



CFD Analysis of Wind Microclimate Pedestrian Conditions

30-36 Clarendon Road, Haringey

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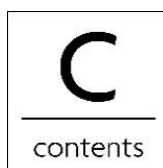
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1. Executive Summary

1.1. Introduction

A new development is proposed for the Jessica Buttons Factory site, at 30-36 Clarendon Road as the first phase of a forthcoming wider masterplan. The proposed development will provide commercial space together with sustainable new homes, including affordable homes. The proposal rises to 12 stories, with balconies and roof terraces at several levels.

Hilson Moran has been appointed by Paul Simon Magic Group to provide a wind microclimate assessment for the proposed development. Levels of pedestrian comfort and distress were quantitatively assessed against the widely used Lawson Criteria (LDDC method), as set out in Building Aerodynamics by Tom Lawson, [Imperial College Press (2001)]. The assessment used Computational Fluid Dynamics (CFD) to simulate wind from 36 wind directions, and combined the results with meteorological data to assess the conditions against the quantitative thresholds. As a conservative measure, the simulations did not include the effect of the many proposed and existing trees and other soft landscaping.

1.2. Effects of the development

1.2.1. Comfort

Simulations show that the site of the proposed development is in a very sheltered location. The proposed building is likely to increase wind speeds in the adjacent roads but in all places these are likely to remain within the assessment criteria.

1.2.2. Distress

Simulations showed no likely regions of pedestrian distress.

1.3. Conclusions

Simulations show that the impact of the proposed massing on the pedestrian wind microclimate for either comfort or distress is likely to produce conditions that are acceptable, and therefore meets the policy test referenced previously.



Figure 1.1: Lawson Comfort Plot

Table 1.1: LDDC Lawson Comfort Criteria Typical Activities

	Comfort category	Colour	Location examples
I	Pedestrian sitting	Blue	Cafés, Outdoor Auditoria
II	Pedestrian standing	Light Blue	Bus stops, Main entrances, Playgrounds, Park Benches, Markets
III	Pedestrian walking	Green	Retail Areas, Parks, Canals
IV	Business walking	Yellow	“Busy” getting from A-to-B (i.e. not necessarily financial)
	Roads and Car Parks	Red	Roads and Car Parks

2. Introduction

2.1. Outline of the Proposed Development

A new development is proposed for the Jessica Buttons Factory site, at 30-36 Clarendon Road as the first phase of a forthcoming wider masterplan. The proposed development will provide commercial space together with sustainable new homes, including affordable homes. The proposal rises to 12 stories, with balconies and roof terraces at several levels.

Hilson Moran has been appointed by the developer, Paul Simon Magic Group, to provide a wind microclimate assessment for the proposed development. The objective of this study is to provide a ground level wind microclimate assessment based on a series of computational models.

The site is bordered to the west, north, and east by Clarendon Road and to the south by a day centre.

The existing built environment around the proposed site is typically low rise (<25m), with a 7-storey neighbour to the southwest, and a railway embankment beyond. A recently completed development lies to the north, on the site of the former Gasworks.

2.2. Purpose and Scope of the CFD Study

The purpose of this report is to assess the acceptability of wind conditions as a result of the proposed development. This analysis considers two scenarios: Existing, & Proposed. No cumulative developments were identified.

The investigation was performed using a CFD model constructed using the general purpose ANSYS-Fluent CFD package. The models enable a quantitative analysis of flow characteristics in the microclimate around the buildings. Simulations were performed from 36 wind directions in 10° increments around the compass.

This report summarises the models constructed, the simulation methodology, main assumptions made and the boundary conditions applied. The results of the CFD simulations were interrogated to compare the proposed uses with metrics of user comfort criteria.

Wind conditions were quantitatively assessed against the widely used Lawson Criteria, as set out in Building Aerodynamics by Tom Lawson, [Imperial College Press (2001)].

The CFD results were analysed including a brief discussion of possible causes of undesirable flow features and possible measures to counteract these. This report includes appropriate conclusions and recommendations.

2.3. Limitations of Modelling

2.3.1. Suitability for Purpose

The analysis reported in this document uses CFD models to simulate the likely wind speeds under a variety of wind conditions, for comparison against the LDDC Lawson comfort criteria. CFD is widely used for this purpose, and more importantly is well-validated against both empirical data and other modelling methods.

Irrespective of modelling methodology, the results of modelling physical phenomena have uncertainty compared with the real life performance. All modelling techniques fail to predict reality with perfect precision, due to necessary assumptions, unpredictable boundary conditions or other simplifications. It is therefore important to address the purpose for which the modelling was undertaken.

