THERMAL COMFORT GUIDELINES

FOR DEVELOPMENTS IN THE CITY OF LONDON

CITY OF LONDON

DECEMBER 2020

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1. INTRODUCTION

These Guidelines introduce a new technique into planning to understand the microclimatic qualities of the City's public spaces as well as a methodology to assess the impact of new developments on the microclimate of the City's streets, parks, public roof gardens and terraces and other public spaces.

The technique involves merging wind, sunlight, temperature and humidity microclimate data at a seasonal level to gain a holistic understanding of Thermal Comfort, how a microclimatic character of a place actually feels to the public.

This technique is a new initiative within the British planning system (indeed probably globally) and the Guidelines were developed through a collaboration between academic, technical specialists and Microclimate Engineering consultants' review. As microclimatic data (especially Climate Change implications) and modelling techniques become more refined it is anticipated that these Guidelines will be the subject of frequent and continuous updating and review.

The public spaces of the City, its streets, alleys, parks, squares, pocket parks and roof level public gardens and terraces are a much valued and key part of the City's appeal. These areas are intensely used by workers, residents and visitors of all ages and backgrounds. The City Corporation is committed to protect the quality and experience of these spaces and negotiate new high-quality public spaces for all to enjoy.

www.cityoflondon.gov.uk/wind-microclimate-guidelines

The urban design quality of a public space, such as a well-designed public realm with high quality buildings, active uses and landscaping can provide an attractive area to dwell. However, how people actually experience the quality of public spaces is dependent on a number of other factors such as sunlight, wind, noise, temperature, humidity, traffic movement, pollution, even pleasant or unpleasant smells.

Such a myriad of factors makes assessing the impact of new development on existing public spaces or in providing new spaces both complex and challenging for planners. The City Corporation is determined to refine the way that these impacts can be understood and establish a toolkit for making sustainable decisions in order to protect or deliver public spaces which are of the highest quality.

One of the obvious factors in people's experience of a public space is the wind conditions they experience. In the City of London climate, windy areas are seldom comfortable for people to dwell or relax in. The City Corporation, through its Wind Modelling initiative and subsequent Wind Microclimate Guidelines has developed a toolkit to assess the impact of new developments on both wind movement and its strength on the City's public spaces. This is to ensure new developments result in a safe and comfortable public realm. However, whether its windy or tranquil is just one factor in how comfortable people feel in open spaces.

People are known to favour sitting in sunny areas most times of the year in the City. The City Corporation has modelled the amount of sunlight reaching the ground floor public realm throughout the year to map the relatively sunny areas and those less so. This has proved to be a valuable tool to inform assessments of new developments and deliver high quality public realm exploiting a sunny aspect.

Combining the wind and sunlight modelling enables the City Corporation to understand, by season, which parts of the City are generally sunny and tranquil and which areas are in shade and windy. This has already informed negotiations for development schemes, for example where outdoor café and seating should be provided or more significantly, the value of providing elevated public roof gardens, terraces and winter gardens on the roofs of the taller buildings in the City cluster of towers.

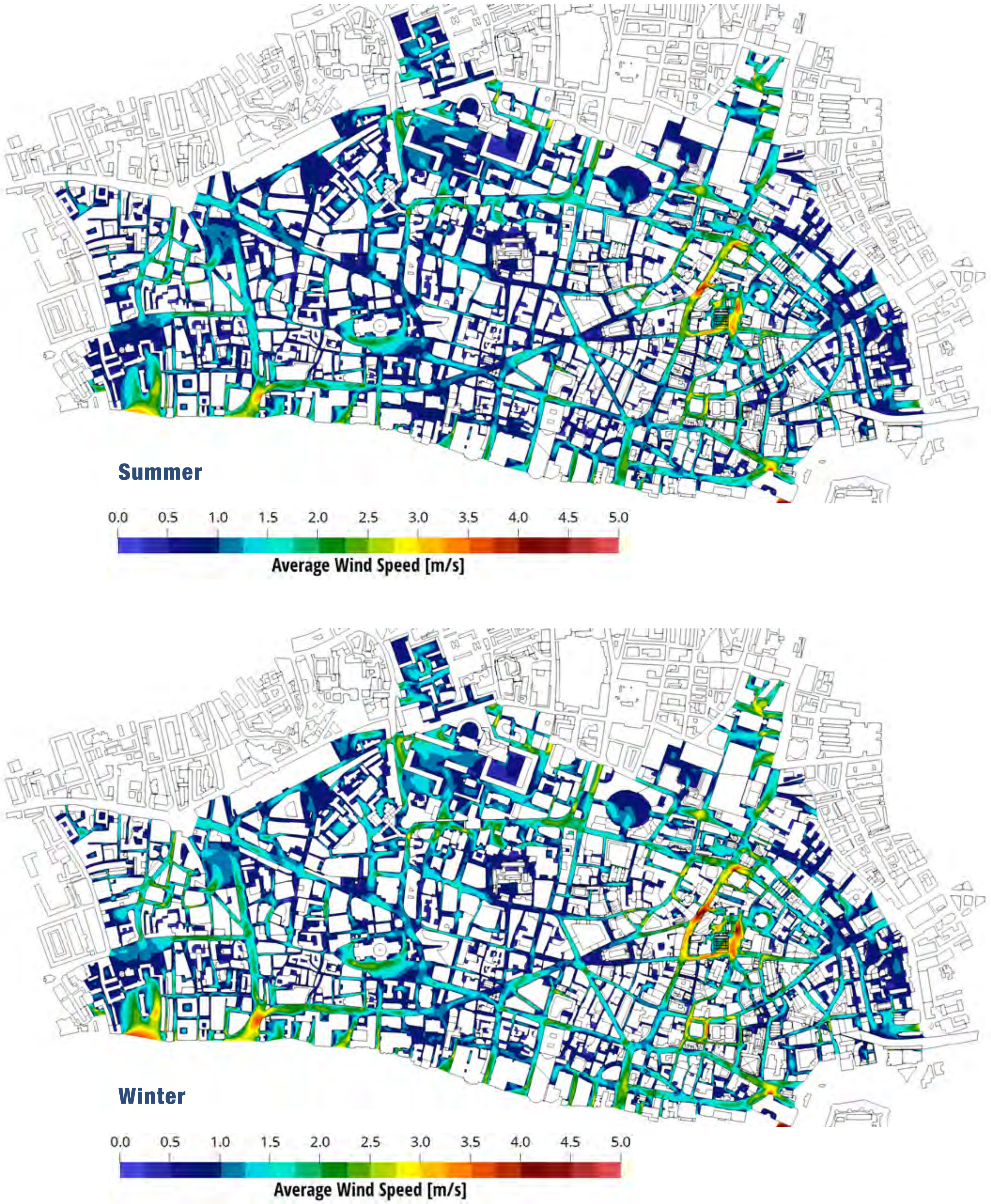


Figure 1: Wind maps of the City (Summer / Winter Season)

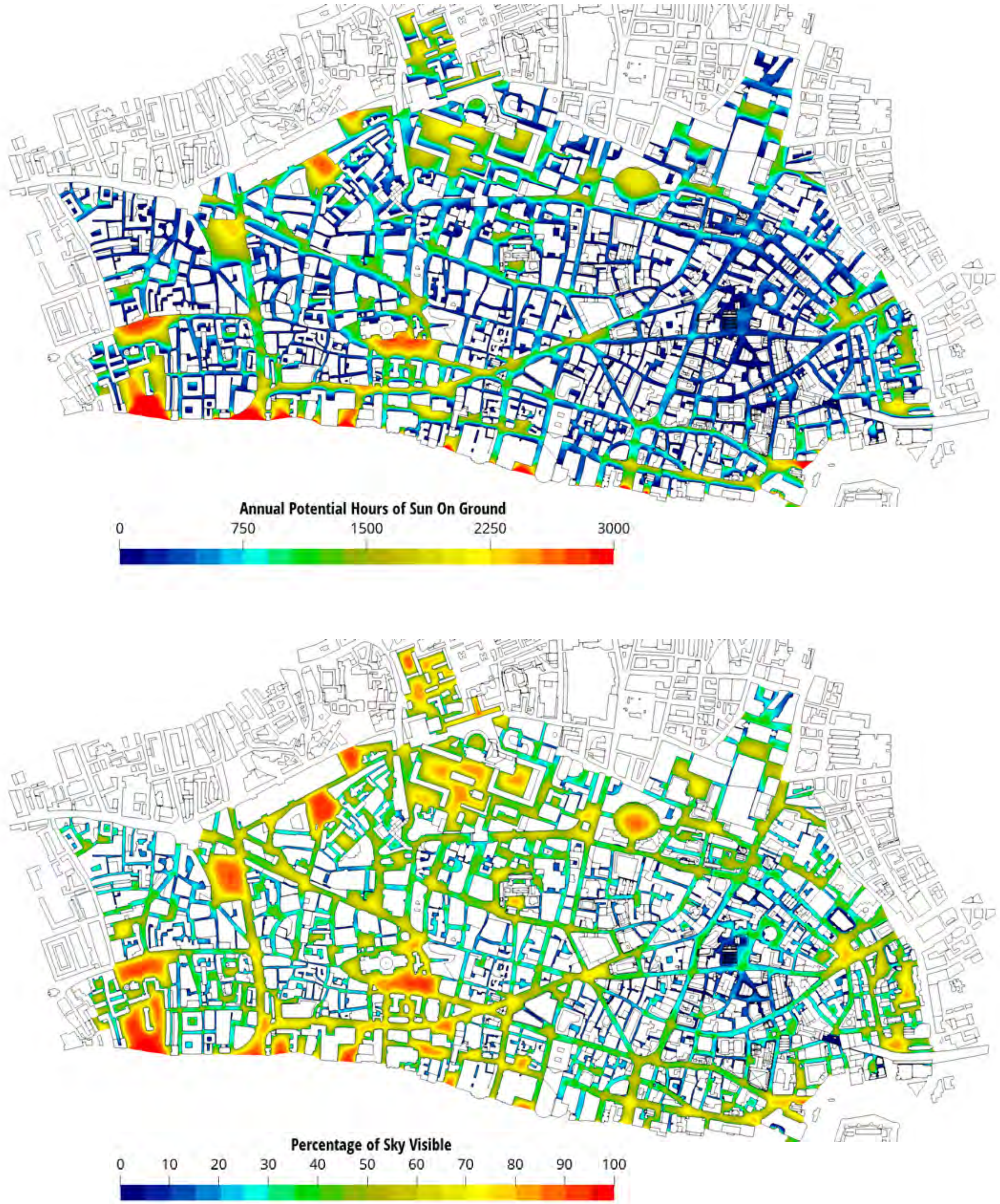


Figure 2: Plots Illustrating Annual Potential Hours of Sun on Ground and Percentage of Sky Visible

2. WHAT IS THERMAL COMFORT

It is clear from the City Corporation's research that the most important factor in the quality of a public space is the overall microclimatic experience of the public of a combination of:

- sunlight, skylight and shade,
- wind,
- temperature and
- humidity.

