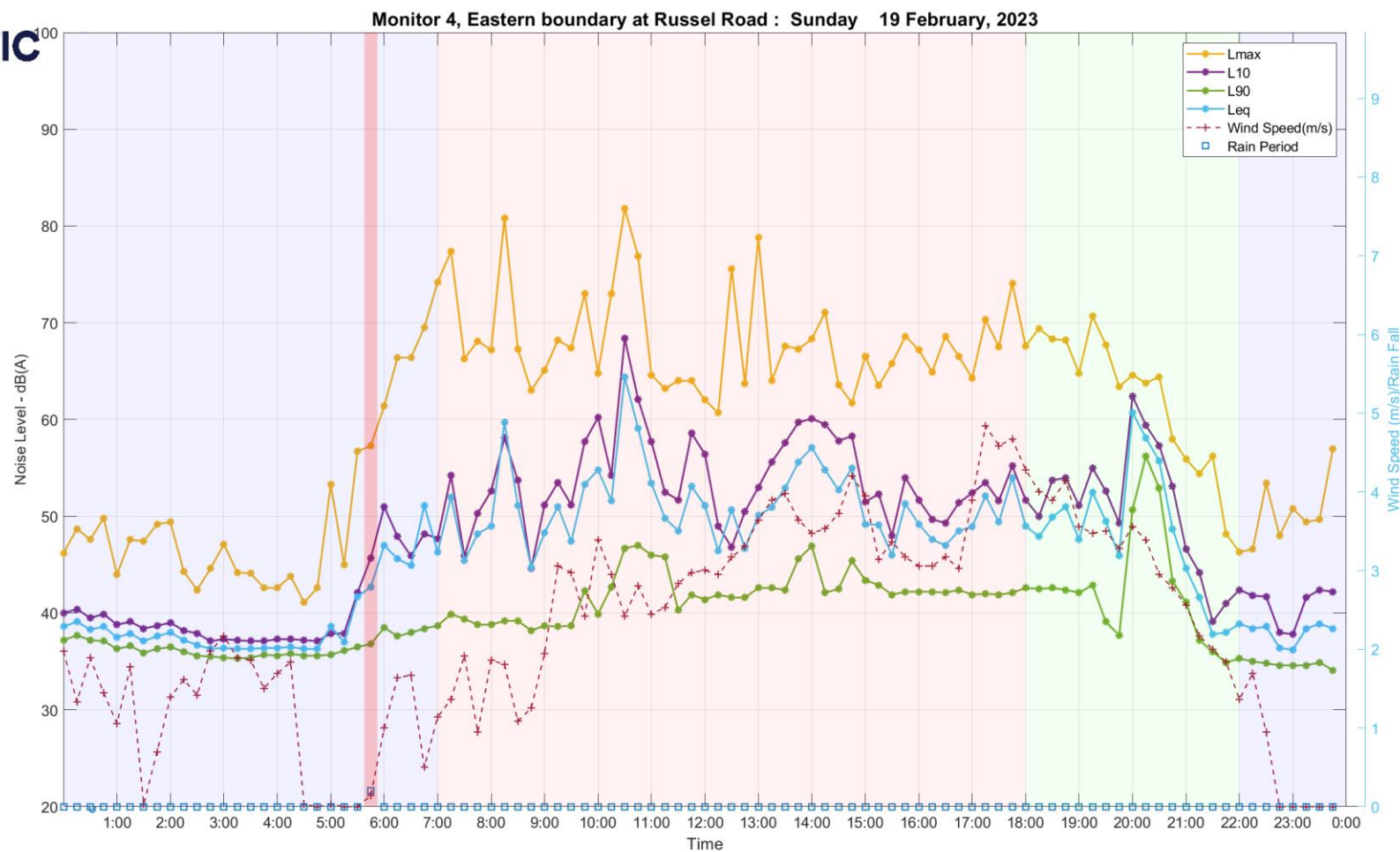


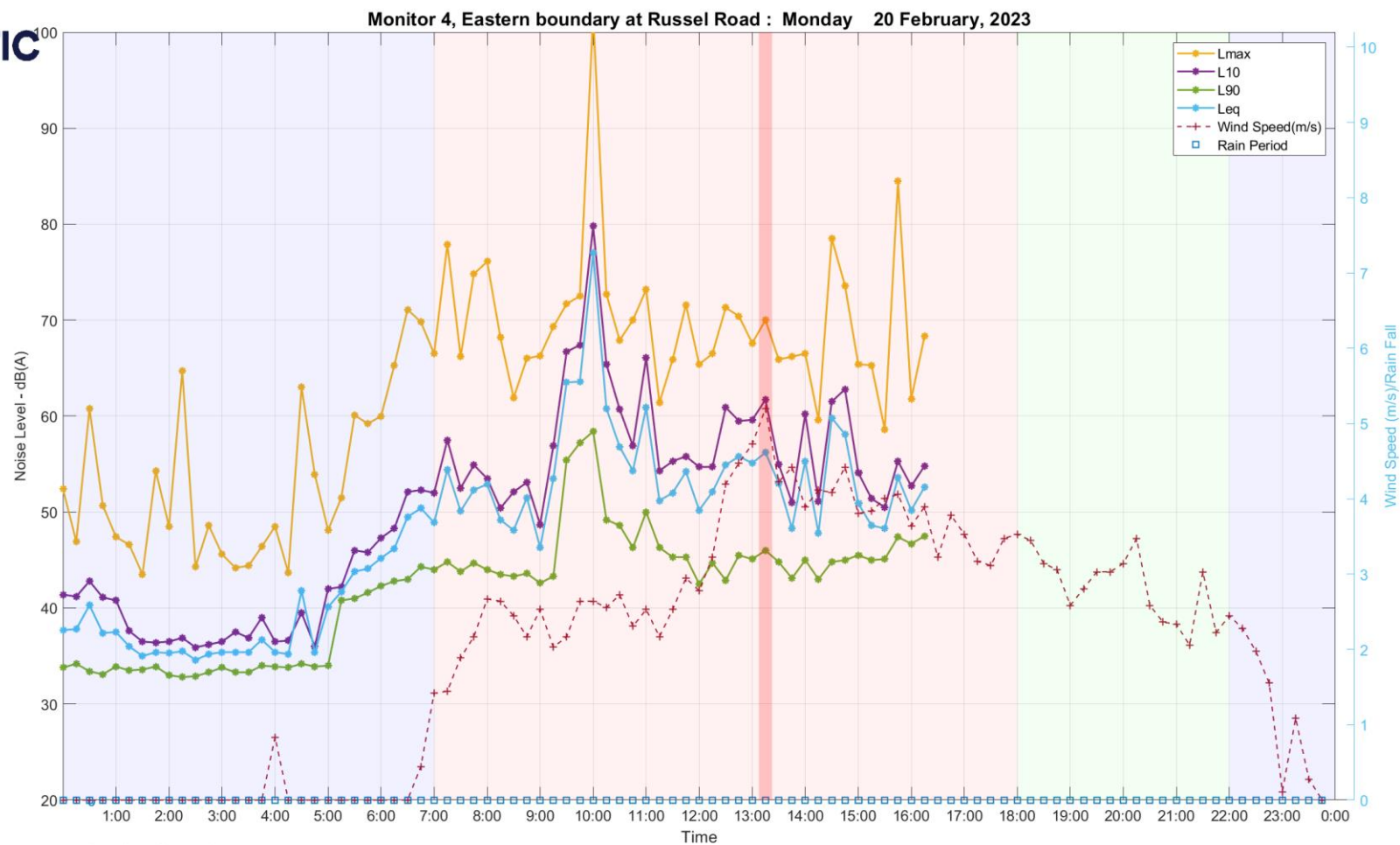












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