160-172 LORD SHEFFIELD CIRCUIT

NORTH PENRITH, NSW

WIND AND THERMAL COMFORT DESIGN REVIEW

PROJECT # 2206353

03 NOVEMBER 2022

SUBMITTED TO

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INTRODUCTION

BACKGROUND, METHODOLOGY AND SCOPE

INTRODUCTION

This Pedestrian Wind and Thermal Comfort Design Review is submitted to Penrith City Council on behalf of Urban Property Group (UPG) in support of a Development Application (DA) for a 9-storey residential and commercial mixed-use development at 160-170 Lord Sheffield Circuit, North Penrith (the site).

The proposed development, which is known as 'Mayfair on Penrith', seeks approval for the following scope of works:

- Construction of two residential towers above a joint commercial podium, with ground floor retail, containing:
  - 'East Tower':
    To consist of 8 levels above the podium (excl. rooftop), which will include:
    - 152 residential apartments.
    - Common circulation areas.
    - Rooftop open space, including 1x swimming pool, landscaped areas and other communal amenities.
  - 'West Tower':
    To consist of 8 levels above the podium (excl. rooftop), which will include:
    - 135 residential apartments.
    - Common circulation areas.
    - Rooftop open space, including 1x swimming pool, landscaped areas and other communal amenities.
  - 2-storey podium, including:
    - 15x retail units at ground level with a combined Gross Floor Area (GFA) of 1936 m^2.
    - Flexible commercial floorspace at level 1 with a GFA of 4280 m^2.
    - Rooftop landscaping
- Joint three level below ground basement parking for:
  - Car and Motorcycle Parking:
    A total of 412 car parking spaces, including:
    - 331 car parking spaces for residential occupants and residential visitors (incl. 29 accessible spaces).
    - 81 car parking spaces for commercial visitors and staff (incl. 3 accessible spaces).
    - 0 motorcycle spaces.
  - Building Services:
    Building services and plant rooms, the majority of which will be sited at Ground & Basement level 1.

This assessment is based on Computational Fluid Dynamics (CFD) modelling of the proposed precinct to understand the wind conditions around the site. In addition, solar exposure studies have also been carried out to assess the overall thermal comfort conditions around the site. The study informs on the possible Heat Island Effect and mitigation strategies (imagery shown in the body of the report and in the appendix).

INTRODUCTION

The aerial view of site with approximate site extents within the existing surrounding context is shown in Image 1.

Renders of the development and the ground level colonnade are shown in Image 2.

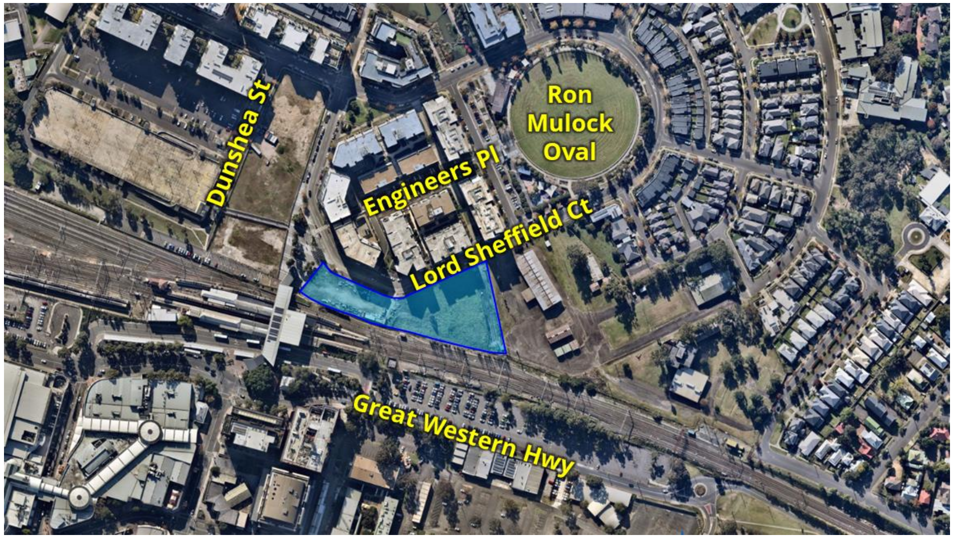


Image 1: Aerial View of the Existing Site and Surroundings
Source: Nearmap

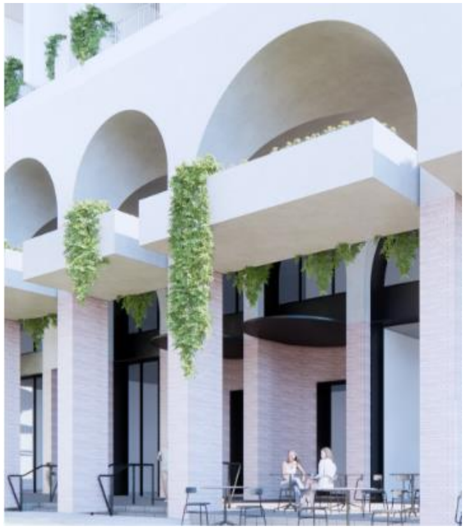


Image 2: Rendering of the Proposed Development

BACKGROUND AND METHODOLOGY

Objectives and Scope

Predicting outdoor wind conditions around a building is a complex process that involves the combined assessment of building geometry, orientation, position and height of surrounding buildings, upstream terrain and the local wind climate. Computational Fluid Dynamics is a useful tool in this regard as it not only combines the impact of these various parameters but can also provide a visual reference for the merits of a particular design of the building. However, wind comfort only represents one aspect of total human comfort and corresponds to the wind force that will likely be experienced by patrons on the site. Additional simulations to understand the impact of solar exposure, temperature, humidity, and activity level can be added on top of the wind study to give a comprehensive understanding of the overall thermal comfort conditions around the subject site. This qualitative assessment is, therefore, based on the following:

- A review of the regional long-term meteorological data.
- Review of drawings and models of the development site received by RWDI between September and November 2022.
- Use of the Orbital Stack, an in-house CFD and thermal assessment tool, to provide numerical estimation of potential wind and thermal comfort conditions around the site.
- Our engineering judgement, experience, and expert knowledge of wind flows around buildings including wind tunnel studies undertaken for similar projects in the region.

CFD in Urban Wind Modelling

Computational fluid dynamics (CFD) is a numerical modelling technique for simulating wind flows in complex environments. For urban wind modelling, CFD techniques are used to generate a virtual wind tunnel where flows around the site, surroundings and the study building are simulated at full scale. The computational domain that covers the site and surroundings are divided into small cells where calculations are performed, which allows for the “mapping” of wind conditions across the entire study domain. CFD excels as a tool for urban wind modelling for providing early design advice and helping diagnose problematic wind conditions.

A Note on Gusts:

Gust conditions are infrequent but deserve special attention due to their potential impact on pedestrian safety. The computational modelling method used in the current assessment does not quantify the transient behaviour of the wind. The effect of gusts on wind safety is predicted qualitatively in this assessment. The assessment has been conducted by experienced microclimate specialists to provide an accurate prediction of wind conditions around the site and to allow for an early-stage assessment of the proposed massing of the building. In order to quantify the transient behaviour of wind, physical scale-model tests in a boundary-layer wind tunnel or detailed transient computational numerical modelling would be required. This is generally undertaken during the DD stage of the project.

SIMULATION MODEL

Wind flows have been simulated through Orbital Stack, an in-house computational fluid dynamics (CFD) tool, using the models of the project building and the existing surrounding context as shown in Image 3. For the purposes of this computational study, the 3D models were simplified to include only the necessary elements that are likely to affect the local wind flows in the area and around the site. Landscaping and other smaller architectural and accessory features were not included in the computer model in order to provide more conservative wind conditions (as is the norm for this level of assessment).

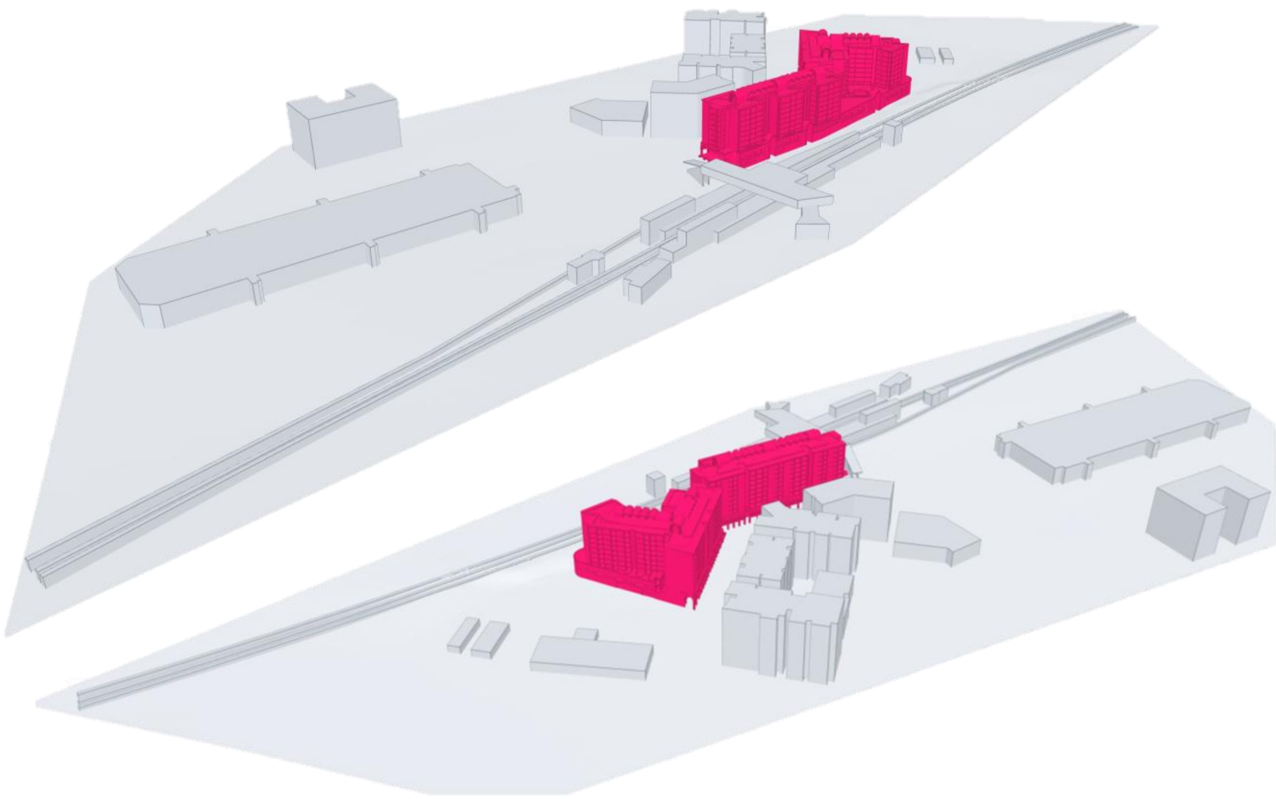
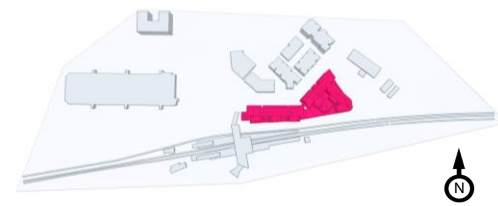


Image 3: Computer Model of the Proposed Development and Surrounding Context
(Isometric and Top-down Views)

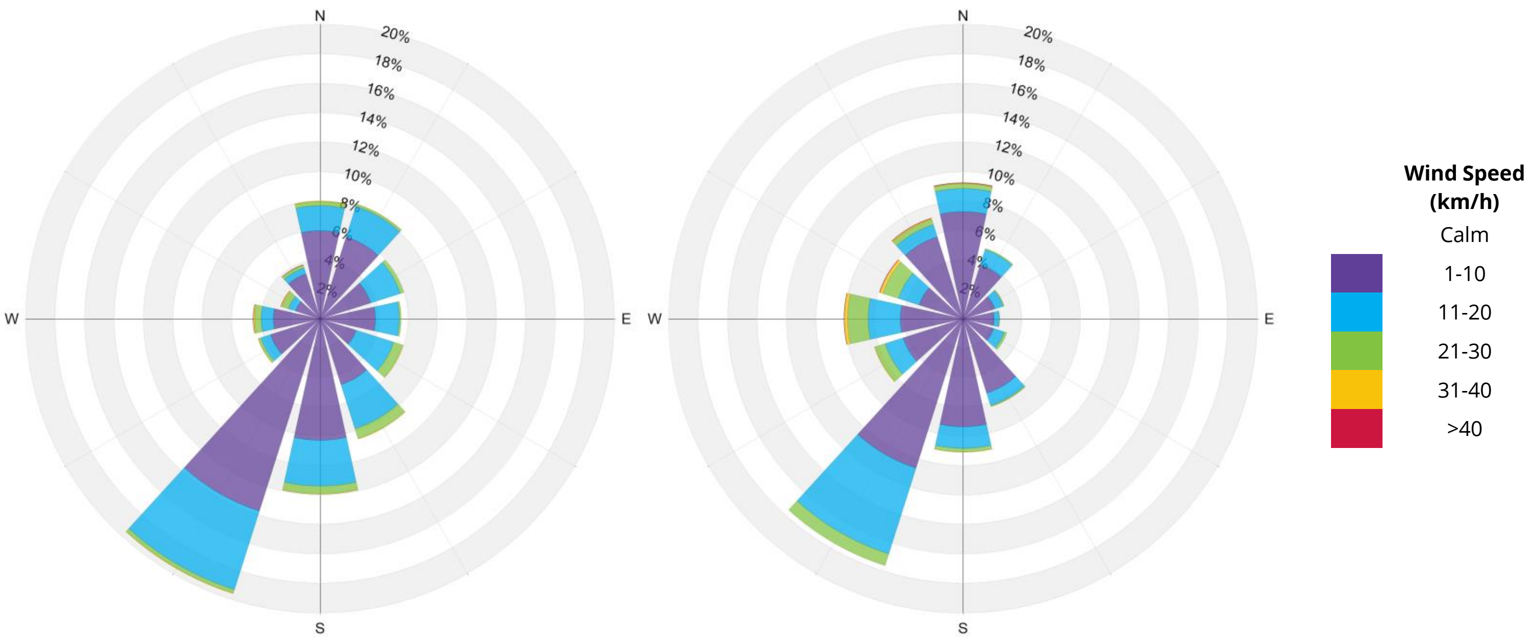


METEOROLOGICAL DATA

Wind Speed and Directionality

Meteorological data recorded at Penrith Lakes Automatic Weather Station, approximately 3km to the west of the project site, from 2010 to 2019 were used as a reference for wind conditions in the area. The distributions of wind frequency and directionality for the summer (Nov - April) and winter (May - Oct) seasons are shown in Image 4. The records indicate that winds from the southwest sector are predominant during both the summer and winter seasons. Seasonal winds from the west and northwest directions are common during the winter and summer seasons, respectively. Comparison with wind data from Richmond RAAF Base shows similar directionality of winds.