This is the "feels like" quality of the microclimate, which we term "Thermal Comfort". For example a sunny open space in February might appear to be an appealing and comfortable place to dwell but if the air temperature is low with high humidity and there is a strong northerly wind, it's likely to feel significantly colder and uncomfortable, even in the sun. This is the perception of Thermal Comfort experienced by those using the space.

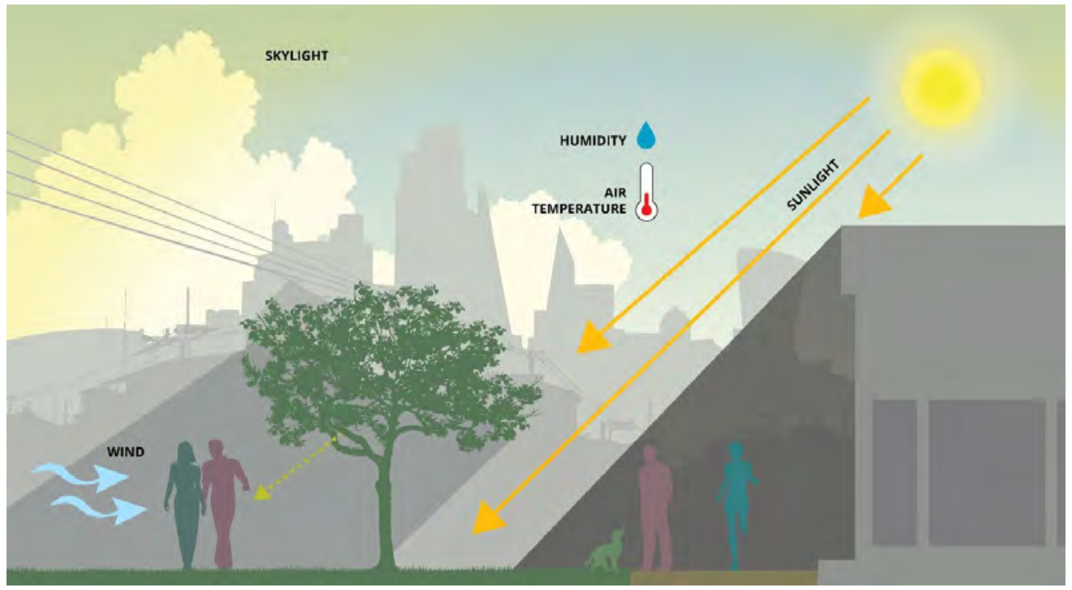
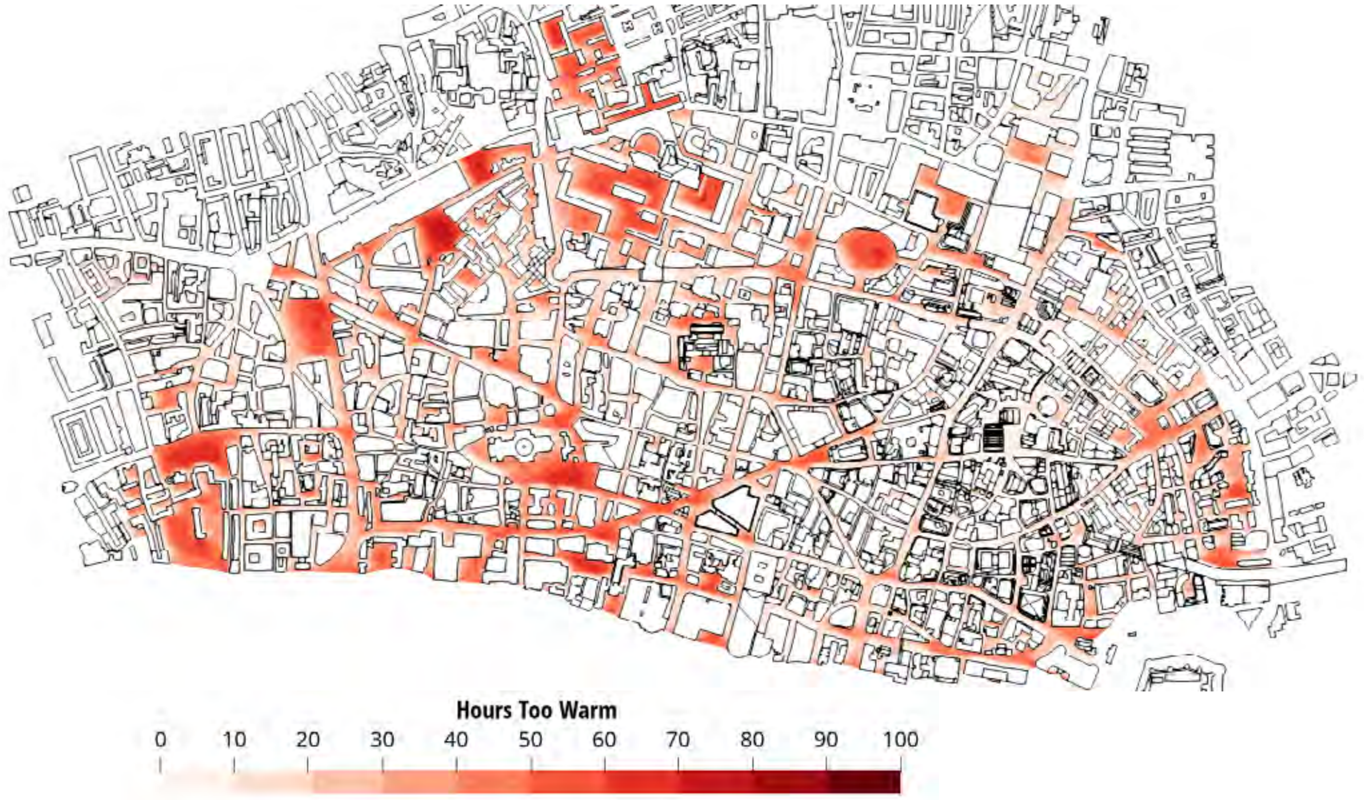


Figure 3: Environmental Factors Included in the Thermal Comfort Analysis

Thermal Comfort in London varies from season to season. So, whilst a dark, shaded and windy area is unappealing and uncomfortable to dwell in the damp winter, on a hot sunny day such areas provide a cooling and comfortable respite. Similarly, a tranquil, wind free and sunny space is a comfortable and warming place to sit in winter but can be too hot and stifling to dwell on a hot, humid summer day.



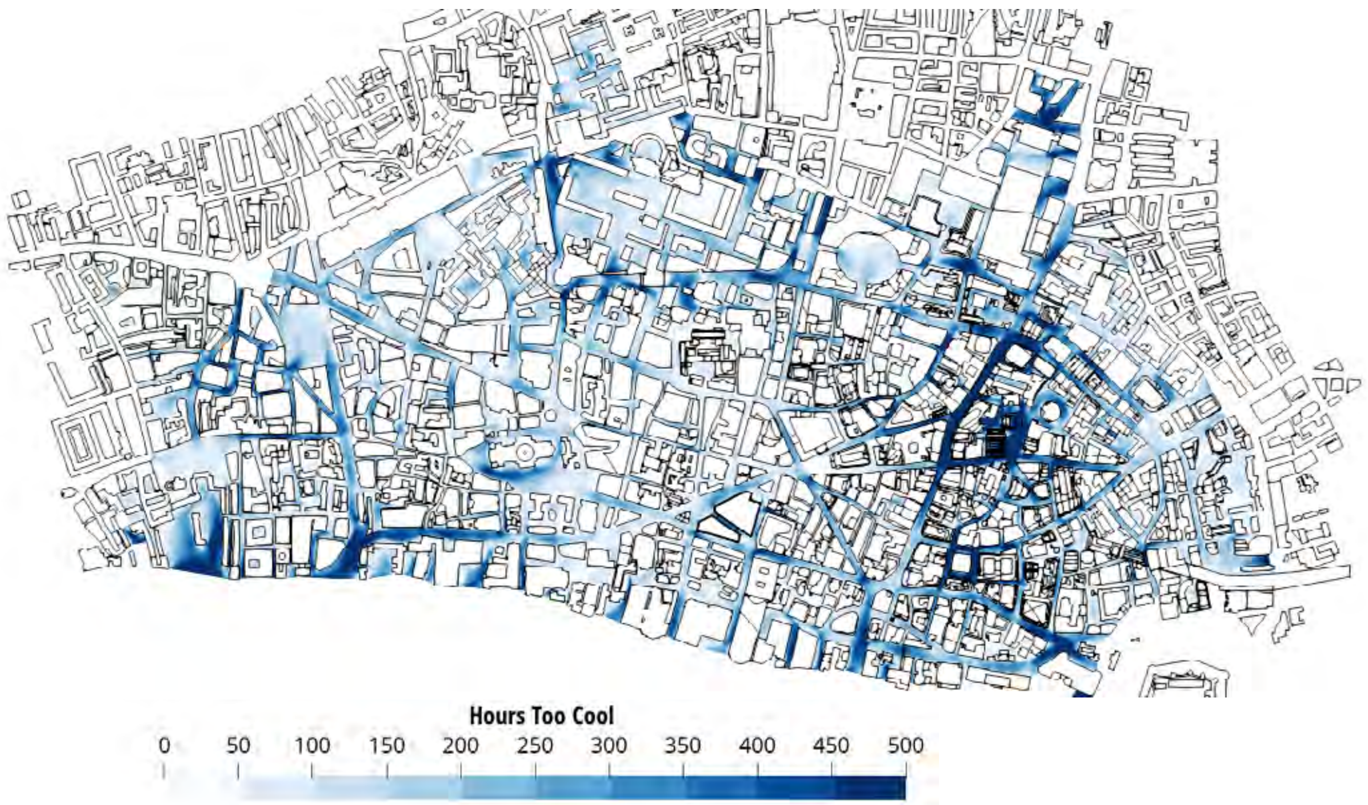


Figure 4: Plots of Average Summer Hours Too Warm (top) and Winter Hours Too Cool (bottom)

There are a number of other factors that influence thermal comfort including the age and physical attributes of members of the public, the amount of clothing, how active they are, the materials of their surroundings (landscaping and buildings) and the proximity of artificial heat sources such as building ventilation grills, exhausts or traffic. These are difficult to accurately quantify early in design and are therefore currently not included in this assessment. These guidelines also do not address other factors such as noise or air quality which contribute to the overall comfort of a space. The City Corporation will look to develop this further, considering how these factors may be modelled, in future versions of these guidelines.