This assessment considers wind pedestrian comfort and distress for general patterns of use (i.e. sitting, standing, strolling, and walking). The following effects were not considered in this analysis:

- More specialised wind design requirements (e.g. sailing, aviation, sports, particle transport, fire safety, etc.)
- Structural effects, resonance calculations, fluid-structure interactions, and acoustic effects;
- Ventilation of internal spaces, wind gusting, urban heat island effects and pollutant tracking;
- Wind effects during construction.

3. Legislation and Planning Policy

Legislation and planning documents of relevance to this assessment include the following:

- The National Planning Policy Framework (July 2021);
- Planning Practice Guidance (October 2019)
- The London Plan (March 2021)

National planning policies do not impose specific limits on the microclimate wind environment around a new development, but there is a requirement to inform the planning process, so that specific site conditions and functions can be assessed, and to show that other users around the development will not be unreasonably affected by the wind microclimate.

As a result it is proposed to assess effects based on UK industry standards, assessing the pedestrian level wind microclimate against the Lawson pedestrian comfort criteria. The Lawson criteria define acceptable windiness for different activities such as sitting, walking and standing.

3.1. Legislation

There is no legislation which specifically governs wind microclimate planning policy.

3.2. National Planning Policy

3.2.1. National Planning Policy Framework (July 2021)

The National Planning Policy Framework (NPPF) does not specifically reference wind or microclimate; however, the NPPF emphasises the benefits of high quality built environment, for example:

- Paragraph 90.b) *“This should include assessment of [...] the impact of the proposal on town centre vitality and viability.”*
- Paragraph 126 *“Good design [...] creates better places in which to live and work and helps make development acceptable to communities.”*
- Paragraph 130.f) *“Planning policies and decisions should ensure that developments create places that are safe, inclusive and accessible [...] with a high standard of amenity for existing and future users.”*

3.2.2. Planning Practice Guidance (October 2019)

Planning Practice Guidance identifies the potential for a development's size and shape to affect the wind microclimate. In particular, paragraphs 25 and 26 state:

“Design: How should buildings and the spaces between them be considered?”

Consider Form: Some forms pose specific design challenges, for example how taller buildings meet the ground and how they affect local wind ... patterns should be carefully considered.

Consider Scale: Account should be taken of local climatic conditions, including ... wind”.

3.3. Regional Planning Policy

The London Plan (March 2021) states:

3.3.8 Buildings should be of high quality and enhance, activate and appropriately frame the public realm. [...] Creating a comfortable pedestrian environment with regard to [...] wind [...] is important.

Policy D8 Public realm

Development Plans and development proposals should:

G) [...] Consideration should also be given to the local microclimate created by buildings. [...]

J) ensure that appropriate shade, shelter, [...] are provided, with other microclimatic considerations, including temperature and wind, taken into account in order to encourage people to spend time in a place.

Policy D9 Tall buildings

3) environmental impact

C Development proposals should address the following impacts:

a) wind [...] 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.

3.4. Local Planning Policy

Haringey's Sustainable Design And Construction SPD (Adopted March 2013), section 3.2 states:

When designing proposals it is important to consider the site's microclimate including the likely impacts of [...] wind, [...] on neighbouring properties, the public realm and open space.

A microclimate assessment should be carried out where tall buildings are proposed in order to demonstrate the impact of the building and mass upon the surrounding microclimate and to identify any mitigation measures required. In Haringey a tall building is considered to be 10 storeys or above. It may also be necessary to undertake a wind tunnel test to ensure that the building does not create an uncomfortable environment for pedestrians.

4. Inputs

4.1. Geometry

The 3D model of the existing built environment for the development site was provided by the architects, including geometry of the recently completed development to the north. In addition, publicly available LiDAR data for the wider region was used in constructing the model.

4.1.1. Proposed Development

The geometry of the proposed development in the CFD model was based on drawings provided by the architects.

4.2. Location

Figure 4.1, shows an overview of the model geometry. The location of the proposed development is highlighted. The model domain extends to a radius of more than 5 times the proposed building height.

4.3. Vegetation

It is extremely difficult to precisely quantify the effect of an individual tree on airflow. The porosity and resistance to flow is highly sensitive to many factors such as species, age, health, aspect, soil, season, etc. In addition, the highest wind speeds experienced in the United Kingdom tend to occur during winter, when deciduous trees are leafless.

Although the presence of a particular tree might conceivably cause an acceleration of flow in one localised region under a specific scenario, its overall effect on the pedestrian environment will be to reduce the average velocity experienced. As a result, vegetation has not been included in the simulations. The omission of individual trees from the models may be considered to be an appropriate conservative measure.