Image 4: Directional Distribution of Winds Approaching Penrith Lakes AWS
Recorded from 2010 - 2019



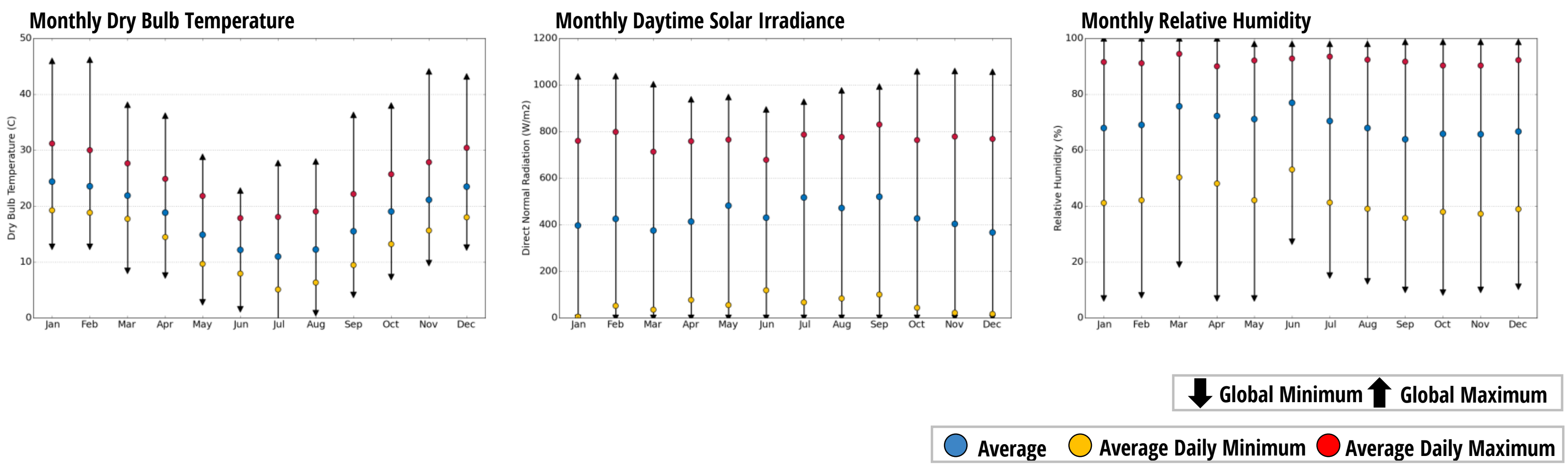
Summer (Nov - Apr) **Winter (May - Oct)**

Temperature, Humidity and Solar Irradiance

Climatological parameters such as the dry bulb temperature, daytime solar irradiation, and relative humidity need to be taken into account, in conjunction with the wind conditions for thermal comfort analysis. The relative variance of these parameters were taken from the Penrith Lake weather station on a monthly basis as illustrated in Image 5. Note that these statistics are taken from the five recent representative available years of data to better acknowledge the changing global climate. Average temperatures range between 11°C and 24°C with the average relative humidity levels ranging between 66% and 80%. The maximum average daily direct solar radiation is consistent between approximately 700 and 800 W/m^2.

Image 5: Monthly Dry Bulb Temperature, Daytime Solar Irradiance and Relative Humidity at Penrith Lake Weather Station

Recorded from 2014 - 2018

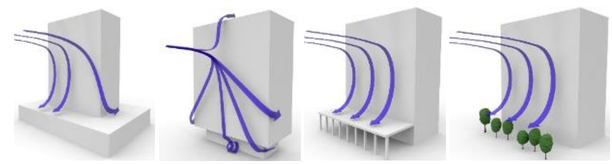


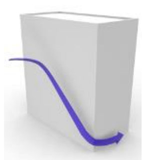
WIND MICROCLIMATE

TYPICAL WIND EFFECTS

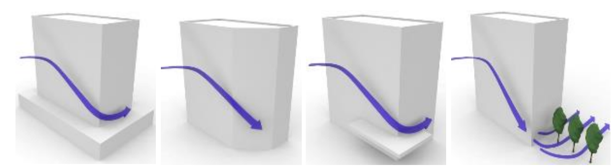
In our discussion of wind conditions on and around the proposed development, reference may be made to the following generalised wind flows (see Image 6). If these building / wind combinations occur for prevailing winds, there is a greater potential for increased wind activity and uncomfortable or potentially unsafe conditions. Design details such as setting back a tower from the edges of a podium for a prevailing, deep canopies close to ground level, wind screens / tall trees with dense landscaping, etc. can help reduce high wind activity. The choice and effectiveness of these measures would depend on the exposure and orientation of the site with respect to the prevailing wind directions and the size and massing of the proposed buildings.

Downwashing
Tall buildings tend to intercept the stronger winds at higher elevations and redirect them to the ground level. This is often the main cause for wind accelerations around large buildings at the pedestrian level.





Corner Acceleration
Winds approach at an oblique angle to a tall façade and are deflected down causing a localised increase in the wind activity or corner acceleration around the exposed building corner(s) at pedestrian level.



Channelling
When two buildings are situated side by side or an underpass is created, wind flow tends to accelerate through the space due to channeling effect caused by the narrow gap.

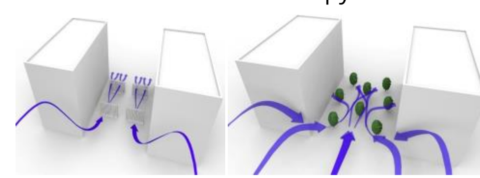


Image 6: General Wind Flow around Buildings with Examples of Common Wind Measures

WIND COMFORT GROUND LEVEL

The predicted wind comfort conditions on the ground level around the proposed development site are presented in Images 7. The comfort contours are presented for the summer and winter seasons calculated based on an abridged RWDI criteria. Note that any instances of uncomfortable wind conditions correspond to regions where high wind activity will generally be observed consistently. Such areas might also correspond to unsafe wind conditions. Image 7 shows most areas around the development site will be comfortable for passive use throughout the year. The proposed alfresco space under the garden colonnade is well-situated and is shielded from the prevailing southwesterly winds throughout the year. The wind conditions within the colonnade are suitable for passive use throughout the year. The proposed and existing landscaping along Lord Sheffield Circuit and the Station Plaza are likely to further reduce the exposure to any strong winds. Slightly higher wind speeds suitable for strolling use are noted at the southeast corner of the precinct during summers due to exposure to southerly and southwesterly winds. The proposed trees and shed structure located at the corner will likely reduce the overall exposure within the community garden space planned here. .

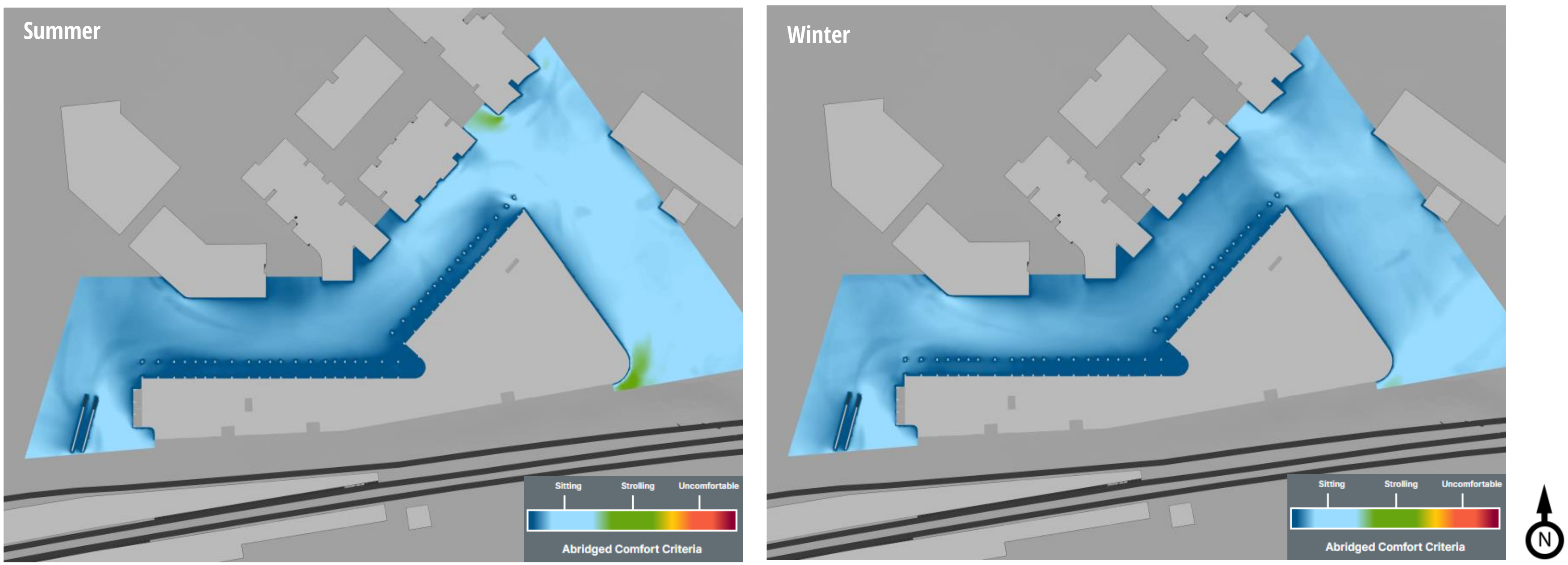


Image 7: Expected Wind Comfort Conditions on the Ground Level Areas

WIND COMFORT
LEVEL 01, 02 AND ROOFTOP TERRACES

The expected wind comfort conditions on the upper-level areas of the development are presented in Image 8. The comfort contours are presented for the summer and winter seasons calculated based on an abridged RWDI criteria. Most areas on the upper-level spaces are noted to be suitable for passive use throughout the year. Higher wind activity suitable for strolling use is noted along the edges of the Rooftop terrace space. These are generally caused by the exposure of the elevated terrace to the regional winds from the southerly sector and the prevailing westerly winds during the winters. The interaction of these winds with the proposed massing of the building is shown in Image 9. The proposed landscaping (Arcadia Landscape DA Design Report – Sept 2022) on the rooftop terrace will likely provide sufficient barrier to the movement of the winds within these spaces. However, as noted in the thermal comfort section of the report, the higher wind speeds will likely be perceived as comfortable particularly during the warmer months of the year.

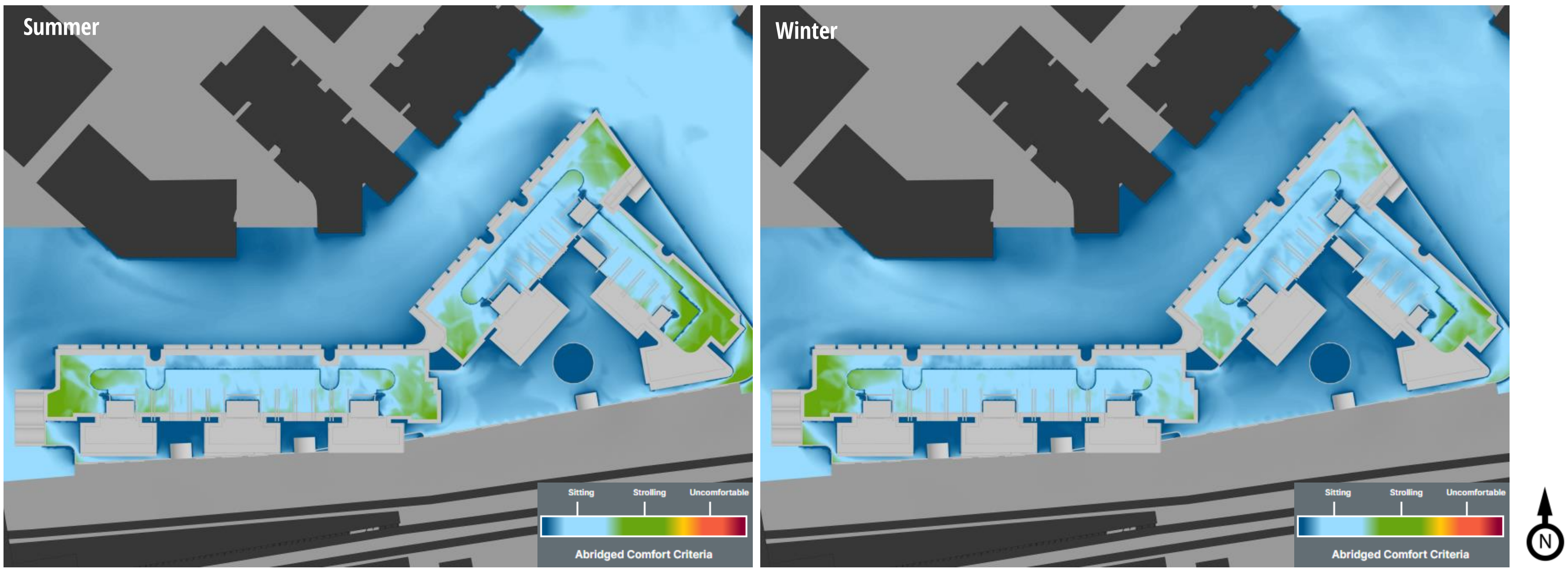
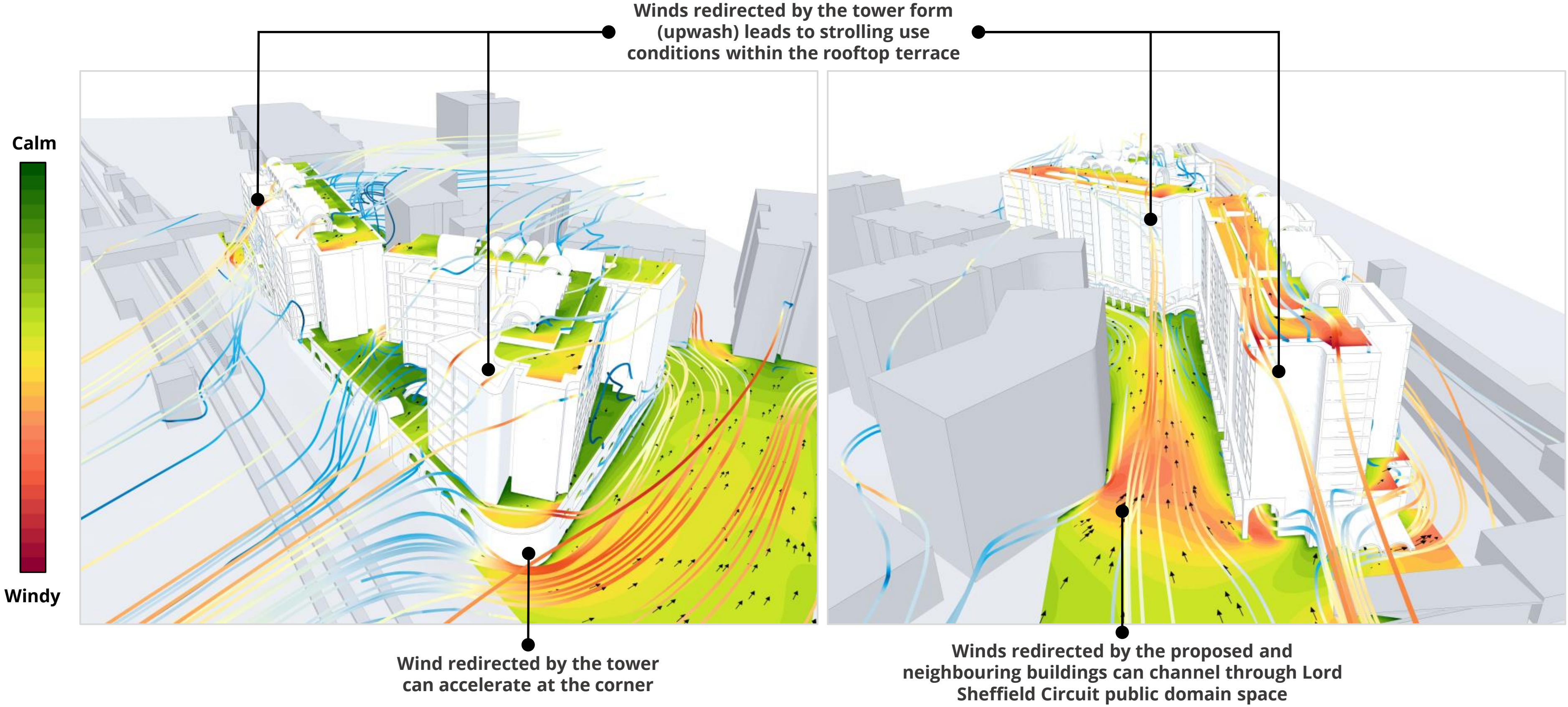


Image 8: Expected Wind Comfort Conditions on Level 02 and Rooftop Terraces

WIND INTERACTIONS

Image 10: Interaction of Prevailing Winds With Proposed Massing With Relative Wind Intensity Indicated for the Simulated Direction

Winds from 150° sector (Left) and 270 ° sector (right)



Note: Relative wind speeds and contours shown here are for informational purposes only and are not representative of the overall wind conditions at the site. The wind comfort conditions are evaluated using the probability of occurrence for all wind directions and are shown in Images 7 and 8.