3. WHY IS THERMAL COMFORT IMPORTANT?

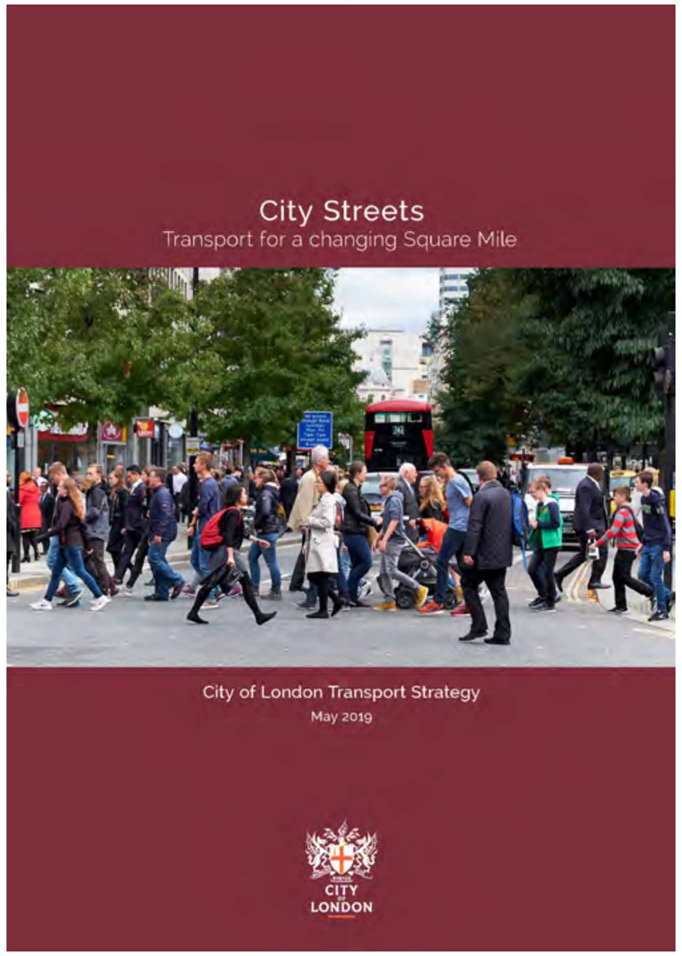
Currently planning studies in the UK consider the impact of wind microclimate and sunlight/daylight separately with little in the way overlap. By combining the various aspects of the Microclimate in a holistic way through Thermal Comfort, we are able to gain a thorough and comprehensive understanding of the comfort levels of public spaces, both existing and new public spaces.

An understanding of Thermal Comfort conditions enables new developments to be designed to deliver new public spaces of the highest microclimatic quality. It informs the location of:

- new pocket parks and public spaces,
- optimum location for cafés, bars and restaurants including outside seating for those uses,
- roof level public gardens and terraces,
- play areas,
- pop up street markets,
- event, performance and public art spaces,
- areas of seating and areas to relax and dwell away from more intense pedestrian flows,
- landscaping and tree planting including selection of spaces etc., and
- vehicular and servicing entrances (to avoid areas of good Thermal Comfort quality).

Thermal Comfort modelling can identify the areas at ground floor level which have particularly poor Thermal Comfort qualities through the year, such as areas of shaded and relatively windy character. Consequently, this understanding enables developments to incorporate roof level public realm in the form of public roof gardens, roof terraces and winter gardens, areas which have higher Thermal Comfort qualities which the public can enjoy. This is a radical new dynamic in the City.

In doing so these Guidelines are key in improving the quality of outdoor spaces, which is a vitally important consideration for the health and wellbeing of the public.



www.cityoflondon.gov.uk/services/transport-and-streets/Documents/city-of-london-transport-strategy.pdf

New developments through their bulk, shape, and alignment should be developed to address the Thermal Comfort qualities of their surroundings.

Comfortable outdoor spaces with good Thermal Comfort qualities also improve the experience of walking, cycling and other forms of active travel, helping to deliver a pedestrian and cycling priority City and reducing the use of private vehicles which in turn delivers a more humane, gentler and cleaner City. Thermal Comfort can inform areas for timed closures and public realm enhancement schemes and is considered a key part of delivering Healthy Streets as part of the City's Transport Strategy.

London has a temperate oceanic climate, with a relatively narrow range of annual temperatures, providing a good baseline potential for outdoor comfort compared to other parts of the world which experience more extreme heat and cold stress. Increasingly, the outdoor spaces are being used for relaxation and socializing by both workers, residents and visitors.

In addition, the City Corporation has commissioned research into the implications of the forecast global temperature rises as part of Climate Change and Global Warming. In doing so, future scenarios of heat stress areas during the summer months can be identified which in turn can inform shading and cooling proposals, such as the location of new mature trees to shade spaces in the hotter summer months or the facing materials of new buildings around these spaces including the cooling effect of vertical greening as well as other landscaping features such as fountains and water features. In this way, Thermal Comfort modelling can help in making the City more resilient to Climate Change.

These guidelines cannot cover every eventuality that may arise in such studies. Therefore, expert judgement from a thermal comfort expert may be required, particularly for issues that are not explicitly covered by these guidelines.

Furthermore, the materials used on buildings (glazing, masonry, green walls etc) and in the public realm (soft or hard landscaping, water etc) can have an impact on Thermal Comfort. For example, glazing could reflect sunlight in to spaces in the winter months improving Thermal Comfort whilst worsening the heat stress of Thermal Comfort in the summer months. Glazing set at a particular angle which reflects the winter sun only could assist. This is a complex field and schemes will be assessed individually. Green living walls in particular are known to have beneficial effects. This is a complex field of analysis and as such should not be included in any analysis at this time. Schemes will however be assessed qualitatively on an individual basis.

These guidelines may be updated from time to time, so users should check the City of London web site to ensure that the latest version of the guidelines are being used.

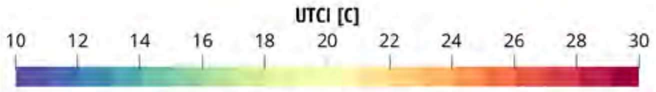


Figure 5: Thermal Comfort Predictions at 1:00 pm, 21 June based on 'typical' climate data and data which has been warped to represent one possible future climate change scenario

4. CITY OF LONDON: OVERVIEW MAPS OF SEASONAL THERMAL COMFORT

In the following pages a general overview of the Thermal Comfort qualities of the City for each season are presented. It is useful in conveying areas of high Thermal Comfort quality and those areas with a lower Thermal Comfort quality. There are obvious differences, particularly in winter, between the high Thermal Comfort qualities of the lower density of development in some areas with generously proportioned public spaces bordered by relatively small developments, and the lower Thermal Comfort qualities found around the City Cluster of towers as a result of increased shadowing and windier conditions.

This difference in microclimatic underlines why the City Corporation is negotiating public roof gardens and terraces on the roofs of many of the taller and major developments in the City Cluster and other areas, so the public are able to access new public realm of high Thermal Comfort quality.

Overall Observations:

In spring, the relatively low average wind conditions and good exposure to sunlight within the central portion of the City result in acceptable conditions being predicted at least 90% of the time in many locations. Areas where acceptable conditions are less likely, occur due to higher average wind conditions. This is seen most prominently immediately west and south of the City Cluster, particularly on Bishopsgate. In the centre of the Cluster, the impact of higher wind speeds is exacerbated by a reduction in sunlight access. A similar condition exists in autumn, though there are small differences due to differences in wind and solar exposure compared to spring.

In winter, cooler temperatures and higher typical windspeeds result in lower frequencies of comfortable conditions across much of the City. Areas which maintain high comfort frequency are those with good access to sunlight with calmer wind conditions (e.g. Finsbury Circus). The negative impact of increased windiness and shadowing in the City Cluster is again made clear.

Typical summer weather in London is conducive to thermal comfort so long as people are dressed appropriately. The shadowing and higher wind speeds in the City Cluster which were negatively impacting thermal comfort is now creating a slight benefit under the warmer summer conditions. However, this small benefit in summer is outweighed by the negative impact in the rest of the year.