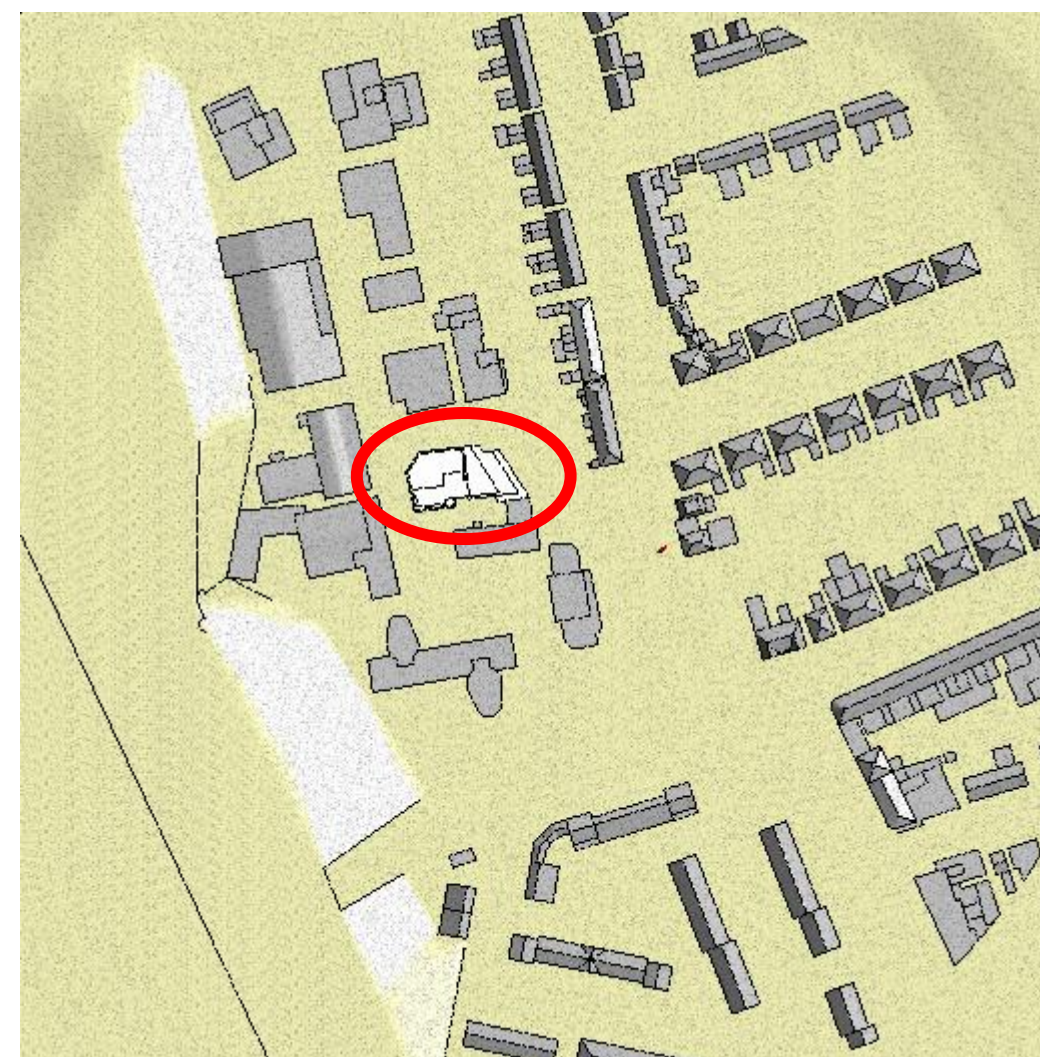


Figure 4.1: Overview of model geometry, and highlighted location of the development

4.4. Raw Wind Data

46 years (1973-2018) of hourly-averaged wind measurements for London Heathrow (~30km W of the proposed development) were used for the study. This is considered to be the most representative long term dataset for the site. The wind data used increments of 0.1m/s for speed and 10° for direction, and was reported for a reference height of 10m above ground level.

The resulting wind rose for the raw wind data is shown in Figure 4.2, which indicates that the prevailing wind direction is from the southwest quadrant (200°-270°) with secondary winds from the northeast.