THERMAL COMFORT

FACTORS AFFECTING THERMAL COMFORT

Thermal comfort is a complex topic that combines an understanding of human behaviour and physiological response to external environmental conditions. The importance of such a holistic approach to human comfort has been discussed by Peddie and Soligo (2020).

There are a myriad of thermal comfort metrics in existence ranging from simple environment-based systems to complex metrics which combine environmental conditions with human physiological models and survey results. Note that thermal comfort metrics are more nuanced and presented at a higher level of granularity. These are used to convey varying levels of thermal discomfort but generally exclude safety concerns.

The metrics presented herein correlate comfort to six primary factors. Four of these factors are related to the ambient environment (Image 10):

- Dry Bulb Temperature
- Humidity
- Air Speed
- Mean Radiant Temperature (temperatures of surfaces around the individual as well as solar exposure)

The other two are related to the individual. These personal or subjective factors are:

- Garment thermal resistance/insulation; and
- Metabolic heat generation (the heat generated by the human body resulting from physical activity).

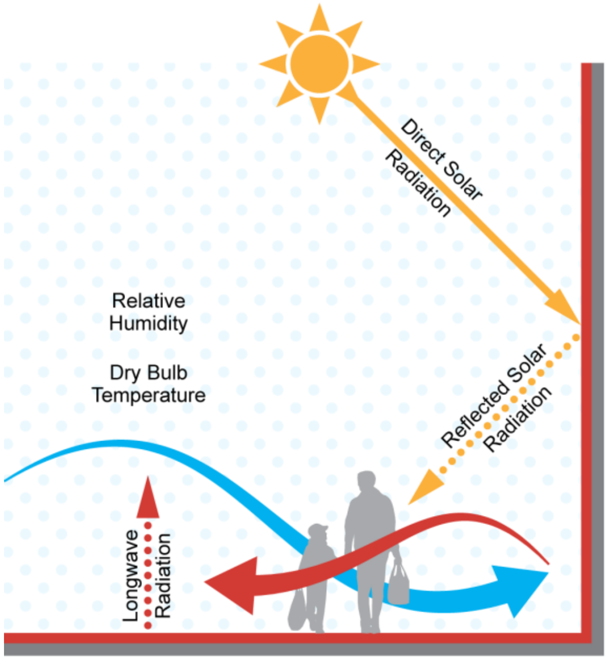


Image 10: Factors Influencing Human Thermal Comfort

CRITERIA AND METHODOLOGY

Thermal Comfort Criteria

In an outdoor environment, the "Standard Predicted Mean Vote Modified" (SPMV*) metric is used which is a modified version of the ASHRAE PMV metric used for indoor environments. The metric is based on surveys and perceptions of individuals. Note that it is not a definitive measure of an individual's thermal comfort since the conditions and activities that impact the perception of comfort are large and varied. Any thermal comfort analysis should, therefore, be viewed as a guide and not as a quantitative assessment.

While the SPMV* index can be used to define the human thermal balance, with a neutral rating (0) considered comfortable indoors, people generally find a wider range of conditions acceptable outdoors and are willing to tolerate some measure of "discomfort". Therefore, the index is broken up into multiple ranges as shown below and has been presented as percentage of time a given space is within the target comfort range:

Comfortable (-1 to 1): People are generally comfortable. The conditions are perceived to be like indoor conditions (RWDI has assumed this to be an appropriate range for the region).

Acceptable (1 to 2 or -1 to -2): This represents a comfortable outdoor environment (allowing for greater variability).

Uncomfortable (2 to 3 or -2 to -3): People will generally accept these conditions outside but will likely seek more comfortable areas when possible.

Thermal Comfort Methodology

Thermal comfort studies require assumptions about what people are doing and what they are wearing. For this work, a relatively relaxed metabolic rate of 87.3 W/m² was applied (equivalent to a slow walk). People were assumed to be wearing trousers and short-sleeved shirt during the summer, trousers and long-sleeved shirt during the shoulder seasons, and trousers with long-sleeved shirt and vest/light jacket in the winter.

Leveraging the wind simulations results, thermal comfort conditions were predicted across the site at pedestrian height during various combinations of seasons and times of day. The seasons were defined as: Spring (September-November), Summer (December-February), Autumn (March-May), and Winter (June-August). The time-intervals include:

- Night, 00:00 - 5:59
- Morning, 6:00 – 10:59
- Midday, 11:00 – 13:59
- Afternoon, 14:00 – 18:59
- Evening, 19:00 – 23:59

Thermal comfort results are typically broken down into more refined time periods than wind studies to better capture the diurnal variation in thermal comfort which is not always relevant for assessing the wind forces.

THERMAL COMFORT RESULTS AND DISCUSSIONS

Solar Exposure

Figures 11a – 11h in the following pages show the results of the solar exposure for selected time periods during the day. The results are presented as the percentage of hours a given location is exposed to direct sun based on the existing surrounding context. The results are presented as coloured contours at a horizontal plane approximately 1.5 m above the local ground and floor levels. Note that during the evening and night times, the aggregate solar exposure over the selected period of day will be zero (as shown in Figures 14d and 14h). As expected, the solar exposure during morning, middays and afternoon is higher compared to the evenings.

Thermal Comfort Conditions and Ratings

The thermal comfort conditions are presented in Figures 12a – 12h. The results are presented for the different periods of the day and seasons throughout the year and are shown as the percentage of hours thermal comfort is predicted to be within the target range (SPMV* between -1 and 1) and is, therefore, expected to the comfortable. Figures A1-A8 in the Appendix section show the thermal comfort rating which indicate areas around the development that are either too cold or too warm. Note that midday generally represents the most challenging time period in terms of thermal comfort especially during summer and the shoulder seasons. In the winter, morning and evenings are the time periods when conditions would be comfortable less often for being too cold.

Ground Level – Public Domain and Garden Colonnade

The results indicate that thermal conditions around the development site at the ground level would generally be perceived as comfortable for the majority of times throughout the year due to wind flows and ample shading by the proposed development and the surrounds. During the midday hours in the summer and shoulder seasons, the public domain space along Lord Sheffield Circuit to the north of the development will likely experience thermal discomfort due to the higher temperature as well as the lower wind exposure along the street front. People will likely seek the shading underneath the Garden Colonnade which is suitable from a thermal comfort standpoint. If desired, fan assisted air movement devices or cooling systems such as misting fan could provide additional cooling during the warmer months and help increase the amount of time patrons would consider the space comfortable.

During winters, conditions are generally predicted to be comfortable less often in the morning and evening periods when the temperatures and sun exposure are lower (Figures 12a and 12d). Exposure to the westerly winter winds can also create a larger region of discomfort at the western edge of the road compared to the eastern edge during morning hours. It is expected that during this time of year, patrons would bring a jacket or sweater to wear as needed. Conditions under the Garden Colonnade will also be considered too cold to use. Heating elements can be used during this time of the year.

THERMAL COMFORT RESULTS AND DISCUSSIONS

Ground Level – Bush Tucker Walk and Station Plaza

Similar to the public domain space to the north of the development along Lord Sheffield Circuit, the areas to the east (Shareway, Bush Tucker Walk, and community garden) will experience higher solar exposure during the summers with conditions likely to be perceived as too warm during summer middays and too cold during winter evenings. Additional shading through canopies or softscape elements can be used to provide comfortable spaces during summer with the added benefit of reduced wind exposure during winters.

Level 01 Outdoor Spaces and Level 02 Garden

Level 01 outdoor spaces are generally well-shielded from solar exposure and winds. Most areas on Level 01 are found to be comfortable throughout the year. The space directly underneath the circular void might be considered slightly warmer during summer middays due to high solar exposure, though the overall impact is generally low for the rest of the time.

It is understood that the Level 02 podium garden space is not intended to be trafficable and is to be used mainly as fire egress. Therefore, the thermal comfort conditions are acceptable for the intended usage of the area.

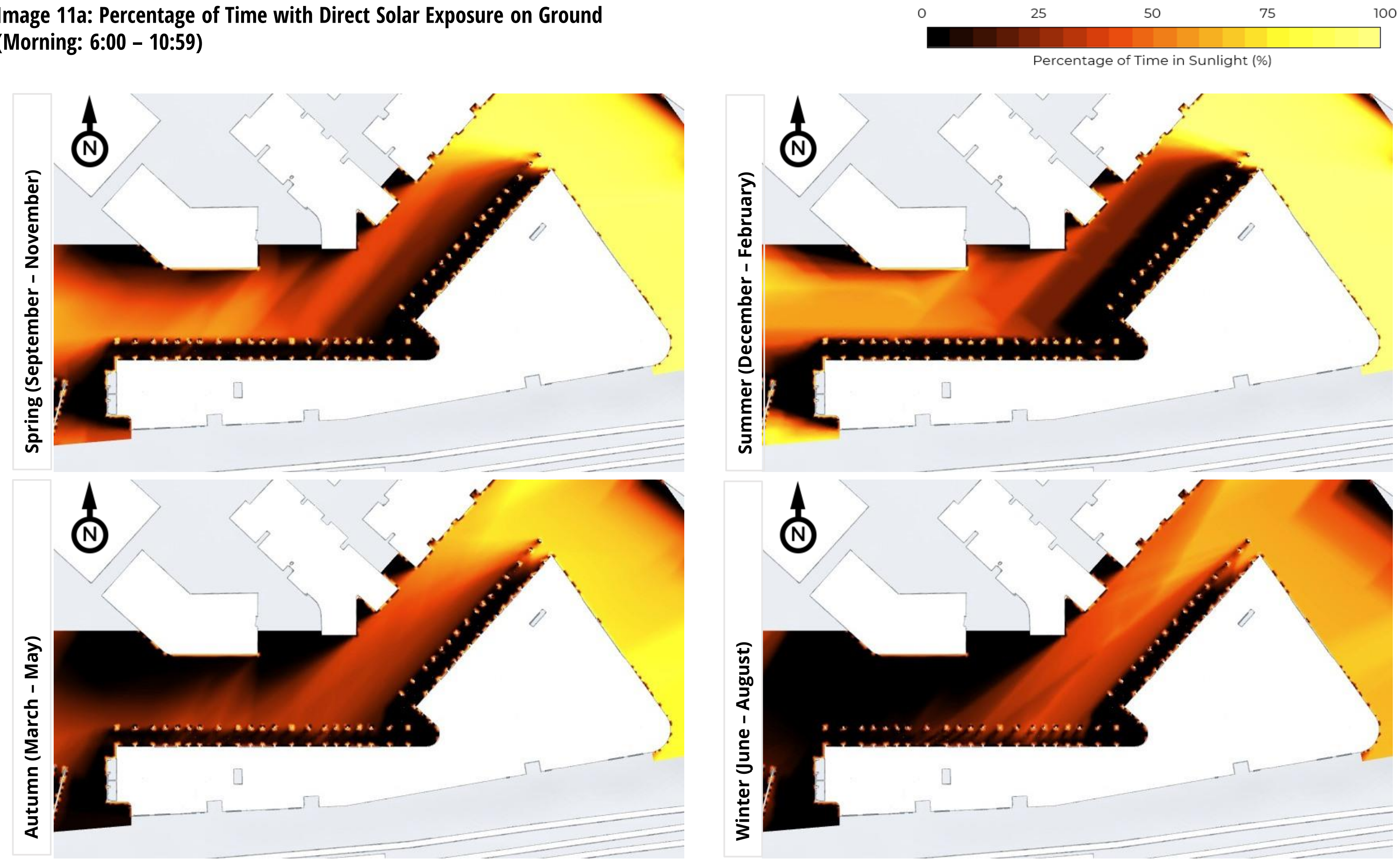
Rooftop Terrace

The thermal comfort frequency on the roof level were predicted to be low during the summer and shoulder seasons , as these areas have high solar exposure (Figures 11e, 11f, and 11g). This poses challenge to thermal comfort especially during the midday and afternoon hours in the summer. The shading effect of the proposed development massing and canopies on the roof level help to improve the conditions directly underneath these elements. Given these are spaces where patrons might linger, additional shading or active cooling measures are recommended. Mechanical assisted air movement devices such as fan or mist cooling could help provide additional cooling, especially during hot summer middays. Landscaping in the form of dense trees, retractable awnings, or localised umbrellas would also be useful in providing shading to increase the spaces where patrons would be comfortable. Examples are shown in Image 13.

The proposed landscape trees along the southern aspect should be maintained to provide shading. However, dense underplanting is not recommended for the trees to allow for wind infiltration within the terrace from the southwest direction during summers. The added ventilation effect will likely assist with the comfort levels in these areas.

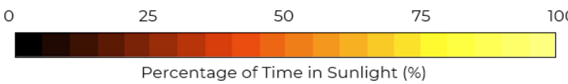
SOLAR EXPOSURE CONTOURS

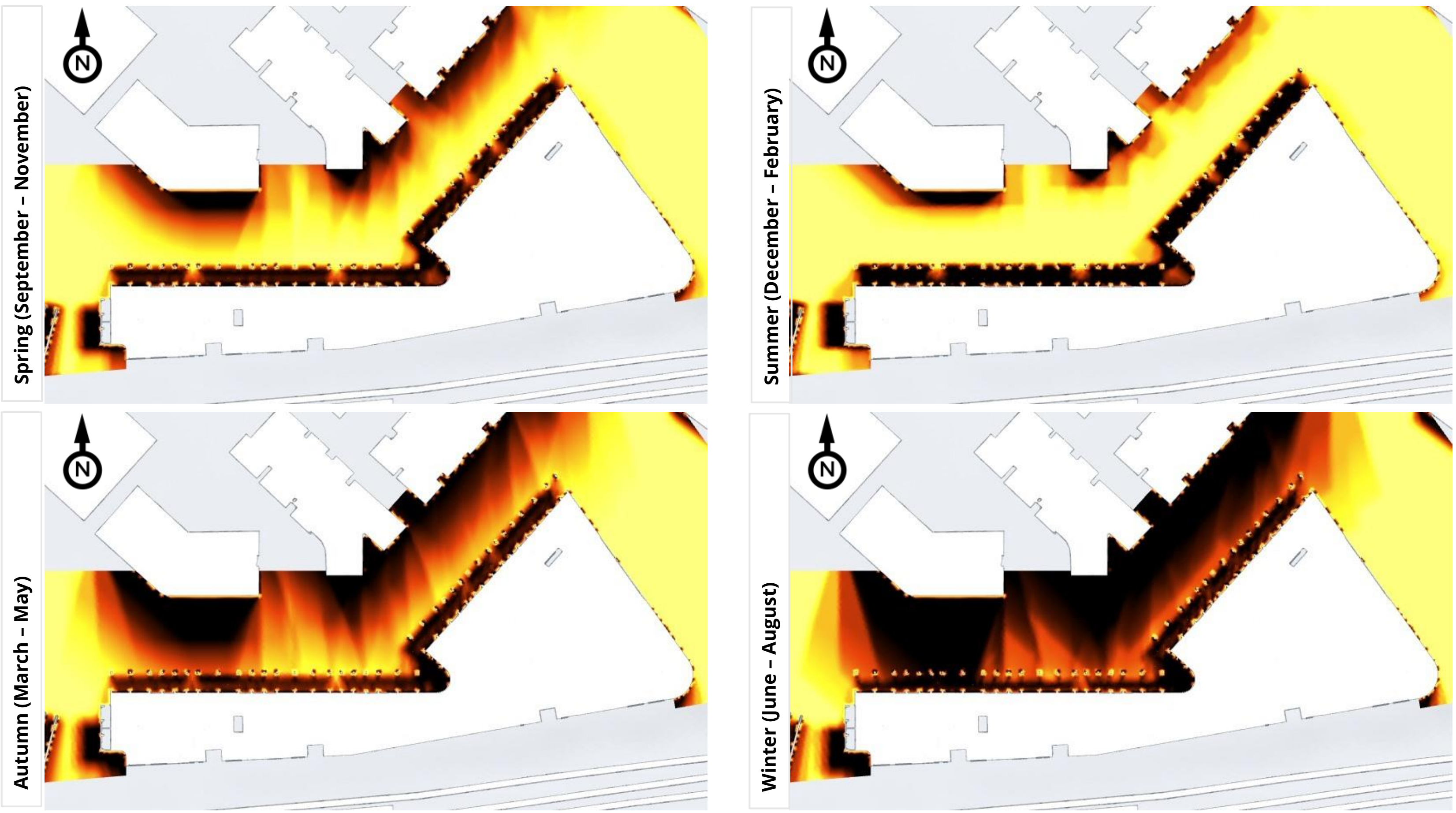
Image 11a: Percentage of Time with Direct Solar Exposure on Ground (Morning: 6:00 – 10:59)