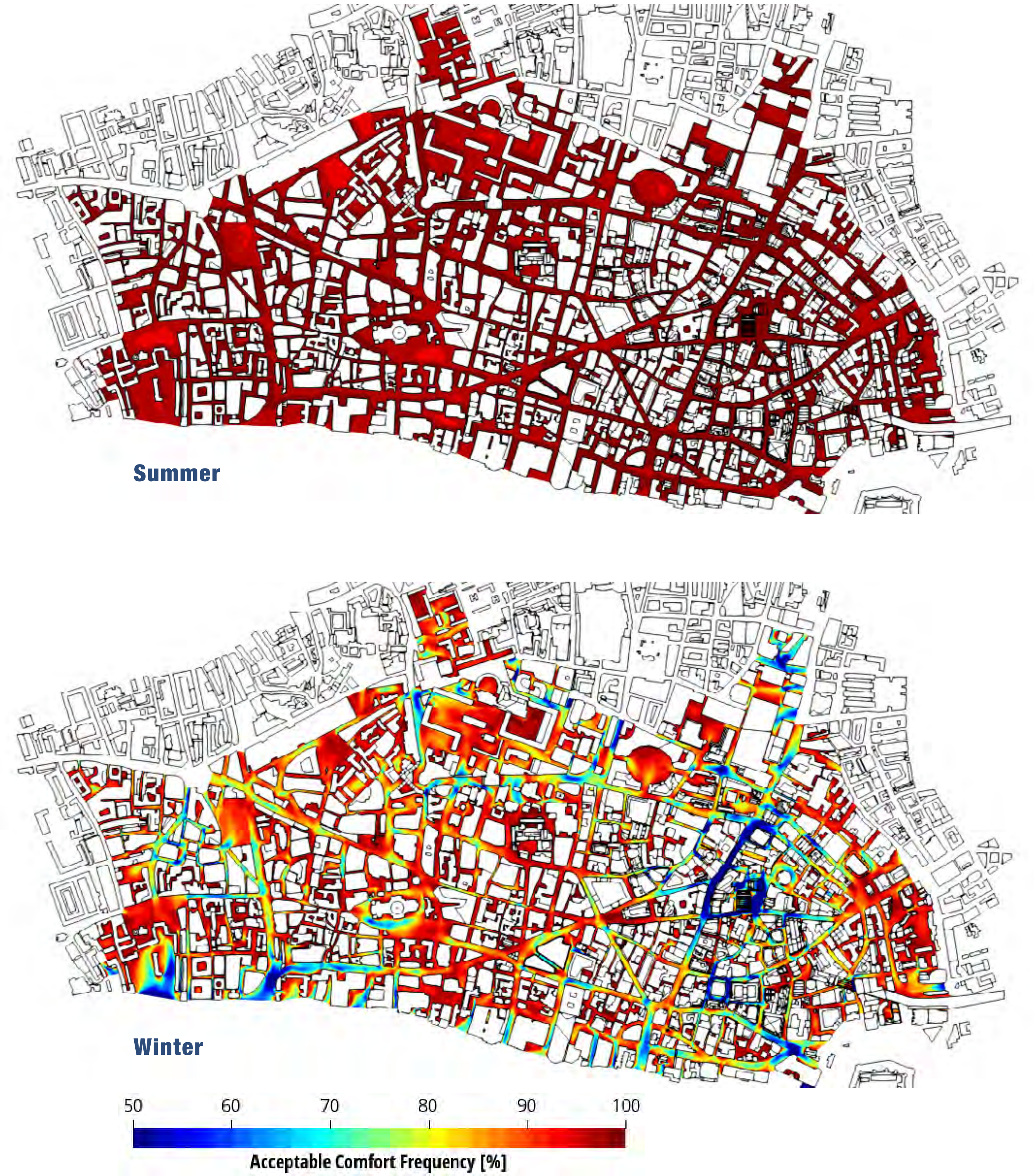
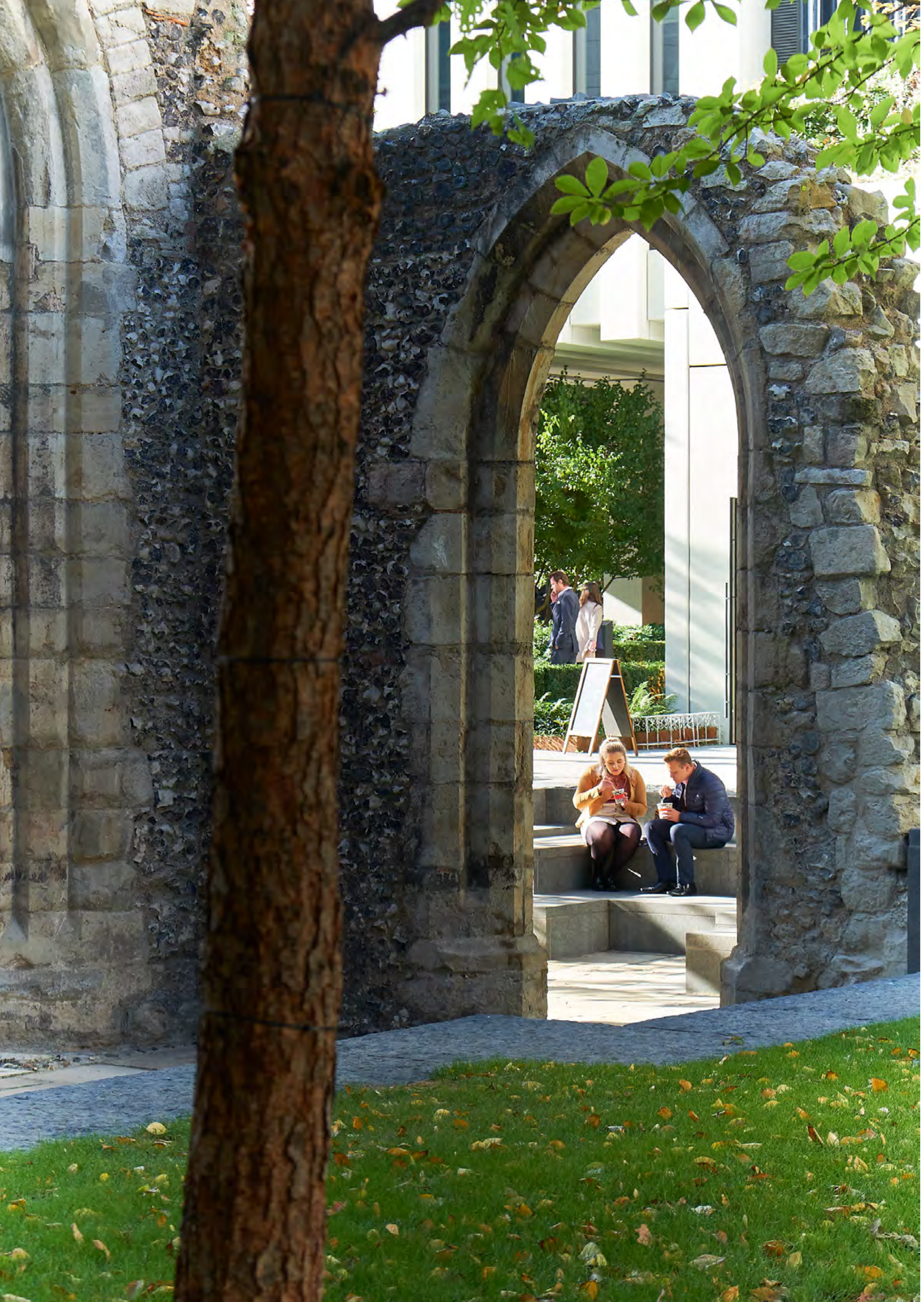


Figure 6: Seasonal Comfort Frequency



5. POLICY BACKGROUND

5.1 National Context

The National Planning Policy Framework (NPPF) paragraph 149 states that strategic policies should take a proactive approach to mitigating and adapting to climate change, considering the long-term implications for flood risk, coastal change, water supply, biodiversity and landscapes, and the risk of overheating from rising temperatures.

National Planning Policy Guidance (NPPG) on Climate Change sets the requirement for local authorities to adopt proactive strategies to mitigate and adapt to climate change in line with the Climate Change Act, helping to increase resilience through the location, mix and design of development. It stresses the importance of local knowledge of carbon emissions and undertaking climate change risk assessments.

NPPG on Natural Environment states that high quality environments can be achieved through green roofs, street trees, open spaces which can provide opportunities for recreation and social interaction, promote health and wellbeing, reduce air pollution and noise, facilitate biodiversity net gain and mitigate against climate change and flooding.

Intend to Publish London Plan

The London Plan has been reviewed and an Intend to Publish version of the Plan made available, pending formal approval by the Secretary of State. Policy SD4 indicates that in the Central Activities Zone (CAZ) practical measures should be taken to improve air quality and to address climate change and the urban heat island effect, whereby central London experiences higher local temperatures than surrounding parts of London.

The Plan sets out a series on objectives to deliver good growth. Objective GG6(A) states that planning and development must seek to improve energy efficiency and support the move towards a low carbon circular economy, contributing towards London becoming a zero-carbon city by 2050. GG6 (B) indicates that planning and development must ensure adaptation to a changing climate, making efficient use of water and reducing impacts from natural hazards like flooding and heatwaves, while mitigating and avoiding contributing to the urban heat island effect.

Proposals should minimise adverse impacts on the urban heat island through design, layout, orientation, materials, green infrastructure and through reducing the potential for internal overheating and reliance on air conditioning systems as per Policy SI4.

Policy D8 indicates that development plans and development proposals should ensure that appropriate shade, shelter, seating and, where possible, areas of direct sunlight are provided, while other microclimatic considerations, including temperature and wind, should be taken into account in order to encourage people to spend time in a place.

Policy D9 states that the environmental impacts of tall buildings - wind, daylight, sunlight penetration and temperature conditions around the building and neighbourhood- must be carefully considered and not compromise comfort and the enjoyment of open spaces.

The London Plan requires major developments to contribute to the greening of London by including urban greening as a fundamental element of site and building design and it promotes the use of an Urban Greening Factor in Policy G5. It also seeks to increase tree canopy cover in London by 10% by 2050 as per Policy G7.

City of London Local Plan review: City Plan 2036

The review of the City of London Local Plan has reached an advanced stage, with Regulation 19 Publication scheduled to take place prior to formal submission of the Plan for examination. As such, the draft plan carries weight in the consideration of development proposals.

