Microclimate Analysis

Pedestrian Wind Comfort

Cambridge Road (RBK) LLP

Cambridge Road Estate
Kingston
London

SRE

Version	Revision	Date	Author	Reviewer	Project Manager
1	A	19.10.2020	Nikolaos Protogeros	Malcolm Maclean	Nikolaos Protogeros
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Executive Summary

This Microclimate - Pedestrian Comfort Analysis has been undertaken by SRE to accompany the planning application of the Proposed Development at Cambridge Road Estate, Burritt Road, Kingston Upon Thames, in order to ascertain the impact and the potential effect of the Proposed Development on pedestrian comfort with respect to wind velocity.

A transient Computational Fluid Dynamic (CFD) wind study has been performed for three scenarios:

1. Existing site with existing surrounding buildings
2. Proposed Development with existing surrounding buildings, and
3. Proposed Development with mitigation measures and existing surrounding buildings

Sixteen most prevailing wind directions have been analysed to provide a robust study and the results have been normalised against hourly weather data for different seasons and the whole year in order to give a thorough comparison against the Lawson Comfort Criteria.

Scenario 1 - existing site, the results of the assessment, indicate that the wind conditions are suitable for sitting to business walking use throughout the Site and the surrounding area. During the windiest (winter) season, there are four localised uncomfortable wind conditions and further eight business walking conditions within the site.

Strong winds exceeding the 15m/s safety threshold, would be expected in 10 no. of areas, mainly around the tower blocks. No areas of the application site exceed the 20m/s upper safety threshold.

Scenario 2 - with the Proposed Development in situ, the results of the wind microclimate assessment indicate that no distressful conditions were found for the whole area, with wind conditions ranging from suitable for sitting to pedestrian walking use. During the windiest season, five incidences of business walking have been identified throughout the Site as a direct result of the Development's layout and massing. In close proximity of two of the access points and entrances within the Development – south of Building D6 (outline Phase 2) and west of Building M2 (outline Phase 4) would have annual wind conditions suitable for walking, which is one category above the suitable for entrances. In 37 no. out of total 391 no. balconies have been identified areas with unsuitable for balconies. Twenty-three balconies located on buildings on Blocks B, C & E (detailed Phase 1) would have localised wind conditions suitable for business walking use during the summer season, which is two categories above that suitable for balconies. Of these, fifteen are 'spots' in the corner of the balconies. There are an additional twelve balconies on buildings on Blocks B, C & E (detailed Phase 1) that also have localised wind conditions suitable for pedestrian walking use during the summer season, which is one category above that suitable for balconies. Most of them are also 'spots' in the corner or on the edges of the balconies.

Fifty-five balconies across Building E1 (20 no.), Building E3 (5 no.) and Building E4 (2 no.), Building C1 (9 no.), Building C2 (10 no.) and Building C3 (9 no.) (all detailed Phase 1) would have small spots/localised instances of strong winds exceeding 15m/s for more than the safety threshold of 0.023% of time annually (e.g. 2hrs). No areas of the application site exceed the 20m/s upper safety threshold.

Scenario 3 - Proposed Development with mitigation measures. The results of the wind microclimate assessment for the whole year and the summer season, indicate that no distressful conditions were found for the whole area and all the areas in and around the Proposed Development would have suitable wind conditions for the intended uses.

The localised spots of 'unsafe' strong wind on balconies and roof terraces have and will be mitigated through the use of suitable balustrades – porous media.

There are no other locations across the Site with instances of 'unsafe' strong winds exceeding the 15m/s lower and 20m/s upper safety threshold for more than 0.023% of the year (e.g. 2 hrs).

With the proposed mitigation measures all areas in and around the Proposed Development would have comfortable, safe and suitable wind conditions for the intended uses.

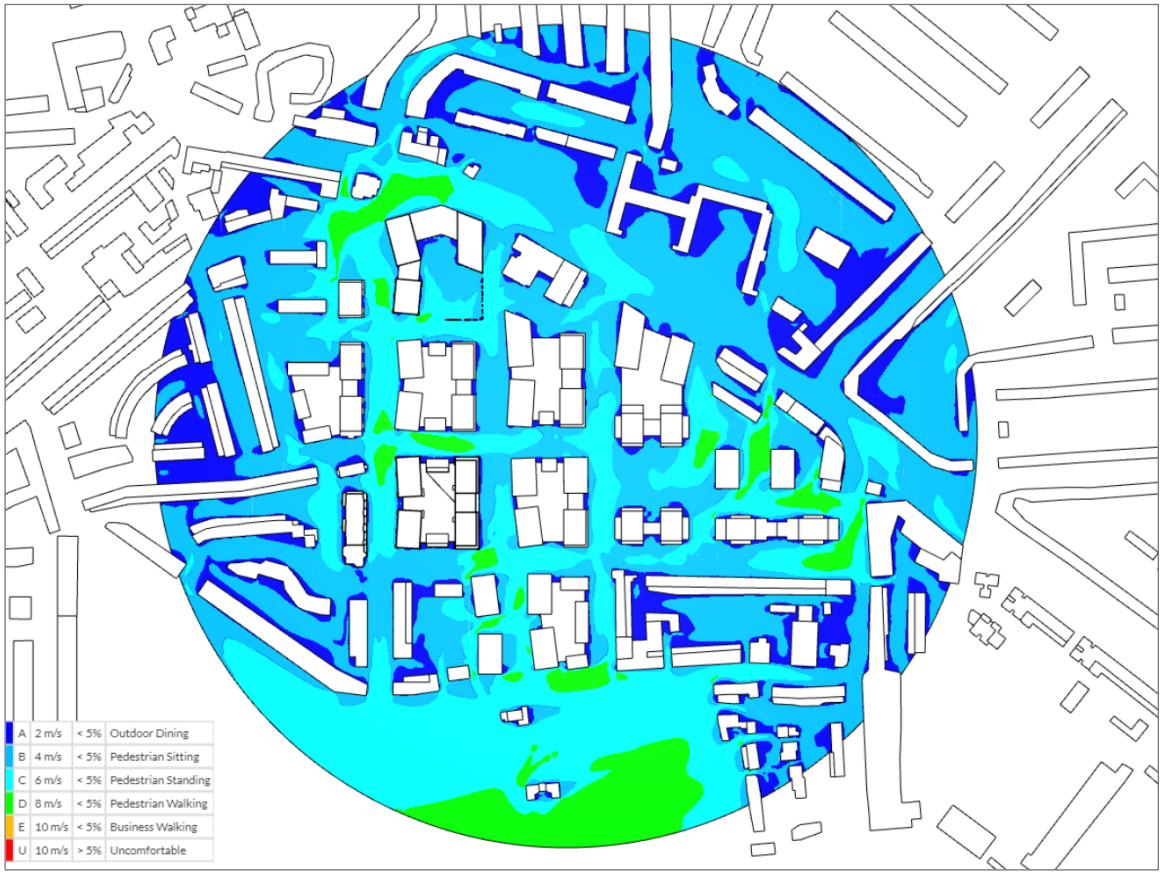

Figure 1 - Lawson Comfort Conditions. Result for the whole year, scenario 2. 1.50m above the ground

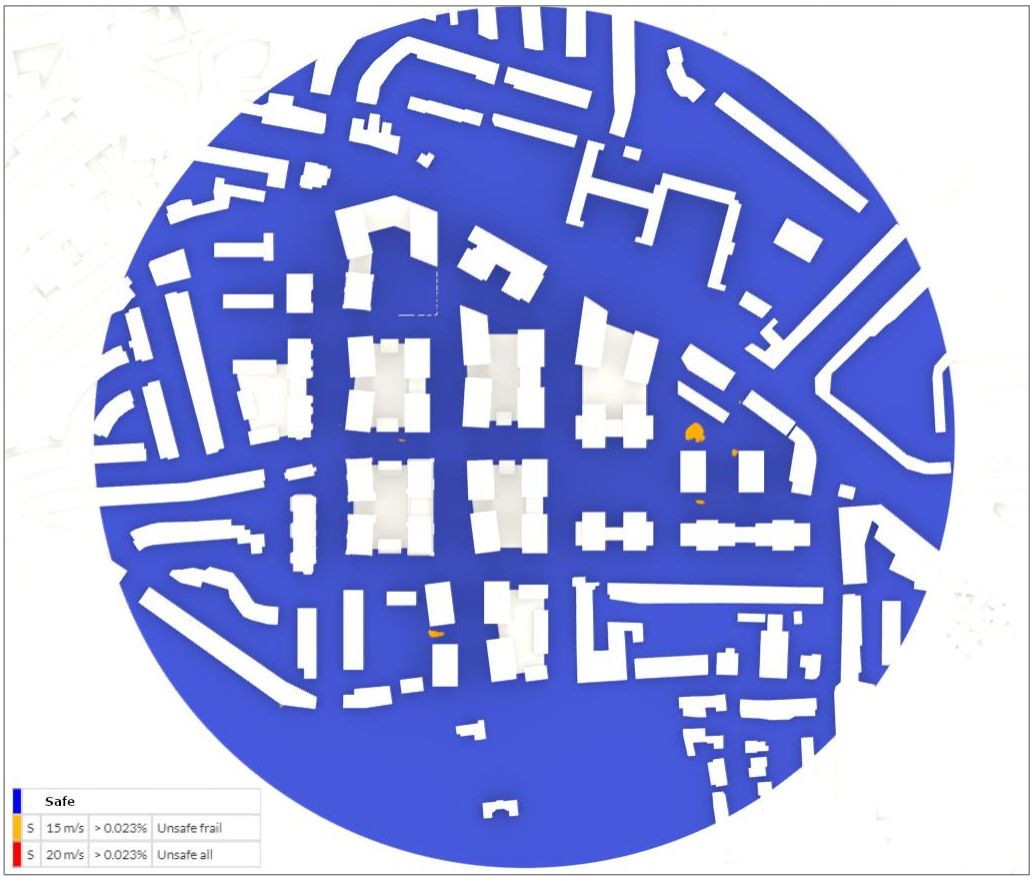

Figure 2 - Lawson Safety Conditions. Result for the whole year, scenario 2. 1.50m above the ground

Introduction

1.0 Introduction

This Microclimate Analysis - Pedestrian Comfort has been prepared by SRE to accompany the planning application of the Proposed Development at Cambridge Road Estate, Burritt Road, Kingston Upon Thames, on behalf of Cambridge Road (RBK) LLP (the Client).

The analysis studies the wind microclimate environment around the Proposed Development. The analysis and the 3D models are based on information, drawings and supporting site survey data for the existing buildings and the Proposed Development provided by the project architects Patel Taylor.

A transient Computational Fluid Dynamic (CFD) wind study, with 16 no. wind directions, has been completed to provide a robust study of the microclimate conditions generated by the Proposed Development, for three scenarios:

1. Existing site with existing surrounding buildings (Figure 3)
2. Proposed Development with existing surrounding buildings (Figures 4 and 5), and
3. Proposed Development with mitigation measures and existing surrounding buildings (Figure 6)

From reviewing data on the Planning Portal there are no new developments immediately adjacent to the Application Site to be taken into account within a further scenario. The only proposed new residential scheme is located over 100m away at the southern end of Hampden Road which is South East of the Application Site. This development is not relevant as this wind direction is the weakest and least frequent wind condition for the area.

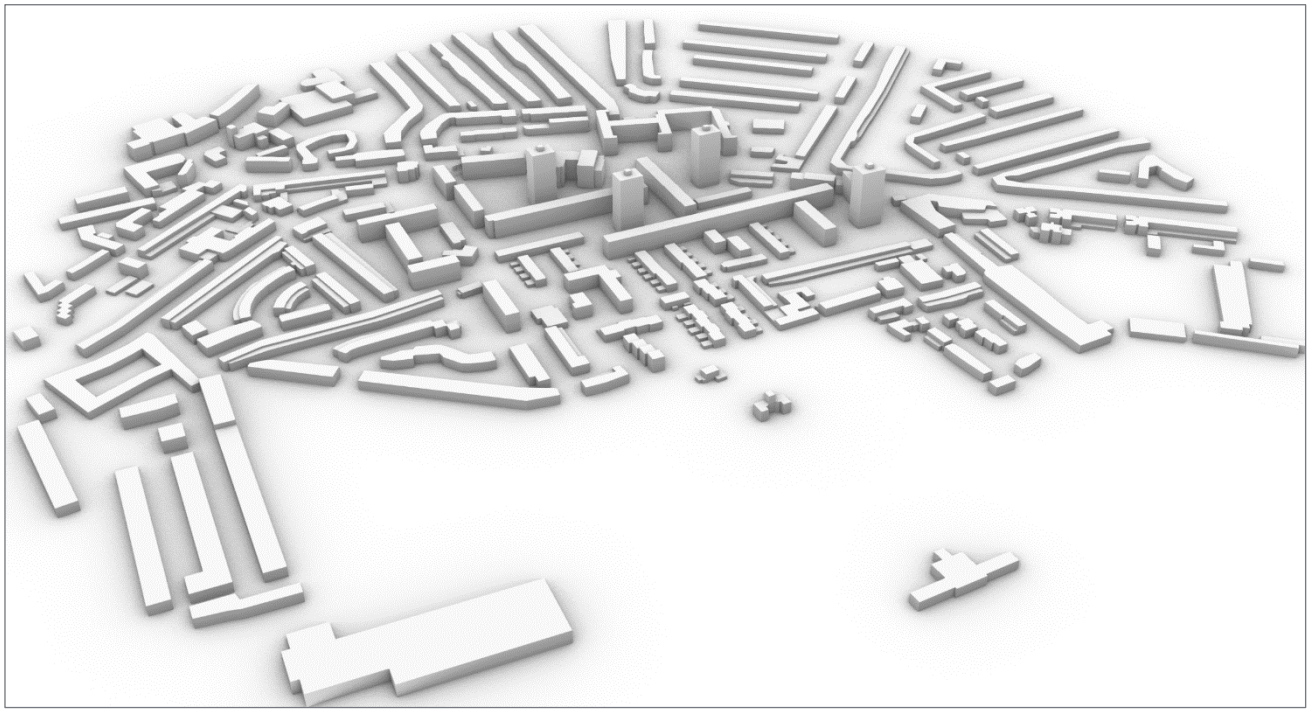

Figure 3 - 3D view of the Existing site with the surrounding buildings. Scenario 1

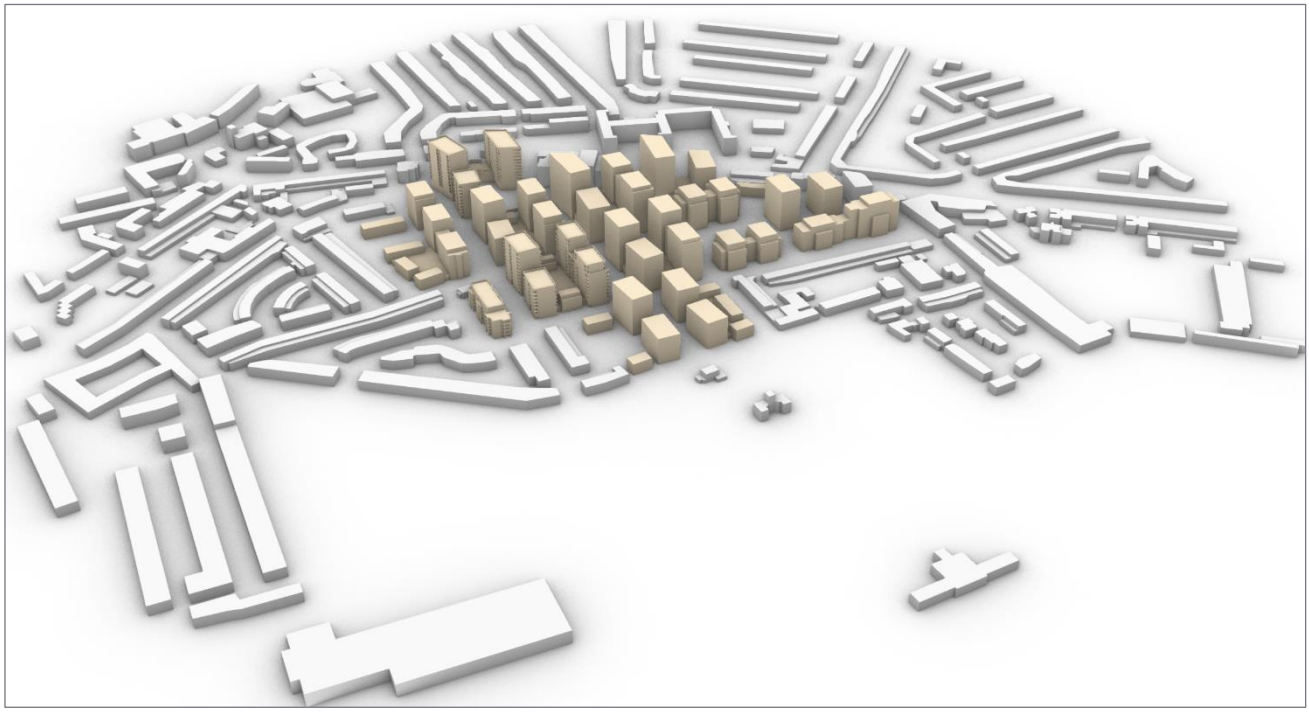

Figure 4 - 3D view of the Proposed Development with the surrounding buildings. Scenario 2

Figure 5 - 3D view of the Proposed Development with the surrounding buildings. Scenario 2

In Figure 5 above, the balcony and terrace details are visible for blocks B, C and E, the Phase 1 elements of the scheme, which have been assessed in greater detail.