SOLAR EXPOSURE CONTOURS

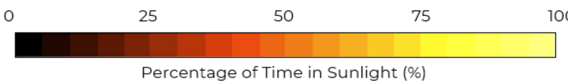
Image 11b: Percentage of Time with Direct Solar Exposure on Ground (Midday: 11:00 – 13:59)

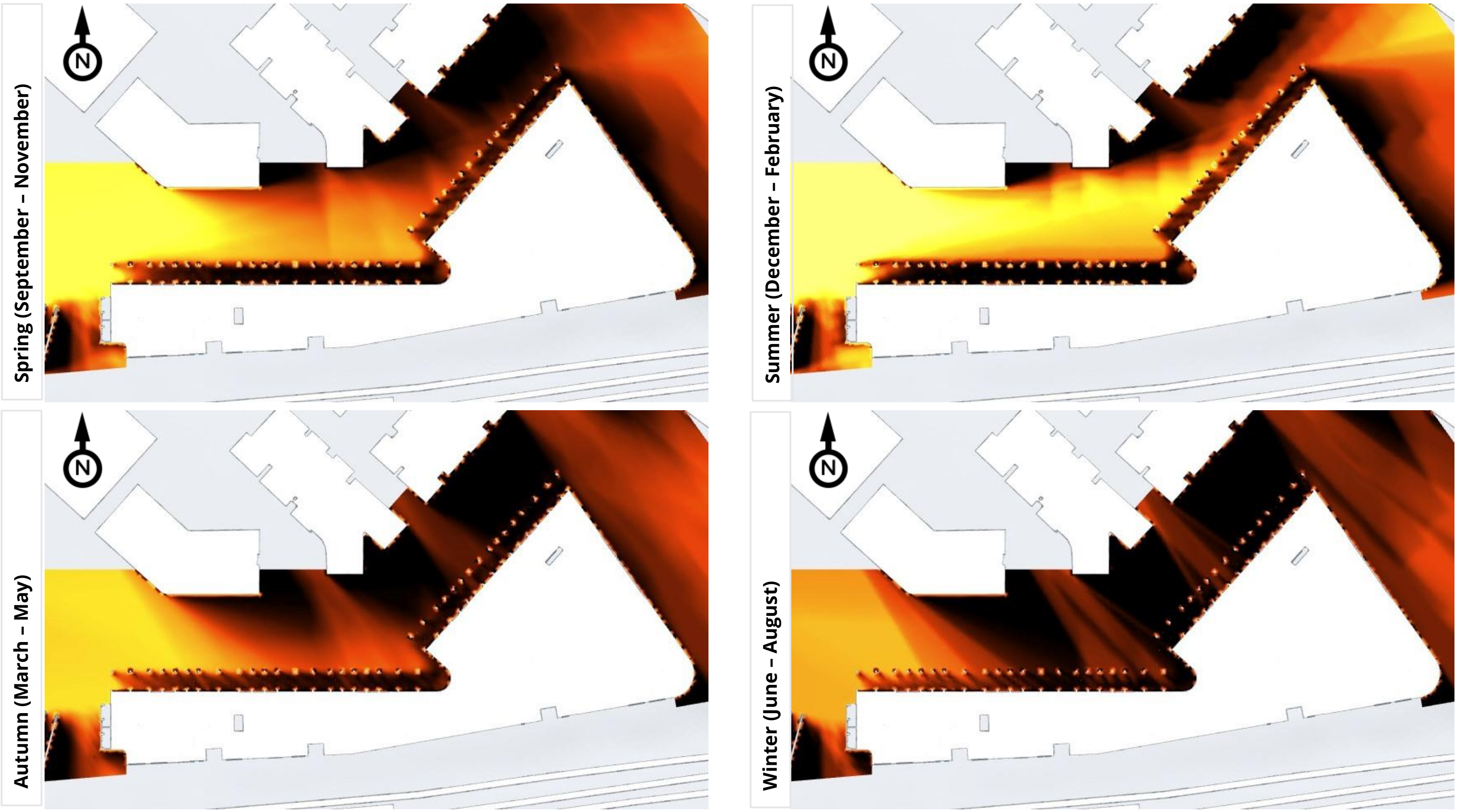




SOLAR EXPOSURE CONTOURS

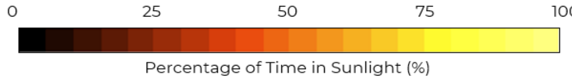
Image 11c: Percentage of Time with Direct Solar Exposure on Ground (Afternoon: 14:00 – 18:59)





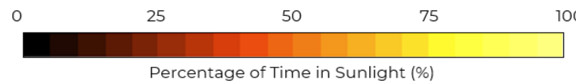
SOLAR EXPOSURE CONTOURS

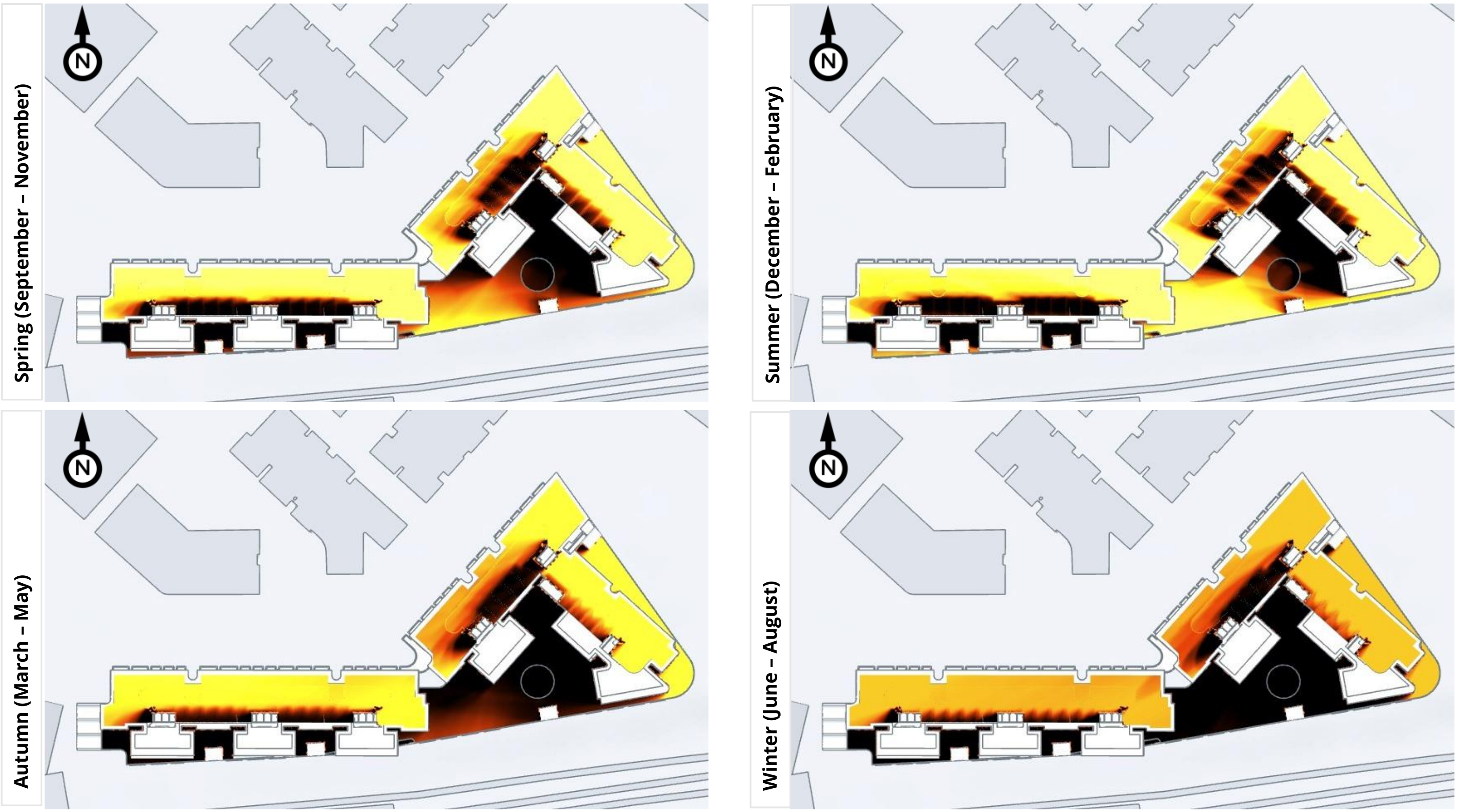
Image 11d: Percentage of Time with Direct Solar Exposure on Ground (Evening: 19:00 – 23:59)



SOLAR EXPOSURE CONTOURS

Image 11e: Percentage of Time with Direct Solar Exposure on Level 2 and Roof (Morning: 6:00 – 10:59)



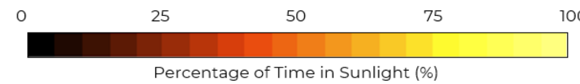


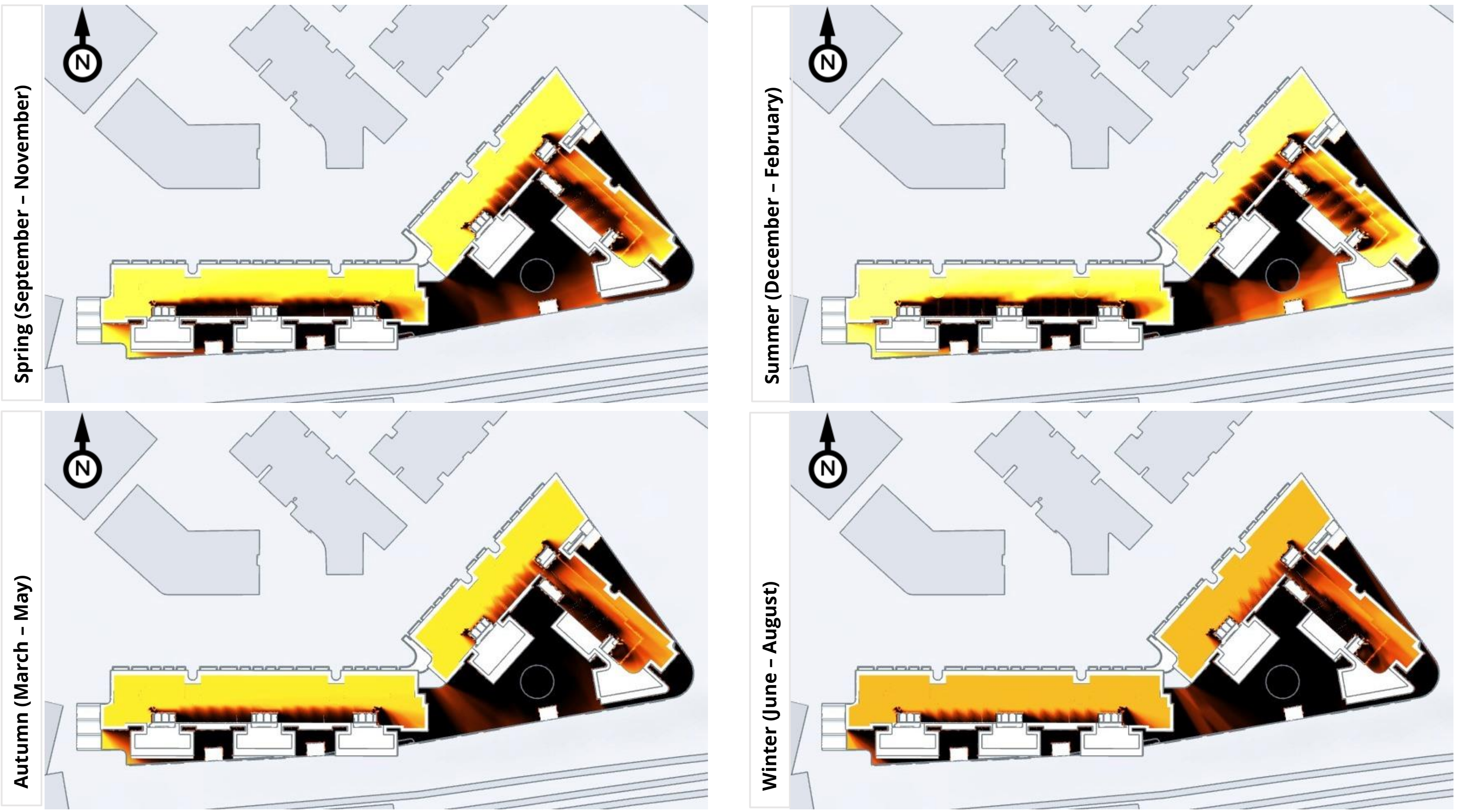
SOLAR EXPOSURE CONTOURS

Image 11f: Percentage of Time with Direct Solar Exposure on Level 2 and Roof (Midday: 11:00 – 13:59)

SOLAR EXPOSURE CONTOURS

Image 11g: Percentage of Time with Direct Solar Exposure on Level 2 and Roof (Afternoon: 14:00 – 18:59)



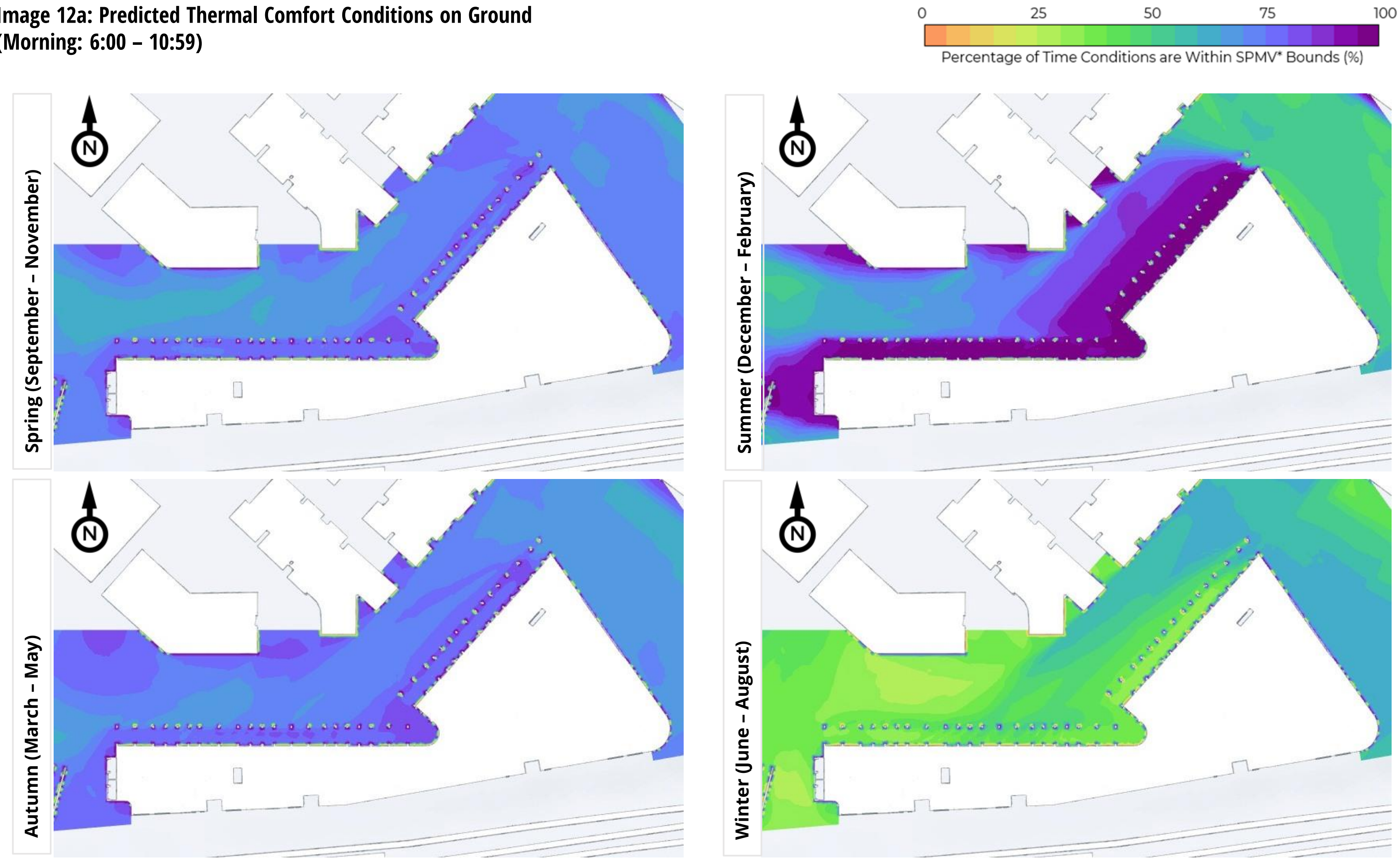


SOLAR EXPOSURE CONTOURS

Image 11h: Percentage of Time with Direct Solar Exposure on Level 2 and Roof (Evening: 19:00 – 23:59)