Strategic Design Policy S8 seeks to optimise micro-climatic conditions, addressing solar glare, daylight and sunlight, wind conditions and thermal comfort and delivering improvements in air quality and open space.

Policy DE2 expects new development to ensure that the design and materials avoid unacceptable wind, loss of sunlight and thermal comfort impacts at street level or intrusive solar glare impacts on the surrounding townscape and public realm. Policy DE3 states that public realm schemes should have regard to the wellbeing of users in relation to air pollution, noise, temperatures, shading and microclimate.

Strategic Policy S12 and the supporting text requires developers to take account of the potential microclimate and thermal comfort impacts from tall building development at an early stage in the design process. It indicates that where tall buildings are acceptable in principle, their design must ensure safe and comfortable levels of wind, daylight and sunlight, solar glare and solar convergence within nearby buildings and the public realm within the vicinity of the building.

Strategic Policy S15 indicates that buildings and the public realm must be designed to be adaptable to future climate conditions and resilient to more frequent extreme weather events. Policy CR1 requires developers to demonstrate that their developments have been designed to reduce the risk of overheating through solar shading to prevent solar gain, particularly on glazed facades; urban greening to improve evaporative cooling; passive ventilation and heat recovery; use of thermal mass to moderate temperature fluctuations; and minimal reliance on energy intensive cooling systems.

Policy OS2 states that all development proposals will be required to demonstrate the highest feasible levels of urban greening consistent with good design and local context and major development proposals will be required to include an Urban Greening Factor (UGF) calculation.

6. RECOMMENDED APPROACH FOR THERMAL COMFORT STUDIES

General

It is expected that thermal comfort studies will be conducted in parallel with the wind microclimate and sunlight studies to contextualize the results in terms of overall thermal comfort.

As such the thermal comfort simulation methodology aims to be consistent with the scope of the existing study types, which is to provide an indicator of how building form influences the urban microclimate.

While the materials used in a building scheme play a role in urban thermal comfort, building form plays a larger role by determining access to wind and sun. It is also an aspect of a building which is not easily manipulated later in the design process. Thus, early detection of problematic forms is critical for urban planning as well as a timely design and construction process.

Further, the exact material types are often unknown at the time these studies are to be undertaken. Therefore, the effects of building materials cannot be reliably included in the assessment and are therefor excluded. Much like how material properties of surrounding buildings are not modelled in detail for the current daylight/sunlight studies.

In cases where the City Corporation consider the public realm to be particularly sensitive and is potentially frequently shadowed, the City Corporation may require a thermal comfort study to be undertaken for buildings below the 25m threshold. The need for such a study will be determined through early pre-application discussions.

Frequent shadowing during high use times can occur when a space is within 2 building heights to the north, east or west of the building, or 1 height to the south.

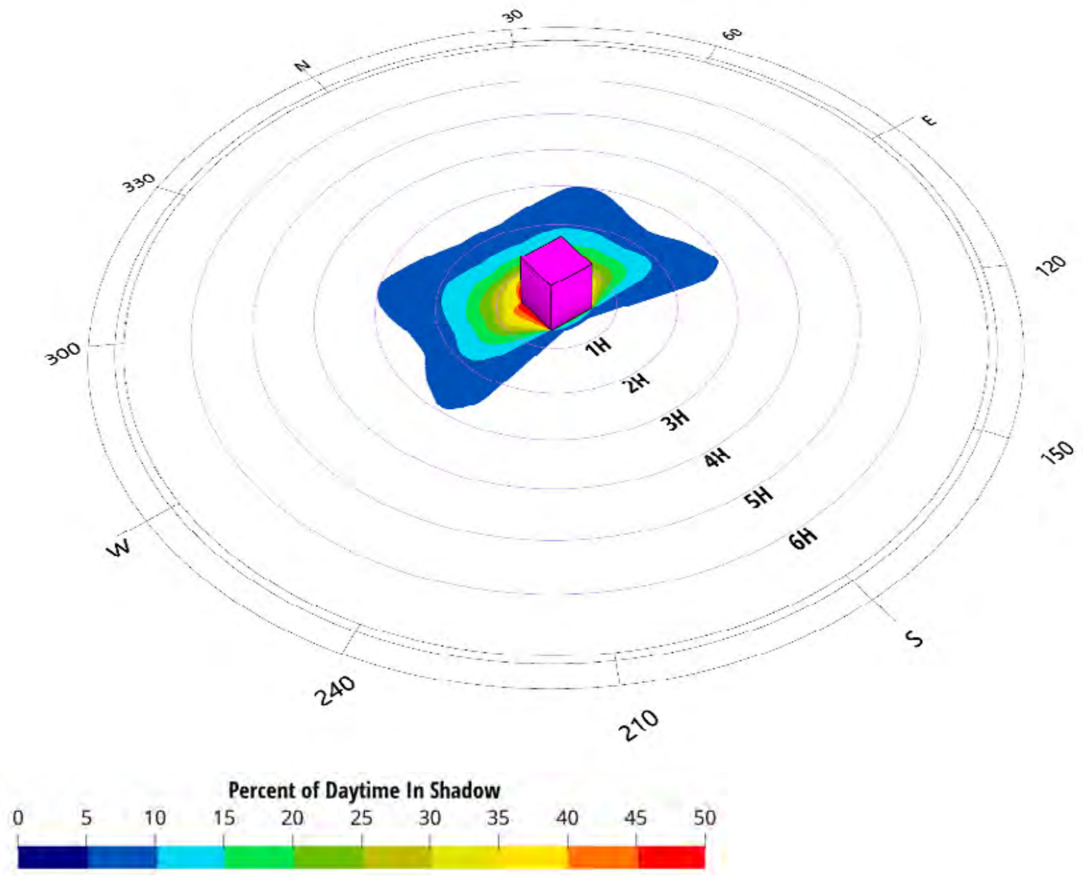


Figure 7: Extent of Shadowing from A Hypothetical Building (H=24m)

The thermal comfort study should include the evaluation of following scenarios:

- Existing site;
- Proposed scheme with existing surrounds; and
- Proposed scheme with planning consented for future schemes (see below).

If wind microclimate or sunlight studies require any mitigation measures, these should be included in the thermal comfort scenarios.

Applicants should liaise with City Corporation to agree the planning consented or future schemes for inclusion in thermal comfort studies.

Computational approaches are preferred for thermal comfort studies since they permit a more detailed understanding of the spatial distribution of comfort. Wind tunnel velocity ratios can also be used providing that outdoor public spaces have an adequate number of sensors which are both in-line with the City of London Wind Microclimate Guidelines and reflect the higher spatial variation of thermal comfort compared to wind. Spatial resolutions of 5m are recommended.

It is acknowledged that the computational approaches that are proposed within the City of London Wind Microclimate Guidelines do not capture transient effects such as wind gusts. However, these effects are less critical in a thermal comfort analysis which includes the impact of a variety of other environmental parameters. Further, it is expected that any excessively gusty conditions would be identified and mitigated through the wind microclimate analysis.

When is thermal comfort modelling required ?

To be consistent with the current City's Wind Microclimate guidelines, all new schemes of 25m or taller in the City of London will be subjected to the requirements of this guidelines

However, the City will exercise discretion as development lower than this threshold can have a harmful impact on the sunlight and thermal comfort qualities of some of the City's most cherished public spaces. These include parks, squares, churchyards and streets where the public dwell to relax, sit or where there are tables and chairs for alfresco dining. In addition, there are more sensitive uses such as children's play area, landscaped areas and gardens of special historical or other significance which might require a more rigorous approach. In these instances, the City may require Thermal Comfort modelling as part of the assessment of development schemes

Thermal Comfort modelling should form part of early massing studies in the initial development of schemes, much in the same way as wind modelling.

Meteorological inputs

The input weather data is the backbone of a thermal comfort simulation. Much like wind studies, a thorough understanding of the statistics of thermal comfort is paramount. Unlike wind studies however, thermal comfort relies on an understanding of multiple climactic parameters simultaneously at a specific time and date. This makes time-history style inputs a necessity. Statistical approaches (e.g. monthly sunshine hours or Weibull distributions) are not appropriate since they only deal with one parameter (i.e. sun and wind) in isolation.

A long-term time-history climate file has been generated for use in these studies. This bespoke file contains five years (2015-2019 inclusive) of hourly climate parameters generated using information from the Copernicus Atmosphere Monitoring Service. This data set was chosen because it contains enough data to reasonably describe the range of weather conditions in the City (including the impact of urban heat island effects), while being recent enough to acknowledge the changing climate without requiring additional assumptions or projections.

Further details regarding this data set and where it can be accessed is included as Appendix A.

Currently it is recommended that the temperature and humidity from the record should be applied uniformly across the study domain. This avoids the need for complex estimations of the effects of localized urban heat island and humidity transport effects which can unduly influence the predictions.

While the entire period from 1 Jan 2015 00:00 to 31 Dec 2019 23:00 is included in the weather data, consultants should be aware of the intended usage of the space(s) being assessed. At a minimum, the consultants should clip the record to the hours between 8:00 am and 8:00 pm GMT for public spaces to focus on the times when the pedestrian realm will be most active. However, spaces with a well-defined operating time period may be analysed over only those hours.

Excessive clipping must be avoided to ensure a statistically reasonable number of records in each season and any temporal filtering beyond the 8am-8pm noted above should be clearly described and justified in the report.

Thermal comfort should be computed for every hour in the clipped record.

Results should be presented seasonally using the following definitions (all ranges inclusive):

- Spring: March-May
- Summer: June-August
- Autumn: September-November
- Winter: December-February

Wind simulations

The prediction of pedestrian height (1.5 m) wind speeds should generally follow the CFD Requirements for in the City of London Wind Microclimate Guidelines. The primary exception is that statistical wind distributions cannot be used, as noted above. Care must also be taken to ensure sufficient spatial resolution in the areas of interest. For initial simulations, trees should not be included but can be included in more detailed simulations once landscaping plans are better defined. The impact of trees will include both wind adjustments and shading. If trees are included, both should be acknowledged in the simulations. See note below on trees.