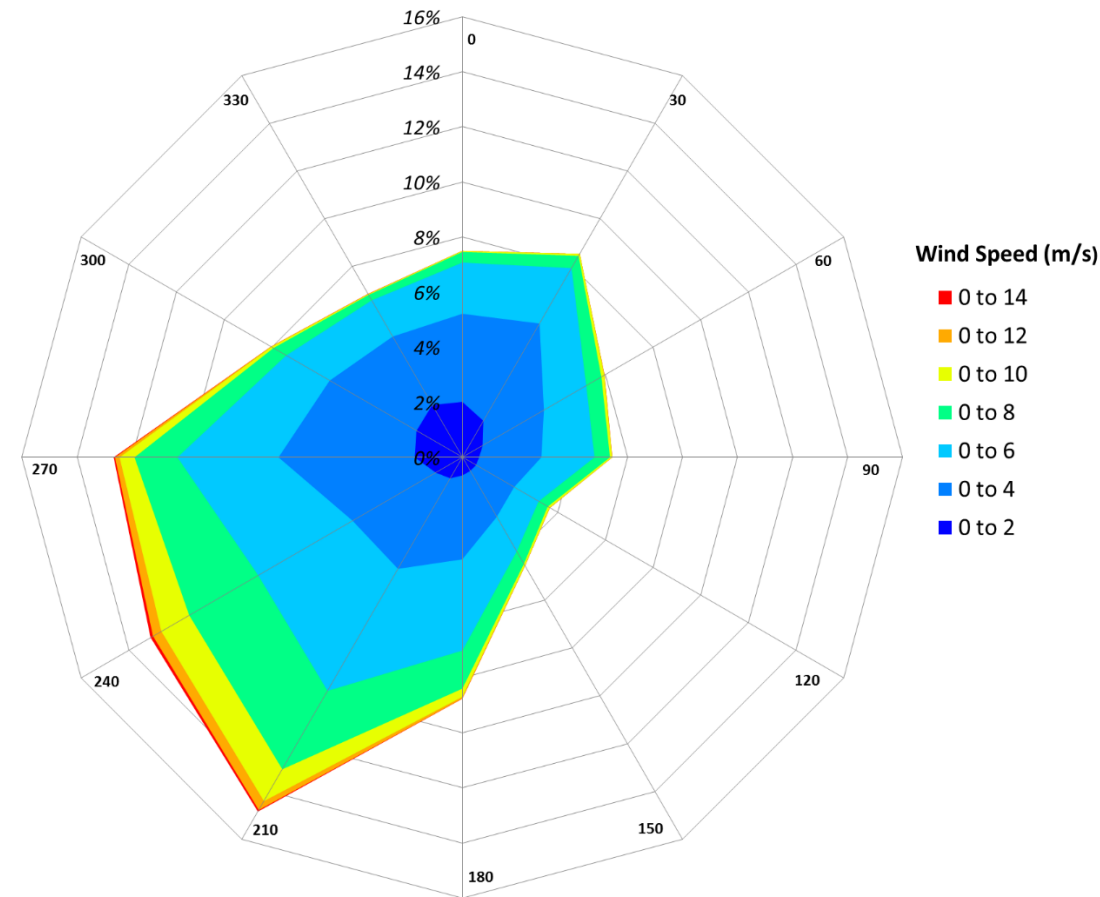


Figure 4.2: Wind Rose for Heathrow Airport (Raw Data)

4.5. Surface Roughness

Average wind speed increases with distance from the ground and this, along with turbulence effects has a significant impact on the resulting wind profiles around the buildings.

The roughness of the upwind ground surface is important in the formulation of the wind boundary layer. It affects the variation in atmospheric boundary layer, thus affecting the wind velocity felt at pedestrian level on the site.

The raw wind data is processed to produce Weibull functions representing all 36 wind directions to be simulated, accounting for upwind terrain roughness for both the measurement sites and also the proposed development. Weibull functions are a way of statistically analysing large quantities of data to establish probabilities of occurrence, in this case wind speed and direction.

Table 4.1 indicates the roughnesses appropriate for various terrains surrounding the proposed development. For each direction an approaching terrain roughness was chosen, at 10° intervals, according to the method described in 'EN 1991-1-4:2 05+A1:2010 (E)'.

Table 4.1: Terrain Categories

Terrain Category	Description	K_R	z_0 (m)	z_{min} (m)
I	Rough open sea; Lake shore with at least 5 km fetch up-wind and smooth flat country without obstacles	0.17	0.01	2
II	Farm land with boundary hedges, occasional small farm structures, houses or trees	0.19	0.05	4
III	Suburban or industrial areas and permanent forests	0.22	0.30	8
IV	Urban areas in which at least 15% of surface is covered with buildings of average height exceeding 15m	0.24	1.00	16

5. Methodology

To identify the likely effect of the proposed development on the pedestrian level wind environment, 3D CFD models of the proposed development and surrounding site were created. This section describes the methodology for the creation of this model and the inputs used.

5.1. Computational Fluid Dynamics

Simulations of the microclimate were conducted using ANSYS-Fluent CFD software.