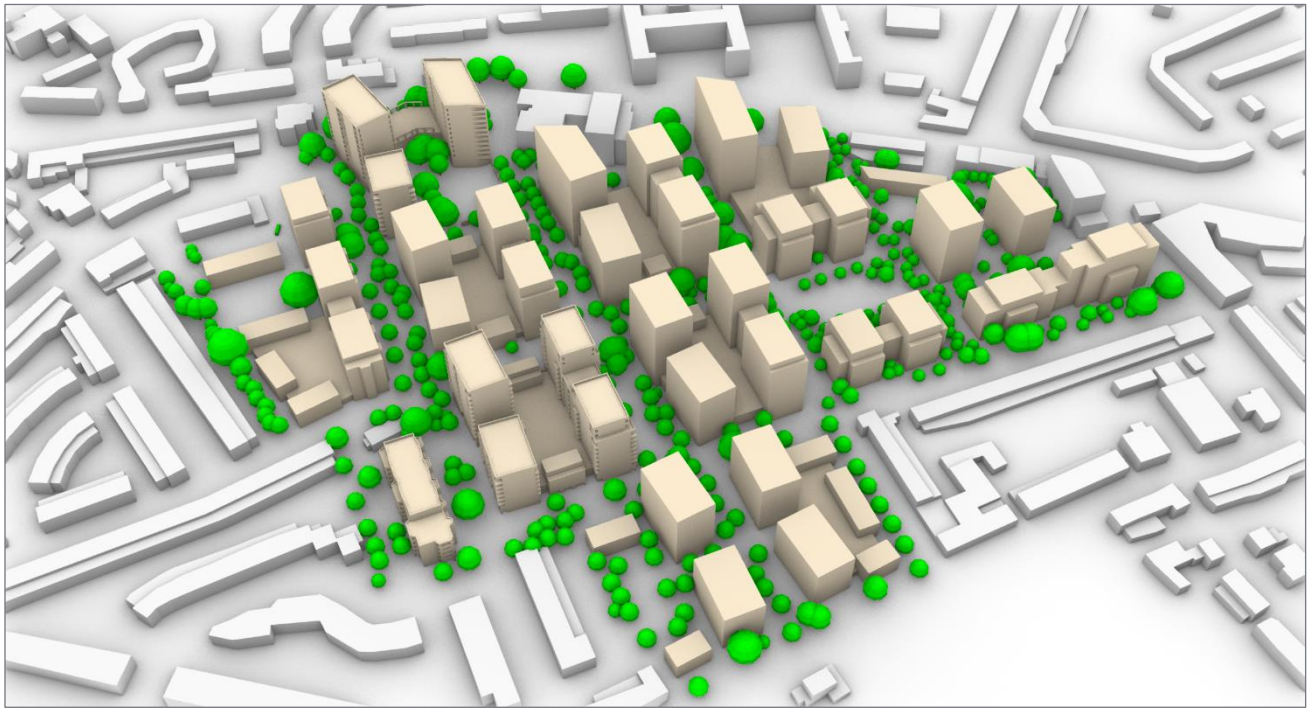

Figure 6 - 3D view of the Proposed Development with the surrounding buildings and the proposed trees. Scenario 3

The assessment has been conducted using SimScale Pacefish software which implement the transient lattice Boltzmann (LBM) method.

All results are based on the output from computer modelling software and have uncertainty compared with real life. All modelling techniques fail to predict reality with perfect precision, due to necessary assumptions, unpredictable boundary conditions and other simplifications that have to be made to allow the model to work successfully.

It is important to note that as with any modelling exercise there are assumptions and approximations that have to be made and used. As far as possible, details of all these are supplied as part of the report.

1.1 The Proposed Development

The hybrid Outline Planning Application is for a mixed-use development, including demolition of existing buildings and erection of up to 2,170 residential units (Use Class C3), 290sqm of flexible office floorspace (Use Class E), 1,395sqm of flexible retail/commercial floorspace (Use Class E/Sui Generis), 1,250sqm community floorspace (Use Class F2), new publicly accessible open space and associated access, servicing, landscaping and works.

Detailed permission is sought for access, layout, scale, appearance and landscaping of Phase 1 (blocks B, C and E) for erection of 452 residential units (Use Class C3), 1,250sqm community floorspace (Use Class F2), 290sqm of flexible office floorspace (Use Class E), 395sqm of flexible retail/commercial floorspace (Use Class E/Sui Generis), new publicly accessible open space and associated access, servicing, parking, landscaping works including tree removal, refuse/recycling and bicycle storage, energy centre and works (the Proposed Development).

The Site is located in Kingston Upon Thames, close to Kingston Town Centre. The existing site, The Cambridge Road Estate (CRE), hosts the largest concentration of Council housing in RBKuT. Currently, 832 homes are located here on the c8.6 hectares site comprising a mix of high-rise blocks, lower-rise flats and maisonette blocks as well as terraced houses. The immediate surrounding area in general comprises of low to medium height buildings.

Figure 7 – Site location plan – Existing Site with planning boundary

Applicable Policy and Standards

2.0 Applicable Policy and Standards

The following planning policy and guidance are applicable to this assessment:

- BRE Guide 'Wind Microclimate Around Buildings' (DG 520)

National Planning Policy

There are no national codes of practice or policies relating to the assessment of environmental wind flows in the built environment. National planning policies do not impose specific limits on the microclimate wind environment around a new development. The effect of wind on pedestrian level and the suitability of these spaces for planned usage are described by and compared against the industry standard Lawson Comfort Criteria, which are recognised as a suitable benchmark for wind assessments.

Regional Planning Policy

- The London Plan - Spatial Development Strategy for Greater London (2021)

2.1 BRE Guide "Wind Microclimate Around Buildings" (DG 530)

There are no statutory requirements in the UK governing pedestrian-level wind microclimate around buildings, nor are there any national planning policies directly relating to wind microclimate. However, most regional or local planning policies include some requirements for wind microclimate.

In order to assess wind conditions against the full LCC, the CFD study should determine mean and gust wind speeds for a minimum of 8 wind directions. It is also an essential requirement of a CFD study that it can calculate peak wind speeds with a low probability of occurrence to determine the likelihood of distress or safety thresholds being exceeded.

Some basic requirements for a CFD assessment are:

- Do not use the standard k-ε turbulence model. Use more advanced linear eddy viscosity models such as RNG k-ε, or ideally use non-linear eddy viscosity models.
- Ensure that the blockage of the modelled development is below 3%.
- Verify the assumption of an equilibrium boundary layer corresponding to the approach flow conditions by performing a simulation on an empty domain.
- Do not use first-order schemes for numerical approximations.

2.2 The London Plan - Spatial Development Strategy for Greater London (2021)

The London Plan places great importance on the creation and maintenance of a high-quality environment for London. The following policies apply in relation to wind microclimate:

The 'new' London Plan refines the above policies that apply in relation to wind microclimate:

Policy D8 Public Realm:

"Development Plans and development proposals should: […] G ensure buildings are of a design that activates and defines the public realm and provides natural surveillance. Consideration should also be given to the local microclimate created by buildings, and the impact of service entrances and facades on the public realm."

Policy D9 Tall Buildings:

"C Development proposals should address the following impacts: […] 3) environmental impact a) wind, daylight, sunlight penetration and temperature conditions around the building(s) and neighbourhood must be carefully considered and not compromise comfort and the enjoyment of open spaces, including water spaces, around the building.

[…] 4) cumulative impacts a) the cumulative visual, functional and environmental impacts of proposed, consented and planned tall buildings in an area must be considered when assessing tall building proposals and when developing plans for an area. Mitigation measures should be identified and designed into the building as integral features from the outset to avoid retro-fitting."

2.3 Lawson Comfort Criteria

The Lawson Comfort Criteria (LCC) is considered to be the industry standard in the UK. In the BRE guide it is stated that:

"In the UK most wind comfort assessments use the Lawson Comfort Criteria (the 'LCC'). These are preferred because they have been calibrated by BRE and others against wind conditions around real developments and have been shown to represent good standards of environmental practice."

The Lawson Comfort Criteria (LCC) which sets six threshold wind speeds and then dictates the probability of wind speeds exceeding that threshold. The different threshold values, as well as the probability values, determine the likely reaction of an average pedestrian to the wind.

Each wind level corresponds to a pedestrian activity that could be achieved in an acceptable manner (sitting, standing etc) and the probability is calculated using the statical weather data for the local area. If the measured wind conditions exceed the threshold wind speed for more than 5% of the time, then they are unacceptable for the stated pedestrian activity and the expectation is that people will not use the particular area for its intended purpose.

The LCC sets out five levels of pedestrian activities in ascending order relating to wind conditions: outdoor sitting, pedestrian sitting, pedestrian standing, pedestrian walking, business walking/cycling. The sixth level is for those conditions that are uncomfortable for all pedestrian uses. This is summarised in the following Table 1.

Colour	Comfort Category	Threshold Wind speed (m/s)	Percent Exceedance (%)	Description
	Outdoor Dining	2	<5	Reading a newspaper and eating and drinking, sitting in outdoor cafes, patios, terraces, benches, gardens, parks (considered to be of long duration)
	Pedestrian Sitting	4	<5	Pedestrian Sitting, sitting in parks and outdoor spaces
	Pedestrian Standing	6	<5	Pedestrian Standing (or sitting for a short time or exposure). Appropriate for bus stops, building entrances or exits, children's play areas
	Pedestrian Walking/Strolling	8	<5	General areas of walking, strolling and sightseeing, window shopping, public/private sidewalks, pathways, public spaces
	Business Walking/Cycling	10	<5	Local areas around tall buildings where people are not expected to linger. Walking from one place to another quickly, or where individuals pass rapidly through local areas around buildings, roads and car parks, cyclists' pathways

	Uncomfortable	>10	>5	Uncomfortable for all pedestrian activities

Table 1 - The Lawson comfort criteria thresholds

The Lawson Comfort Criteria are derived for open air conditions and assume that pedestrians would be suitably dressed for the season. Thermal comfort is not evaluated as part of this microclimate assessment.

2.4 Strong winds – Lawson Safe Criteria

The LCC also specifies two strong wind categories and exceeding these indicates a need for remedial measures or a careful assessment of the expected use of that location. The location is 'safe' if these infrequent strong winds appear for less than 0.023% (e.g. 2 hrs) of the whole year period. Outside of these parameters the location is deemed 'unsafe'. The lower limit, 15m/s, is intended to identify wind conditions which elderly people, cyclists or children may find physically difficult. Infrequent strong wind can cause some pedestrians to have difficulties with walking, to stumble or fall. Wind speeds that exceed the upper limit, 20m/s, represent a safety risk for all members of the population. This is summarised in the following Table 2.

Colour	Comfort Category	Threshold Wind speed (m/s)	Percent Exceedance (%)	Description
	Safe			
	Unsafe Frail	>15	>0.023	Safety risk for elderly people, cyclists or children, difficulties with walking, to stumble or fall
	Unsafe All	>20	>0.023	Safety risk for all members of the population

Table 2 - The Lawson safe criteria thresholds

2.5 Defining Significance

The wind conditions are compared with the intended pedestrian use. The following description of categories for the Application Site:

- Thoroughfares & Roads – targeting walking wind conditions.
- Entrances – targeting standing wind conditions.
- Amenity Areas: ground floor, podium, roof terraces and balconies are targeting a mix of sitting and standing conditions during the summer season.

2.6 Scale & Significance

The criteria used in the assessment of both potential and residual effects is based upon the relationship between the desired pedestrian use of an area of the Proposed Development and its immediate surroundings (based on the LCC comfort categories) and, the predicted wind conditions at that area. This approach allows for the microclimate assessment to account for any change in pedestrian activity that might arise because of the Proposed Development.

The scale used within the assessment to assess the significance of an effect is:

- Negligible (no effect) – wind conditions are those required.
- Minor Adverse – wind conditions are one category windier than required.
- Moderate adverse – wind conditions are two categories windier than required.
- Major Adverse - wind conditions are three categories windier than required.

Methodology

Computational Fluid Dynamics (CFD)

3.0 Methodology – Computational Fluid Dynamics (CFD)

Simulations of the wind microclimate around the complex environment of the existing surroundings and proposed buildings were conducted using SimScale Pacefish software which implement the transient lattice Boltzmann (LBM) method. Rhino 6 and SketchUp 2017 have been used to create and simplify the 3D model.

Further analysis was also undertaken to assess compliance with the Lawson Comfort Criteria (LCC) by interpolating the transient CFD results of the site with hourly weather data in order to predict the frequencies of wind speeds across the course of a whole year and the different seasons.

Within the CFD model the following assumptions have been made:

- The K-omega SST DDES (Delayed Detached Eddy Simulation) turbulence model has been used, which is highly accurate and widely used turbulence model for CFD studies in the built environment.
- Wall functions have been used to calculate near-wall properties of turbulence.
- An orthogonal computational domain was created for each wind direction.
- In all CFD cases the blockage ratio of the model is always below 3.00%.
- The computational model was discretized into up to 28 million cells with refinement close to the areas of expected high velocity gradients, the areas of interest and the small details.
- All surfaces in the model, including the ground, have been modelled with 'no-slip' wall boundary condition.