Mean radiant temperature (MRT)

For initial studies, the MRT calculation should be computed at pedestrian height (1.5 m) in all spaces of study. MRT should be computed for a standing person per the approach outlined in CIBSE Guide A. The calculation should include the impact of direct and diffuse sunlight, with all surfaces assumed to be non-reflective and at ambient temperature. This avoids the need for more complex methods which require information or assumptions about the surrounding environment and buildings. These details are not often available and can have unanticipated impacts on the results.

The modelling of direct and diffuse solar radiation should be conducted using sky models which reasonably capture the changing distribution of energy from the sun and sky hour to hour. Given London's climate, the distribution of diffuse energy is particularly important to capture well. As such, the use of simplistic sky models with fixed energy distributions such as the CIE Standard Overcast Sky cannot be used. The computation of diffuse solar exposure must be based on a non-isotropic sky model which can vary based on climatic conditions, the Perez All-Weather Sky model for example. The model used and the details of the sky discretization should be included in the reporting.

The shading effect of trees should not be included during initial simulations to be consistent with the wind simulations. For detailed simulations, their effect can be included so long as they are represented in a reasonable fashion. i.e. deciduous trees should have their shading factor vary by season (when appropriate), canopy size and shape should be appropriate for the species, etc.

7. THERMAL COMFORT CRITERIA

The Universal Thermal Climate Index (UTCI) metric will be utilized for predicting thermal comfort in the City of London. The methodology for computing this metric is freely available at http://www.utci.org/ as is a Windows-based executable to calculate UTCI and its underlying code.

Note that the UTCI metric was originally designed for a 10m wind speed as an input. This speed is then scaled to pedestrian height assuming an open wind profile. Therefore, the computed pedestrian height (1.5m) wind speed results must be scaled to a 10 m equivalent using an aerodynamic roughness length (z_0) of 0.01 before being input into the UTCI calculation. This equates to a multiplicative factor of 1.4 ($U_{10}=U_{1.5}*1.4$).

UTCI should be computed for every hour in the climate time-history using the standard formulation available at the website above, and the frequency that UTCI is between 0° and 32° should be computed for each season. This range is currently considered 'appropriate' for outdoor pedestrian use.

The following table should then be used to define the categorization of a given location.

Note that the colours have been deliberately chosen to ensure distinctiveness in plots for those with colour-blindness. The colours should not be adjusted.

Usage Category	% of hours with Acceptable UTCI	Description	Colour (HTML Colour Code)
All Season	≥90% in each season	Appropriate for use year-round (e.g. parks).	Green (#378c4b)
Seasonal	≥90% spring-autumn AND ≥70% winter	Appropriate for use during most of the year (e.g. outdoor dining).	Purple (#c86ebe)
Short-term	≥50% in all seasons	Appropriate for short duration and/or infrequent sedentary uses (e.g. unsheltered bus stops or entrances) year-round.	Cyan (#1effff)
Short-term Seasonal	≥50% spring-autumn AND ≥25% winter	Appropriate for short duration and/or infrequent sedentary uses during most of the year.	Orange (#fab92d)
Transient	<25% in winter OR <50% in any other season	Appropriate for public spaces where people are not expected to linger for extended period (e.g. pavements, cycle paths).	Red (#de2d26)

Figure 8: Categorization of Existing City Conditions

8. PRESENTATION OF RESULTS AND REPORTING

Simulation Inputs

Details of the wind simulations must be included per the requirements of the Wind Microclimate guidelines.

Any other assumptions or changes to the basic methodology (i.e. alternate time periods studied) must be explained and justified.

Simulation Results

For each configuration, an overall plan view of the public realm should be presented. The percentage of hours the public realm is within the UTCI target range should be presented as colour plots for each season. These plots provide valuable context of the predicted existing and future comfort conditions.

A separate plan view plot illustrating the annual thermal comfort categories should be presented for each configuration following the colour scheme defined above. This is used to evaluate the overall change in thermal comfort.

Additional plots should be included as needed to clearly present all studied areas.

Significance Criteria

Currently, thermal comfort will not be a required component of the Environmental Impact Assessment. However, the findings of these assessments will be reviewed by the City Corporation and used to conduct a more holistic review of a building's impact on its surroundings.

Therefore, a review of current and expected future pedestrian uses should be carried out in accordance with the City of London Wind Microclimate guidelines and compared to the predicted thermal comfort categories as defined above. A summary of key observations should be included as part of the assessment.

Practitioners should be aware that thermal comfort may become a requirement in an EIA submission in the future. Should this occur, these guidelines will be updated to include criteria defining the significance of a project's impact on thermal comfort.

Sample Reporting

Appendix B presents a truncated version of a previous thermal comfort study conducted using the above process.

The intent is to provide an example of the expected level of reporting, rather than a fixed template.

APPENDIX A – CLIMATE INPUT SOURCE

Notes

As noted above, the input climate file is critical to the prediction of thermal comfort. therefore, all studies must use the same file as an input to ensure consistency between schemes.

The underlying data was sourced from the EU's Copernicus Atmosphere Monitoring Service. The data was then modified to provide the required climate parameters in a more accessible form. Solar insolation was split into direct and diffuse components using the methodology of Skartveit et al. and relative humidity was computed based on dry bulb and dew point temperatures using standard psychrometric calculations.

The data is provided for the period between 00:00 on 1 January 2015 through 23:00 on 31 December 2019 (inclusive) at one-hour increments as a comma separated value (CSV) file.

Air temperature (°C), relative humidity (%), air pressure (kPa) and solar insolation (W/m^2) values are given at pedestrian height. Wind speed (km/h) and direction (degrees east of north) are provided at 10m. Any wind speed scaling should be conducted based on a roughness length (z_0) of 0.3.

All times referenced in the file are in GMT and the 2016 leap day is included.

Aside from temporal clipping of the datafile, no other modifications to its contents should be made.

These climate properties have been extracted for the City of London and may not be appropriate for other parts of London or other cities.

Neither the European Commission nor the European Commission for Medium Range Weather forecasting (ECMWF) is responsible for any use that may be made of the Copernicus information or data it contains.

Climate Source File

The climate source file can be accessed at the same web address as this PDF.

APPENDIX B – CASE STUDY – Citicape House

Background

The following case study demonstrates the implementation of the City of London Thermal Comfort guidelines on a real project.

Citicape House is a planned 10 storey hotel development bounded by Snow Hill and Holborn Viaduct in London. The project features a roof terrace at level 10 with main entrances along Holborn Viaduct. The location of the proposed development is shown in Figure B1.

Figure B1: Aerial View of the Site (Approximate Extents in Yellow)

The proposed development is generally of a similar height to its surrounds, which consists mainly of residential and office buildings with retail, food and beverage spaces at ground level.

Images showing the computational model of the proposed development in the context of surrounding buildings is shown in Figure B2.

Figure B2: 3D model of the Proposed Development (View from South)

The project had previously undergone a CFD-based wind comfort analysis per City of London Wind Microclimate Guidelines (published August 2019). In addition, solar simulations were undertaken as per the methodology outlined in the main body of this document. Both of these simulations were undertaken in the absence of any landscaping.

Output from the wind simulations and solar simulations were combined with the climate data presented in Appendix A to provide an assessment of Thermal Comfort both at ground level and at the terrace levels for the following configurations,

Baseline: Existing site with existing surrounding buildings

Proposed: The Proposed Development with existing surrounding buildings

A review of the pedestrian spaces around the site was conducted based on Google Street View imagery captured in May 2019. Figure B3 below illustrates the assumed usage types. All spaces were studied for the full 8am-8pm time period.

Figure B3 Proposed space usage at ground and upper levels

Results

Results from the simulations are initially presented in terms of the % of time that conditions are considered acceptable (UTCI between 0°C and 32°C) and then in terms of the comfort categories as set out in the main body of this report.

Seasonal Acceptance – Baseline Scenario

Seasonal acceptance at ground level for each season for the baseline assessment is shown in Figure B4.

For the pedestrian realm immediately surrounding the site, most locations reported conditions which were acceptable for the majority (>90%) of the time from spring to autumn.

During winter, when wind speeds are highest and temperatures lowest, an area immediately south of 49 Farringdon Street was predicted to be comfortable less often (between 70% and 80% of the time). This is primarily due to a slight downdraughting effect caused by that building during the strong south-westerly winds which are common during winter.

Seasonal Acceptance – Proposed Development

Seasonal acceptance at ground level for each season for the Proposed Development is shown in Figure B5.

The proposed development is not significantly taller than the Existing building and therefore was not expected to create a significant change in local thermal comfort conditions. Conditions around the site remain comfortable at least 95% of the time from spring through autumn.

In winter, localized shadowing cause by the project does create a small reduction in predicted comfort levels to the north and east of the site along Snow Hill. Output from the assessment reported comfortable conditions at least 85% of the time in the majority of ground level locations.

This assessment also considered thermal comfort conditions on the terrace spaces of the proposed development; as these are indented to be amenity spaces for the building. Seasonal acceptance at terrace level for each season for the proposed development is shown in Figure B6.

In spring and autumn, conditions were predicted to be comfortable at least 95% of the time. In summer, the high degree of exposure to direct sun was predicted to lead to a slight reduction (6% at most) in comfort frequencies across the terraces. Areas with higher wind speeds (e.g. the south and southeast end of the building) and areas with shading elements are provided were predicted to remain comfortable throughout the year.

The windier and shaded areas were predicted to have reduced comfort frequency in winter. The southeast tip of the terraces experience winds which are slightly accelerated by the building (although remain acceptable in terms of the City of London Lawson Criteria). These areas were predicted to be comfortable between 75% and 85% of the time. Much of the remainder of the terraces was predicted to be comfortable greater than 85% of the time, and in the more sheltered areas, up to 95% of the time.