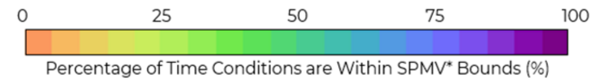
THERMAL COMFORT CONTOURS

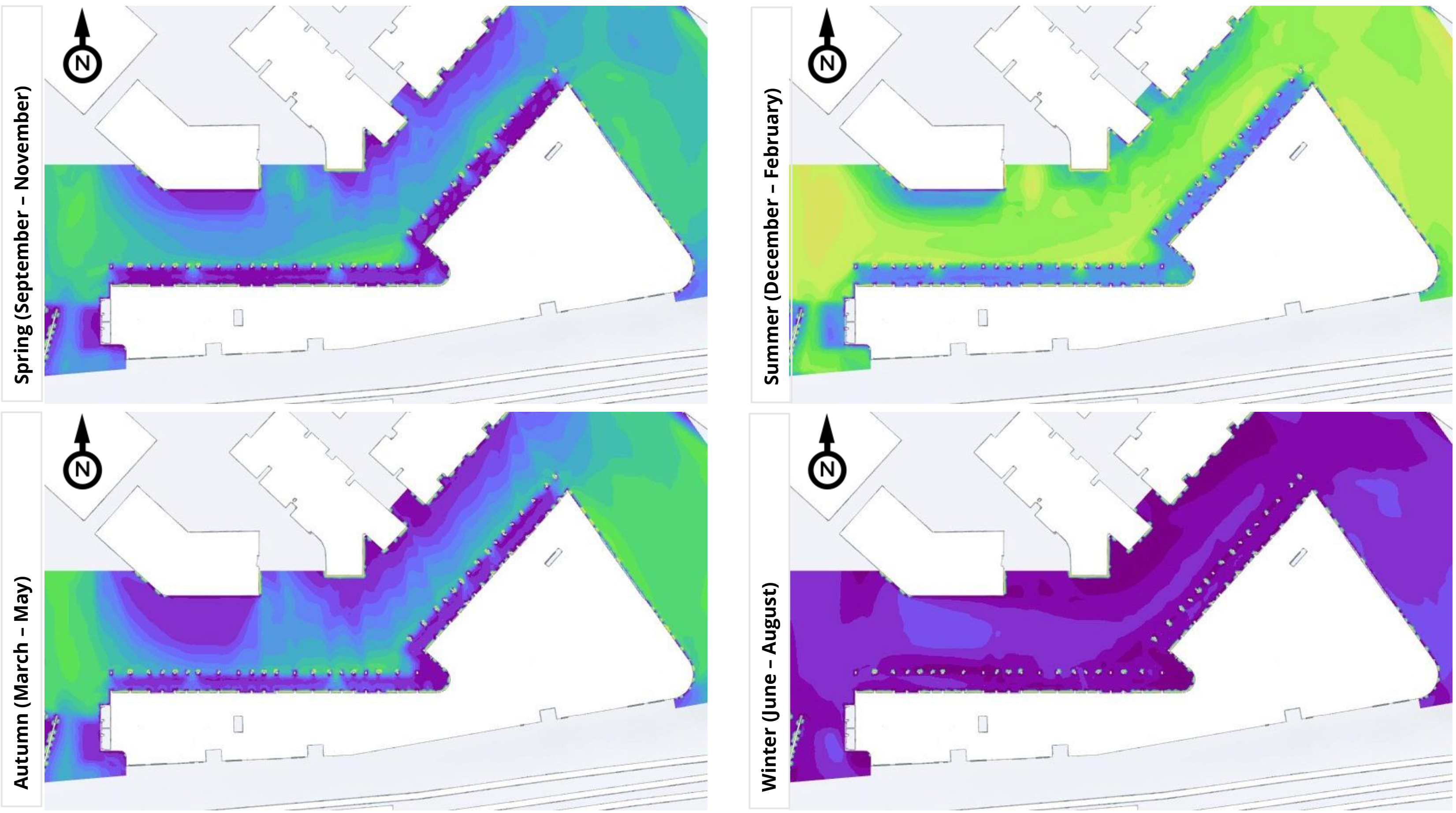
Image 12a: Predicted Thermal Comfort Conditions on Ground
(Morning: 6:00 – 10:59)



THERMAL COMFORT CONTOURS

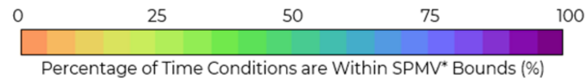
Image 12b: Predicted Thermal Comfort Conditions on Ground (Midday: 11:00 – 13:59)

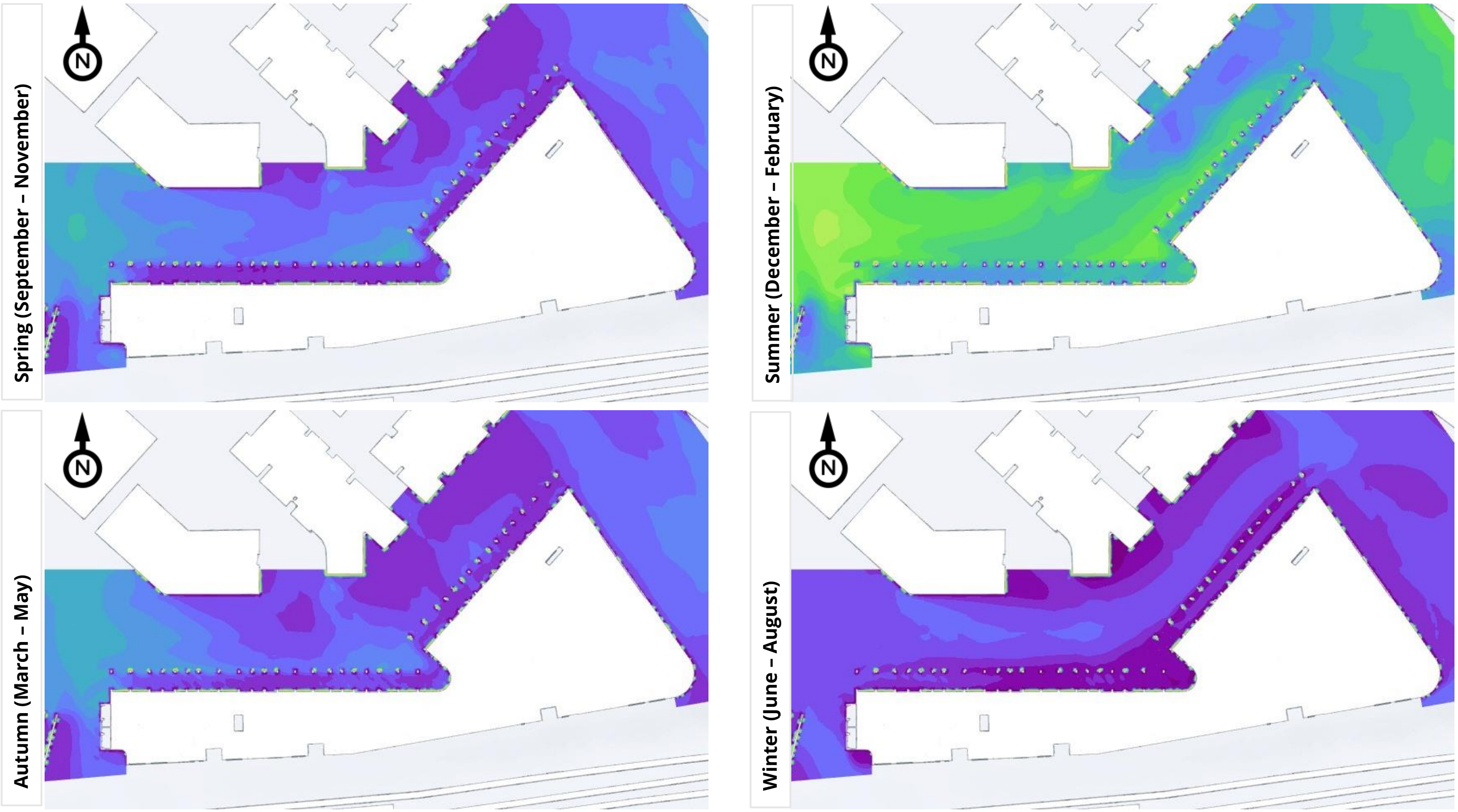




THERMAL COMFORT CONTOURS

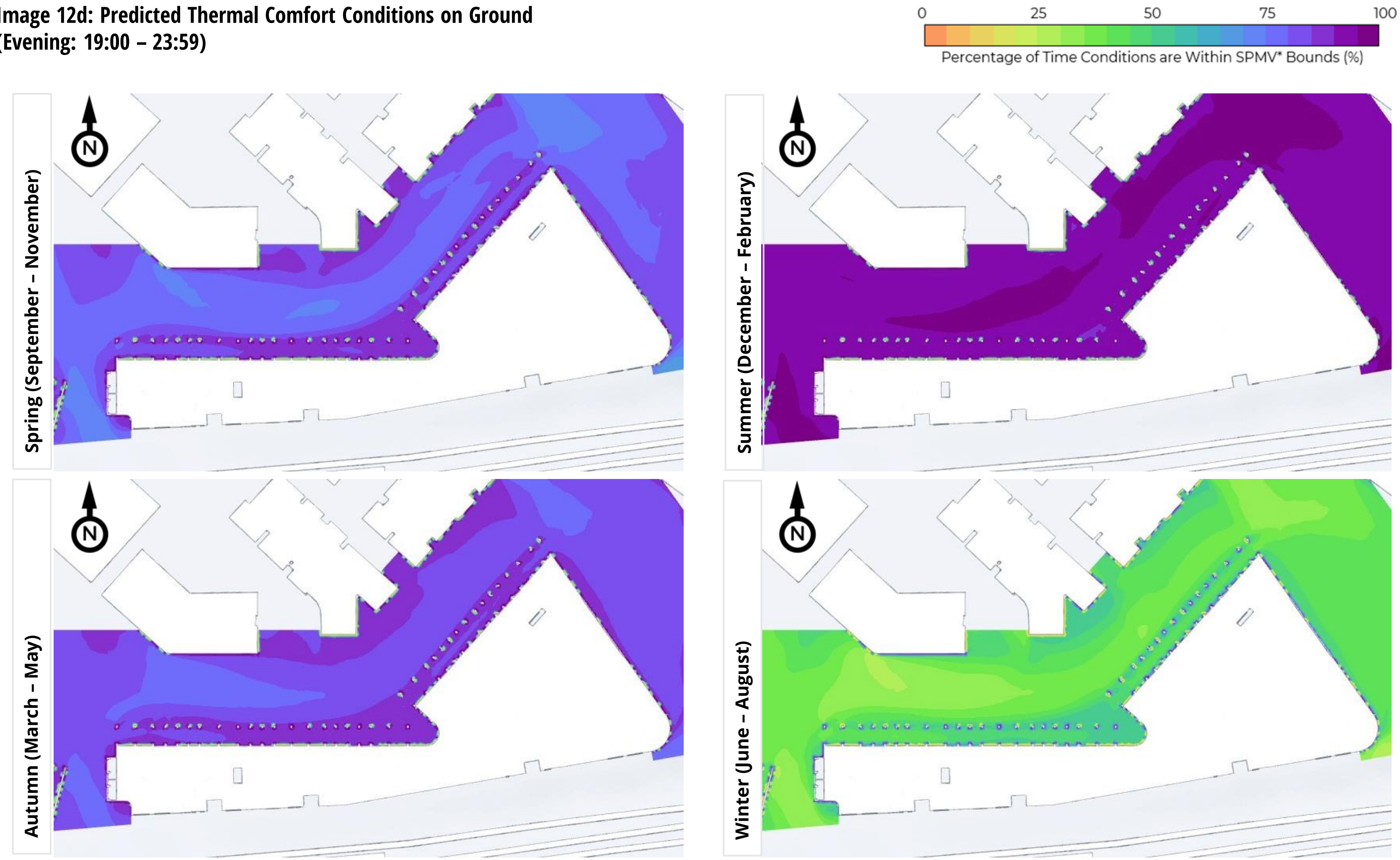
Image 12c: Predicted Thermal Comfort Conditions on Ground (Afternoon: 14:00 – 18:59)





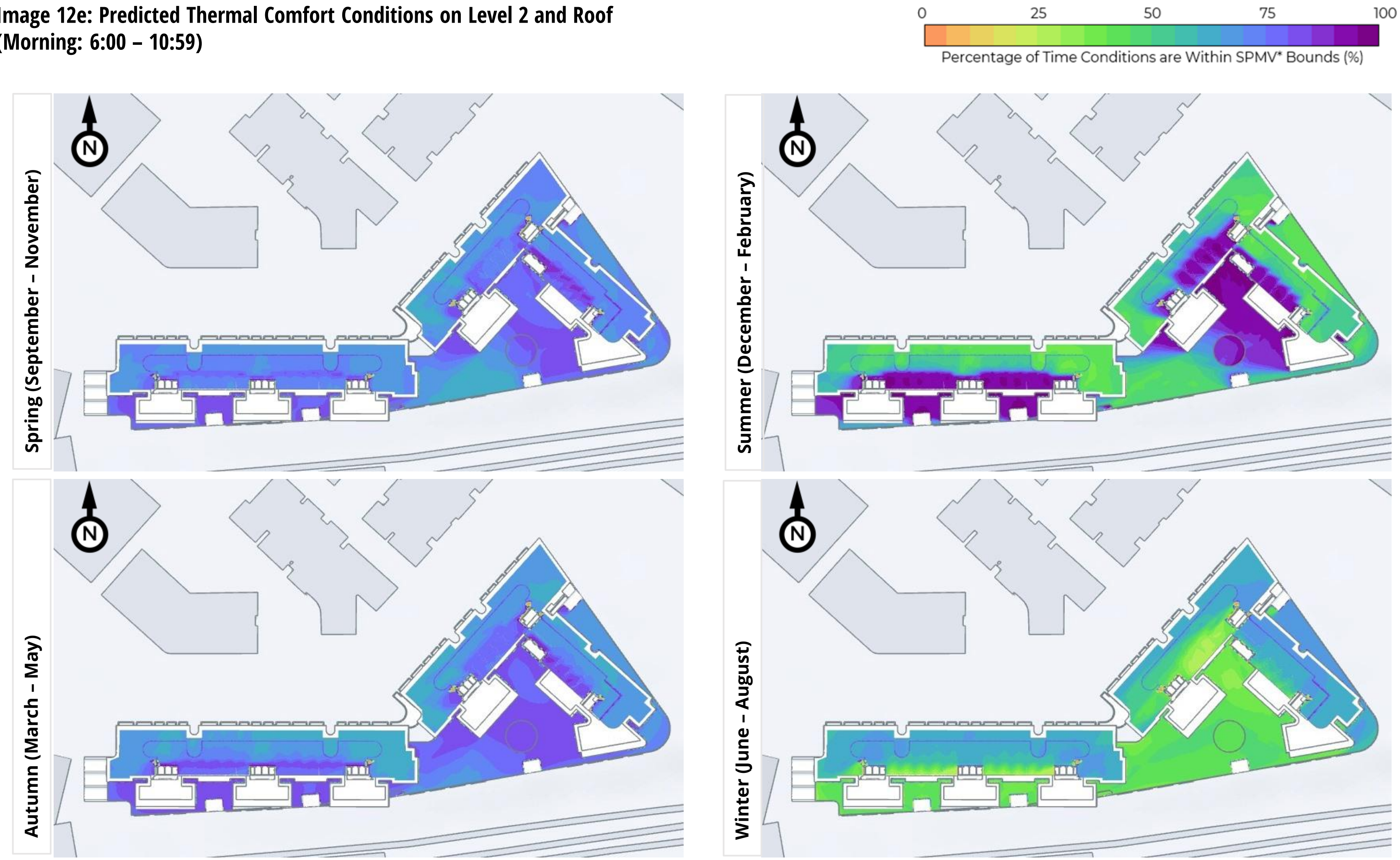
THERMAL COMFORT CONTOURS

Image 12d: Predicted Thermal Comfort Conditions on Ground (Evening: 19:00 – 23:59)