The computational process involves the solution of fundamental equations of fluid motion within the CFD software. A computational mesh was created to represent the geometry by dividing the domain into a large number of cell volumes. During the simulation, the values of each variable are determined in each cell of the mesh and so a comprehensive assessment of velocity and scalar variation within the calculation domain is obtained. The dependent variables are as follows:

- Velocities in the three co-ordinate directions (U, V, W)
- Pressure (P)
- Turbulence Kinetic Energy (k)
- Turbulence Dissipation Rate (ϵ)
- Turbulence Specific Dissipation (ω)

Steady-state simulations were conducted to convergence for 36 wind directions for each geometrical model, using the k- ω SST turbulence model. The coupled, pseudo-transient solver was used with second order discretization for all variables, including pressure.

5.2. Geometry

CFD simulation of likely wind patterns requires the generation of a 3D computer model of the site and surrounding buildings.

The data listed in section 4.1 was used to construct a model of the buildings and surrounding area. Figures 5.1 to 5.2 show the modelled geometry.



Figure 5.1: Simulated Geometry: Plan View

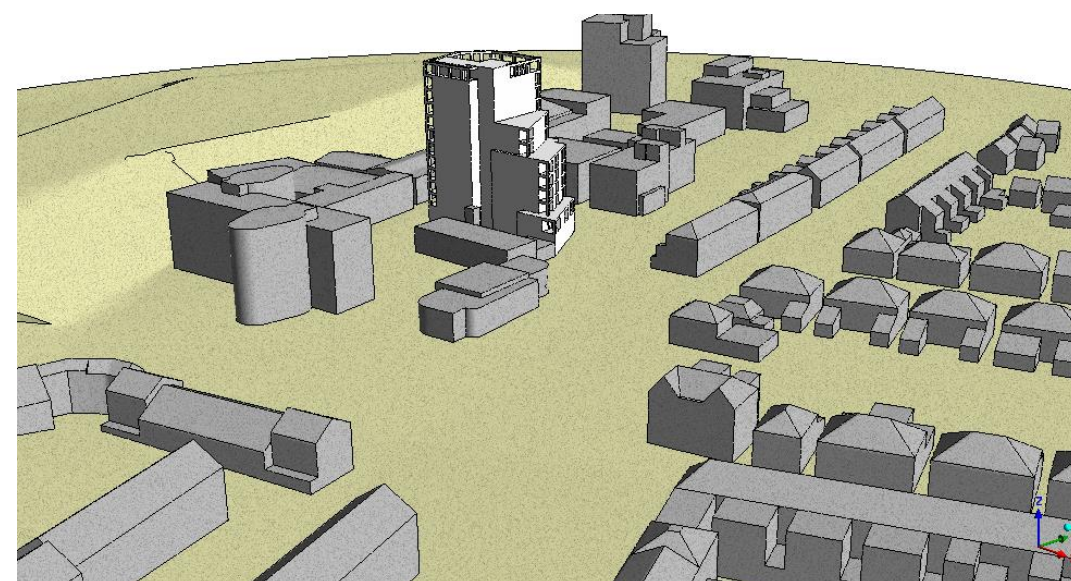


Figure 5.2: Simulated Geometry: Isometric View of Proposed Development

5.3. Mesh

To improve the resolution of the results, the mesh was concentrated in the areas of most interest (at pedestrian level around the Proposed Development) and around significant small-scale flow features. This ensures greater accuracy of the variables under investigation. Layers of thin prisms were applied to all solid boundaries, to improve resolution of boundary layers at these locations. The models used more than 12 million nodes.