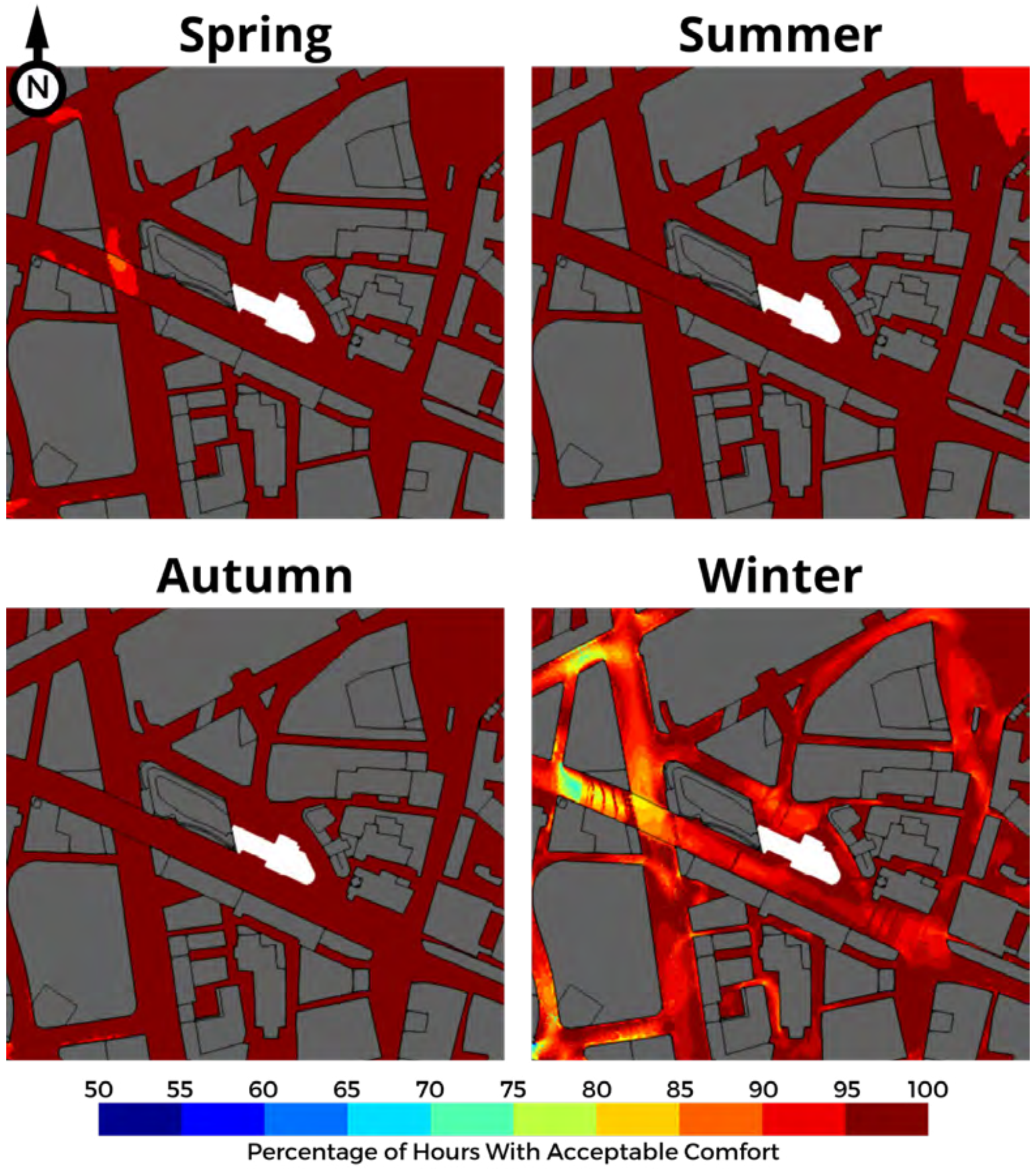


Figure B4: Seasonal Acceptable Comfort Frequency – Baseline

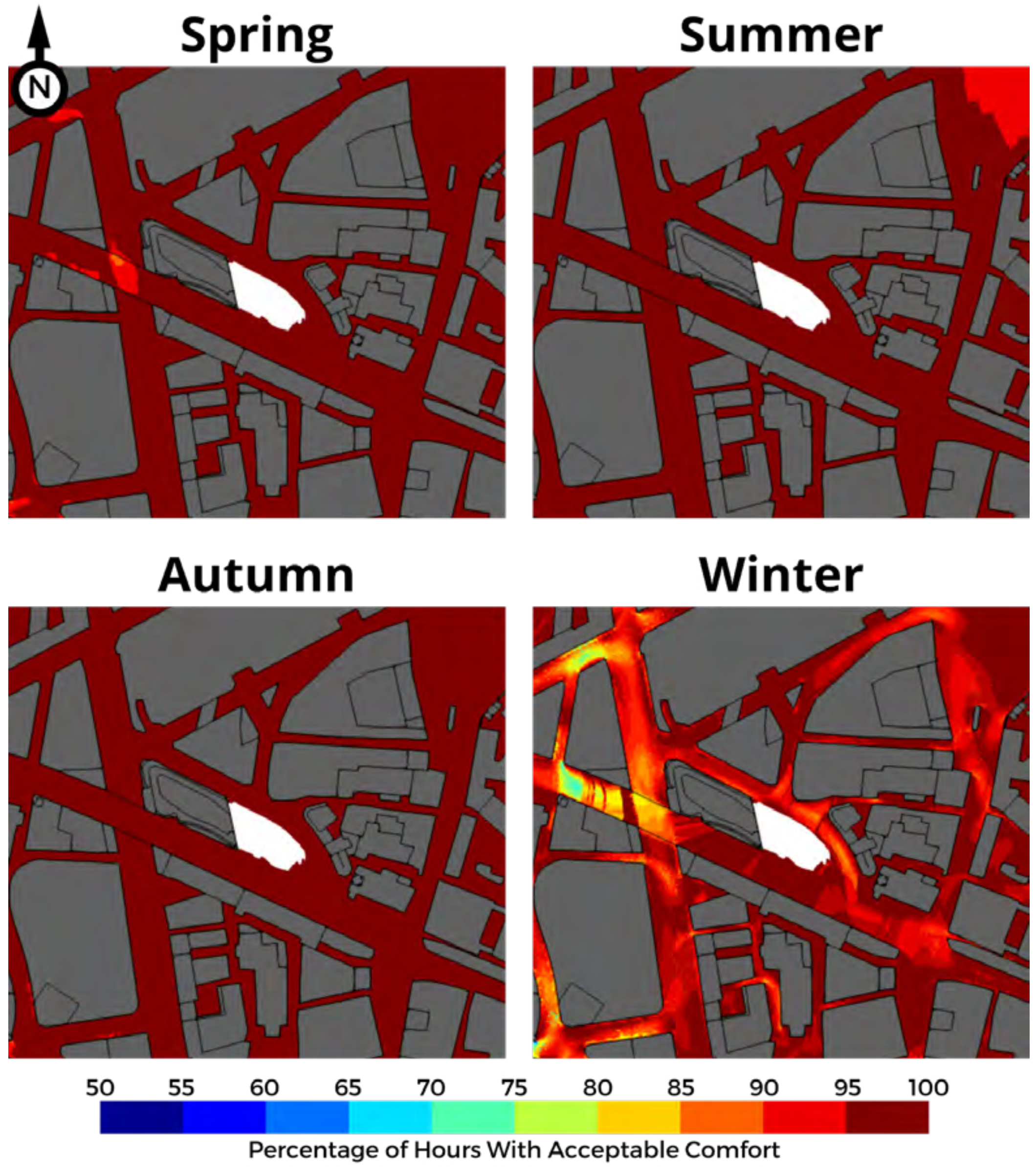


Figure B5: Seasonal Acceptable Comfort Frequency – Proposed Development

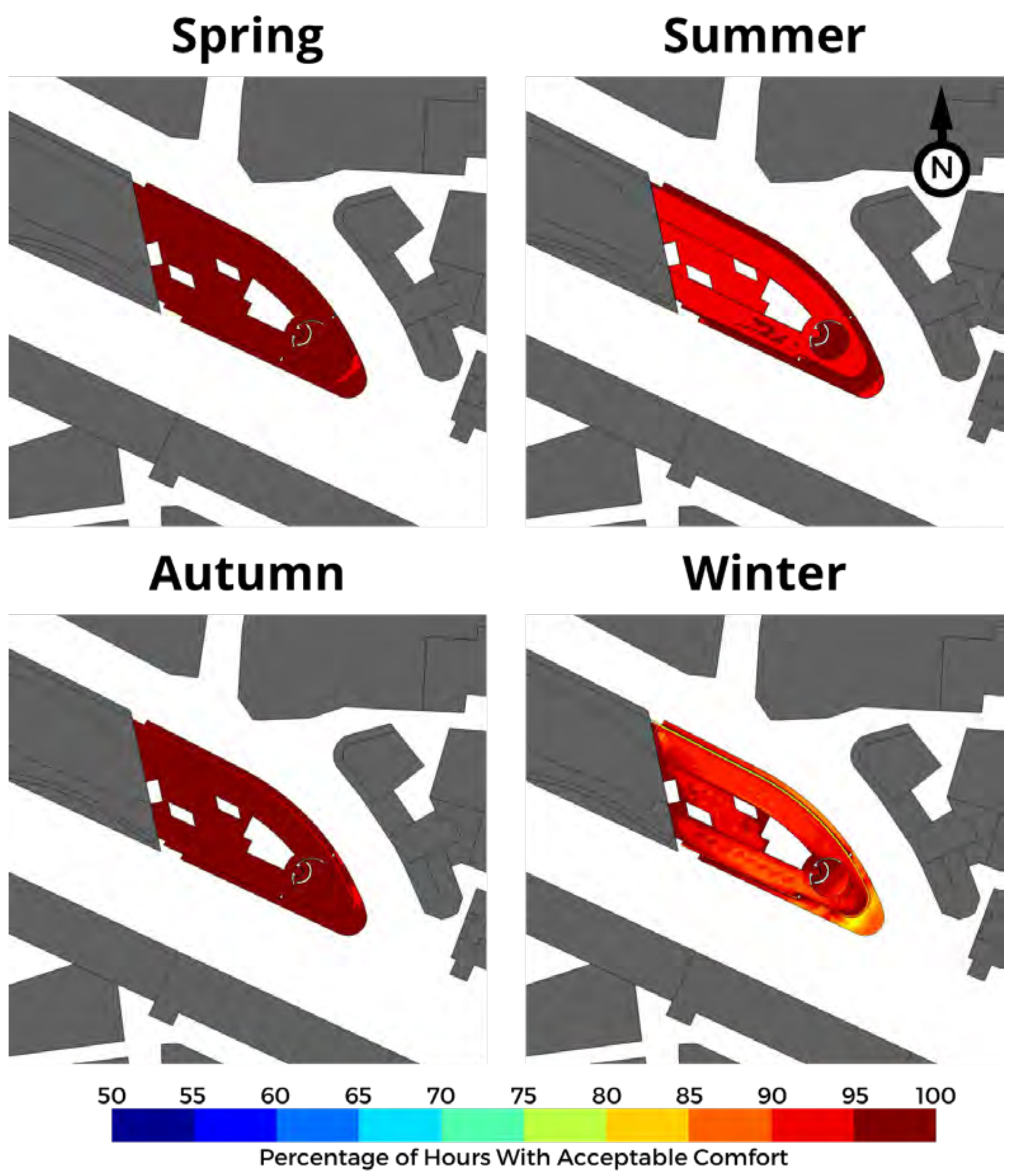


Figure B6: Seasonal Acceptable Comfort Frequency (Terrace) – Proposed Configuration