Mitigation Measures

Mitigation measures were developed during a number of Mitigation Workshops (21.09.2020 & 02.10.2020) hosted by SRE to enhance the detailed design (Phase 1) and the Site landscaping strategy. The measures were incorporated into the Development and assessed with further CFD modelling (Scenario 3).

Within the CFD model at Scenario 3, the following additional assumptions have been made:

- All the trees in the proposed development area, remaining existing and proposed, have been included as porous media entities in the CFD model with low Leaf Area Index (LAI), in order to capture a worst-case wind environment.
- All trees modelled with different heights and porosity based on the landscape design and the site survey data. The foliage has been represented in the model in a conservative way, with medium tree height and width and with medium to low LAI values.
- Balustrades have been included only in the balconies with minor adverse wind conditions and above, as porous media entities with porosity based on the architectural drawings and specifications (23%, 50% and 73%) and height of 1.5m.

3.1 Terrain Roughness Approaching Site, Atmospheric Boundary Layer (ABL) Profile

Average wind speed increases with distance from the ground and this, along with turbulence has a significant impact on the wind profiles around buildings. In this study a logarithmic upstream wind profile has been assumed and the appropriate terrain roughness and the exposure categories has been taken into account, based on the EN 1991-1-4 standards. For all 16 wind directions the suburban wind exposure is selected.

3.2 Wind Analysis

The studies focusing on the assessment of wind microclimatic conditions and the mechanical effects of wind on people take into account a combination of parameters such as the wind statistics, the roughness characteristics of the site and the wind comfort and safety criteria.

The wind speed and direction throughout the year have been calculated based on historic weather data obtained from a nearby weather station. The dataset is based on hourly averages, taken from the Heathrow

Airport weather station (11.5 km Northwest of the Site), which is expected to be a suitable approximation of the prevailing wind conditions on the Application Site.

The statistical meteorological wind data give information about the wind climate of the area under investigation, providing information about the mean wind speeds, the wind gusts and the wind directions. The wind statistics are directly associated with the pedestrian wind comfort. The meteorological station needs to be exposed correctly and the data needs to provide sufficient sequences of measurements over several years to maximize accuracy and identify the potential extreme values (National Meteorological Library, 2013).

For this study, the wind data were collected from Heathrow (latitude: 51.479; longitude: -0.449) meteorological station (SRC_ID: 708) at West London (Postcode: TW6; OS Grid Reference: TQ 070766), which is on the boundary of 'Town' terrain. Hourly averaged wind data for a 15-year period (2006-2020) divided into 16 wind directions in intervals of 22.5 degrees were analysed. The wind data have been corrected considering for each wind direction the upwind distance from the site to the sea and additionally the upwind distance of the site to the edge of the city, including the transition between the roughness categories.

The wind climate in the southern part of the UK is reasonably consistent; the annual prevailing winds are from SW (225°), SSW (202.5°) and W (270°) occurring for 11.51%, 11.26% and 10.44% of the annual time respectively. Wind speeds greater than 15m/s may occur for up to 0.02% of the yearly time at the location of the meteorological location, while wind speeds of 10-15m/s occur for 1.81% of the annual time. On the other hand, low wind speeds of no more than 4m/s occur for as much as 46.14% of the yearly time.

Regarding the seasonal wind climatic data, the SW (225°), SSW (202.5°) and W (270°) are also the three prevailing wind directions for both winter and summer. Winter is the windiest season of the year followed by spring, while summer is the calmest season followed by autumn. During winter, wind speeds greater than 10m/s occur for more than 3.4% of the time and wind speeds lower than 4m/s occur for no more than 43% of the time. On the contrary, wind speeds greater than 10m/s occur for less than 0.64% of the time during summer, while wind speeds lower than 4m/s occur for more than 47% of the time for the same season. Figure 8 shows the annual as well as the winter and summer wind roses at London Heathrow meteorological station for the period 2006-2020.

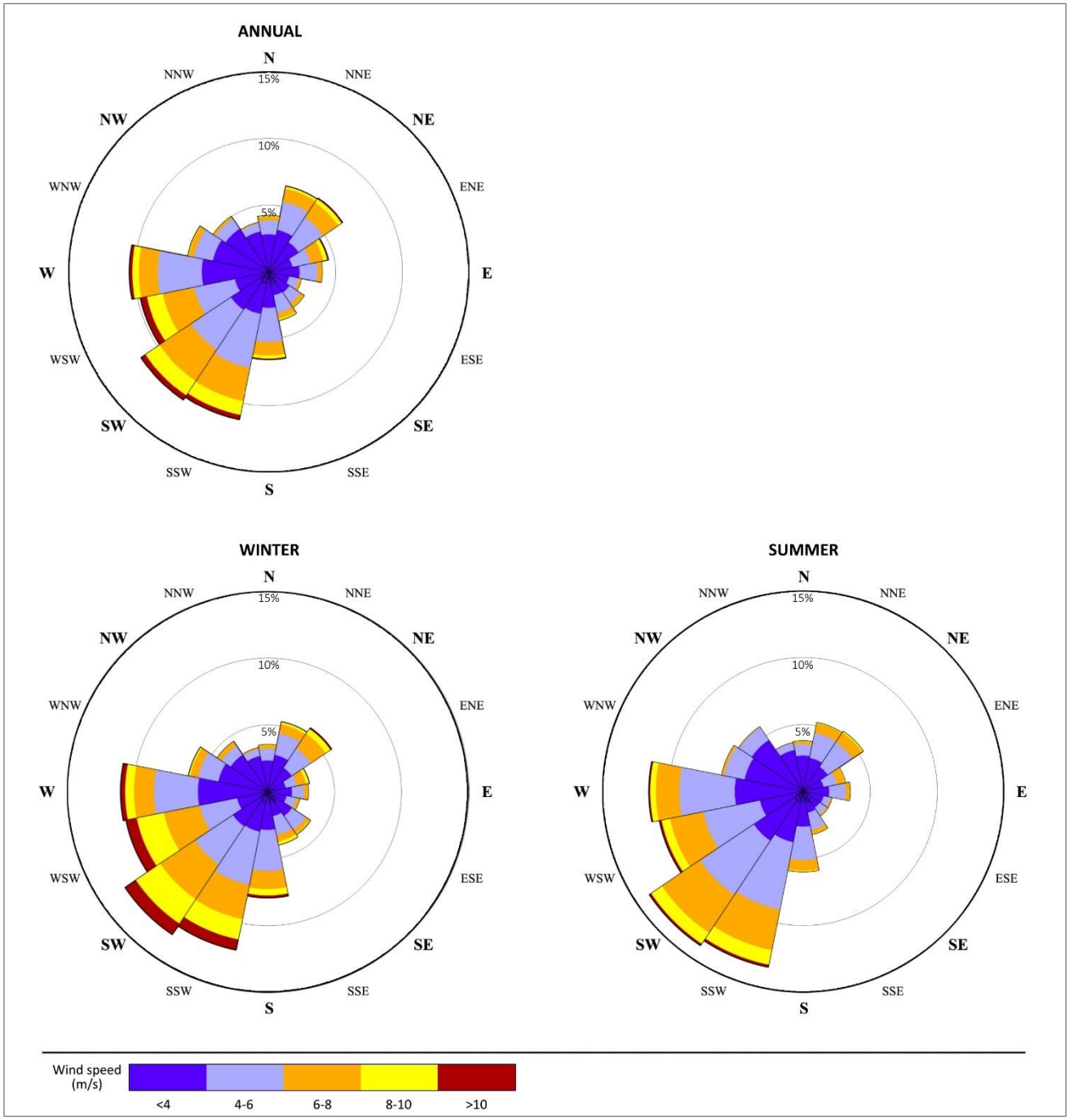

Figure 8 – Annual, Winter and Summer wind roses, data from Heathrow airport weather station

Strong winds, above 14.0 m/s, account for only 6 hours throughout the whole year.

Wind speeds at pedestrian height are low compared to the comfort criteria. Without considering acceleration caused by the built environment, wind speeds are likely to be comfortable for long-term sedentary activities for the majority of the time.

3.3 Aerodynamic information – Terrain roughness

The roughness of the ground surfaces lying around the area of investigation affects the local wind conditions in terms of mean wind velocities and turbulence characteristics. Smooth surfaces, such as those which correspond to open terrains covered by water, grass or low vegetation, permit the free acceleration of wind at the ground level resulting in much greater mean wind velocities and relatively little turbulence. On the other hand, as wind

blows over rough terrains such as those of towns, cities and mature forests, the mean wind speed is reduced, and the turbulence is increased.

As a result, the wind data derived from the meteorological station need to be transformed according to the building location by applying a roughness factor. The roughness factor accounts for the surface roughness effects across the intervening terrain for the individual wind directions as well as for the transition between the various roughness categories.

Information about the terrain categories in a circular distance of 100km around the site of the Proposed Development is given in Figure 1.

In the UK, the five terrain categories (Table 3) recommended by the BS EN 1991-1-4 (CEN, 2010) are not applicable (Blackmore, 2015). Instead, an alternative classification is used, where the five terrain categories have been simplified into three terrain categories: 'Sea' (category 0), 'Country' (categories I and II) and 'Town' (categories III and IV).

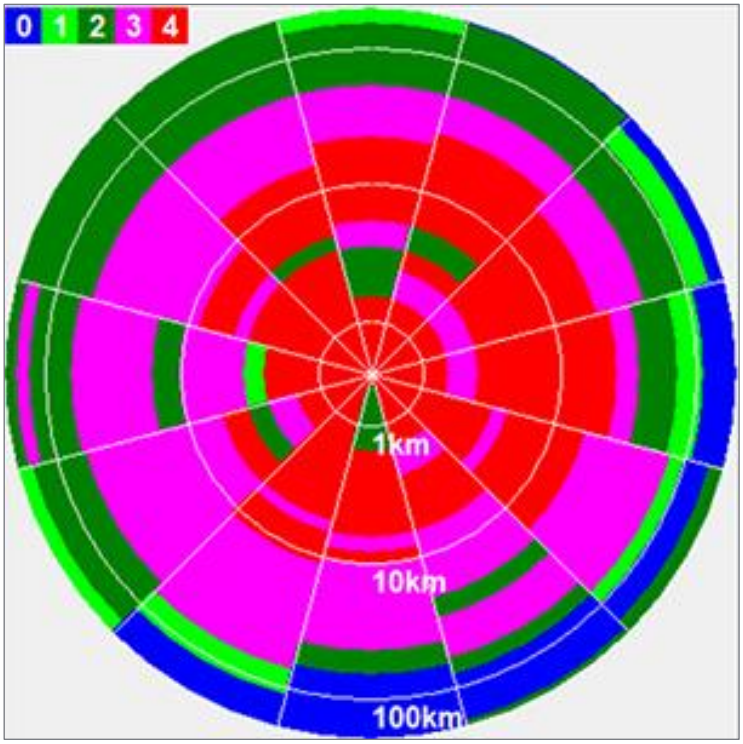

Figure 9 - Terrain categories around the site of the Proposed Development divided into 12 wind directions, analysis with BREVe software

	Terrain category	z_o (m)
0	Sea or coastal area exposed to the open sea	0.003
1	Lakes or flat and horizontal area with negligible vegetation and without obstacles	0.01
2	Area with low vegetation such as grass and isolated obstacles (trees, buildings) with separations of at least 20 obstacle heights	0.05
3	Area with regular cover of vegetation or buildings or with isolated obstacles with separations of maximum 20 obstacle heights (such as villages, suburban terrain, permanent forest)	0.3
4	Area in which at least 15% of the surface is covered with buildings and their average height exceeds 15m	1

Table 3 - Terrain categories and equivalent aerodynamic roughness length (z0)

The site of the Proposed Development is within the city of London and, as a result, it has been treated as 'Town' terrain category. The estimation of the roughness factor in 'Town' terrains depends on the upwind distance from the sea and additionally to the distance upwind to the edge of the urban area.

For the different wind incidence angles, the building site is up to 28.5km inside 'Town' terrain and at least 68km to the nearest shoreline. Information about the topography was derived through BREVe software. Table 4 shows the roughness factors applied in the meteorological wind data to be transposed on the Proposed Development site at 120m above ground based on mean wind speeds.

Roughness factors at 120m								
Wind direction	0°	22.5°	45°	67.5°	90°	112.5°	135°	157.5°
Roughness factor	1.43	1.36	1.33	1.33	1.33	1.34	1.36	1.41
Wind direction	180°	202.5°	225°	247.5°	270°	292.5°	315°	337.5°
Roughness factor	1.51	1.39	1.39	1.43	1.41	1.37	1.35	1.36

Table 4 - The estimated roughness factors for the different wind directions at the building location and at 120m above ground

3.4 Gust-Equivalent Mean (GEM)

SimScale Pacefish LBM solver is an explicit transient simulation and therefore a time-dependent solver. Within Pacefish LBM solver, gusts are locally resolved within the simulation. All directions ran for 810 seconds, of which only the last 20% have been used (162 seconds) in order to calculate the U_{mean}.

In order to calculate the GEM the following approach has been used.

Using the K-omega SST DDES turbulence model, two parts of the turbulence have been resolved and modelled:

- The standard deviation of the velocity fluctuations
- The standard deviation based on the modelled TKE k

The total standard deviation (σ) derived from the geometrical combination of both.

The Gust speed calculated based on the below equation:

$U_{gust} = U_{mean} + g * \sigma$, with gust factor g=3.5

The Gust-Equivalent Mean plots for each wind direction calculated based on the below equation:

$U_{GEM} = U_{gust}/1.85$

In order to calculate the Lawson safety plots, for each wind direction, the maximum value from U_{mean} and U_{GEM} has been selected.

3.5 Comfort and Safety Plots

As a point of clarification, as agreed with the local authority, the comfort plots for scenarios 1 and 2 are derived from the U_{mean} results.

Safety plots for all Scenarios (1, 2 and 3) and the comfort plots for Scenario 3 (Proposed with mitigation) are derived from the U_{max}, the maximum results per point of the U_{mean} and U_{GEM}.

Results and Conclusions

4.0 Results

4.1 Scenario 1 - Existing Site - Comfort Conditions

Sixteen most prevailing wind directions have been analysed to provide a robust study and the results have been normalised against hourly weather data for different seasons and the whole year in order to give a thorough comparison against the LCC.

For the existing site (Scenario 1) the results of the assessment are shown in Figure 9, 10 and 11 for the annual, summer and windiest (winter) seasons. Furthermore:

Pedestrian level:

Annually, wind conditions are suitable for sitting to business walking use throughout the Site and the surrounding area.

During the summer season, the wind conditions are suitable for sitting to walking use, with five localised areas of Business Walking identified throughout the Site and the surrounding area.

During the windiest (winter) season, wind conditions are suitable for sitting to business walking use throughout the Site and the surrounding area and including four localised uncomfortable wind conditions and further eight business walking conditions within the site.

Thoroughfares, secondary roads, pedestrian, cycling and emergency routes:

Annually the wind conditions are suitable for sitting to business walking use throughout the Site and the surrounding area, one level above suitable for the use. Localised areas of business walking wind speeds are present at the northern section of Hampden Road, the pedestrian access to the East of Tower Block C and in the vicinity of the entrance to the podium to the East of Tower Block A

During the windiest (winter) season and the summer, wind conditions are suitable for sitting to uncomfortable wind conditions throughout the Site and the surrounding area, two levels above suitable for the use. Four instances of uncomfortable wind levels are noted, three around the thorough fare and access road to Tower Block D (NW, NE and SE corners) and the pedestrian access to the East of Tower Block C which crosses part of Cambridge Road.