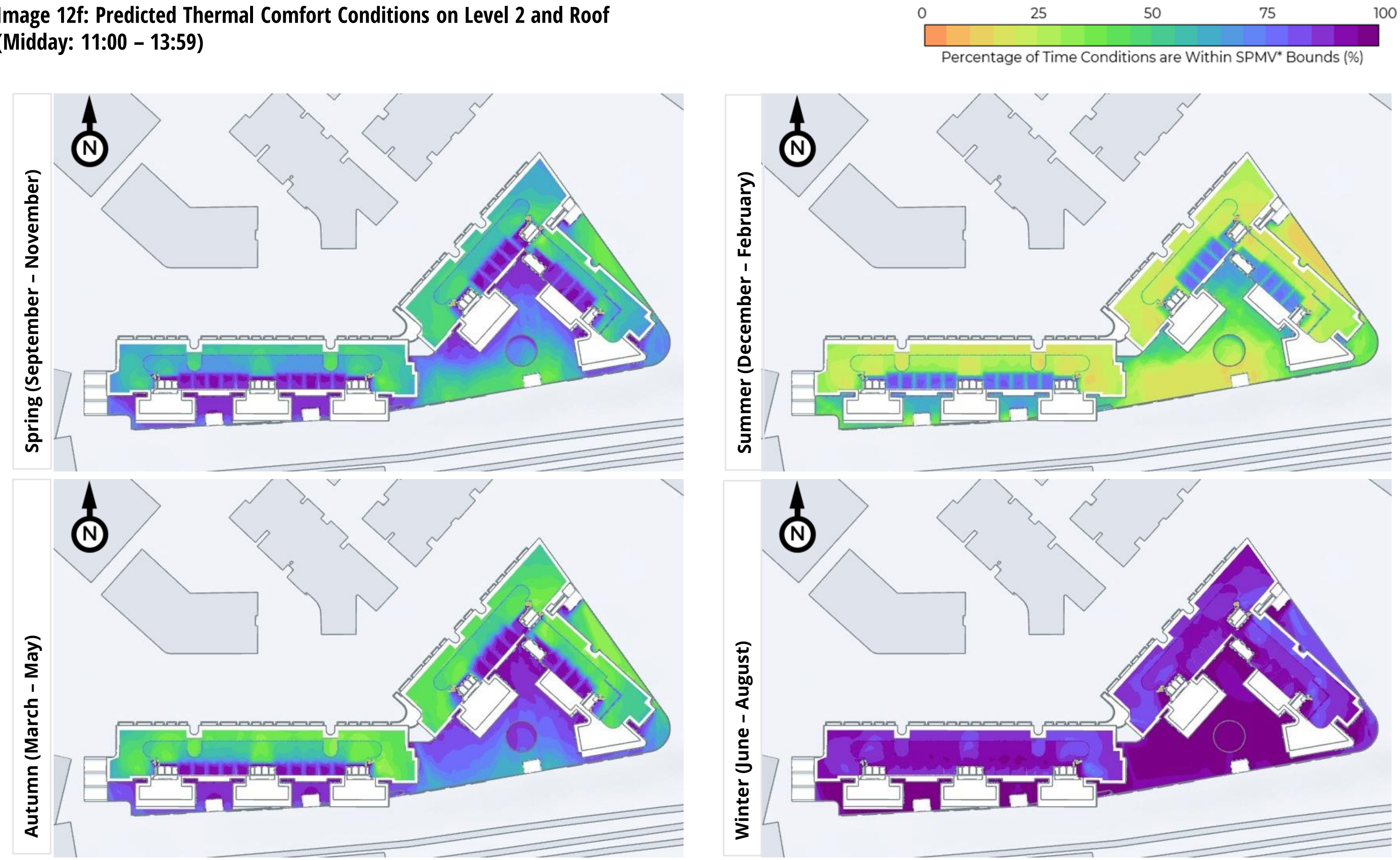
THERMAL COMFORT CONTOURS

Image 12e: Predicted Thermal Comfort Conditions on Level 2 and Roof (Morning: 6:00 – 10:59)



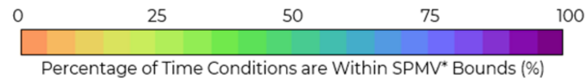
THERMAL COMFORT CONTOURS

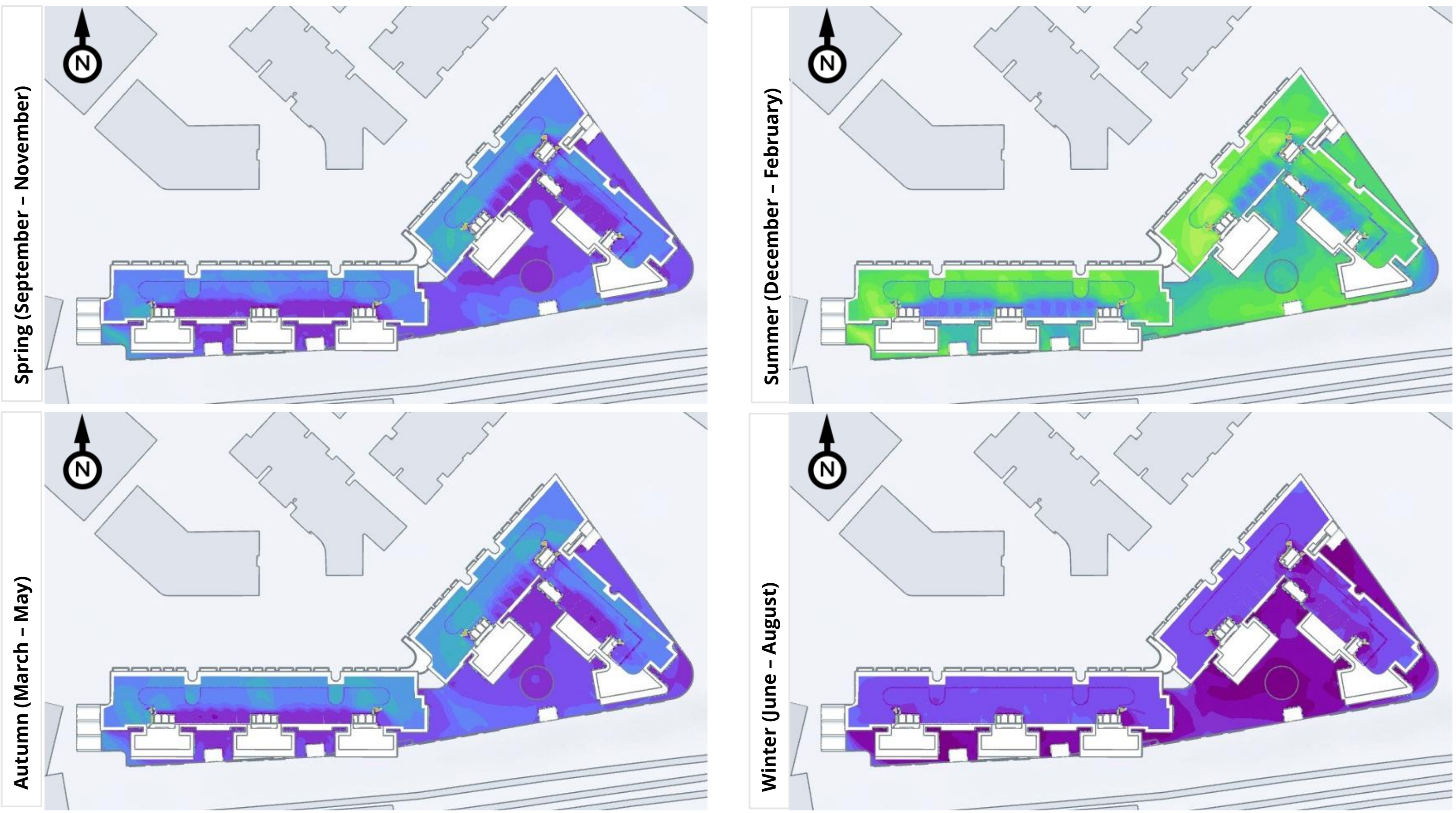
Image 12f: Predicted Thermal Comfort Conditions on Level 2 and Roof (Midday: 11:00 – 13:59)



THERMAL COMFORT CONTOURS

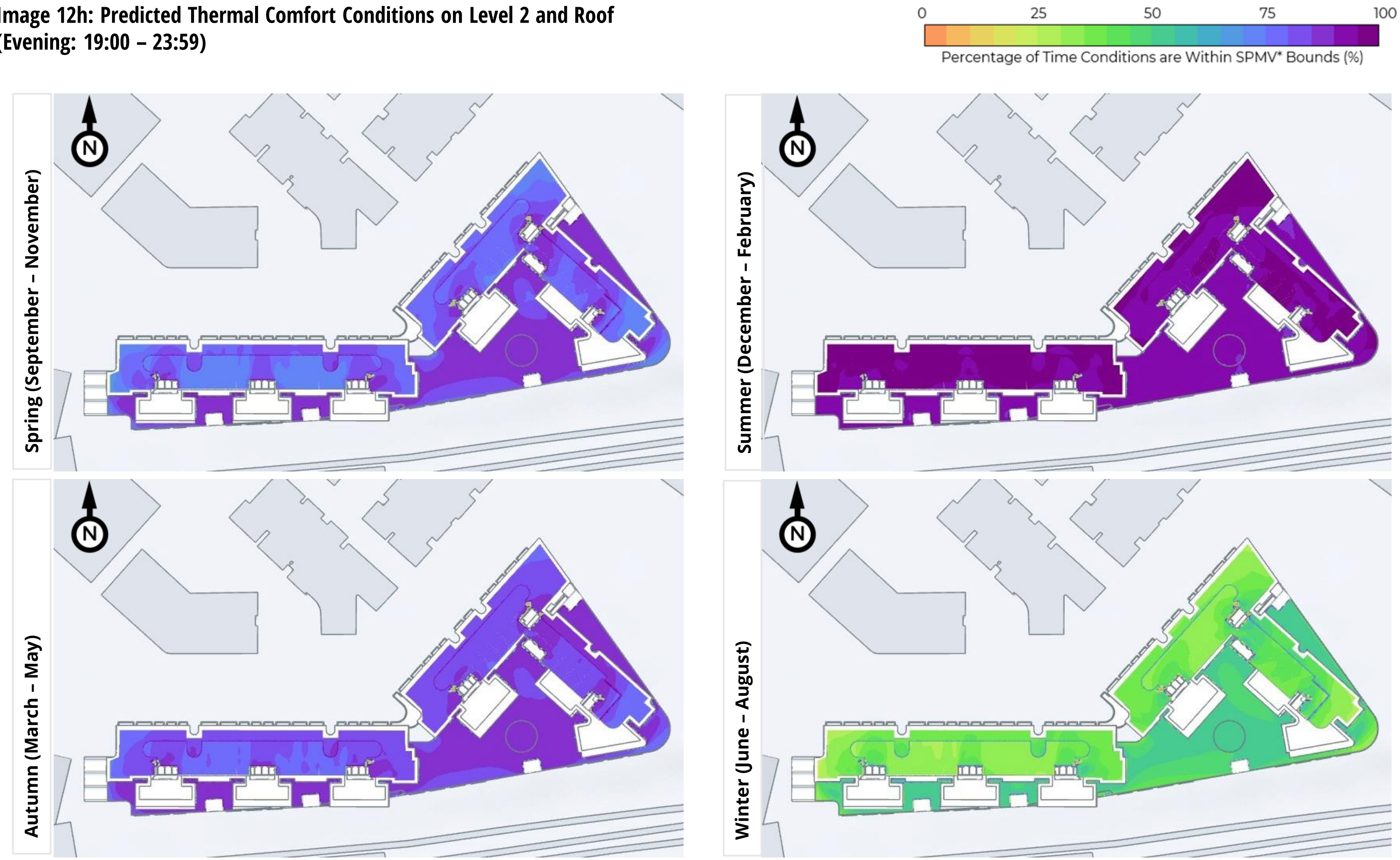
Image 12g: Predicted Thermal Comfort Conditions on Level 2 and Roof (Afternoon: 14:00 – 18:59)





THERMAL COMFORT CONTOURS

Image 12h: Predicted Thermal Comfort Conditions on Level 2 and Roof (Evening: 19:00 – 23:59)



CONTROL MEASURES

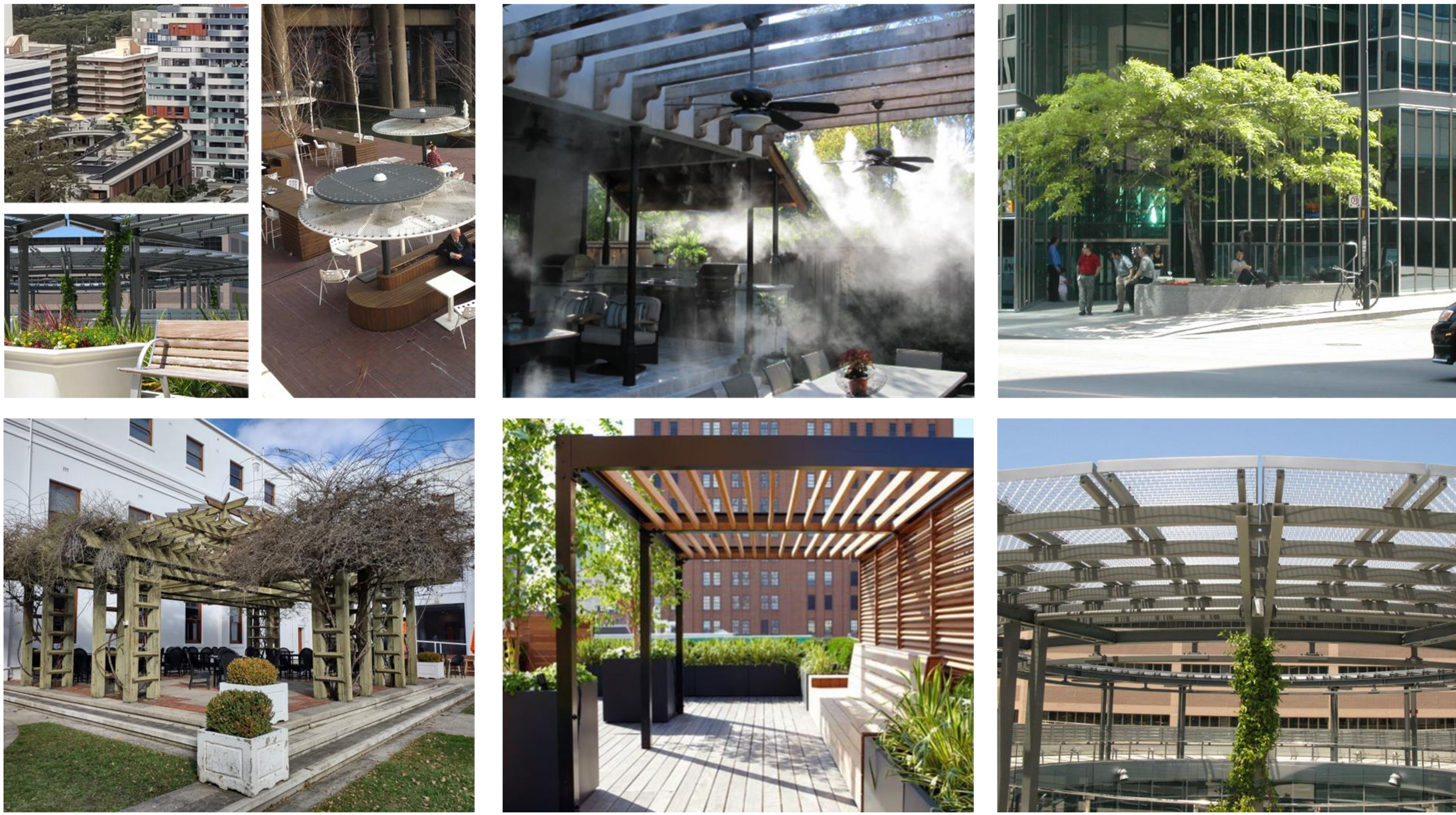


Image 13: Example of Control Measures to Improve Thermal Comfort Around the Site

SUMMARY AND LIMITATIONS

SUMMARY AND LIMITATIONS

Wind and thermal comfort conditions around the proposed Mayfair on Penrith development are discussed in this report. This desk-based review is based on the CFD analysis of the proposed massing of the tower and the existing surrounding context for the prevailing winds of the region using Orbital Stack. Additional solar simulations have been added on top of the wind simulations to obtain a holistic understanding of human comfort around the precinct. Design advice has also been provided to improve the outdoor wind and thermal comfort around the proposed development site. Note that additional information such as ventilation potential and contours for wind etc. can be viewed online through the Orbital Stack platform.

