Microclimate Analysis

Pedestrian Wind Comfort

Cambridge Road (RBK) LLP

Cambridge Road Estate
Kingston
London

SRE

Version	Revision	Date	Author	Reviewer	Project Manager
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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, for both the winter, the windiest, and the summer season, indicate that no distressful conditions were found for the whole area. Furthermore:

- At the pedestrian level (1.50m above the ground level), the wind conditions are suitable for activities from pedestrian walking to outdoor dining.
- All thoroughfares, secondary roads, pedestrian and cycling routes would have suitable activities for their intended use.
- All on-site and off-site entrances would have wind conditions suitable from pedestrian standing to outdoor dining, acceptable wind conditions for entrances.
- Ground and podium level amenity spaces. The small semi-private communal garden and play area adjacent to Tower Block D (Figure 10) (SW of Burritt Rd & Hampden Rd Junction) has wind conditions suitable for pedestrian walking, one level windier than suitable for a sitting location. On two podium areas adjacent to Tower Block A & B, wind conditions are one level windier than suitable for sitting. The ground level area adjacent to the access point for the Tower Block A podium has acceptable wind conditions suitable for pedestrian walking. All other amenity spaces have comfortable wind conditions.

Strong winds exceeding the 15m/s safety threshold, for more than 0.023% of the time (e.g. 2 hrs annually), would be expected only in the winter season in 7 no. of areas, mainly around the 4 no. existing 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 for both the winter and the summer season, indicate that no distressful conditions were found for the whole area. Furthermore:

- At the pedestrian level (1.50m above the ground level), the wind conditions are suitable for activities from pedestrian walking to outdoor dining.
- All thoroughfares, secondary roads, pedestrian, cycling and emergency routes would have suitable activities for their intended use.
- Entrances. In close proximity of one of the entrances into the Development, west of block M2, would have wind conditions suitable for walking during the windiest season only, which is one category above that suitable for entrances. All other on-site and off-site entrances would have wind conditions suitable from pedestrian standing to outdoor dining, for both the winter and the summer season, acceptable wind conditions for entrances.
- All accessible podium level and roof terrace amenity spaces on the Proposed Development located at blocks B, C and E (Phase 1), in the summer season, when these areas will be used, are suitable for activities from pedestrian standing to outdoor dining, acceptable conditions for amenity. Only one roof, between the building C1 and C3, would have wind conditions suitable mainly for pedestrian walking. As this roof is not accessible to building users, no mitigation would be required.

- All the balconies at the blocks B, C and E (Phase 1), have been modelled. In the summer season, 36 no. out of total 391 no. balconies have been identified with wind conditions suitable for walking, one category above the suitable for balconies. 10 no. at building C1, 10 no. at building C2, 4 no. at building C3, 8 no. at building E1 and 4 no. at building E3. This is a minor adverse effect and further modelling with balustrades 1.5m height in place have been conducted (Scenario 3), and with different porosity based on the architectural drawings and specification. All other balconies would have wind conditions suitable for activities from pedestrian standing to outdoor dining, acceptable conditions for balconies.

Strong winds exceeding the 15m/s safety threshold for more than 0.023% of the time (e.g. 2 hrs annually) would be expected:

- At the pedestrian level, and only in the winter season in 5 no. of areas:
  - around North West corners and the area from North East to South East corner of block P2,
  - in the North West corner of building C1,
  - the North East corner of building C3,
  - the South West corner of block K1, and
  - the area from North West corner to West of block M1
- There would be 27 no. out of total 391 no. balconies (10 no. at building E1, 7 no. at building C3 and 10 no. at building C2) in the summer season, that would have instances of strong winds exceeding 15m/s for more than 2 hrs annually (0.023% of the time).

All podium level and roof terrace amenity spaces, in the summer season, would have safe wind conditions.

No strong winds are expected to exceed the 20m/s upper safety threshold for more than 0.023% of the year (e.g. 2 hrs).

Scenario 3 - Proposed Development with mitigation measures. The results of the wind microclimate assessment for the winter, the windiest, season, indicate that no distressful conditions were found for the whole area (Figure 1). Furthermore:

- At the pedestrian level (1.50m above the ground level), the wind conditions are suitable for activities from pedestrian walking to outdoor dining.
- All thoroughfares, secondary roads, pedestrian, cycling and emergency routes would have suitable activities for their intended use.
- All entrances would have comfortable wind conditions.
- All accessible podium level and roof terrace amenity spaces located at blocks B, C and E, in the summer season, are suitable for activities from pedestrian standing to outdoor dining.
- All the balconies in the blocks B, C and E, would have wind conditions for activities from pedestrian standing to outdoor dining.

Strong winds exceeding the 15m/s safety threshold for more than 0.023% of the time (e.g. 2 hrs annually) would be expected only in 4 no. of small localised spots at the pedestrian level and only in the winter season (Figure 2):

- at the North West corners of block P2,
- at the North West corners of block P1,
- at the South West corner of block K1, and
- at the North West corner of block M1.

The above small localised spots can be easily mitigated with additional low-level planting and screens. The final architectural and landscape drawings demonstrate how the above suggestions have been incorporated into the design.

All podium level and roof terrace amenity spaces, in the summer season, would have safe wind conditions.

All balconies would have safe wind conditions.

No strong winds are expected to exceed the 20m/s upper safety threshold for more than 0.023% of the year.

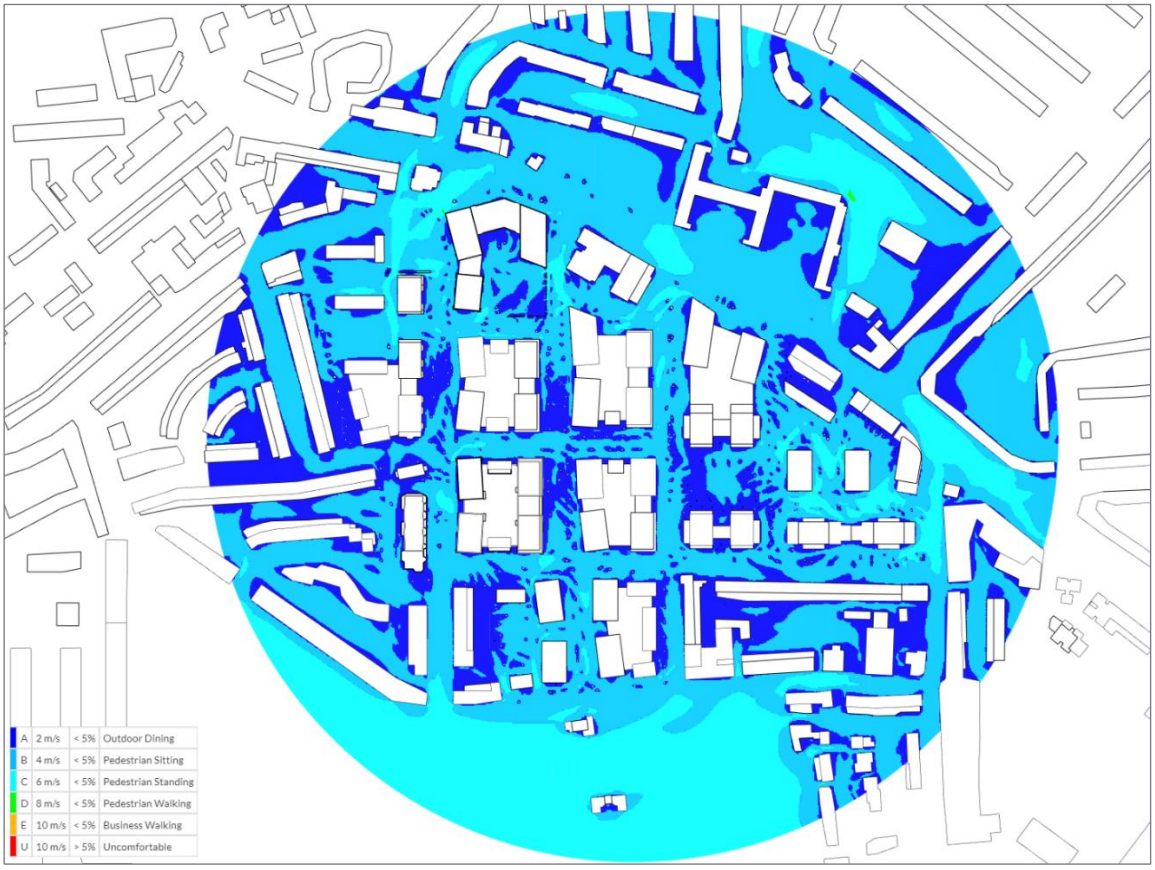

Figure 1 - Lawson Comfort Conditions. Result for the windiest, winter season, scenario 3. 1.50m above the ground

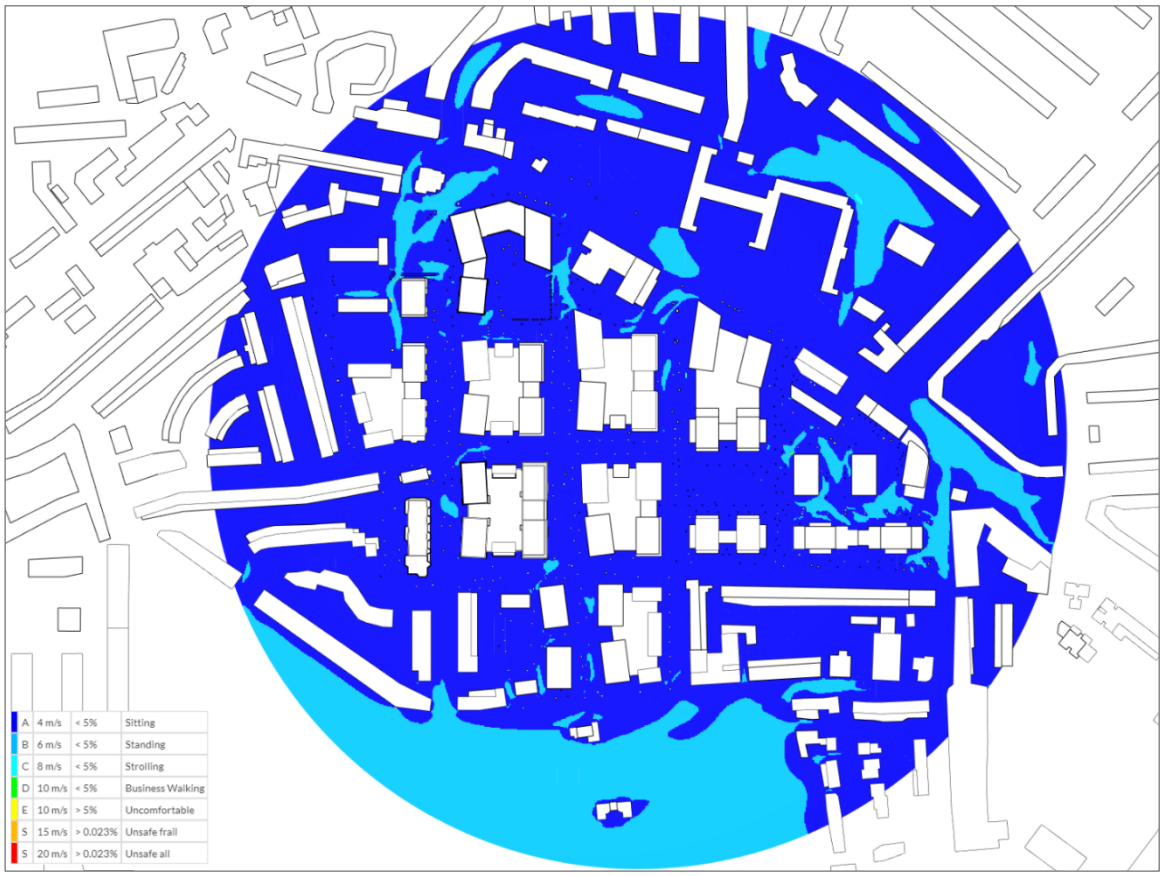

Figure 2 - Lawson Safety Conditions. Result for the windiest, winter season, scenario 3. 1.50m above the ground

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.