Entrances:

During the windiest (winter) season, wind conditions are suitable for sitting to standing for all existing on-site and off-site entrance locations, which are acceptable conditions for the intended use. Higher wind speeds are noted in the vicinity of the entrance to Blocks A & D.

Pedestrian Crossings:

During the windiest (winter) season, wind conditions are suitable for sitting to walking use throughout most of the Site and the surrounding area. There is one instance of business walking at the pedestrian crossing NE of Tower Block D, at the junction with Hamden Road, one level above suitable for the use.

Ground and podium level amenity spaces:

Annually the wind conditions are suitable for sitting and standing for the main existing ground level amenity space around the Site. However there are two main instances concerning the amenity space west of Block A has areas of pedestrian standing, one level above the suitable use, along with the small semi-private communal garden and play area adjacent to Tower Block D (SW of Burritt Rd & Hampden Rd Junction) has wind conditions suitable for business walking, two levels windier than suitable for a sitting location.

During the summer season, wind conditions are suitable for sitting for almost all existing ground level amenity space around the Site other than the small semi-private communal garden and play area adjacent to Tower Block D (SW of Burritt Rd & Hampden Rd Junction) has wind conditions suitable for business walking, two levels windier than suitable for a sitting location.

Podium Level Amenity – Seating:

Annual and summer wind conditions are one level windier than suitable for a sitting location on the two main podium areas adjacent to Tower Blocks A & B. It should also be noted that the ground level area leading up to the access point for, and directly adjacent to, the Tower Block A podium has acceptable wind conditions for that area suitable for walking use.

Roads:

During the windiest (winter) season, wind conditions are mostly suitable for sitting to walking use throughout the Site and the surrounding area. There are two occurrences of business walking on Hampden Road and East of Tower Block C on Cambridge Road, one level above the intended use, and a localised area of uncomfortable wind on the edge of Cambridge Road again to the East of Tower Block C, two levels above suitable for the use.

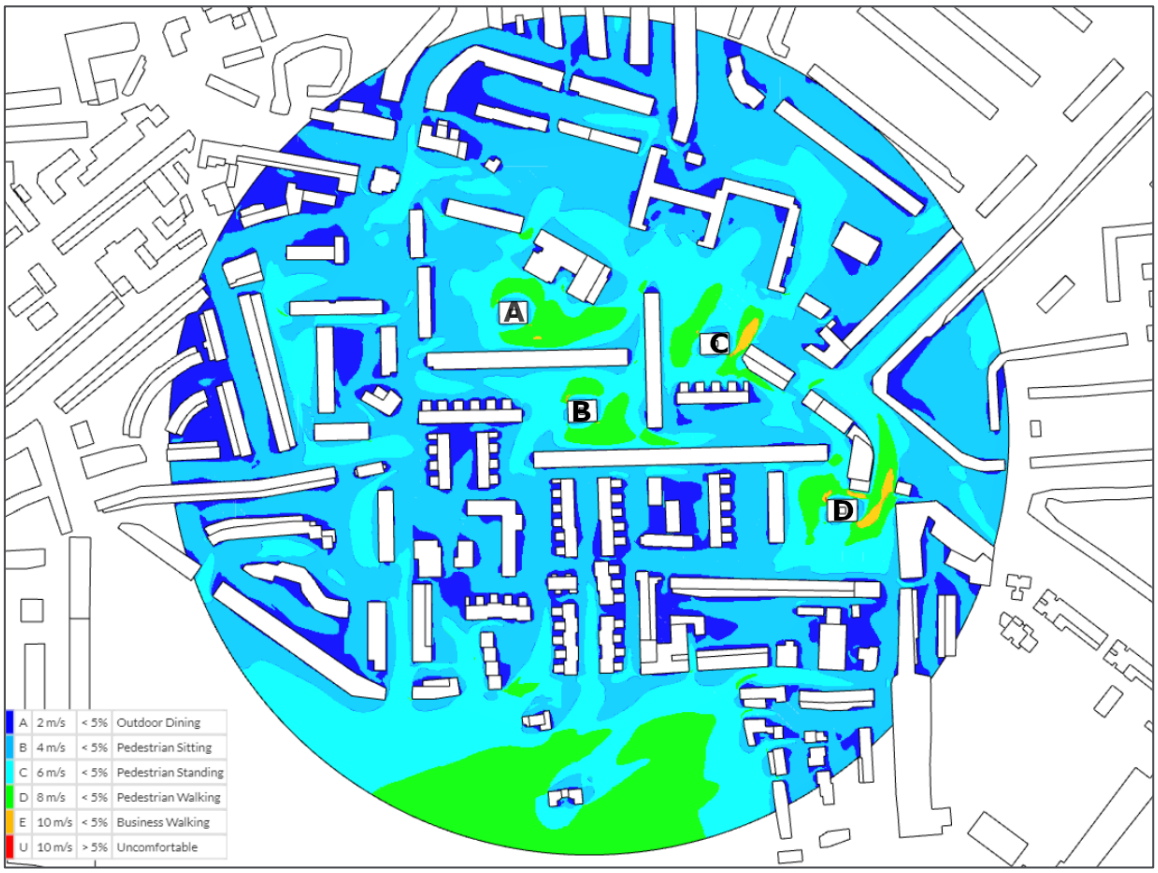

Figure 10 - Lawson Comfort Conditions. Existing conditions, scenario 1, result for the whole year. 1.50m above the ground

Figure 11 - Lawson Comfort Conditions. Existing conditions, scenario 1, result for the summer season. 1.50m above the ground

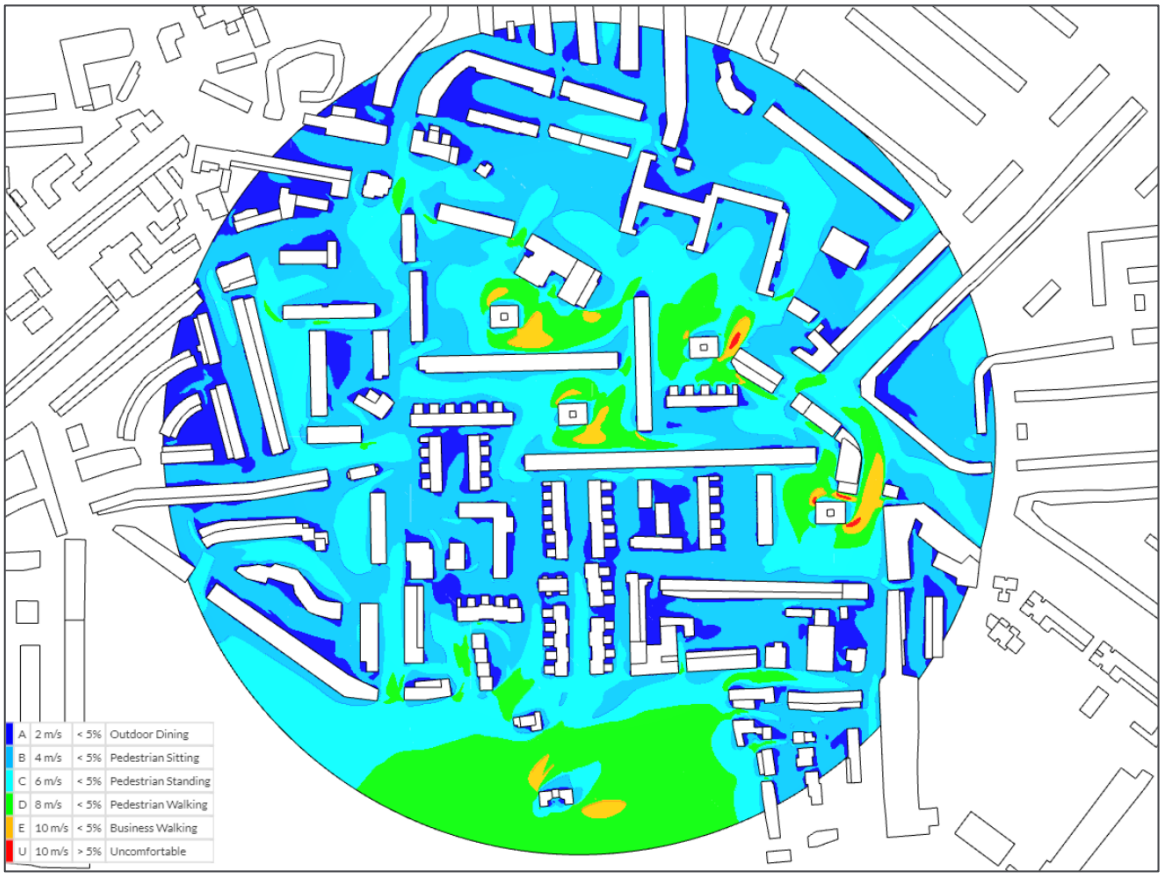

Figure 12 - Lawson Comfort Conditions. Existing conditions, scenario 1, result for the windiest, winter season. 1.50m above the ground

4.2 Scenario 1 - Existing Site - Strong Winds, Safe Conditions

Annually, wind conditions are predominantly suitable for sitting to walking use throughout the Site and the surrounding area.

There are ten occurrences at ground level (all around Tower Blocks A, B, C & D) of strong winds exceeding 15m/s for more than the safety threshold of >0.023% of time annually (e.g. 2hrs) in the baseline scenario. This equates to 'unsafe frail' wind conditions, which is two wind conditions above suitable for the use.

The wind conditions around the rest of the existing Site are suitable for sitting to strolling use with all remaining locations having acceptable wind conditions for the current use.

There are no safety exceedances above 20m/s – equating to 'unsafe all' due to strong winds in the annual baseline condition.

Figure 13 - Lawson Safe Conditions. Existing conditions, scenario 1, result for the whole year. 1.50m above the ground

4.3 Scenario 2 – Proposed Development - Comfort Conditions

For the Scenario 2, Proposed Development with existing surroundings, the results of the assessment are shown in Figure 13, 14 and 15 for the annual, summer and windiest (winter) seasons.

With the Proposed Development in situ, the results of the wind microclimate assessment for both the windiest winter and summer season, indicate that no distressful conditions were found for the whole area. Furthermore:

Pedestrian level:

With the completion of the Development, the results of the wind microclimate assessment indicate annual wind conditions ranging from suitable for sitting to pedestrian walking use.

The wind conditions around the Site and adjacent areas are suitable for activities from sitting to pedestrian walking during the windiest season. However, five incidences of business walking have been identified throughout the Site as a direct result of the Development's layout and massing, one level above suitable for the use. Therefore, mitigation measures would need to be implemented prior to the completion and occupation of those buildings of the Development.

The wind conditions around the Site and adjacent areas are suitable for activities from sitting to pedestrian walking during the summer season.

Thoroughfares, secondary roads, pedestrian, cycling and emergency routes:

All the on-site and off-site thoroughfares would have acceptable annual and summer season wind conditions ranging from suitable for sitting to walking use, acceptable conditions for the intended use. The wind conditions on these thoroughfares would represent negligible effects (not significant).

There are four instances of business walking wind conditions on-site, one level above suitable for the use, during the windiest season. Two instances are located to the South of Building D6, one South of Building J4 and one between Buildings M1 and M2 (outline Phase 4). The wind conditions on these thoroughfares would represent minor adverse effects (significant) and mitigation is required in these locations.

Entrances:

In close proximity of two of the access points and entrances within the Development – south of Building D6 (outline Phase 2) and west of Building M2 (outline Phase 4) would have annual wind conditions suitable for walking, which is one category above the suitable for entrances. This represent a minor adverse effect (significant) and mitigation is required at these locations.

All other on-site entrances within the Development would have annual wind conditions suitable for sitting to standing acceptable conditions for entrance locations, which would represent negligible effects (not significant).

All off-site entrance locations would have wind conditions suitable for sitting and standing use during both the windiest season and the summer season, acceptable wind conditions for entrances, representing negligible effects (not significant).

Pedestrian Crossings:

All off-site pedestrian crossings would have annual wind conditions suitable for sitting and standing use, acceptable wind conditions for the intended use and representing negligible effects (not significant).

There is one instance at an off-site pedestrian crossing of pedestrian walking wind conditions, one level above suitable for the use, both annually and in the windiest season. The crossing is located to the NW of Building C1 (detailed Phase 1) representing minor adverse effects (significant) and mitigation is required in this location.

One on-site pedestrian crossing would have annual and windiest season wind conditions suitable for sitting to pedestrian walking, one level above suitable for the use. This located to the south of Building J4 (outline Phase 3) and represent minor adverse effects (significant) and mitigation is required in these locations.

Ground Level Amenity – Seating:

Three areas of the ground level amenity spaces within the Development – west of Building C3 (detailed Phase 1), east of Building F1 & F2 (outline Phase 3) and south of K3 (outline Phase 4), would experience wind conditions suitable for standing during the annual and summer season, which is one category above the suitable for amenity. This represent a minor adverse effect (significant) and mitigation is required at this location.

All other on-site and off-site ground level amenity – seating areas would have wind conditions suitable for sitting use during the annual and summer season, acceptable wind conditions for the intended use and representing negligible effects (not significant).

Podium Level Amenity – Seating:

At the centre and west of the on-site podium level amenities areas at Block E (detailed Phase 1), this would have wind conditions suitable from seating to standing with localised areas of pedestrian walking during the annual and summer season, which is two categories above the suitable for amenity. This represents a moderate adverse effect (significant), and mitigation is required at this location.

Additionally, the podium between Buildings C1 and C2 would have annual wind conditions from sitting to standing with localise areas on the southern boundary for pedestrian walking. As the podium will provide a mix of amenity seating and access, the wind conditions are two categories above the suitable for amenity. This represents a moderate adverse effect (significant), and mitigation is required at this location.

All other detailed application on-site podium level amenity – seating areas would have wind conditions suitable for sitting use during the summer season, acceptable wind conditions for the intended use and representing negligible effects (not significant).

Balconies:

All balconies have been modelled without any enclosure and as such the results would represent the ‘worst case’ scenario.

Twenty-three balconies located on buildings on Blocks B, C & E (detailed Phase 1) would have localised wind conditions suitable for business walking use during the summer season, which is two categories above that suitable for balconies. Of these, fifteen are ‘spots’ in the corner of the balconies. This represents a moderate adverse effect (significant), and mitigation is required at these locations.

There are an additional twelve balconies on buildings on Blocks B, C & E (detailed Phase 1) that also have localised wind conditions suitable for pedestrian walking use during the summer season, which is one category above that suitable for balconies. Most of them are also ‘spots’ in the corner or on the edges of the balconies. This represents a minor adverse effect (significant), and mitigation is required at these locations.

All other balconies would have wind conditions suitable for long-term sitting to standing during the summer season, acceptable wind conditions for the intended use, resulting in negligible effects (not significant). Please see Appendices for the results.

Terraces:

One roof terrace on Building E3 (detailed Phase 1) has wind conditions from sitting to business walking during the summer season, two categories above that suitable for amenity space. This represents a moderate adverse effect (significant), and mitigation is required at these locations.

All other roof terraces would have a mixture of sitting and standing conditions during the summer season. This would be acceptable on the basis that no fixed seating is placed in areas suitable for standing use, otherwise mitigation measures would be required.