The findings of the report should be assessed based on the limitations listed below:

1. The analysis presented was based on the historical climate conditions for the North Penrith region.
2. The design has not been examined under extreme conditions (i.e., intense heat/cold, high humidity or extremely high/low winds). It would be unreasonable to judge the design of the development against such extreme conditions since these will understandably lead to thermal discomfort and would be expected by any user of the space.
3. It is noted that the conditions presented herein depict statistical conditions for certain seasons and times of day. It would be prudent to be reminded that specific seasonal trends (i.e., a heatwave) would be expected to result in ambient conditions which could create longer durations of uncomfortable conditions.
4. The effect of climate change (i.e., forward predictions of trends in meteorological conditions) has not been considered in the analysis. However, the use of the latest meteorological information should give some indication.
5. The CFD simulations were conducted using a steady-state analysis. This means that the wind speed predictions and, therefore, the SPMV* calculations, represent an 'average' of the expected conditions within and around the development. As such, RWDI would expect the thermal comfort conditions to be more dynamic in reality than the 'static' images presented herein.
6. Gusts are an important part of overall wind microclimate that can impact safety. These have not been considered in this study. Higher fidelity CFD simulations or wind tunnel testing is recommended as the design evolves.

APPLICABILITY OF ASSESSMENT

This report entitled Pedestrian Wind and Thermal Comfort Design Review, dated November 03, 2022 was prepared by RWDI Australia Pty Ltd ("RWDI"). The findings and conclusions presented in this report have been prepared for the Client and are specific to the project described herein ("Project"). The conclusions and recommendations contained in this report are based on the information available to RWDI when this report was prepared.

Because the contents of this report may not reflect the final design of the Project or subsequent changes made after the date of this report, RWDI recommends that it be retained by Client during the final stages of the project to verify that the results and recommendations provided in this report have been correctly interpreted in the final design of the Project.

The conclusions and recommendations contained in this report have also been made for the specific purpose(s) set out herein. Should the Client or any other third party utilize the report and/or implement the conclusions and recommendations contained therein for any other purpose or project without the involvement of RWDI, the Client or such third party assumes any and all risk of any and all consequences arising from such use and RWDI accepts no responsibility for any liability, loss, or damage of any kind suffered by Client or any other third party arising therefrom.

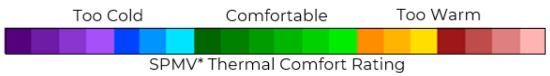
Finally, it is imperative that the Client and/or any party relying on the conclusions and recommendations in this report carefully review the stated assumptions contained herein and to understand the different factors which may impact the conclusions and recommendations provided.

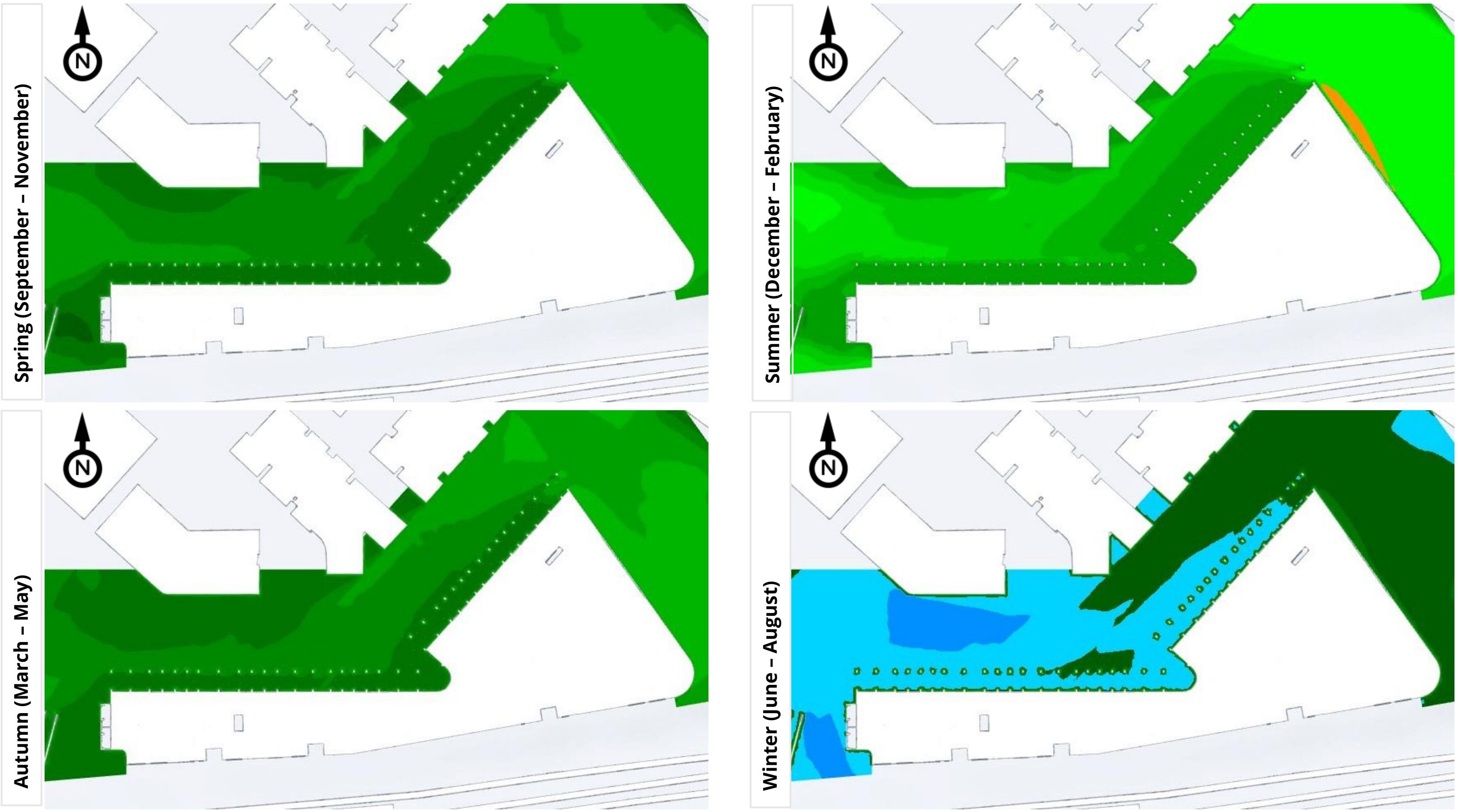
APPENDIX

THERMAL COMFORT RATING CONTOURS

THERMAL COMFORT RATING CONTOURS

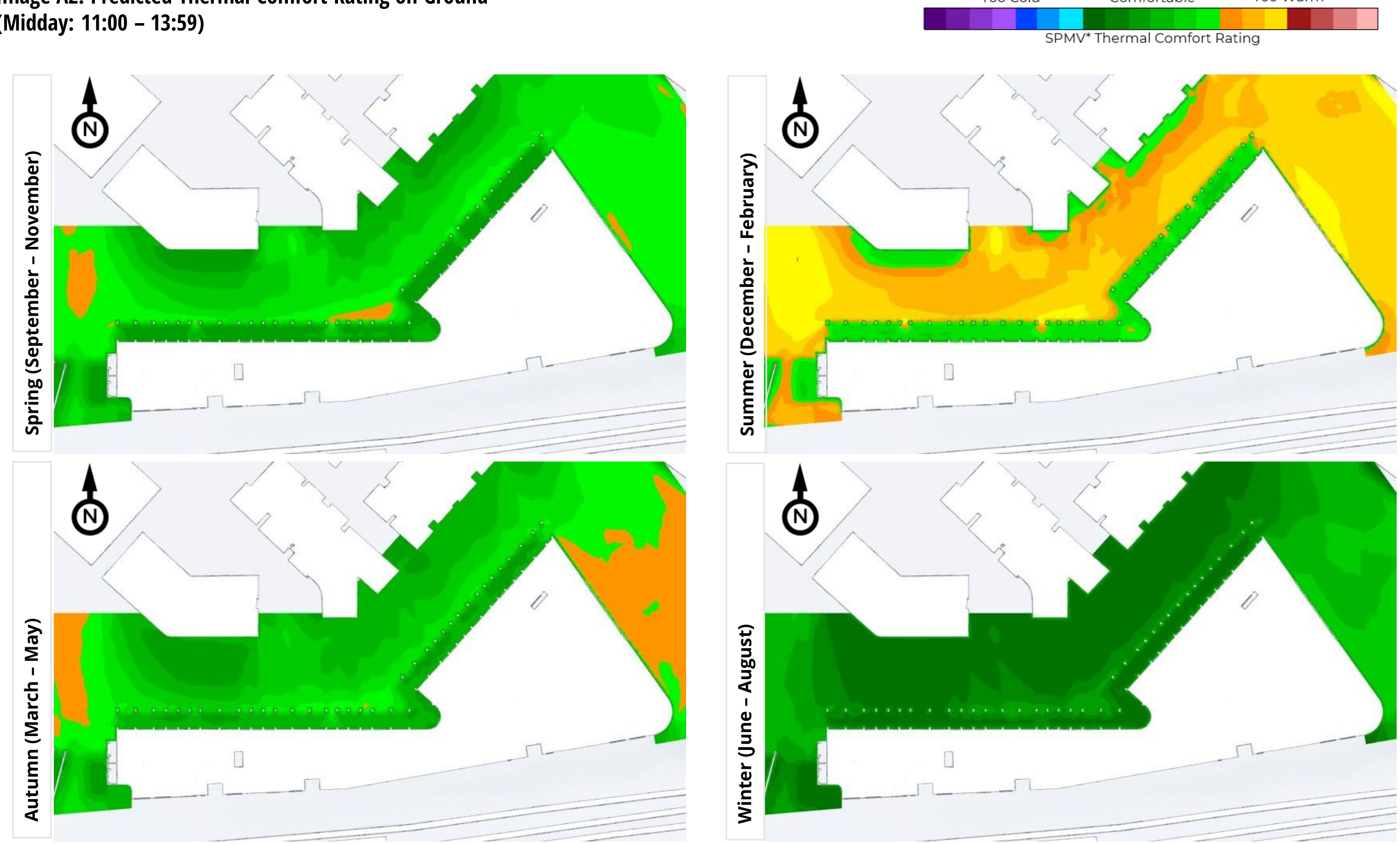
Image A1: Predicted Thermal Comfort Rating on Ground
(Morning: 6:00 – 10:59)





THERMAL COMFORT RATING CONTOURS

Image A2: Predicted Thermal Comfort Rating on Ground
(Midday: 11:00 – 13:59)



THERMAL COMFORT RATING CONTOURS

Image A3: Predicted Thermal Comfort Rating on Ground
(Afternoon: 14:00 – 18:59)

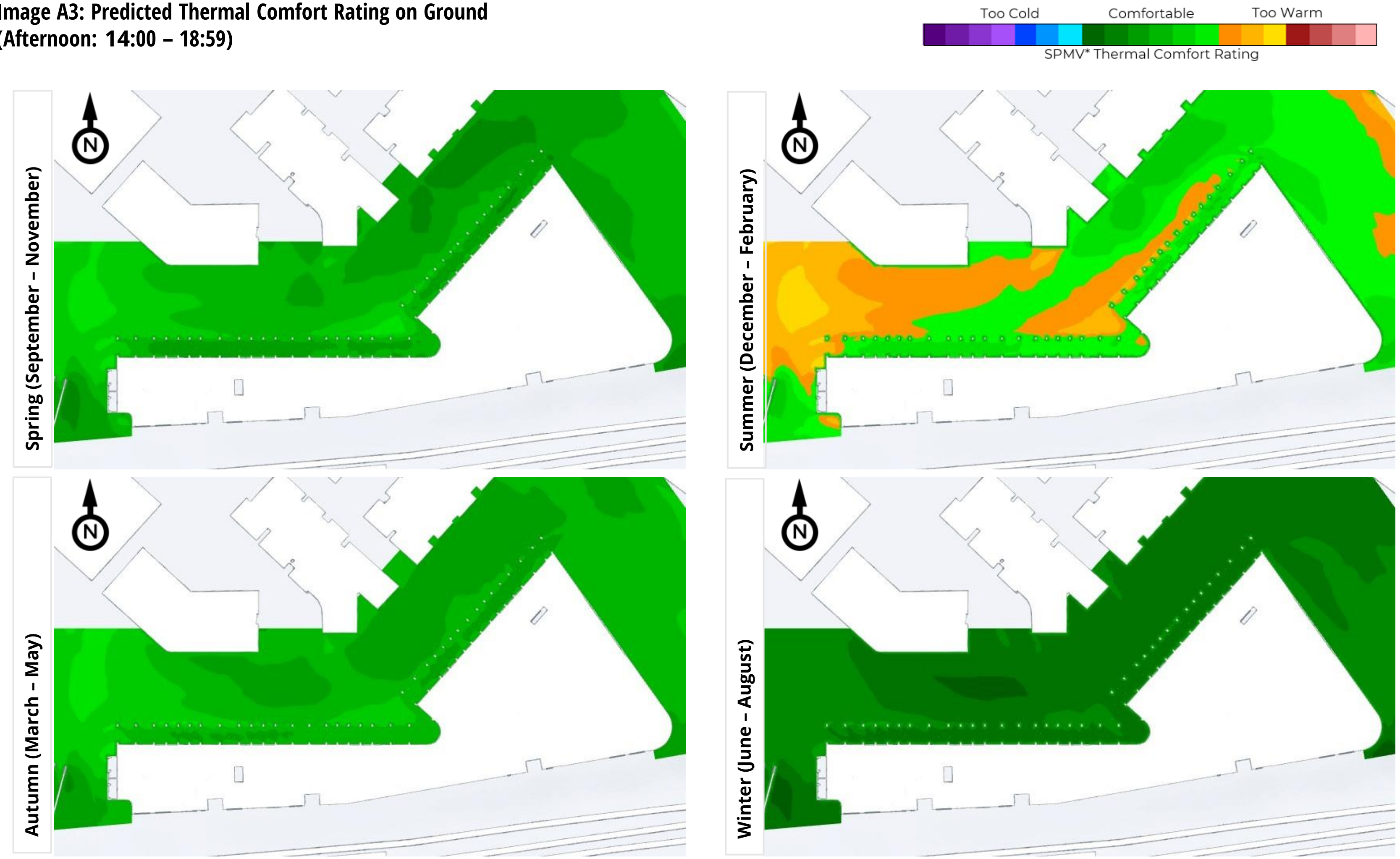
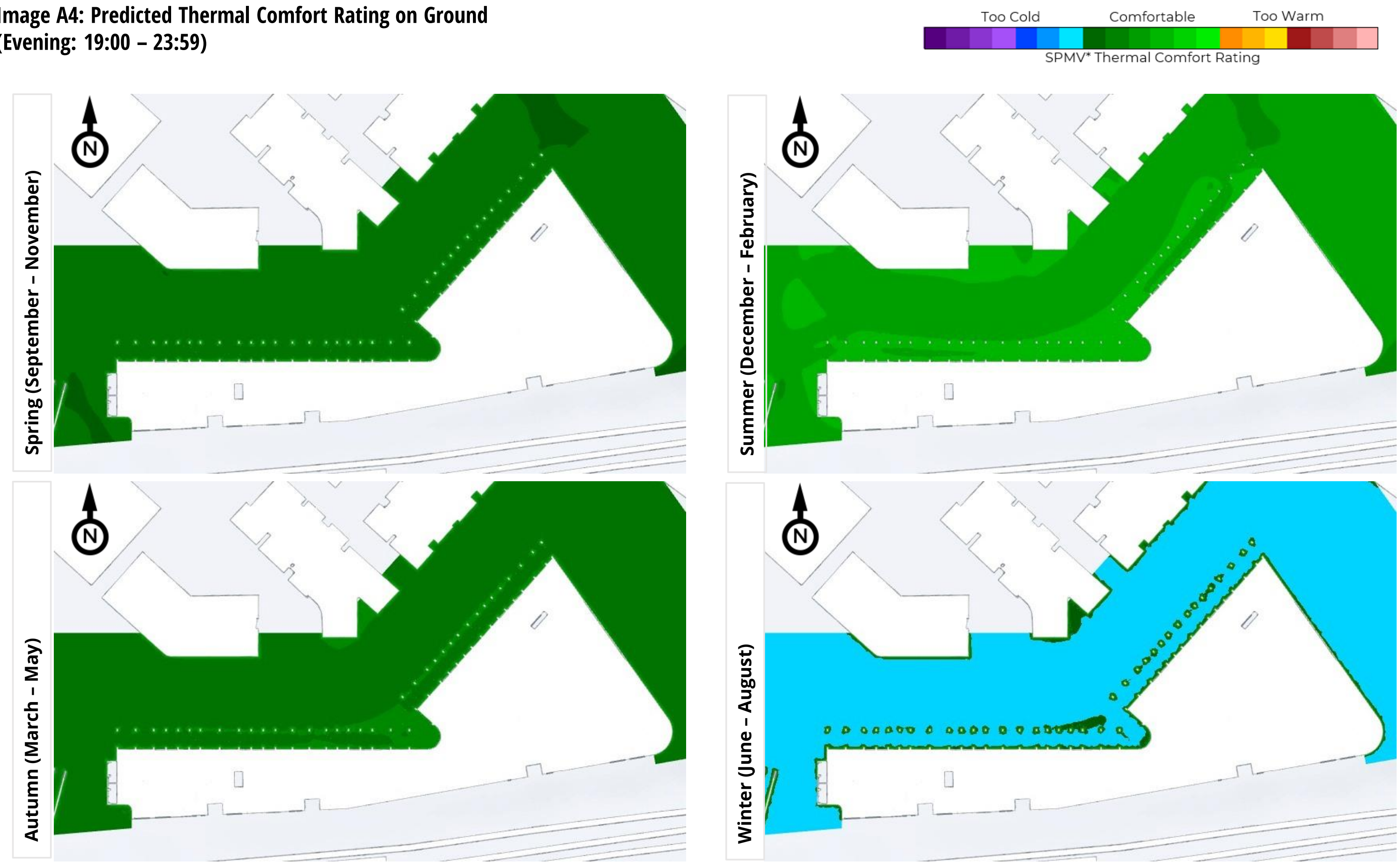
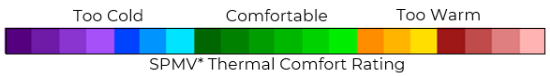