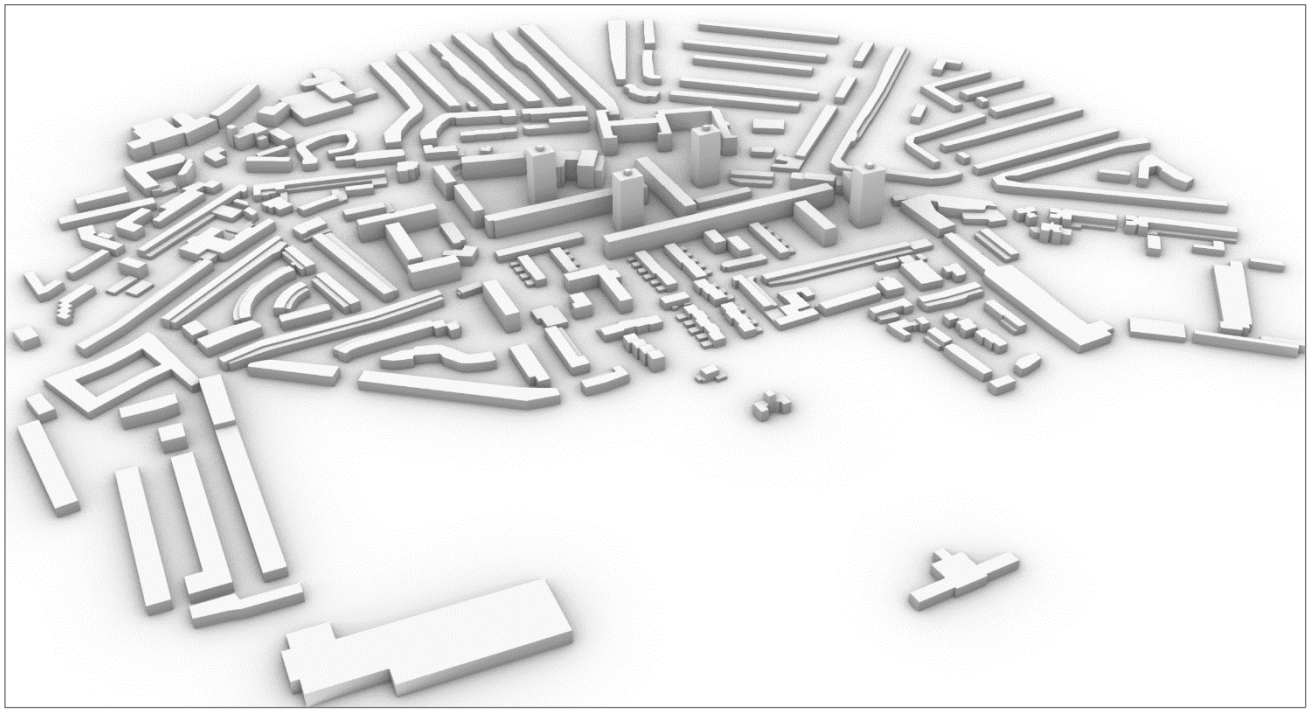

Figure 3 - 3D view of the Existing site with the surrounding buildings. Scenario 1

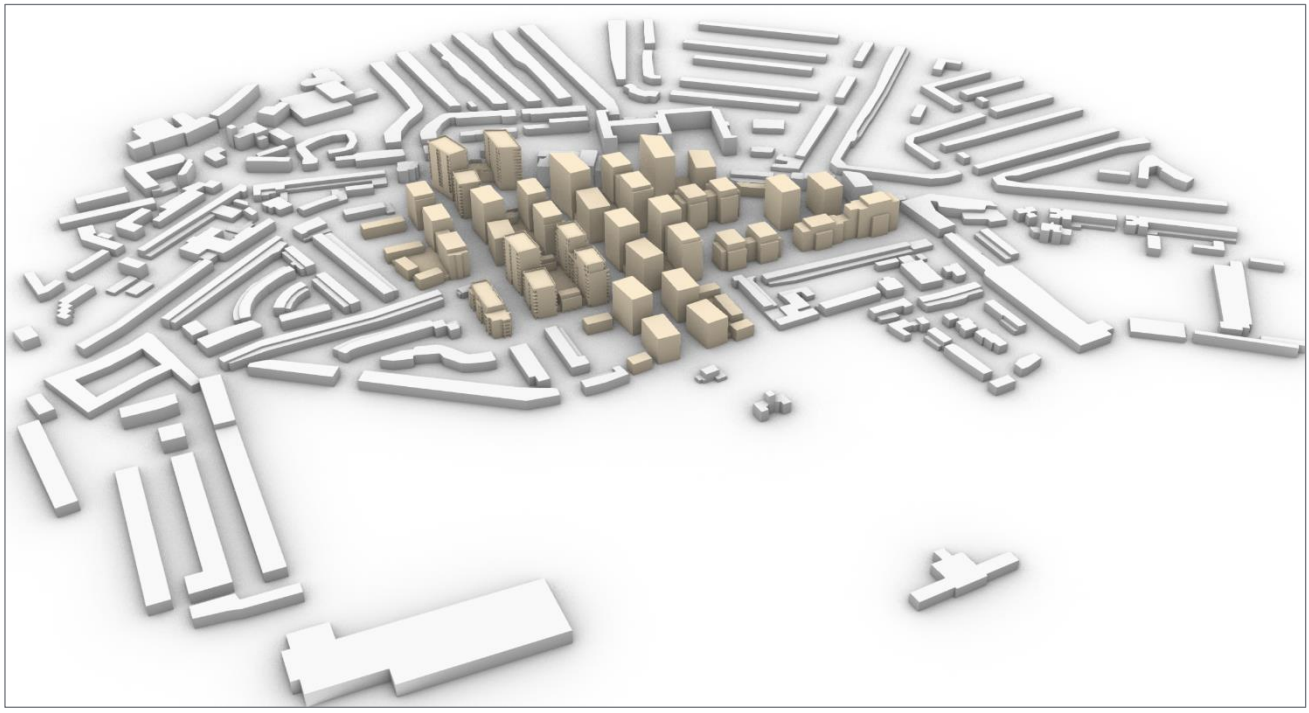

Figure 4 - 3D view of the Proposed Development with the surrounding buildings. Scenario 2

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.

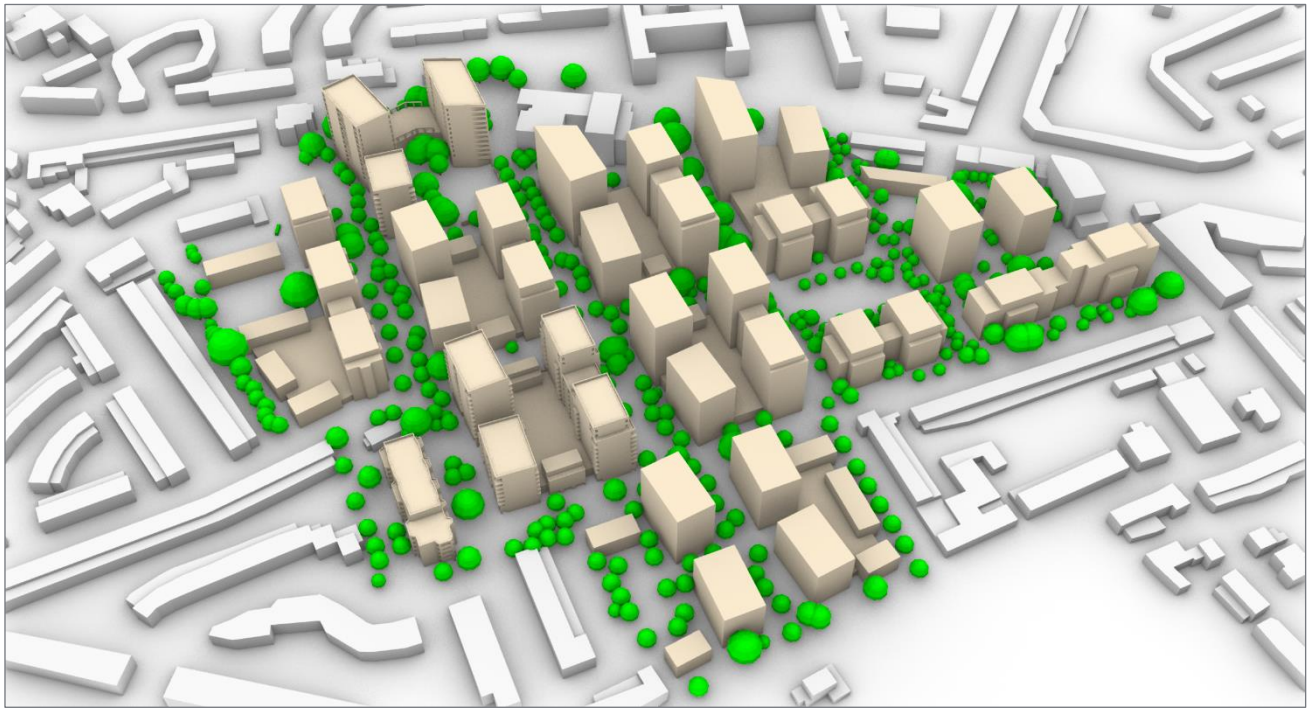

Figure 6 - 3D view of the Proposed Development with the surrounding buildings and the proposed trees. Scenario 3

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 London - Consolidated with Alterations (2016)
- The London Plan Intend to Publish (clean version) - Spatial Development Strategy for Greater London (2019)

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 London - Consolidated with Alterations (2016)

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:

Policy 7.6 Architecture:

"Architecture should make a positive contribution to a coherent public realm, streetscape and wider cityscape. It should incorporate the highest quality materials and design appropriate to its context."