The south east corner of the non-accessible roof terrace level located between Buildings C1 and C3 and one between E2 and E3 (detailed Phase 1) would have localised wind conditions suitable for walking use. As these spaces are not accessible to building users, no mitigation would be required.

Roads:

Road locations around the Site would have wind conditions ranging from suitable for sitting use to pedestrian walking use throughout the year (annual) and during both the windiest season and the summer season, representing negligible effects (not significant).

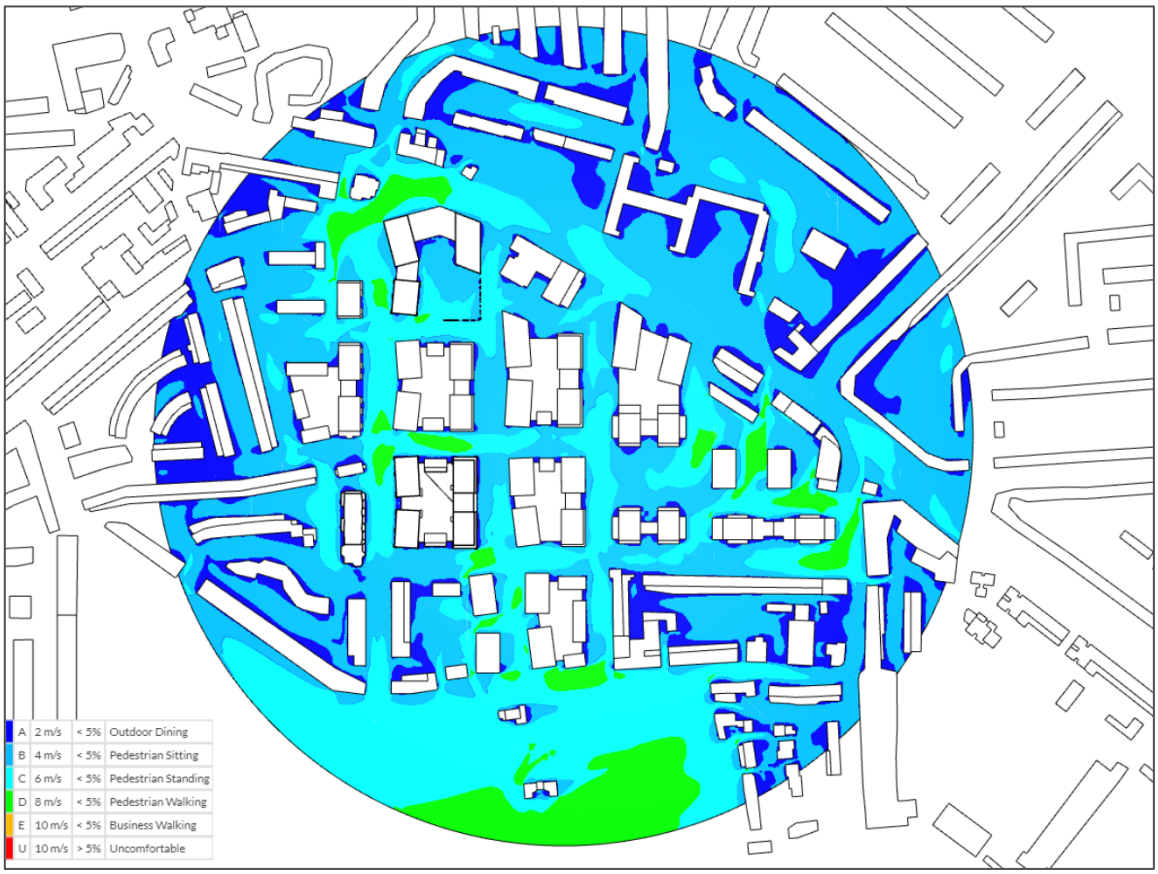

Figure 14 - Lawson Comfort Conditions. Proposed Development, scenario 2, result for the whole year. 1.50m above the ground

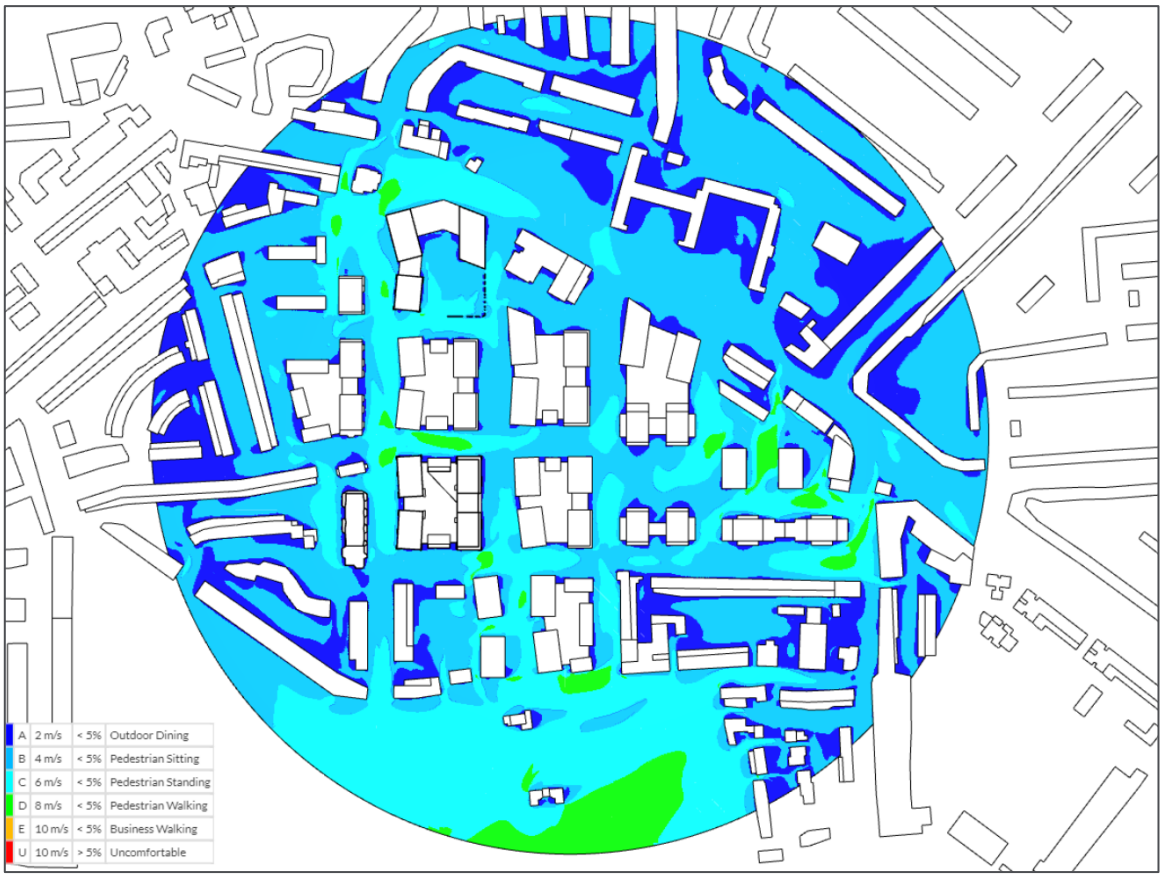

Figure 15 - Lawson Comfort Conditions. Proposed Development, scenario 2, result for the summer season. 1.50m above the ground

Figure 16 - Lawson Comfort Conditions. Proposed Development, scenario 2, result for the winter season. 1.50m above the ground

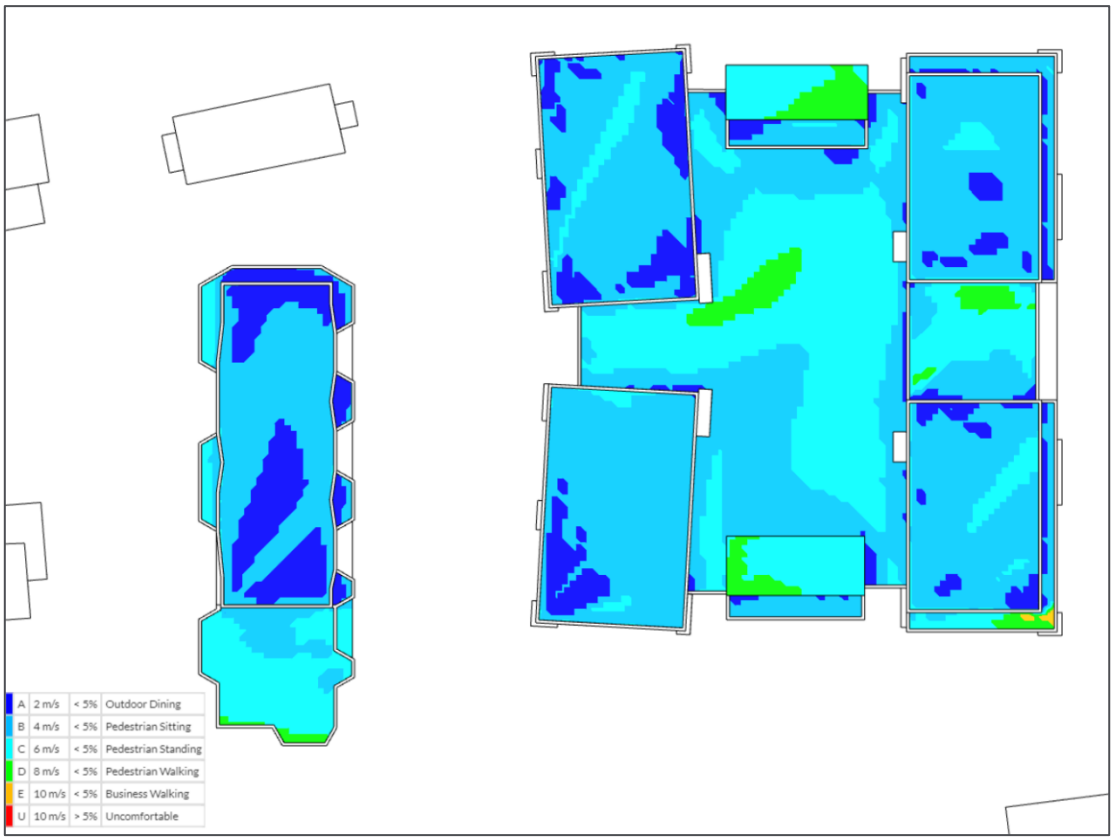

Figure 17 - Lawson Comfort Conditions. Proposed Development, scenario 2, result for the podium level and roof terraces at block B and E, summer season. 1.50m above floor level

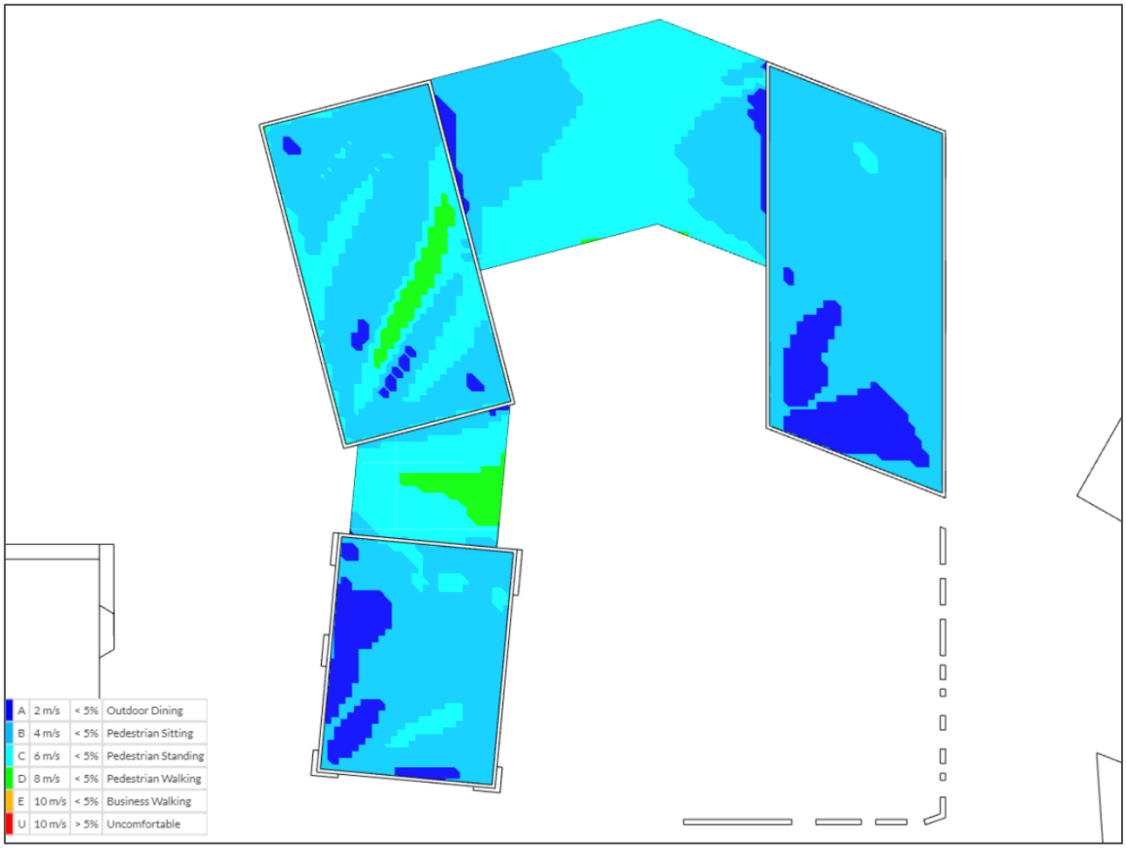

Figure 18 - Lawson Comfort Conditions. Proposed Development, scenario 2, result for the podium level and roof terraces at block C, summer season. 1.50m above floor level

4.4 Scenario 2 - Proposed Development - Strong Winds, Safe Conditions

At ground level, there would be six localised areas of expected strong annual winds exceeding the lower safety threshold level 'unsafe frail' of 15m/s for more than 0.023% throughout the year (ie 2 hours). These are located to the South of Blocks D, F, West of Block Q and North & South of Block M. All of these locations require mitigation to eliminate these safety exceedances.

There are no strong annual winds exceeding the upper safety threshold level 'unsafe all' of 20m/s for more than 0.023% throughout the year (ie 2 hours).

Only two roof areas on Block C and Block E (detailed Phase 1) will have annual 'uncomfortable' wind conditions. As these spaces are not accessible to building users, no mitigation would be required.

Fifty-five balconies across Building E1 (20 no.), Building E3 (5 no.) and Building E4 (2 no.), Building C1 (9 no.), Building C2 (10 no.) and Building C3 (9 no.) (all detailed Phase 1) would have small spots/localised instances of strong winds exceeding 15m/s for more than the safety threshold of 0.023% of time annually (e.g. 2hrs). All these locations require mitigation to eliminate these safety exceedances.