Ground Level Comfort Conditions

The ground level pedestrian spaces in the vicinity of the proposed development are primarily transient spaces (i.e. pavements and cycle paths). Nearby bus stops are generally sheltered, reducing exposure to winds and direct sunlight.

External amenity spaces include seating within St Sepulchre's Churchyard, seating on the southwest corner of the junction between Holborn Viaduct and Old Bailey, café seating around the corner of Snow Hill and Farringdon St and external seating for the Starbucks Coffee shop within Fleet Place immediately to the south of the Proposed Development.

Under the existing condition, predicted thermal comfort in the vicinity of the project is appropriate for the above noted uses, ranging from All Season to Short Term.

With the proposed development in place conditions remain generally the same. A small area to the northeast of the building does fall from All Season to Seasonal. This is due to a slight increase in shadowing in the winter, however this area consists solely of roads and pavements thus the actual impact on people is expected to be negligible.

Figure B7 below illustrates the Thermal Comfort Categorization for the ground level pedestrian spaces for both the existing and proposed configurations.

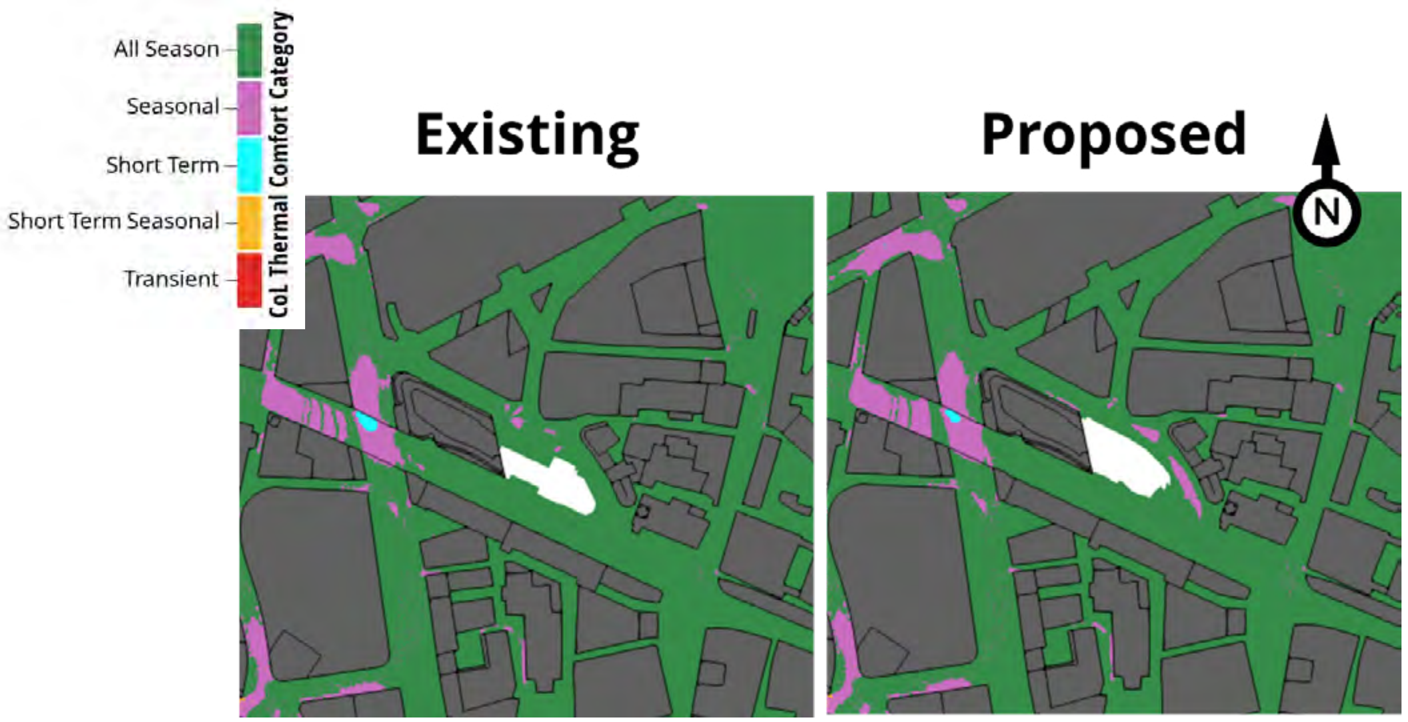


Figure B7: Ground Level Thermal Comfort Categorisations for Existing (left) and Proposed (right) Configurations

Terrace Level Comfort Conditions

Approximately 80% of the terrace area is expected to have comfort conditions appropriate for year-round occupant use.

Locations where the categorisation drops from All Season to Seasonal are those which are more shaded and/or more exposed to winds during the winter months.

Figure B8 below illustrates the Thermal Comfort categorization of the terraces under the proposed configuration.

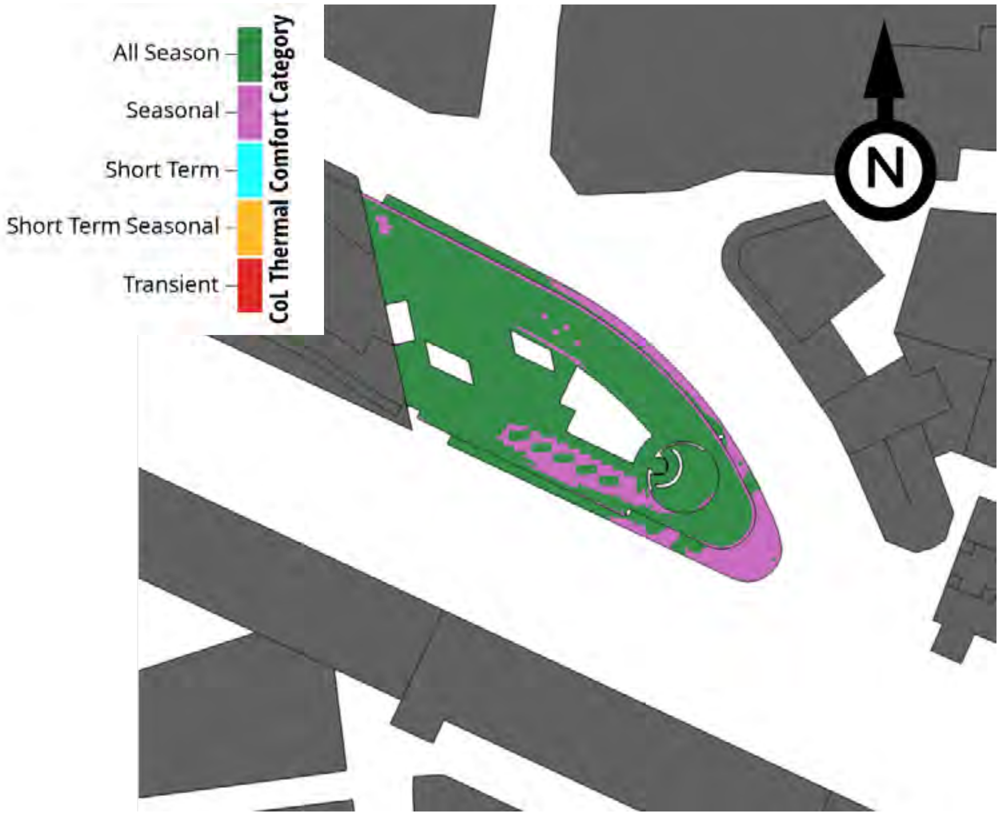


Figure B8: Terrace Thermal Comfort Categorisations for Proposed Configuration

Concluding Statements

The proposed development's impact on Thermal Comfort in the existing pedestrian realm is expected to be minor to negligible. All existing spaces are predicted to have appropriate thermal comfort conditions post-construction.

In the few places where pedestrians would linger (e.g. City Thameslink Stop HL south of the site, Holborn Circus Stop K, the Smithfield Rotunda Garden, etc.), the change in predicted thermal comfort conditions was predicted to be very small.

Similarly, there is very little change in predicted thermal comfort conditions for the seated amenity spaces at 1 Fleet Street.

While the proposed development eliminates some ground-level greenspace, the existing space is not accessible to the public. Further, the development adds substantially more public space (by approximately 1700 m^2) through its terraces. The majority of which are predicted to be comfortable for use year-round.

If there is a desire to further enhance thermal comfort in the remaining spaces only uncomfortable in winter, wind control measures could be implemented. These measures should ideally be temporary in nature and employed only when the weather is cool, so as not to degrade thermal comfort during warmer weather.

Temporary solar control measures (e.g. umbrellas or adjustable canopies) could also be considered to enhance thermal comfort during times of atypically warm conditions in summer.

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