"Buildings and structures should: […] d) Not cause unacceptable harm to the amenity of surrounding land and buildings, particularly residential buildings, in relation to privacy, overshadowing, wind and microclimate. This is particularly important for tall buildings."

Policy 7.7 Location and Design of Tall and Large Buildings:

"Tall and large buildings should be part of a plan-led approach to changing or developing an area by the identification of appropriate, sensitive and inappropriate locations. Tall and large buildings should not have an unacceptably harmful impact on their surroundings.

Applications for tall or large buildings should include an urban design analysis that demonstrates the proposal is part of a strategy that will meet the criteria below. This is particularly important if the site is not identified as a location for tall or large buildings in the borough's LDF [Local Development Framework].

Tall buildings: a) Should not affect their surroundings adversely in terms of microclimate, wind turbulence, overshadowing, noise, reflected glare, aviation and telecommunication interference."

2.3 The London Plan Intend to Publish (clean version) - Spatial Development Strategy for Greater London (2019)

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."

2.4 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	Light breeze suitable for outside restaurants and seating areas where one can read a paper or comfortably sit for long periods of time
	Pedestrian Sitting	4	>5	Breeze suitable for shorter periods of sitting in parks and outdoor spaces
	Pedestrian Standing	6	>5	Gentle breeze suitable for entrances, play areas and bus stops
	Pedestrian Walking	8	>5	Moderate breeze suitable for slow paced walking with occasional stops, strolling and sightseeing, window shopping, public/private sidewalks, pathways, public spaces
	Business Walking/Cycling	10	>5	Windy conditions that are uncomfortable for all pedestrian activities
	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.

2.5 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
	Sitting	4	<5	Reading a newspaper and eating and drinking, sitting in outdoor cafes, patios, terraces, benches, gardens, parks
	Standing	6	<5	Appropriate for bus stops, building entrances or exits, children's play areas
	Strolling	8	<5	Gentle breeze suitable for entrances, play areas and bus stops

Colour	Comfort Category	Threshold Wind speed (m/s)	Percent Exceedance (%)	Description
	Business Walking/Cycling	10	<5	Moderate breeze suitable for slow paced walking with occasional stops, strolling and sightseeing, window shopping, public/private sidewalks, pathways, public spaces
	Uncomfortable	>10	>5	Windy conditions that are uncomfortable for all pedestrian activities
	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

2.6 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.

2.7 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.

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.
- 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

Average wind speed increases with distance from the ground and this, along with turbulence has a significant impact on the wind profiles around buildings. As such, when assessing pedestrian level wind speed, the appropriate terrain roughness and wind velocity profile must be taken into account.

In this study the EN 1991-1-4 standards have been used in order to define the terrain roughness and the exposure categories. For all 16 wind directions the suburban wind exposure is selected.

3.2 Wind Analysis

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 analysis of the hourly weather data was conducted using the WRPLOT Lakes Environmental software and the Ladybug Wind Rose component. The resulting annual wind rose for Heathrow wind data is presented in Figure 8 and shows the frequency and average wind speed from each direction.

The wind data used increments of 0.10 m/s for speed and 10° for direction. Based on the suburban site located for the current assessment, a total of 16 no. wind directions (every 22.5° around the compass) were analysed. Results from the statistical analysis can be found in Tables 2 and 3.

The wind rose indicates that there are four dominant wind directions, namely from: the southwest (225° and 247.5°), west (270°) and northwest (292.5°). There is a second, less strong wind peak from the northeast (75°).

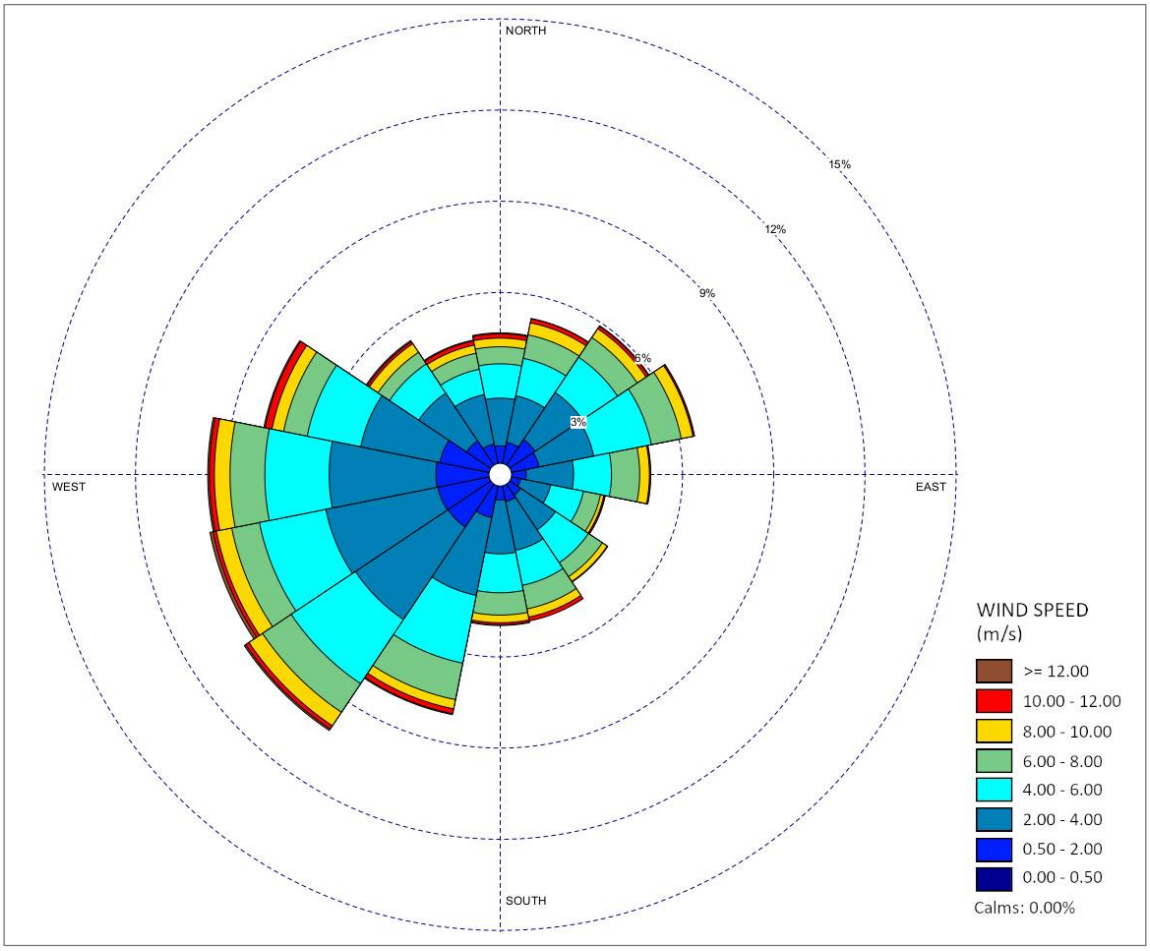

Figure 8 - Annual wind rose data from Heathrow airport weather station

Directions	Average Wind Speed (m/s)	Frequency
N	4.21	4.66
NNE	4.38	5.23
NE	4.03	5.88
ENE	4.17	6.51
E	4.27	4.94
ESE	4.22	3.52
SE	4.04	4.25
SSE	4.16	4.90
S	4.18	4.95
SSW	4.17	8.04
SW	4.01	10.10
WSW	3.92	9.71

Directions	Average Wind Speed (m/s)	Frequency
W	3.92	9.60
WNW	3.90	7.91
NNW	3.81	5.30
N	4.01	4.51

Table 2 - Average wind speed and frequency for 16 no. wind directions (every 22.5° around the compass) throughout the year

	Directions	Wind Classes (m/s) / Hours								Total Hours
		0.00 - 0.50	0.50 - 2.00	2.00 - 4.00	4.00 - 6.00	6.00 - 8.00	8.00 - 10.00	10.20 - 12.00	>= 12.00	
1	348.75 - 11.25	8	75	137	99	49	25	12	3	408
2	11.25 - 33.75	6	89	136	110	69	35	12	1	458
3	33.75 - 56.25	10	111	163	122	68	31	8	2	515
4	56.25 - 78.75	14	100	160	169	88	34	4	1	570
5	78.75 - 101.25	7	68	136	109	81	28	3	1	433
6	101.25 - 123.75	5	55	88	96	50	10	3	1	308
7	123.75 - 146.25	10	61	120	114	48	17	0	2	372
8	146.25 - 168.75	10	69	143	103	69	24	11	0	429
9	168.75 - 191.25	6	67	155	112	64	22	6	2	434
10	191.25 - 213.75	9	117	228	199	107	27	14	3	704
11	213.75 - 236.25	20	161	320	222	99	47	11	5	885
12	236.25 - 258.75	12	171	328	195	81	45	10	9	851
13	258.75 - 281.25	14	171	307	185	100	45	14	5	841
14	281.25 - 303.75	16	161	232	157	69	34	21	3	693
15	303.75 - 326.25	8	109	165	101	40	30	7	4	464
16	326.25 - 348.75	5	85	145	74	47	24	12	3	395
Sub-Total (H)		160	1670	2963	2167	1129	478	148	45	8760
Percentage (%)		1.83%	19.06%	33.82%	24.74%	12.89%	5.46%	1.69%	0.51%	100.00%
Missing/Incomplete										0
Total (Hours)										8760

Table 3 - Frequency distribution for 16 no. wind directions (every 22.5° around the compass) throughout the year

Seasonal changes can provide a significant difference in wind speed and direction. Summer winds are likely to be considerably lower in speed than those expected at windier and colder times of the year. This seasonal variation needs to be taken into account when analysing the activities likely to be undertaken in a particular area. For example, it is unlikely that outdoor seating areas will be used frequently in colder winter months, whilst in warmer, less windy summer months, it is expected that these areas would be used by pedestrians throughout the day.

As demonstrated in the seasonal wind roses in Figure 9, there are four dominant wind directions. Therefore, these wind directions are expected to be the most important directions of relevance to the site and would contribute most to pedestrian comfort levels.