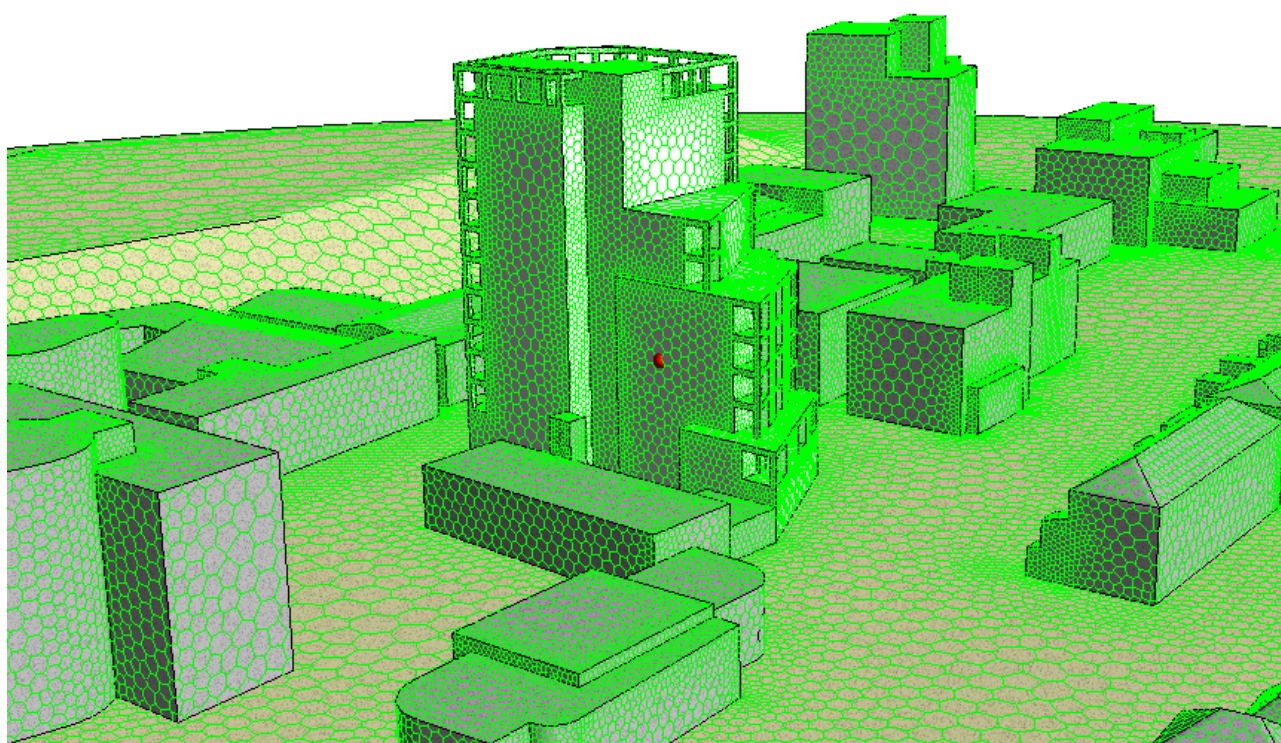


Figure 5.3: CFD Surface Mesh of Proposed Site with Adjacent Buildings

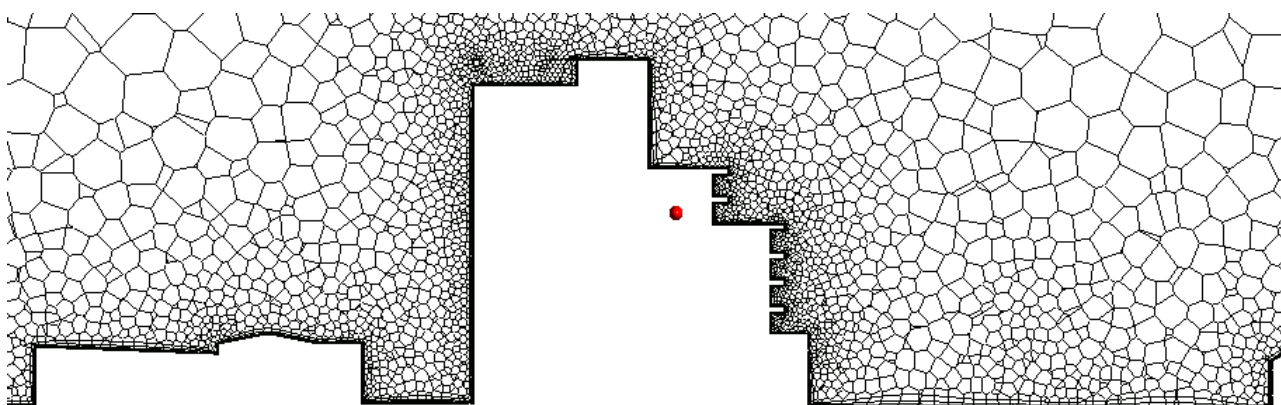


Figure 5.4: Vertical section through CFD Volume Mesh, showing HexCore, Polyhedra, and Prisms.

5.4. Boundary Conditions

A cylindrical computational domain was used for the analysis. This allows the wind direction to be altered without changing the computational mesh. Around the perimeter of the domain, a profile for the velocity and turbulence parameters was specified to take into account how the wind speed changes with the height from the ground. Surfaces within the model were specified as having 'no slip'. This condition ensures that flow moving parallel to a surface is brought to rest at the point where it meets the surface.

Accurate specification of the boundary layer wind profile is crucial in correctly simulating the pedestrian level wind environment. For this reason, a logarithmic profile was assumed, which creates a neutral wind boundary layer profile based on the assumption that wind speed increases proportionally with the natural logarithm of the height from the ground. The upstream logarithmic velocity profile has been applied for the simulations. This profile is for a wind in the highest decile of measured wind speeds, and is representative of typical strong winds.