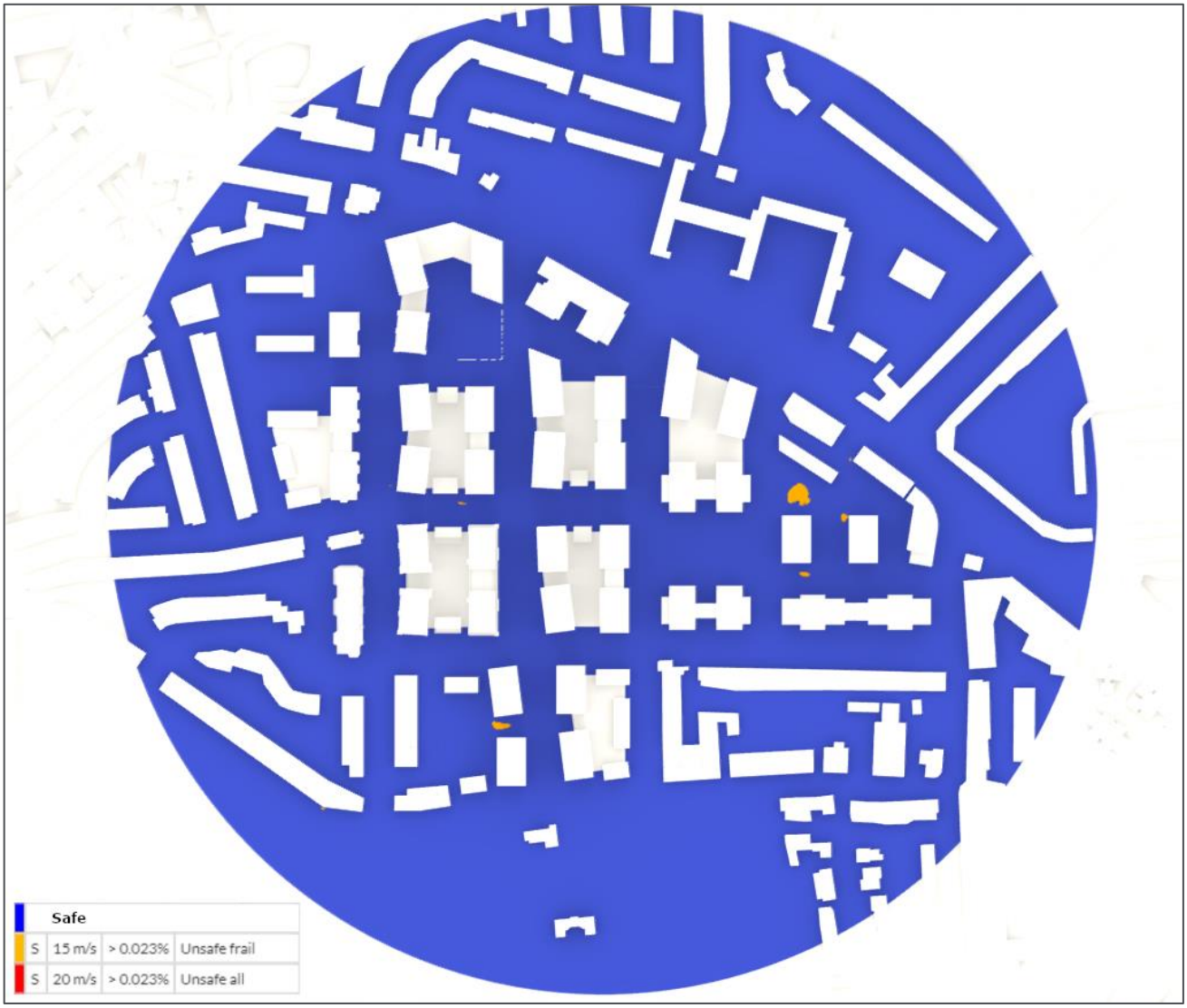

Figure 19 - Lawson Safe Conditions. Proposed Development, scenario 2, result for the whole year. 1.50m above the ground

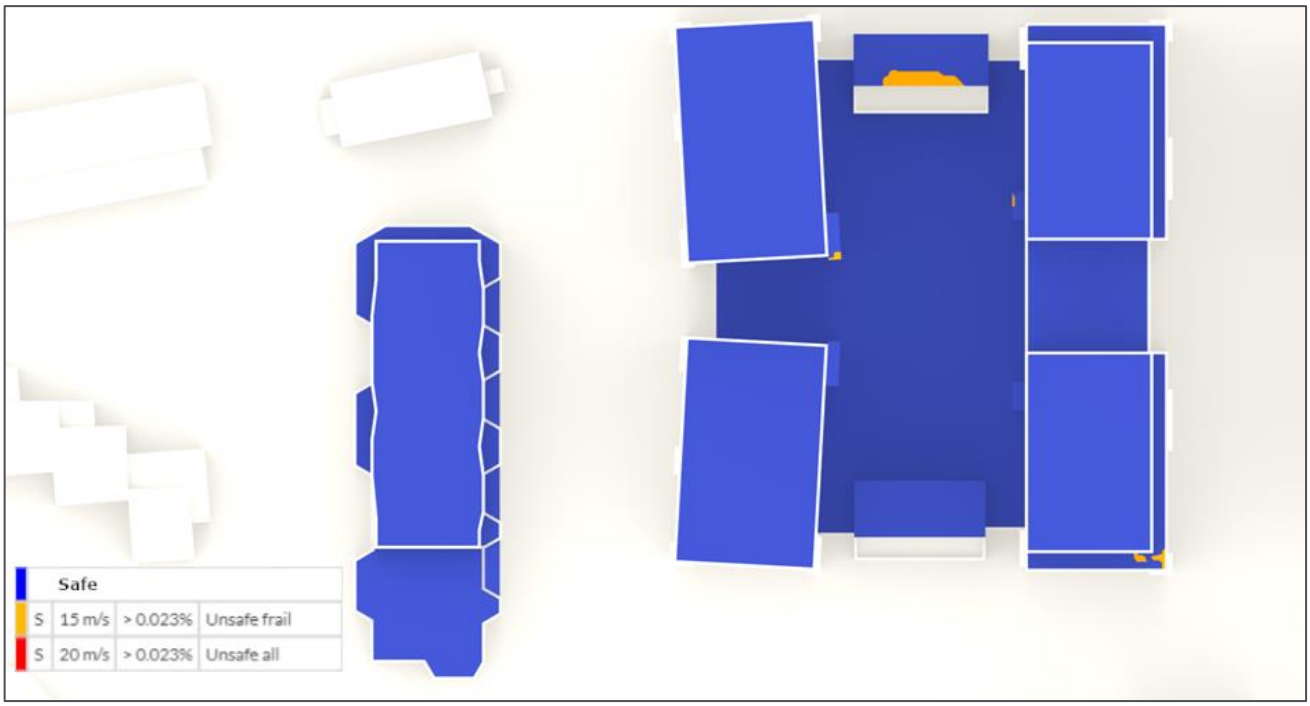

Figure 20 - Lawson Safe Conditions. Proposed Development, scenario 2, result for the podium level and roof terraces at block B and E, whole year. 1.50m above floor level

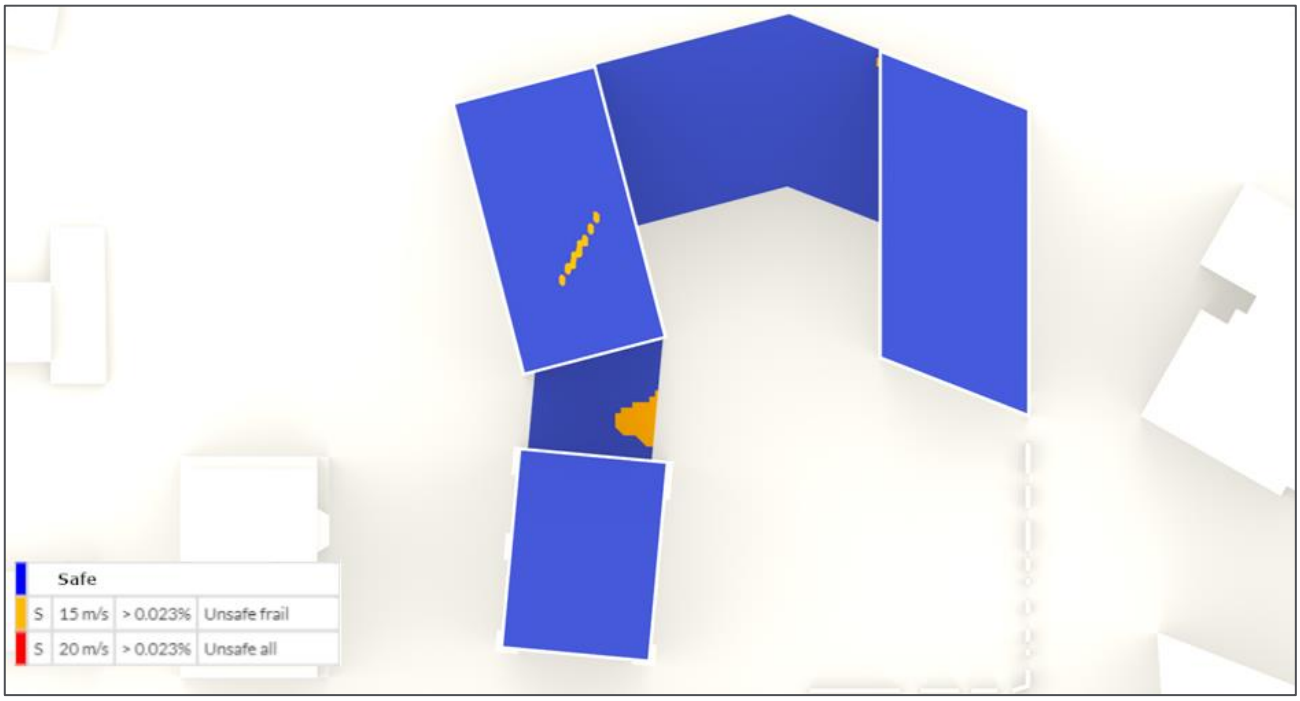

Figure 21 - Lawson Safe Conditions. Proposed Development, scenario 2, result for the podium level and roof terraces at block C, whole year. 1.50m above floor level

4.5 Scenario 3 – Proposed Development with mitigation - Comfort Conditions

CFD modelling results for pedestrian wind comfort for the Development are shown in Figure 21 and 22 for the annual and summer season to address the safety and comfort exceedances specifically within the balconies (detailed Phase 1). Only the mitigation measures previously agreed with the design team have been remodelled and as such a number of balconies still show safety and comfort exceedances. However, if the same mitigation measures and approach are adopted in these locations the conditions will be successfully mitigated.

As there are no other 'unsafe' wind conditions within the Proposed Development no further mitigation modelling has been completed at this time.

Mitigation measures were developed during a number of Mitigation Workshops (21.09.2020 & 02.10.2020) hosted by SRE to enhance the detailed design (Phase 1 of the Development) and the Site wide landscaping strategy. The measures were incorporated into the Development and assessed with further CFD modelling (Scenario 3).

Balustrades have now been included as porous media entities only on the balconies with minor adverse wind conditions. The porosity is based on the detailed drawings for Phase 1 of the Development (refer to Appendix 3.2) and balcony specification details with three levels being used to reflect the different designs (23%, 50% & 73%) and all set to 1.5m in height.

All trees (retained and proposed) have been included as porous media entities within the CFD model with low Leaf Area Index (LAI), in order to capture a worst-case wind environment for deciduous trees. (e.g. representing average winter conditions). The heights are as per the landscape plan and the Site Survey data.

Additional mitigation measures were developed during the workshops and incorporated into the Development, and consisted of:

- An additional deciduous tree (7.5m high) at NE corner of Building P2 (outline Phase 2);
- Mesh between the columns on the north elevation of the podium level terrace between Buildings C1 & C2 (detailed Phase 1)
- Suitable areas for seating (temporary or fixed) clarified on the podium level terraces of buildings on Block E and between Buildings C1 & C2 (all detailed Phase 1); and

Pedestrian level:

With the inclusion of the above completed mitigation measures for the Development, the results of the wind microclimate assessment indicate annual wind conditions ranging from suitable for sitting to walking use.

All Scenario 2 elements with adverse effects have been re-assessed for the Development against the annual and summer wind conditions.

Entrances:

The wind conditions south of Building D6 (outline Phase 2) and around Building M1 (outline Phase 4) would have wind conditions suitable for sitting and standing during the windiest season which now reflects the required wind level for this use and is therefore of negligible effect (not significant). No further mitigation is required.

Pedestrian Crossings:

The off-site pedestrian crossings located to the NW of Building C1 (detailed Phase 1) now has pedestrian standing wind conditions, suitable for the use under annual and summer season. This represent a negligible effect (not significant) and no further mitigation is required.

The on-site pedestrian crossing located to the south of Building J4 (outline Phase 3) would have annual wind conditions suitable for sitting to pedestrian standing, suitable for the use. This represent a negligible effect (not significant) and no further mitigation is required.

Ground Level Amenity – Seating:

The ground level amenity space east of Building C3 (detailed Phase 1), will experience wind conditions suitable for pedestrian sitting during the annual and summer season. Where there remain localised pedestrian standing winds, these areas have not been allocated any permanent seating as part of the landscape design. This represent a negligible effect (not significant) and no further mitigation is required.

Podium Level Amenity – Seating:

At the centre and west of the on-site podium level amenity areas on Block E (detailed Phase 1), any proposed fixed seating/amenity have been removed from the landscaping plan and this area would be used for pedestrian access – which requires wind conditions suitable for standing during the summer season. No mitigation measures have been modelled on this podium and therefore the remaining area of pedestrian walking will be mitigated by small shrubs and trees. This represents a negligible effect (not significant) for the podium and no further mitigation is required.

The podium level between C1 & C2 (detailed Phase 1), will experience wind conditions suitable for pedestrian sitting with localised areas of standing located on the access routes where there will be no permanent seating installed. This represent a negligible effect (not significant) and no further mitigation is required.

Balconies:

The majority of the thirty-seven failing balconies on buildings within Blocks B, C & E (detailed Phase 1) have been modelled with the porous media entities reflective of the different enclosure/balustrade designs and the 1.5m height and now have wind conditions in the summer season suitable for sitting – acceptable for amenity use and Annual wind safe conditions. This represents a negligible effect (not significant), and no further mitigation is required.

Not all of the balconies located on Buildings E2 and E3 have been modelled with balustrades - the porous media. However, the two balconies that have been (SE corner of Building E3) show that with the inclusion of the balustrades all uncomfortable and unsafe wind conditions are mitigated. If needed a condition to model the additional balconies can be applied to the detailed Phase 1 application. Please see Appendices for the results.

Roads:

Road locations around the Site would have wind conditions ranging from suitable for sitting to walking use annually and during the summer season, representing negligible effects (not significant) and no further mitigation is required.