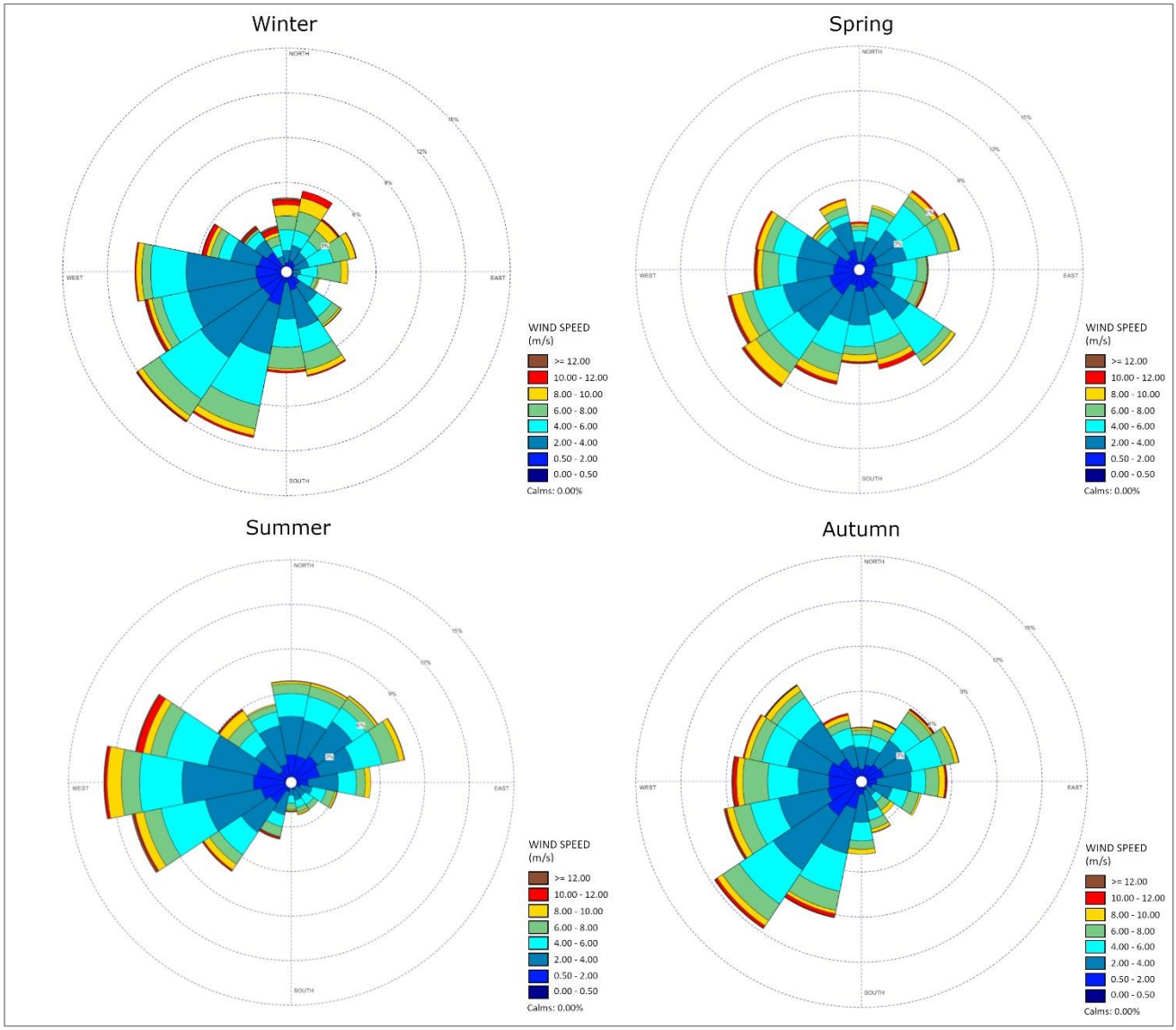

Figure 9 - Seasonal wind rose, data from Heathrow airport weather station

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.

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 for both the windiest winter and summer season (Figures 10 and 11) indicate that at the pedestrian level (1.50m above the ground level), no distressful conditions were found. Furthermore:

Pedestrian level. The wind conditions around the site are suitable for activities from pedestrian walking to outdoor dining, for both the winter and the summer season, acceptable conditions for the intended use (Figures 10 and 11).

Thoroughfares, secondary roads, pedestrian, cycling and emergency routes. All the on-site and off-site routes would have acceptable wind conditions ranging from suitable for pedestrian walking to outdoor dining during both the windiest season and the summer season, acceptable conditions for the intended use (Figures 10 and 11).

Entrances. All on-site and off-site entrances would have wind conditions suitable from pedestrian standing to outdoor dining, for both the winter and the summer season, acceptable wind conditions for entrances (Figures 10 and 11).

Play areas and bus stops. All on-site and off-site play areas and bus stops would have acceptable wind conditions ranging from suitable for pedestrian walking to outdoor dining during both the windiest season and the summer season and have acceptable conditions for the intended use (Figures 10 and 11).

Ground and podium level amenity spaces. During the summer season, wind conditions are suitable for sitting for almost all existing ground and podium level amenity space around the Site. 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 pedestrian walking, one level windier than suitable for a sitting location. On the two main podium areas adjacent to Tower Blocks A & B, wind conditions are one level windier than suitable for a sitting. It should be noted that the ground level area adjacent to the access point for the Tower Block A podium has acceptable wind conditions suitable for pedestrian walking. All other ground and podium level amenity spaces have comfortable wind conditions (Figures 10 and 11).

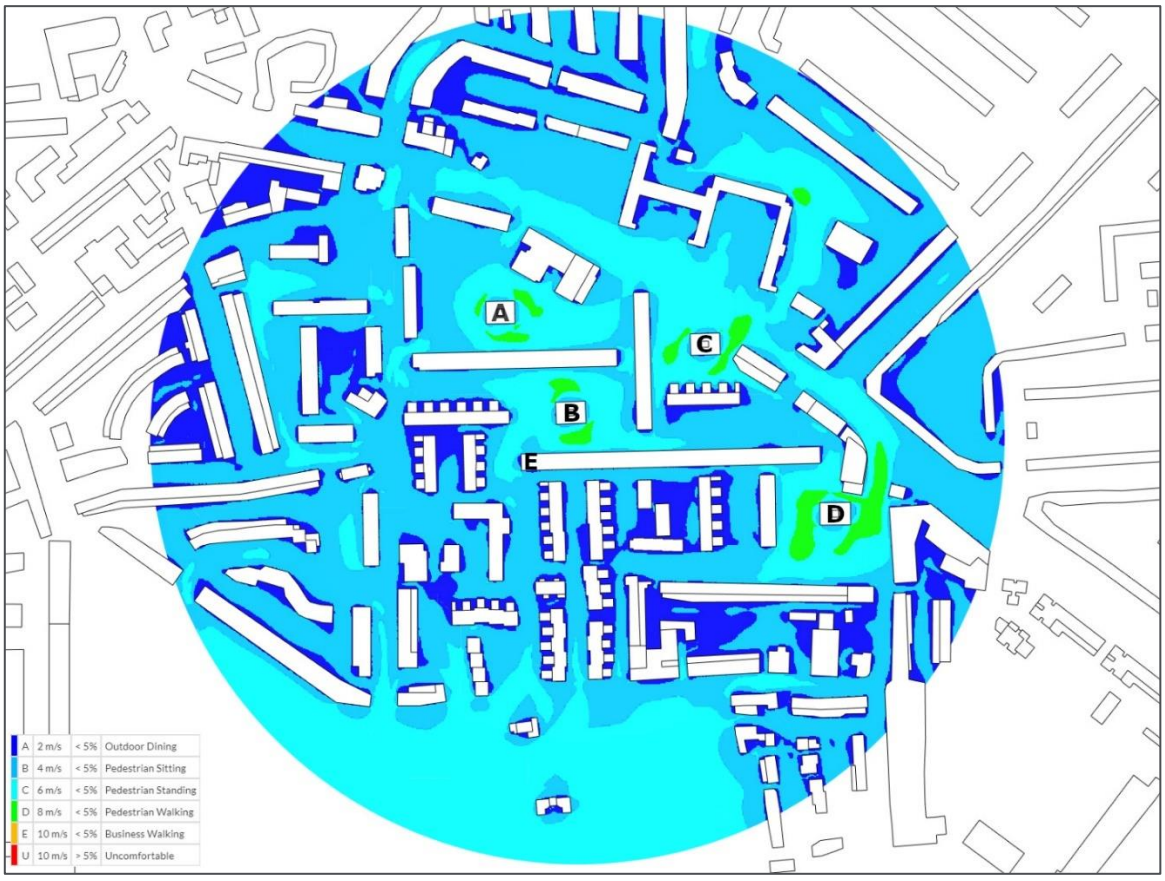

Figure 10 - Lawson Comfort Conditions. Existing conditions, scenario 1, result for the windiest, winter season. 1.50m above the ground

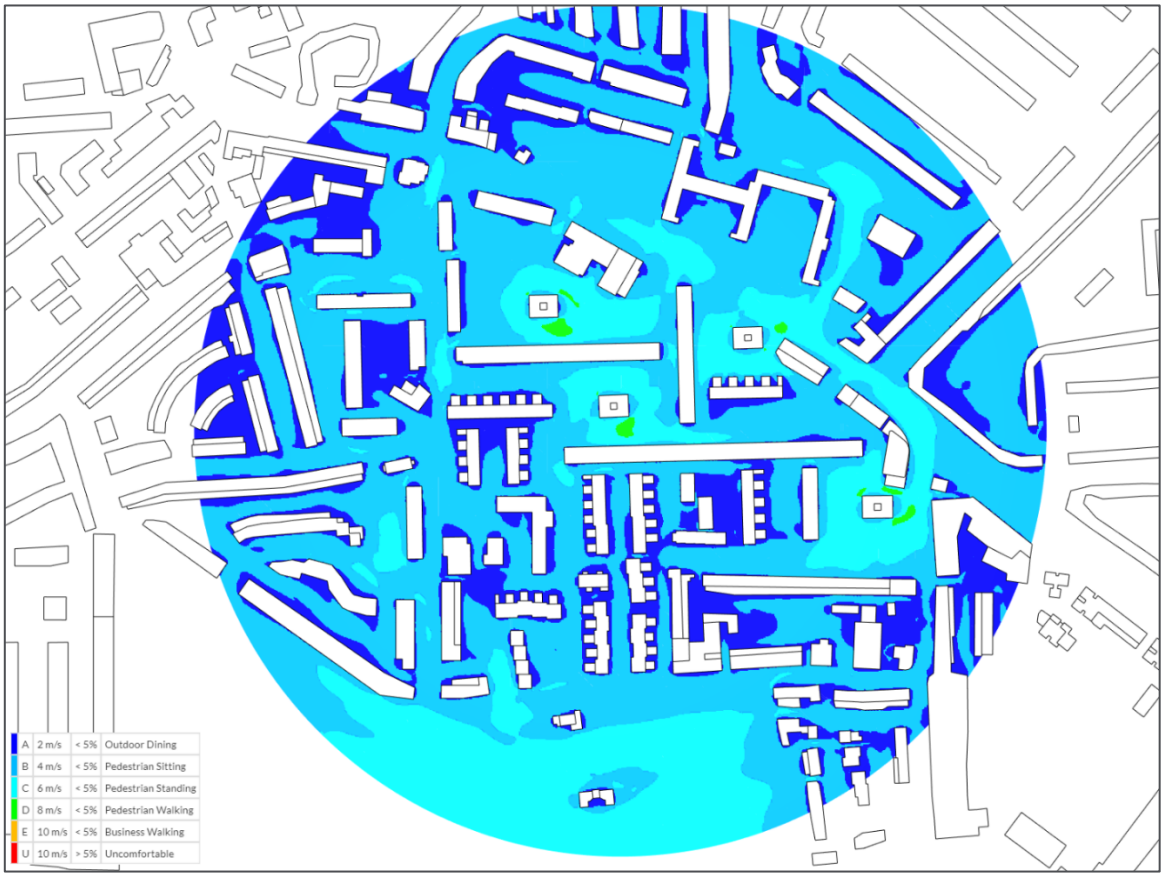

Figure 11 - Lawson Comfort Conditions. Existing conditions, scenario 1, result for the summer season. 1.50m above the ground