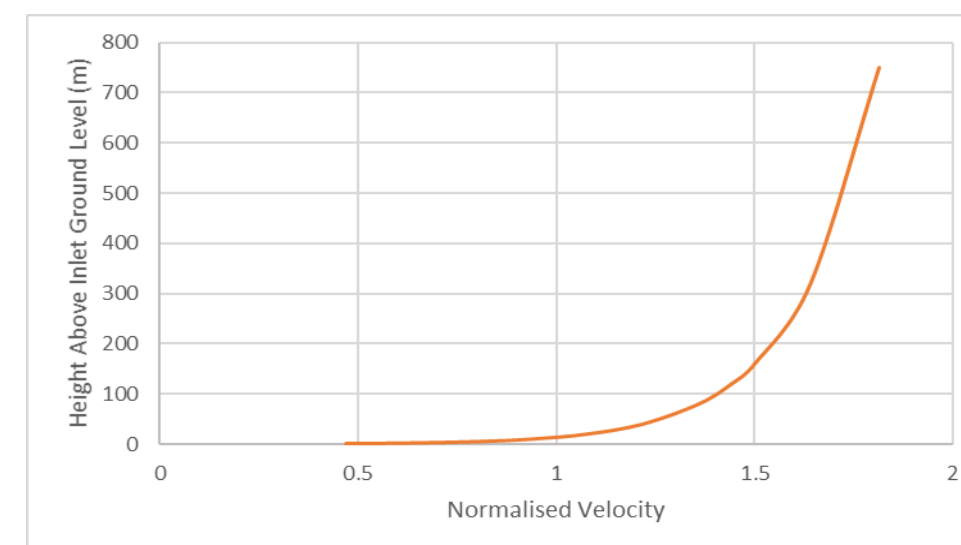


Figure 5.5: Vertical Profile of Inlet Velocity

5.5. Lawson Criteria

This report compares simulated results against the widely used LDDC Lawson Criteria, as set out in Building Aerodynamics by Tom Lawson, [Imperial College Press (2001)].

To produce the Lawson plots shown in section 6.1, statistical analysis of the number of hours and magnitudes of wind for 36 angles (10° increments) around the compass is performed. Results from each of the 36 simulated wind directions (as shown in Appendix 2 of this document) were measured at 1.5m above pedestrian level. From these measurements, the "speed-up" factors for each wind direction are combined with the wind frequency statistics for each direction to estimate the probability that the wind speed exceeds each threshold. This was performed at each point on the site, according to the wind data shown in Figure 4.2.

5.5.1. Comfort Criteria

For reporting the Lawson comfort criteria, this report uses the colour scale shown in Table 5.1. Regions coloured according to a given category are acceptable for the corresponding activity and all those with faster thresholds. E.g., if an area is coloured with the green shown for ‘category III’ then it will be acceptable for pedestrian walking and business walking but not acceptable for pedestrian standing and pedestrian sitting.

The Lawson comfort criteria take full account of reduced use during windier times of the year. They are based on a user’s typical expectations, given the general weather conditions.

Table 5.1: LDDC Lawson Comfort Criteria Definitions

	Lawson Comfort Category	Threshold Wind Speed	Threshold Description	Threshold Condition	Activity
	Pedestrian sitting	95 %ile < 4m/s	Light Breeze	Wind felt on face; leaves rustle; wind vane moved by wind	Long term sitting (e.g. outdoor cafes/bars)
	Pedestrian standing	95 %ile > 4m/s	Gentle Breeze	Leaves and small twigs in constant motion; light flags extended	Standing and main entrances (benches, bus-stops, markets, playgrounds etc.)
	Pedestrian walking	95 %ile > 6m/s	Moderate Breeze	Raises dust and loose paper; small branches moved	Leisure walking (shops, canals, parks, etc.)
	Business walking	95 %ile > 8m/s	Fresh Breeze	Small trees in leaf begin to sway; crested wavelets form on inland waters	People busy getting from A to B
	Roads & Car Parks	95 %ile > 10m/s	Strong Breeze	Large branches in motion; whistling heard in telegraph wires; umbrellas used with difficulty	Roads and Car Parks

5.5.2. Distress Criteria

The distress criteria assessment also uses the LDDC Lawson method, as set out in Building Aerodynamics, [Imperial College Press (2001)]. These state that for elderly or infirm pedestrians, the hourly mean wind speed should exceed 15 m/s for less than 0.025% of the year (approximately 2 hours). For able-bodied pedestrians, the hourly mean wind speed limit should exceed 20 m/s for less than 0.025% of the year. Should these be exceeded for more than 0.025% of the year, the method informs the wind engineer to consider if “the location [is] on a major route through the complex, and are there suitable alternate routes which are not ‘distressful’.