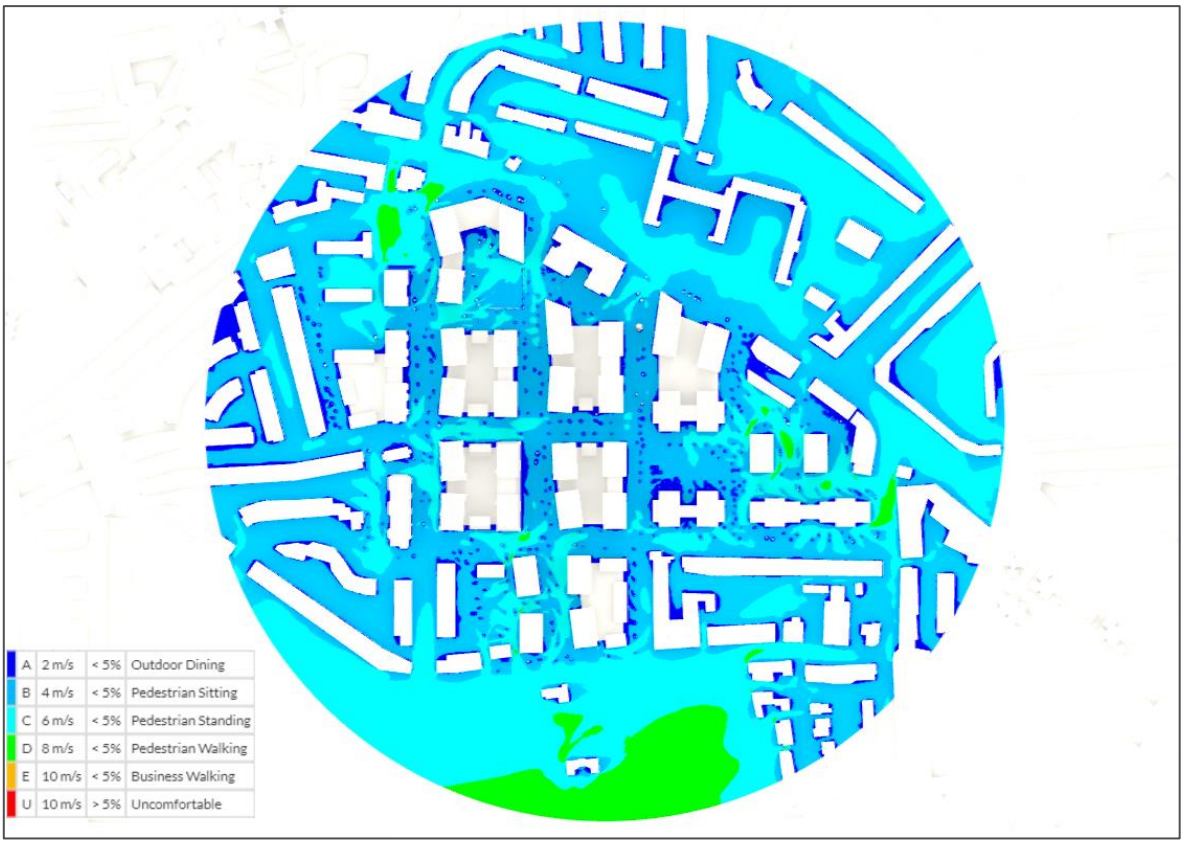

Figure 22 - Lawson Comfort Conditions. Proposed Development with mitigation, scenario 3, result for the whole year. 1.50m above the ground

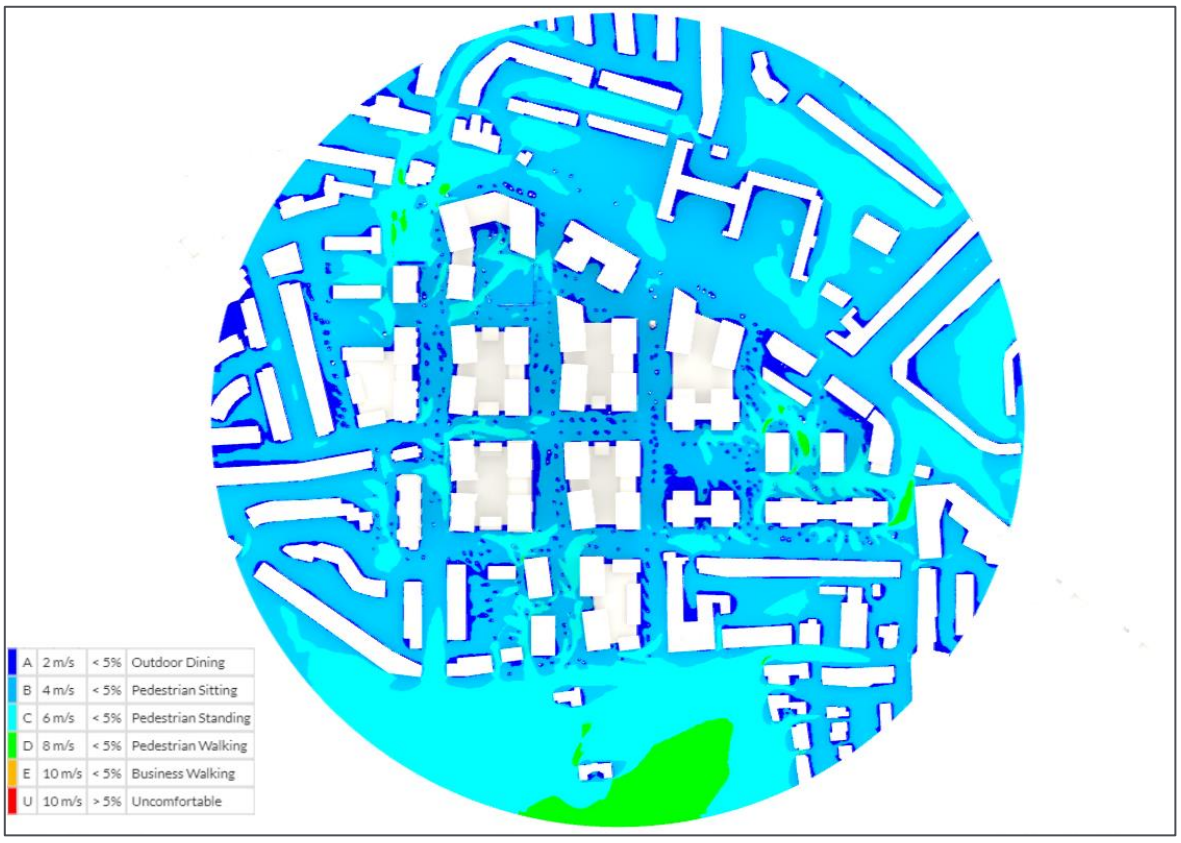

Figure 23 - Lawson Comfort Conditions. Proposed Development with mitigation, scenario 3, result for the summer season. 1.50m above the ground

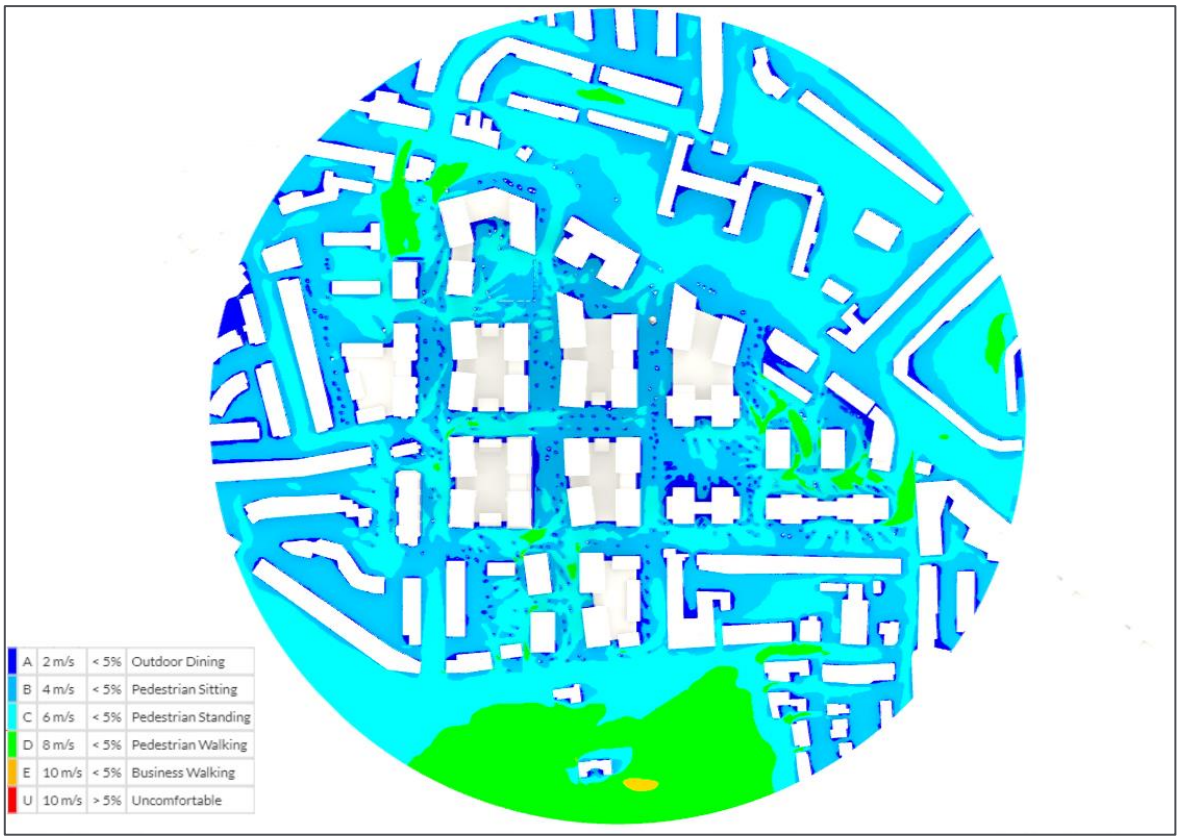

Figure 24 - Lawson Comfort Conditions. Proposed Development with mitigation, scenario 3, result for the winter season. 1.50m above the ground

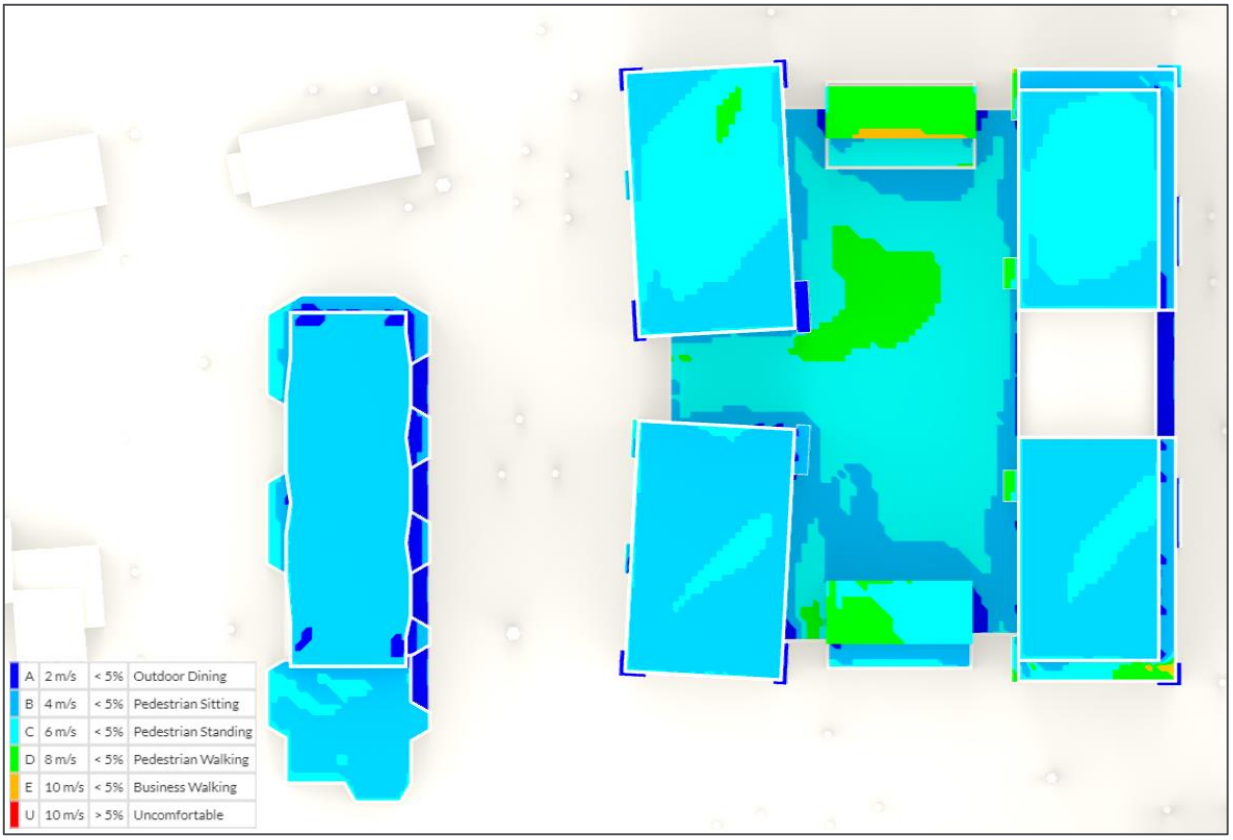

Figure 25 - Lawson Comfort Conditions. Proposed Development with mitigation, scenario 3, result for the podium level and roof terraces at block B and E, summer season. 1.50m above floor level

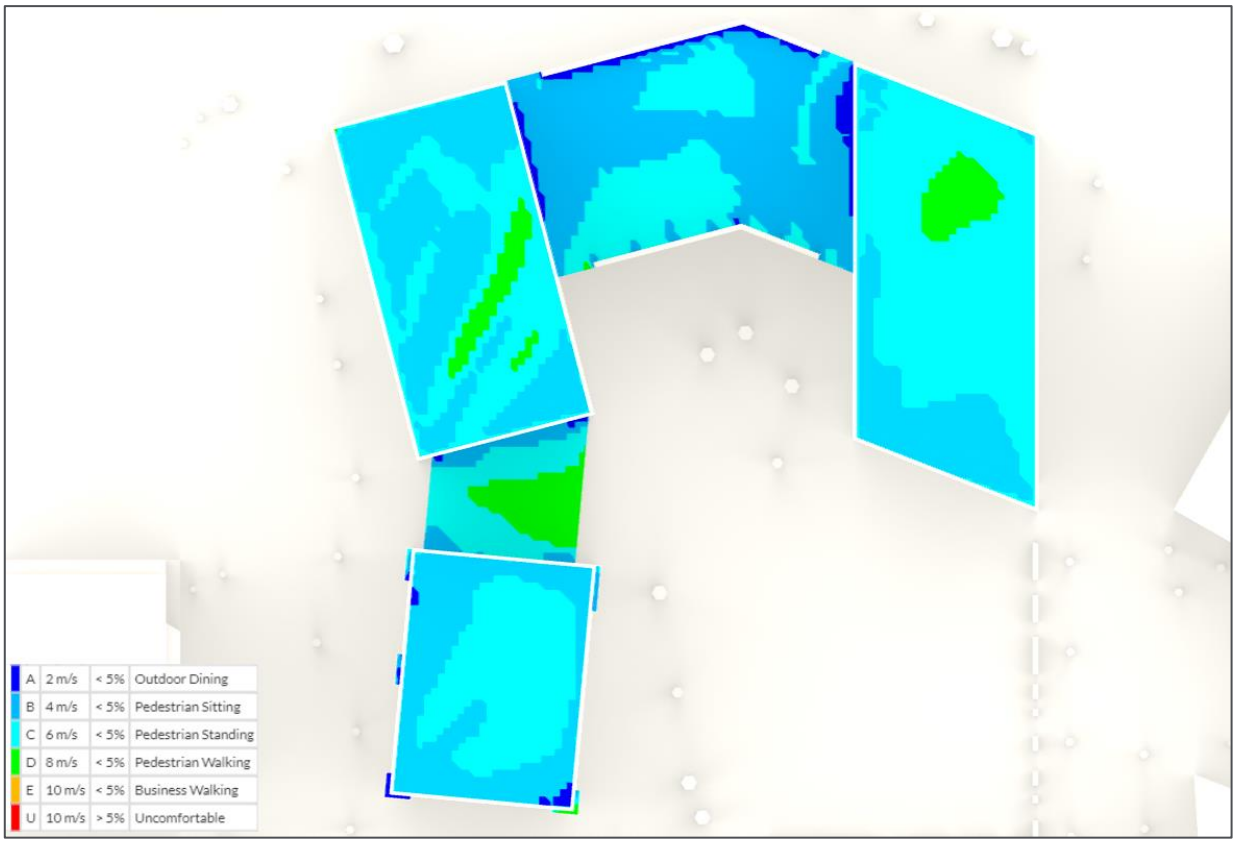

Figure 26 - Lawson Comfort Conditions. Proposed Development with mitigation, scenario 3, result for the podium level and roof terraces at block C, summer season. 1.50m above floor level

4.6 Scenario 3 - Proposed Development with mitigation - Strong Winds, Safe Conditions

At ground level, there are now no localised areas of expected strong annual winds exceeding the lower safety threshold level 'unsafe frail' of 15m/s for more than 0.023% throughout the year (ie 2 hours).