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

Strong winds exceeding the 15m/s safety threshold, for more than 0.023% of the time, would be expected only in the winter season (Figures 13 and 14) and are shown in 7 no. of areas around the 4 no. existing tower blocks (marked A – D) and a building of low-rise flats (marked E) (Figure 12):

- in the North West corner of the tower block A,
- some small spots West of the tower block B,
- the area from the North West to the South West corner and the South East corner of the tower block C,
- the area from the North West to south West corner and from the North East to south East corner of the tower block D, and
- the South West corner of the building E at Willingham Way.

No strong winds are expected to exceed the 20m/s upper safety threshold for more than 0.023% of the year (e.g. 2 hrs).

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

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

4.3 Scenario 2 – Proposed Development - Comfort Conditions

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. The wind conditions around the site would be suitable for activities from pedestrian walking to outdoor dining, for both the winter and the summer season (Figures 14 and 15).

Thoroughfares, secondary roads, pedestrian, cycling and emergency routes. All the on-site and off-site routes would have acceptable wind conditions ranging from suitable for pedestrian walking to outdoor dining during both the windiest season and the summer season, acceptable conditions for the intended use. The wind conditions on these areas would represent negligible effects (not significant) (Figures 14 and 15).

Entrances. In close proximity of one of the entrances into the Development, west of building block M2 (Phase 4), would have wind conditions suitable for walking during the windiest season only, which is one category above the suitable for entrances. This represent a minor adverse effect (significant) and mitigation is required at this location.

All other on-site and off-site entrances would have wind conditions suitable from pedestrian standing to outdoor dining, for both the winter and the summer season, acceptable wind conditions for entrances, representing negligible effects (not significant) (Figures 14 and 15).

Play areas and bus stops. In close proximity to one of the play areas within the Development, west of building C3 (Phase 1), will experience wind conditions suitable for standing during the 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 play areas and bus stops would have acceptable wind conditions ranging from suitable for pedestrian walking to outdoor dining during both the windiest season and the summer season and have acceptable conditions for the intended use. The wind conditions on these areas would represent negligible effects (not significant) (Figures 14 and 15).

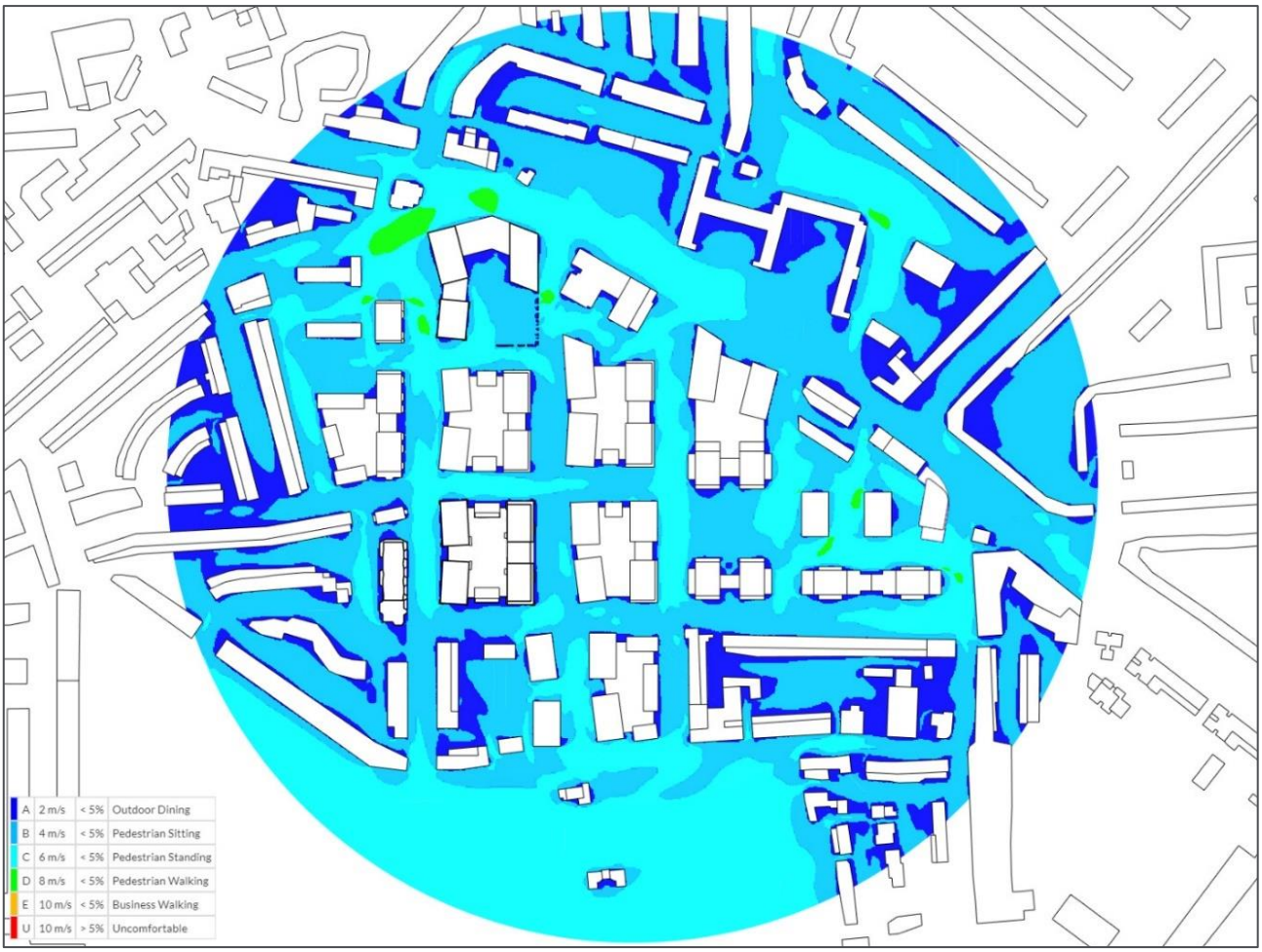

Figure 14 - Lawson Comfort Conditions. Proposed Development, scenario 2, result for the winter season. 1.50m above the ground

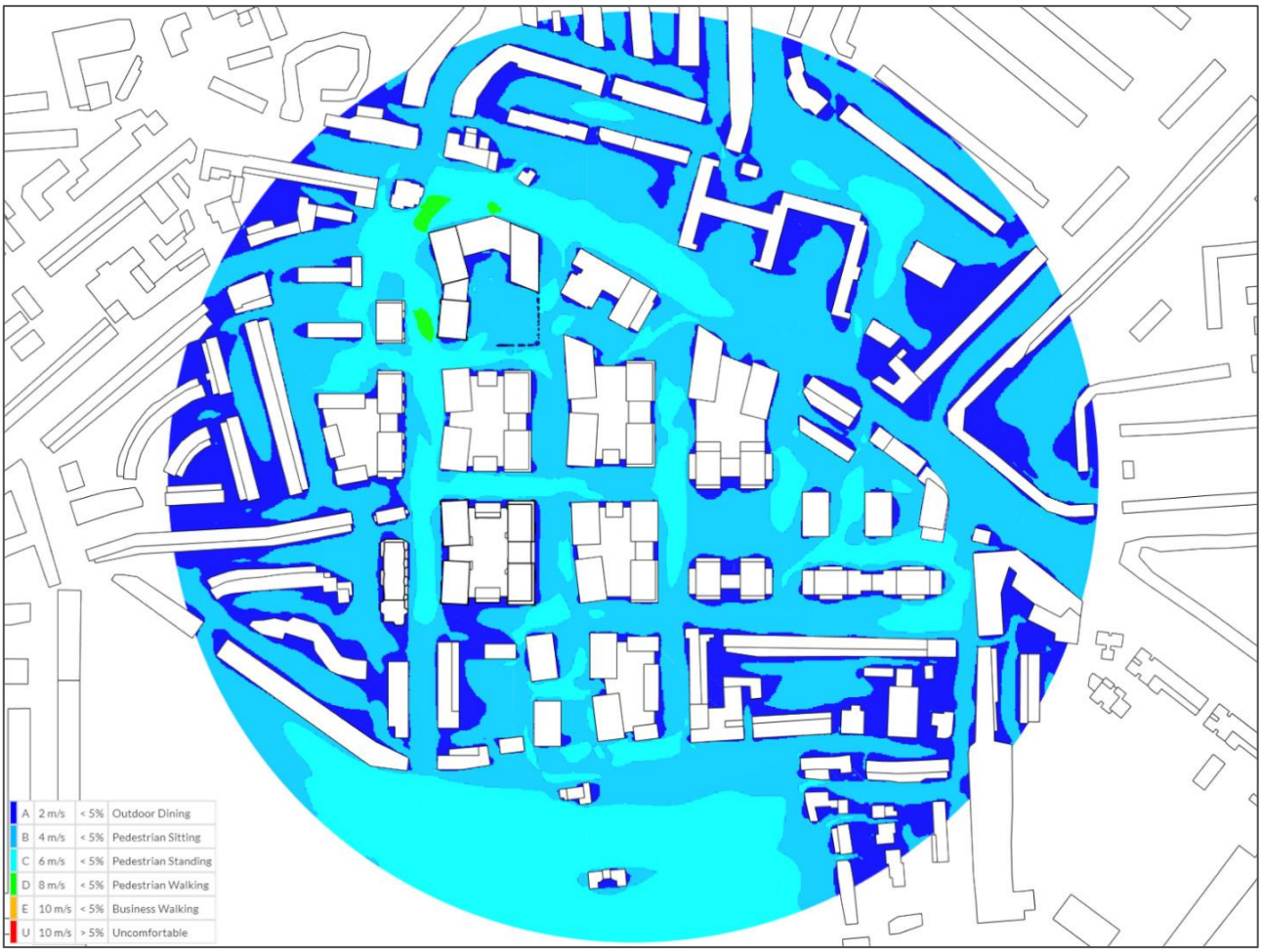

Figure 15 - Lawson Comfort Conditions. Proposed Development, scenario 2, result for the summer season. 1.50m above the ground

Podium level and roof terrace amenity spaces. All podium level and accessible roof terrace amenity spaces on the Proposed Development located at blocks B, C and E (Phase 1), (measured at 1.50m above each space level) in the summer season, where these areas will be used, would have wind conditions suitable for activities from pedestrian standing to outdoor dining. This would be acceptable on the basis that no fixed seating is placed in areas suitable for pedestrian standing use, representing negligible effects (not significant) (Figures 16 and 17).