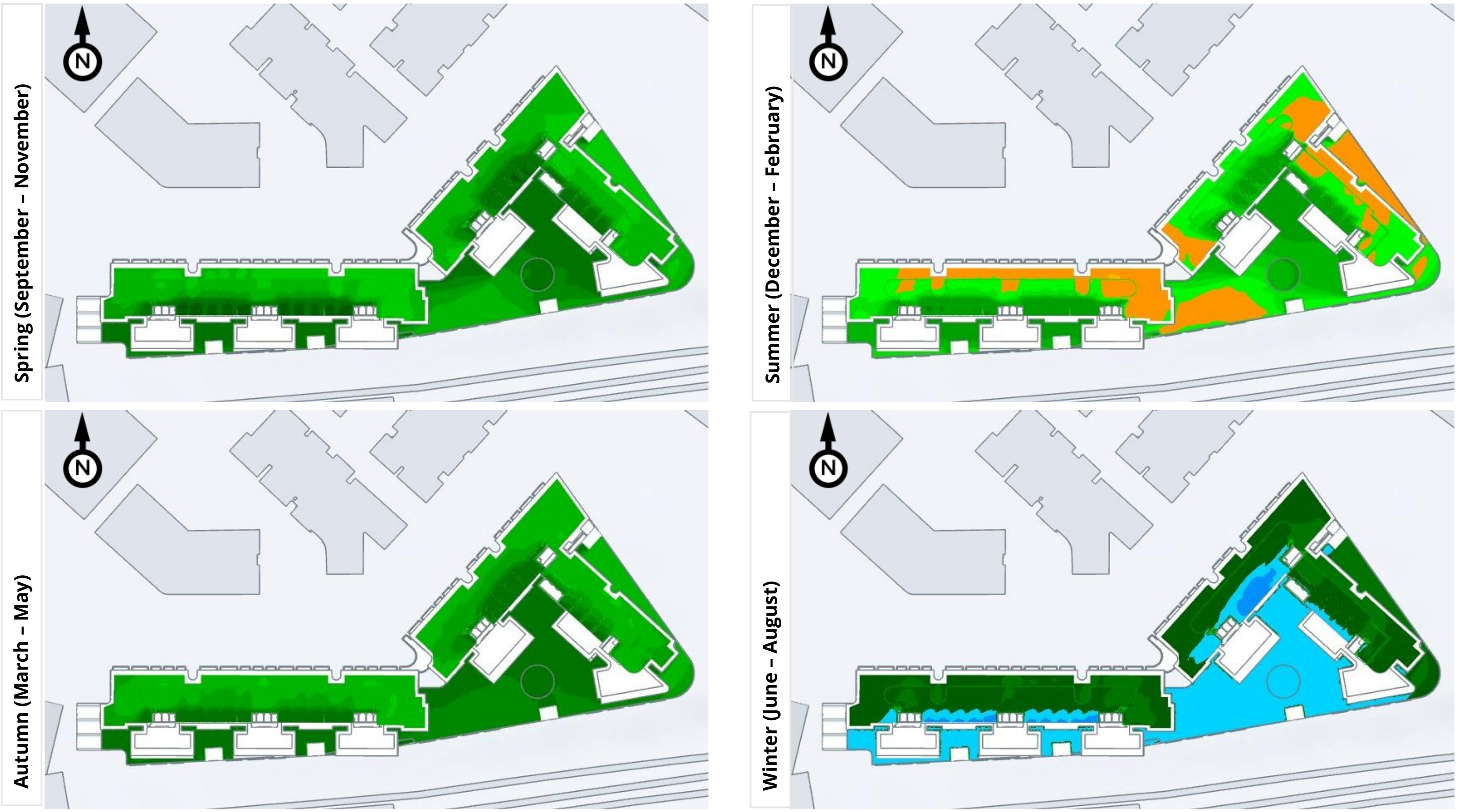
Image A4: Predicted Thermal Comfort Rating on Ground (Evening: 19:00 – 23:59)



THERMAL COMFORT RATING CONTOURS

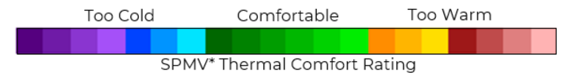
Image A5: Predicted Thermal Comfort Rating on Level 2 and Roof (Morning: 6:00 – 10:59)





THERMAL COMFORT RATING CONTOURS

Image A6: Predicted Thermal Comfort Rating on Level 2 and Roof (Midday: 11:00 – 13:59)



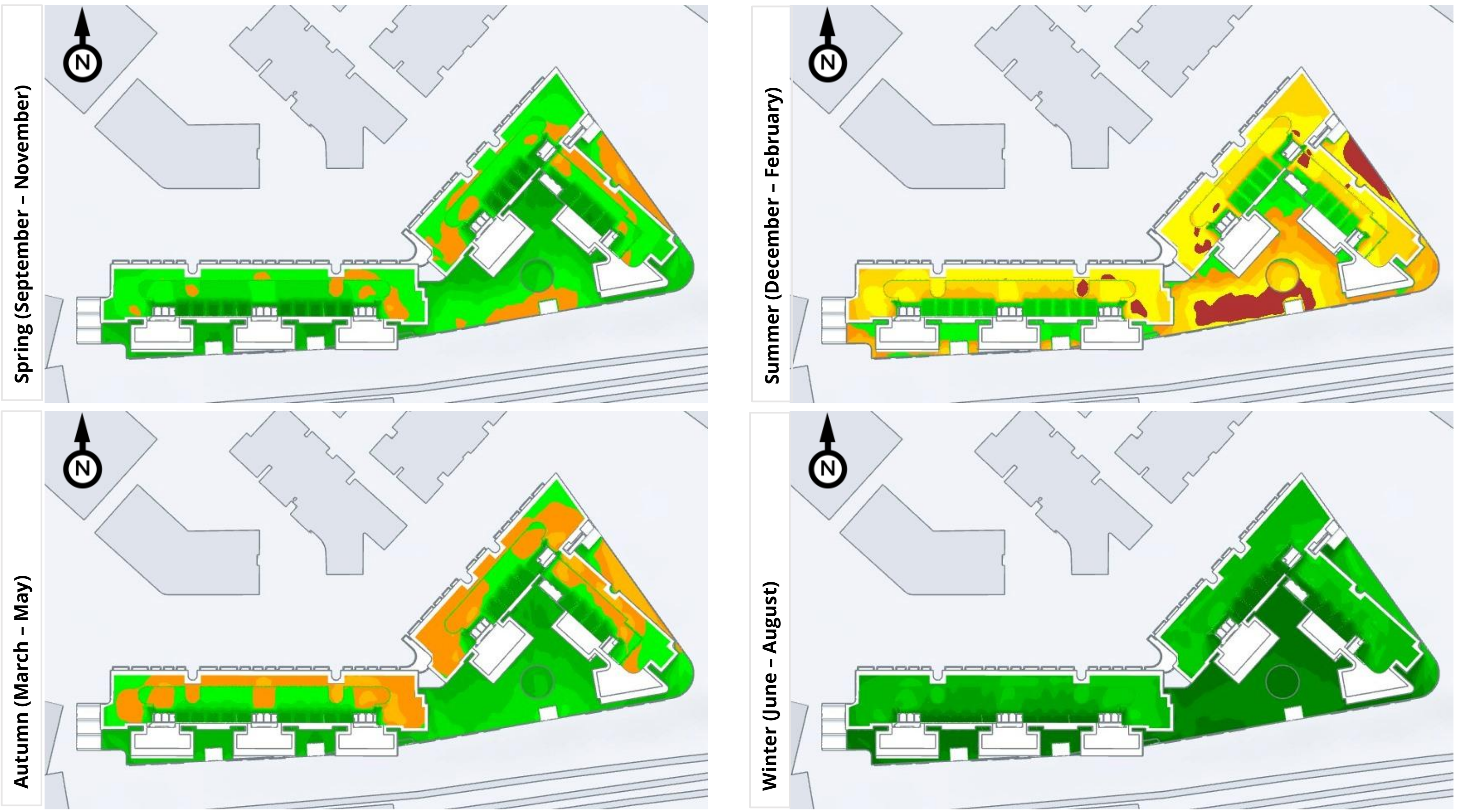
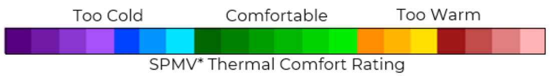
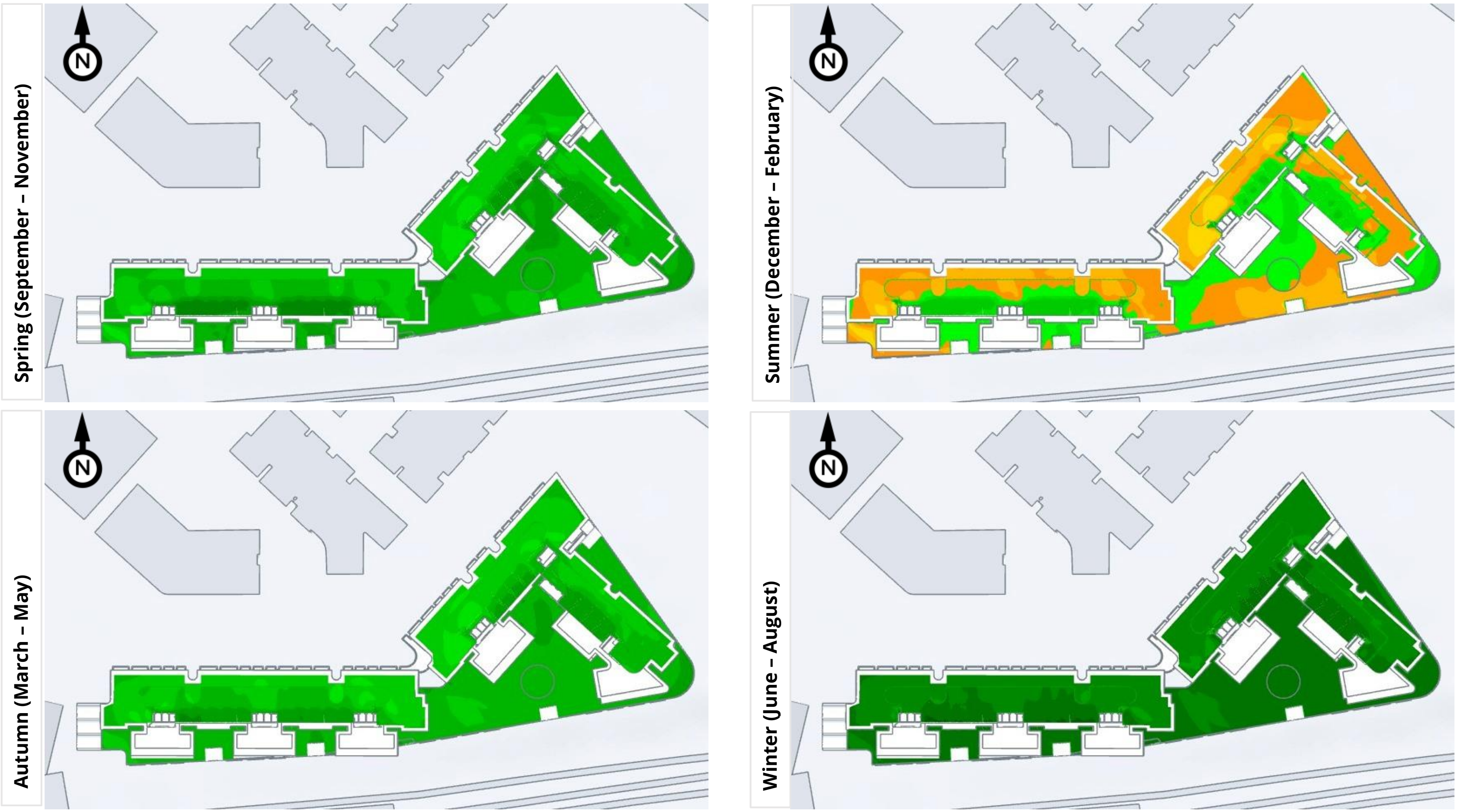


Image A7: Predicted Thermal Comfort Rating on Level 2 and Roof (Afternoon: 14:00 – 19:59)





THERMAL COMFORT RATING CONTOURS

Image A8: Predicted Thermal Comfort Rating on Level 2 and Roof (Evening: 19:00 – 23:59)