Fifty two (of the fifty five) balconies across Building E1 (20 no.), Building E3 (2 no.) and Building E4 (2 no.), Building C1 (9 no.), Building C2 (10 no.) and Building C3 (9 no.) (all detailed Phase 1) no longer have any instances of strong winds exceeding 15m/s for more than the safety threshold of 0.023% of time annually (e.g. 30mins) so the adverse effects have been mitigated.

The remaining 3 balconies (Building E3) have not been modelled with any balustrades - the porous media. However, the two balconies that have been modelled above these balconies (SE corner of Building E3) show that with the inclusion of the balustrades unsafe wind conditions are mitigated. Further CFD modelling of the additional balconies can be conditioned as part of the detailed Phase 1 application.

The roof terrace on Building E3 (detailed Phase 1) has not had any mitigation measures applied to the modelling and as such the unsafe wind conditions remain. However, the two balconies that have been modelled below this terrace (SE corner of Building E3) show that with the inclusion of the balustrades, uncomfortable and unsafe wind conditions are mitigated. Further CFD modelling of the additional balconies can be conditioned as part of the detailed Phase 1 application.

Taking into consideration all of the proposed mitigation measures, the residual effects associated with pedestrian wind comfort on the site will be negligible.

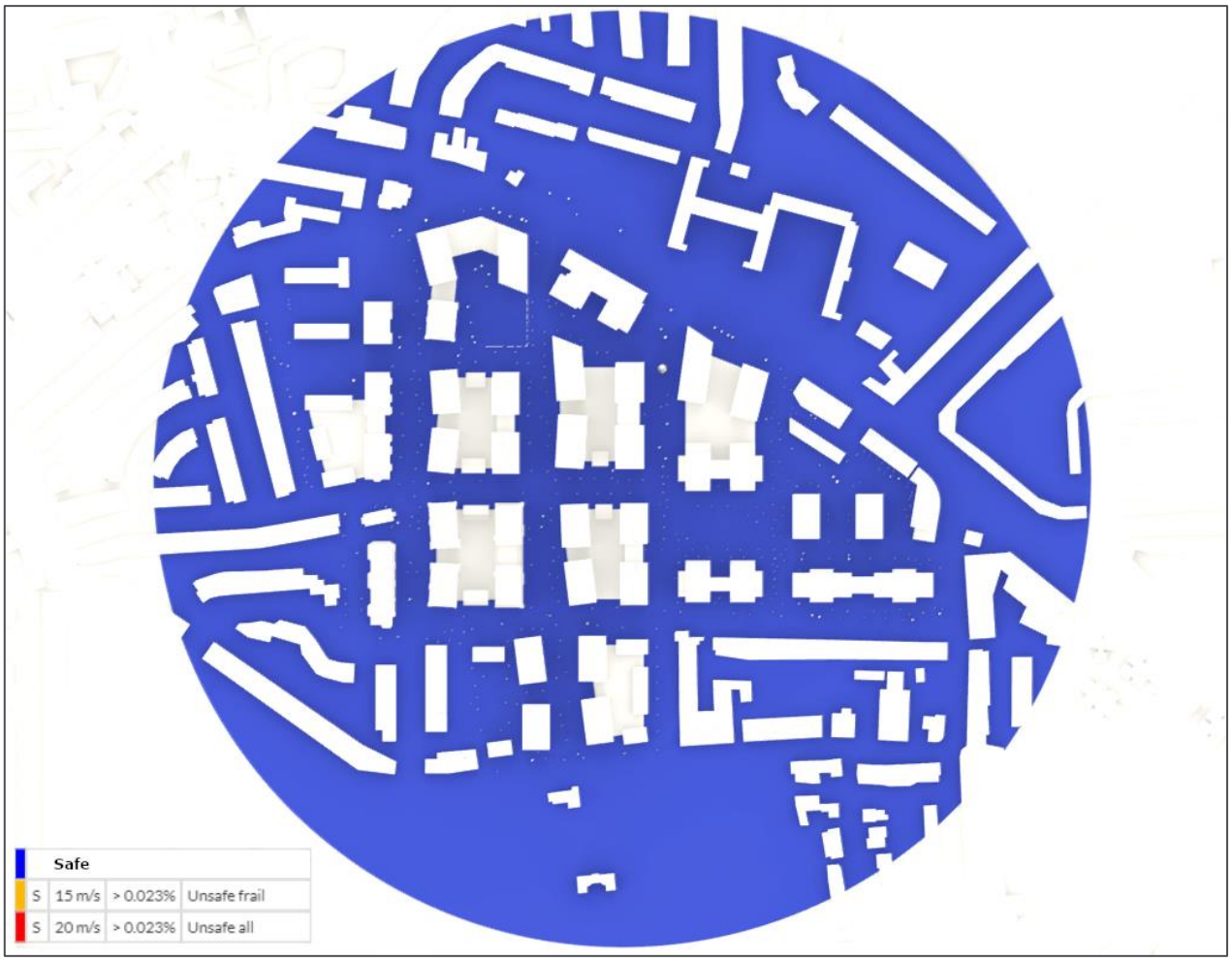

Figure 27 - Lawson Safe Conditions. Proposed Development with mitigation, scenario 3, result for the whole year. 1.50m above the ground

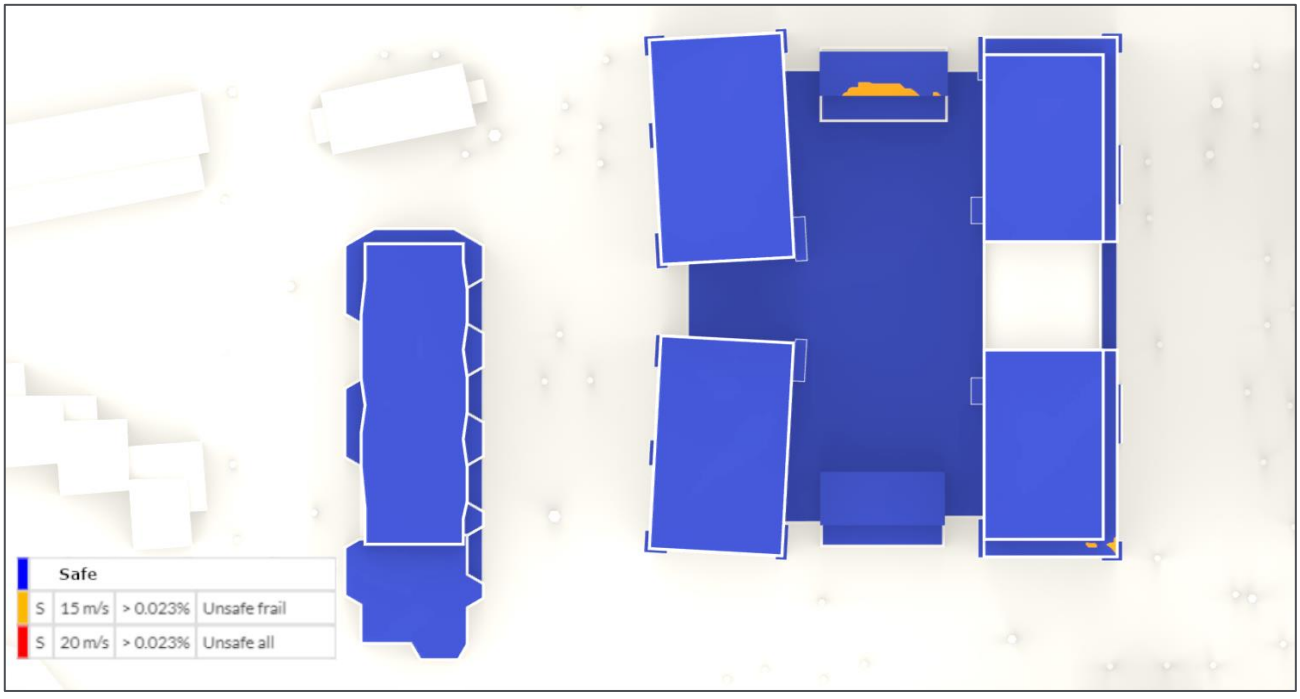

Figure 28 - Lawson Safe Conditions. Proposed Development with mitigation, scenario 3, result for the podium level and roof terraces at block B and E, whole year. 1.50m above floor level

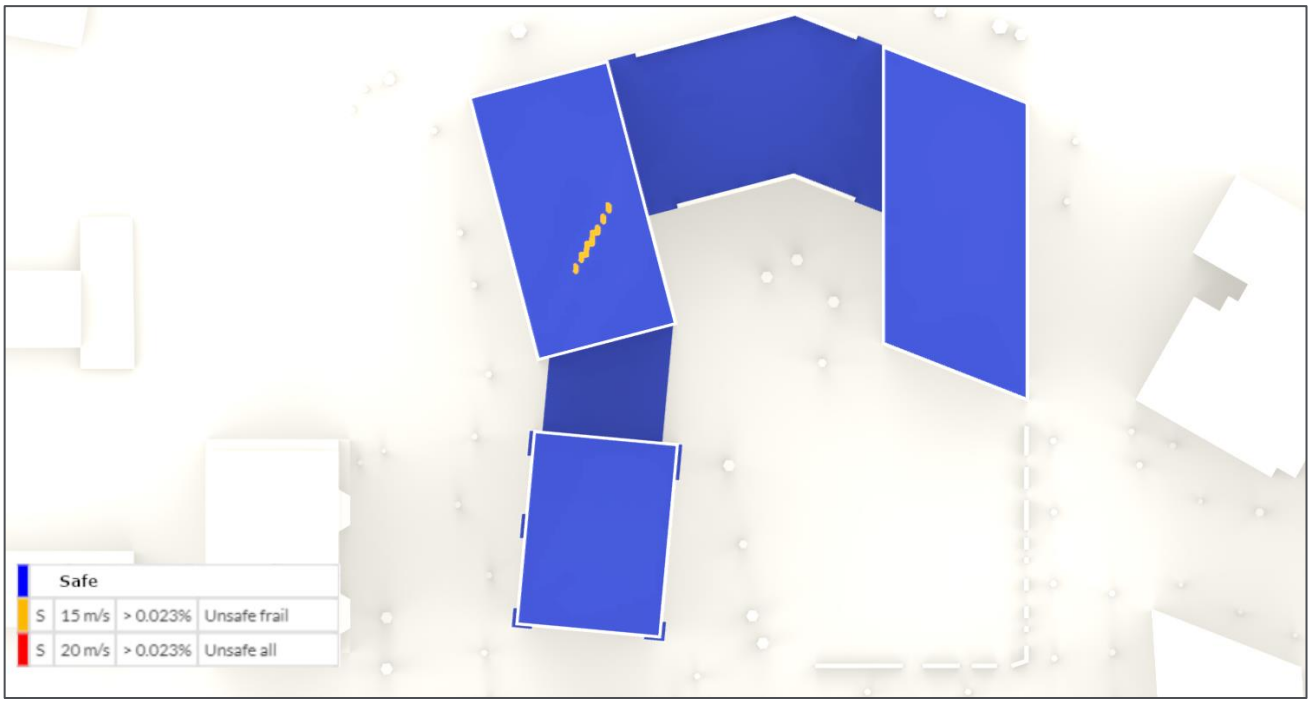

Figure 29 - Lawson Safe Conditions. Proposed Development with mitigation, scenario 3, result for the podium level and roof terraces at block C, whole year. 1.50m above floor level

Conclusions

5.0 Conclusions

A transient computational Fluid Dynamic (CFD) wind study has been performed for the Proposed Development for three scenarios, the existing site, the Proposed Development with existing surrounding buildings, and the Proposed Development with mitigation measures and existing surrounding buildings. The 16 no. most prevailing wind directions have been analysed to provide a robust study and the results have been normalized against hourly weather data for the whole year in order to give a thorough comparison with the Lawson Comfort and Safe Criteria (LCC).

Scenario 1 - existing site, the results of the assessment, indicate that the wind conditions are suitable for sitting to business walking use throughout the Site and the surrounding area. During the windiest (winter) season, there are four localised uncomfortable wind conditions and further eight business walking conditions within the site.

Strong winds exceeding the 15m/s safety threshold, would be expected in 10 no. of areas, mainly around the tower blocks. No areas of the application site exceed the 20m/s upper safety threshold.

Scenario 2 - with the Proposed Development in situ, the results of the wind microclimate assessment indicate that no distressful conditions were found for the whole area, with wind conditions ranging from suitable for sitting to pedestrian walking use. During the windiest season, five incidences of business walking have been identified throughout the Site as a direct result of the Development's layout and massing. In close proximity of two of the access points and entrances within the Development – south of Building D6 (outline Phase 2) and west of Building M2 (outline Phase 4) would have annual wind conditions suitable for walking, which is one category above the suitable for entrances. In 37 no. out of total 391 no. balconies have been identified areas with unsuitable for balconies. Twenty-three balconies located on buildings on Blocks B, C & E (detailed Phase 1) would have localised wind conditions suitable for business walking use during the summer season, which is two categories above that suitable for balconies. Of these, fifteen are 'spots' in the corner of the balconies. There are an additional twelve balconies on buildings on Blocks B, C & E (detailed Phase 1) that also have localised wind conditions suitable for pedestrian walking use during the summer season, which is one category above that suitable for balconies. Most of them are also 'spots' in the corner or on the edges of the balconies.

Fifty-five balconies across Building E1 (20 no.), Building E3 (5 no.) and Building E4 (2 no.), Building C1 (9 no.), Building C2 (10 no.) and Building C3 (9 no.) (all detailed Phase 1) would have small spots/localised instances of strong winds exceeding 15m/s for more than the safety threshold of 0.023% of time annually (e.g. 2hrs). No areas of the application site exceed the 20m/s upper safety threshold.

Scenario 3 - Proposed Development with mitigation measures. The results of the wind microclimate assessment for the whole year and the summer season, indicate that no distressful conditions were found for the whole area and all the areas in and around the Proposed Development would have suitable wind conditions for the intended uses.

The localised spots of 'unsafe' strong wind on balconies and roof terraces have and will be mitigated through the use of suitable balustrades – porous media.

There are no other locations across the Site with instances of 'unsafe' strong winds exceeding the 15m/s lower and 20m/s upper safety threshold for more than 0.023% of the year (e.g. 2 hrs).

With the proposed mitigation measures all areas in and around the Proposed Development would have comfortable, safe and suitable wind conditions for the intended uses.

Appendices

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