Only one roof space, between the buildings C1 and C3, would have wind conditions suitable mainly for pedestrian walking. As this space is not accessible to building users, no mitigation would be required.

Balconies. In this 2nd scenario, all the balconies at blocks B, C and E (Phase 1), have been modelled without any enclosure and as such the results would represent the 'worst case' scenario. In the summer season, 36 no. out of total 391 no. balconies have been identified areas with walking wind conditions, one category above the suitable condition for balconies. 10 no. at building C1, 10 no. at building C2, 4 no. at building C3, 8 no. at building E1 and 4 no. at building E3. This represents a minor adverse effect (significant), and mitigation is required at these locations. All other balconies will have wind conditions for activities from pedestrian standing to outdoor dining. 3D images with all the results can be seen in Appendices B-D.

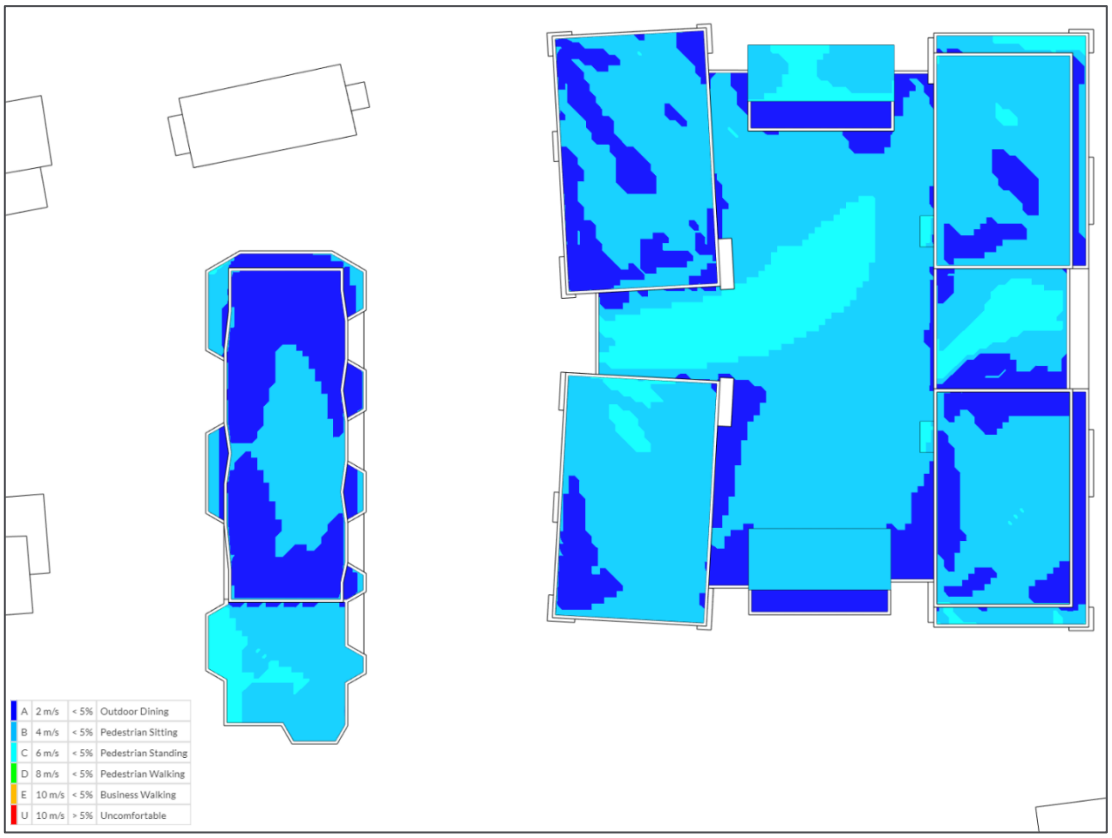

Figure 16 - Lawson Comfort Conditions. Proposed Development, scenario 2, result for the podium level and roof terraces at block B and E, summer season. 1.50m above floor level

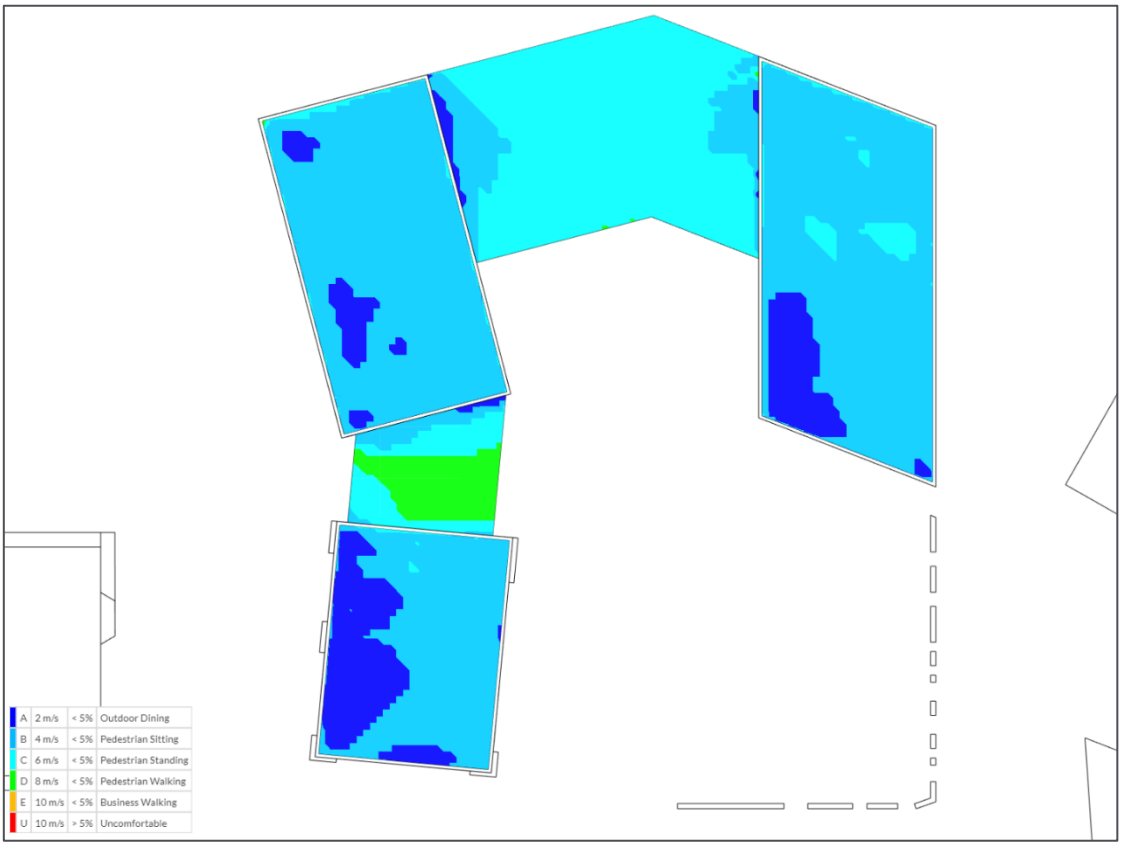

Figure 17 - Lawson Comfort Conditions. Proposed Development, scenario 2, result for the podium level and roof terraces at block C, summer season. 1.50m above floor level

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

Pedestrian level. Strong winds exceeding the 15m/s safety threshold, for more than 0.023% of the time, would be expected only in the winter season (Figures 18 and 19). There are 5 no. areas at pedestrian level that would have instances of strong winds exceeding 15m/s for more than the safety threshold of 0.023% of time annually (e.g. 2 hrs):

- around North West corners and the area from North East to South East corner of block P2,
- at the North West corner of building C1,
- at the North East corner of building C3,
- the South West corner of block K1, and
- the area from North West corner to West of block M1.

All these locations require mitigation to eliminate these safety exceedances

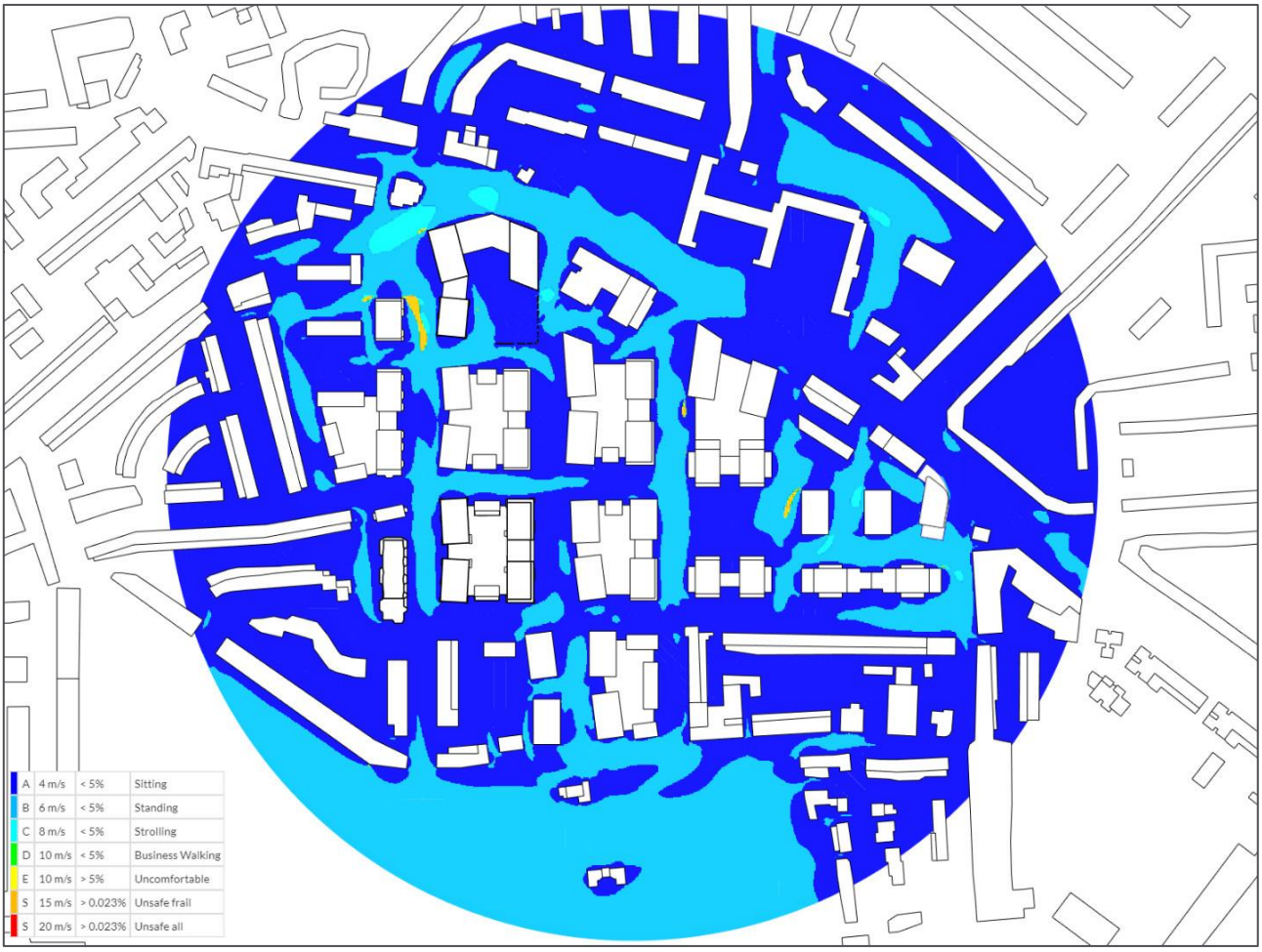

Figure 18 - Lawson Safe Conditions. Proposed Development, scenario 2, result for the winter season. 1.50m above the ground

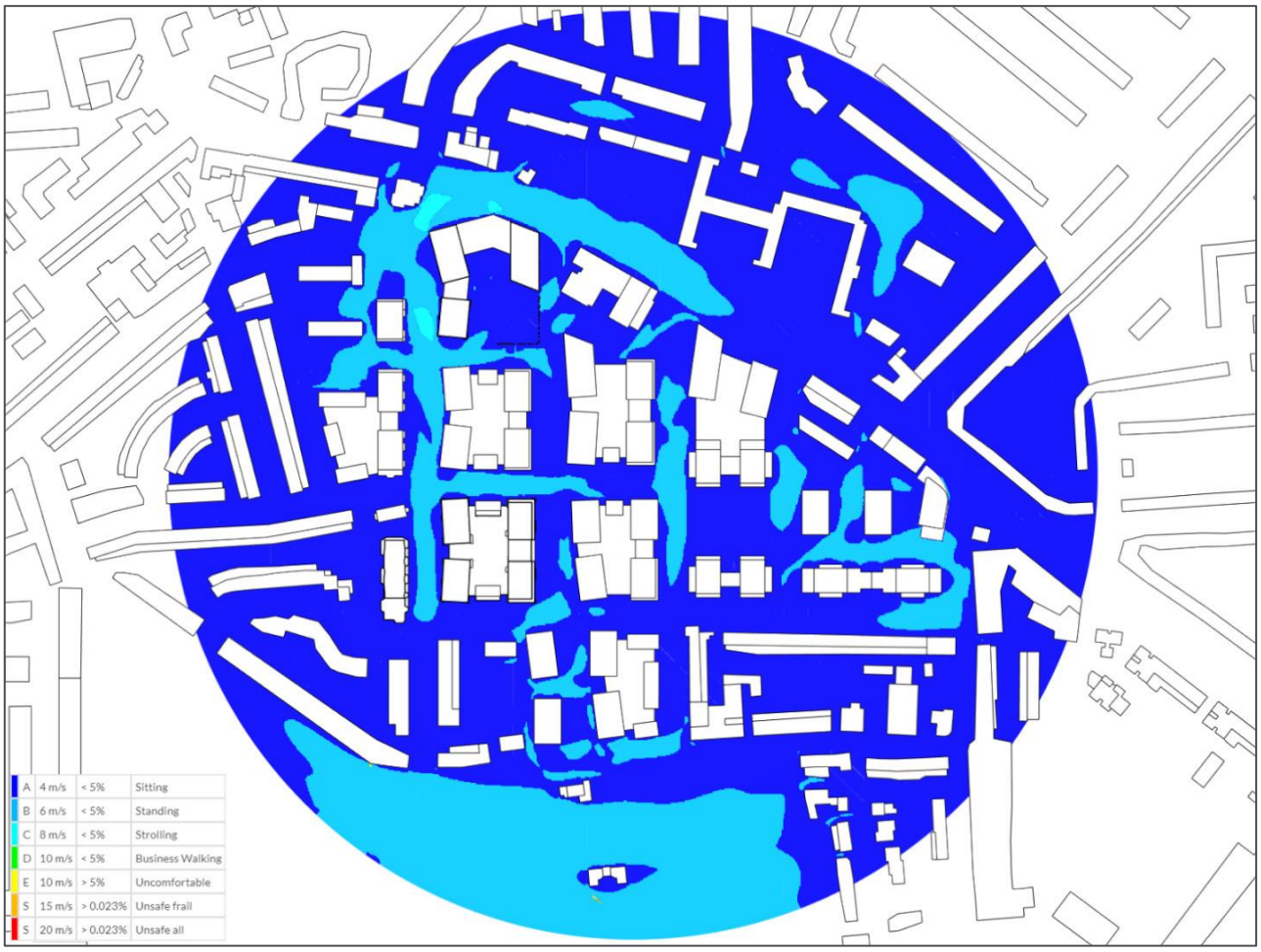

Figure 19 - Lawson Safe Conditions. Proposed Development, scenario 2, result for the summer season. 1.50m above the ground

Podium level and roof terrace amenity spaces. In the summer season, all the podium level and accessible roof terraces on the Proposed Development located at blocks B, C and E (Phase 1) would have safe wind conditions. No strong winds are expected to exceed the 15m/s safety threshold for more than 0.023% of the year (e.g. 2 hrs) (Figures 20 and 21).

Only in one roof space at building C2, would have instances of strong winds exceeding 15m/s for more than 2 hrs annually (0.023% of the time). As this space is not accessible to building users, no mitigation would be required.

Balconies. There would be 27 no. out of total 391 no. balconies (10 no. at building E1, 7 no. at building C3 and 10 no. at building C2) in the summer season, that would have instances of strong winds exceeding 15m/s for more than 2 hrs annually (0.023% of the time). All these locations require mitigation to eliminate these safety exceedances. 3D images with all the results can be seen in Appendices E-G.

No strong winds are expected to exceed the 20m/s upper safety threshold for more than 0.023% of the year (e.g. 2 hrs).

Figure 20 - Lawson Safe 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

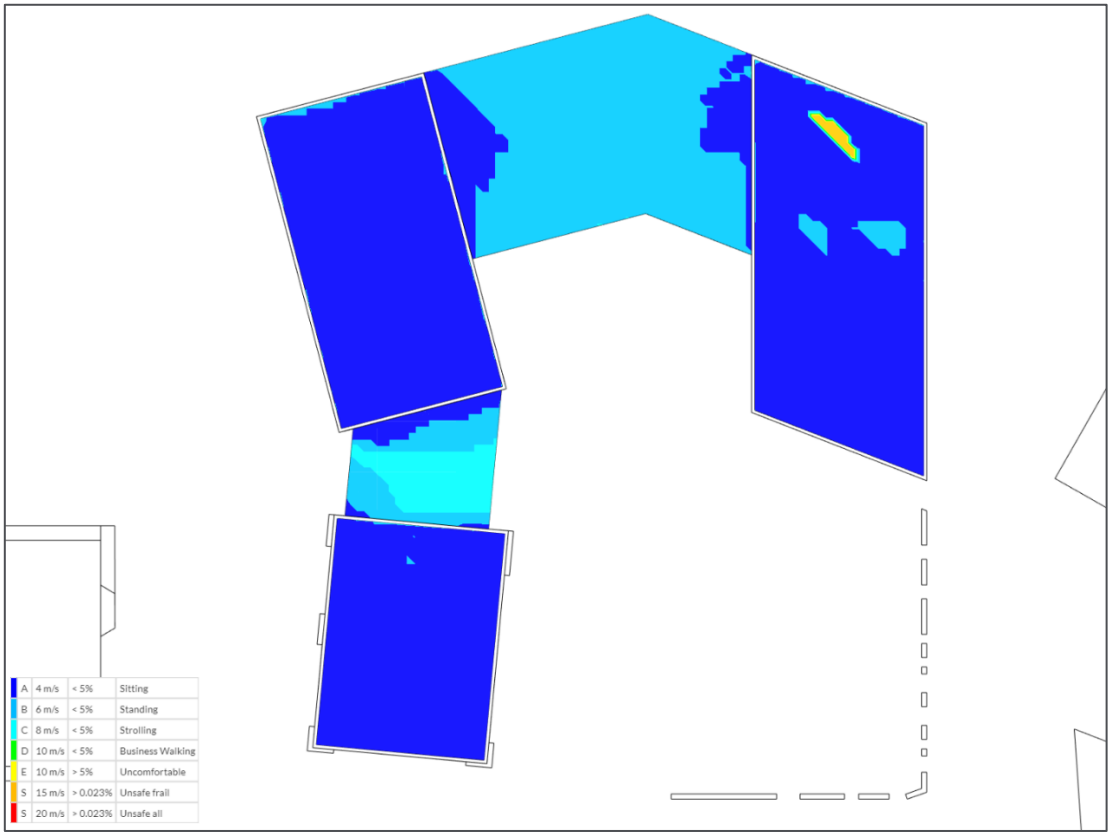

Figure 21 - Lawson Safe Conditions. Proposed Development, scenario 2, result for the podium level and roof terraces at block C, summer season. 1.50m above floor level

4.5 Scenario 3 – Proposed Development with mitigation - Comfort Conditions

The results of the wind microclimate assessment for the windiest, winter season, indicate that no distressful conditions were found for the whole area. Furthermore:

Pedestrian level. In the windiest winter season, the wind conditions around the site are suitable for activities from pedestrian walking to outdoor dining, representing negligible effects (not significant) (Figure 22).

Thoroughfares, secondary areas, pedestrian, cycling and emergency routes. All the on-site and off-site routes would have acceptable wind conditions ranging from suitable for pedestrian standing to outdoor dining during both the windiest season and the summer season, acceptable conditions for the intended use. The wind conditions on these areas would represent negligible effects (not significant) (Figure 22).

Entrances. The wind conditions for all the on-site and off-site entrances are suitable for activities from pedestrian standing to outdoor dining, for the winter season, acceptable wind conditions for entrances, representing negligible effects (not significant) (Figure 22).

Play areas and bus stops. All on-site and off-site play areas and bus stops would have acceptable wind conditions ranging from suitable for pedestrian standing to outdoor dining during the windiest season, acceptable conditions for the intended use. The wind conditions on these areas would represent negligible effects (not significant) (Figure 22).

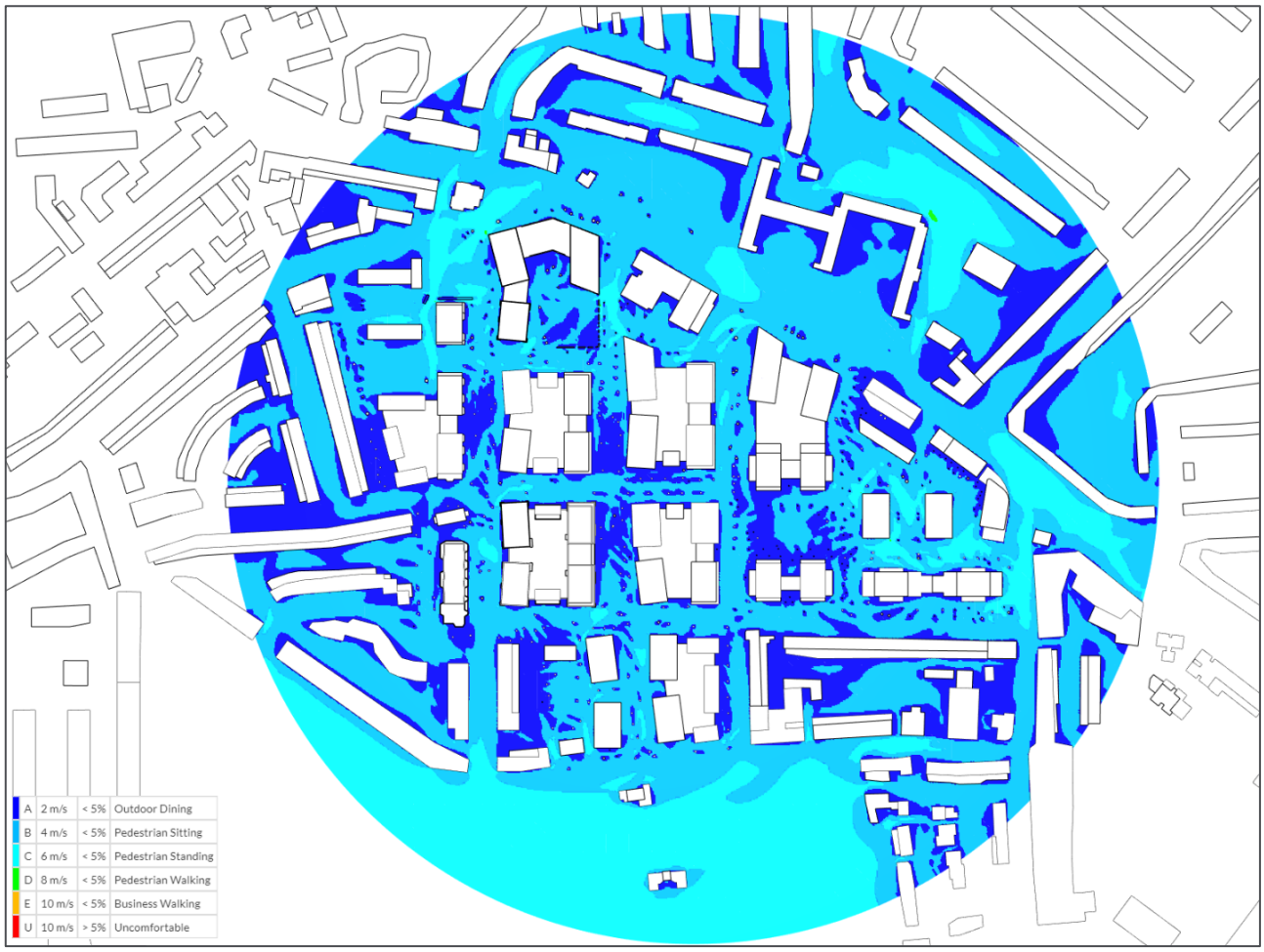

Figure 22 - Lawson Comfort Conditions. Proposed Development with mitigation, scenario 3, result for the winter season. 1.50m above the ground

All **Podium level and roof terrace amenity spaces** would have wind conditions suitable for activities from pedestrian standing to outdoor dining, representing negligible effects (not significant).

Balconies. All balconies at blocks B, C and E (Phase 1), would have wind conditions suitable for activities from pedestrian standing to outdoor dining, representing negligible effects (not significant). 3D images with all the results can be seen in Appendices H-I.

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

Pedestrian level. Strong winds exceeding the 15m/s safety threshold for more than 0.023% of the time (e.g. 2 hrs annually) would be expected only in 4 no. of small spots at the pedestrian level and only in the winter season (Figure 23):

- at the North West corners of block P2,
- at the North West corners of block P1,
- at the South West corner block of K1, and
- at the North West corner of block M1

The above small unsafe spots can be easily mitigated with additional low-level planting. The final architectural and landscape drawings demonstrate how the above suggestions have been incorporated into the design.

All **Podium level and roof terrace amenity spaces** would have safe wind conditions.

All **balconies** would have safe wind conditions. 3D images with all the results can be seen in Appendices J-K.

No strong winds are expected to exceed the 20m/s upper safety threshold for more than 0.023% of the year (e.g. 2 hrs).

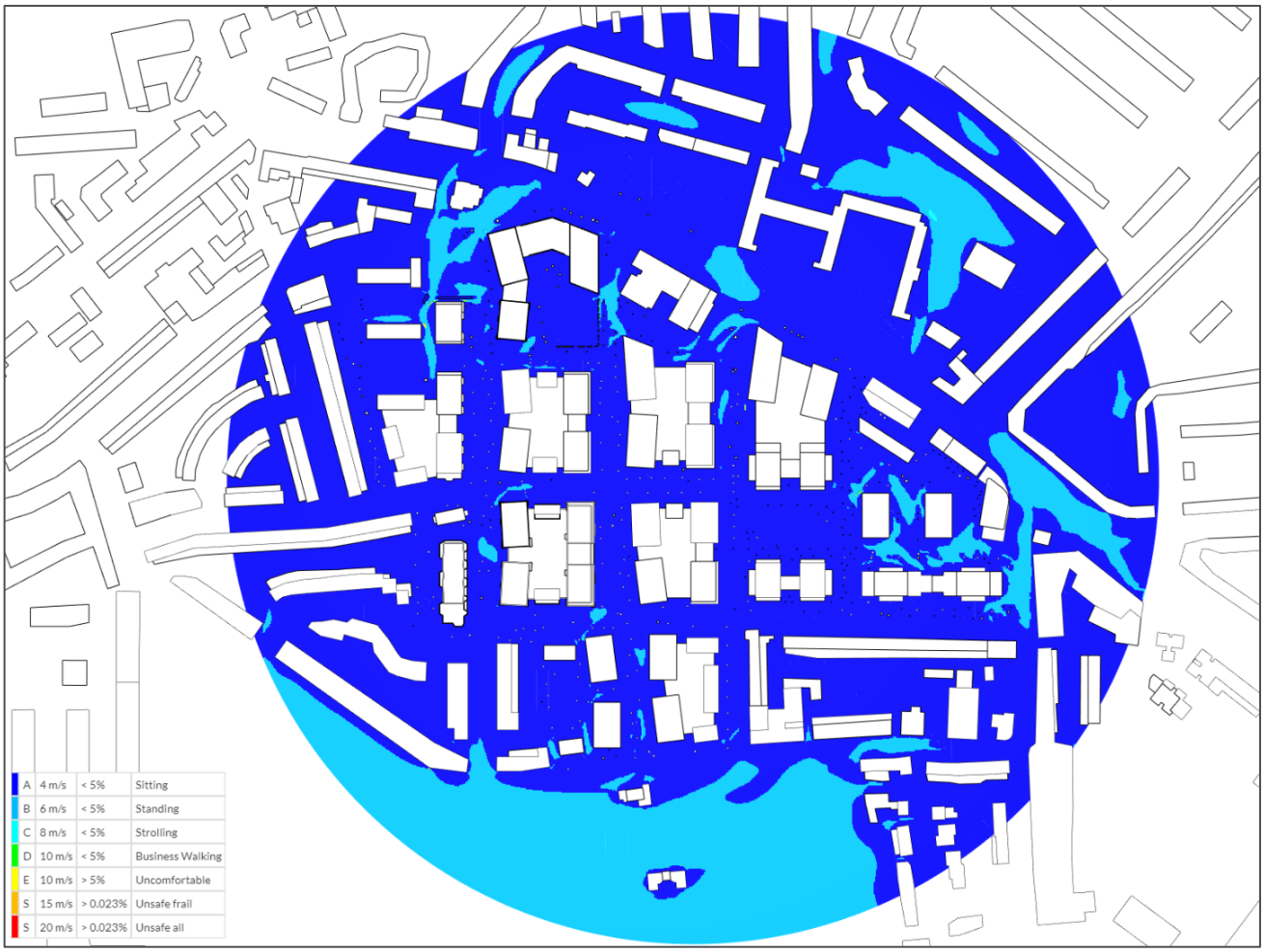

Figure 23 - Lawson Safe Conditions. Proposed Development, scenario 2, result for the winter season. 1.50m above the ground

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 no distressful conditions were found for the whole area and the wind conditions are suitable for activities from pedestrian walking to outdoor dining. 3 no. of ground and podium level amenity spaces are one level windier than suitable for a sitting.

Strong winds exceeding the 15m/s safety threshold, would be expected in 7 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. In close proximity of one of the entrances into the Development, west of building block M2, would have wind conditions suitable for walking, which is one category above the suitable for entrances. In 36 no. out of total 391 no. balconies have been identified areas with walking wind conditions, one category above the suitable for balconies.

Strong winds exceeding the 15m/s safety threshold, would be expected in 5 no. of areas. 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 winter, the windiest, season, indicate that no distressful conditions were found for the whole area and the all areas in and around the Proposed Development would have suitable wind conditions for the intended uses.

Strong winds exceeding the 15m/s safety threshold for more than 0.30 hrs at the windiest winter season, would be expected only in 4 no. of small spots at the pedestrian level. The above small unsafe spots can be easily mitigated with additional low-level planting. The final architectural and landscape drawings demonstrate how the above suggestions have been incorporated into the design.

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.

For Phase 1 detailed planning and Phase 2 to 5 outline planning application, no further simulations would be required.

Appendices

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