For reference, the 20m/s criteria is approximately the same as the Beaufort category for strong/severe gale (Slight structural damage - chimney pots and slates removed).

Although these criteria are formally titled “Pedestrian Distress”, they are commonly used as the basis of discussion for Pedestrian Safety, and have been adopted as such by some councils.

5.5.3. Intended Pedestrian Activities

An assessment was undertaken of the intended pedestrian activities around the proposed development, to identify the relevant pedestrian comfort criteria to be applied in any given location. This assessment considers not only the pedestrian spaces immediately adjacent to the development, but also those surrounding the adjacent buildings. For the purposes of this assessment, the rooftop terrace spaces were presumed to be intended for pedestrian standing.

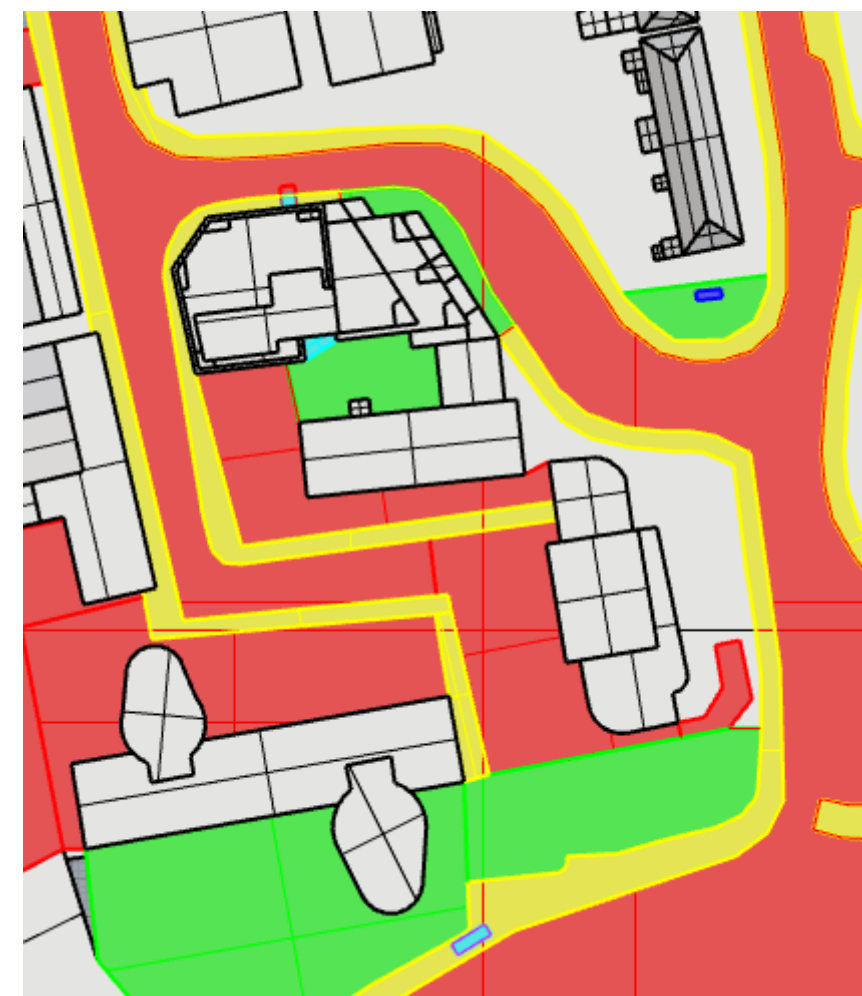


Figure 5.6: Intended Pedestrian Comfort Conditions

6. Results

6.1. Comfort & Distress

Figure 6.1 shows that the site of the proposed development is in a very sheltered location, in the lee of the railway embankment to the southwest.

Figure 6.2 shows that, although the proposed development is likely to increase the windiness of the region, conditions are likely to remain well within the acceptability criteria for all regions.

Results showed no likely regions of pedestrian distress.

Table 6.1: LDDC Lawson Comfort Criteria Typical Activities

	Comfort category	Colour	Location examples
I	Pedestrian sitting	Blue	Cafés, Outdoor Auditoria
II	Pedestrian standing	Cyan	Bus stops, Main entrances, Playgrounds, Park Benches, Markets
III	Pedestrian walking	Green	Retail Areas, Parks, Canals
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Figure 6.1: Lawson Comfort Plot - Existing

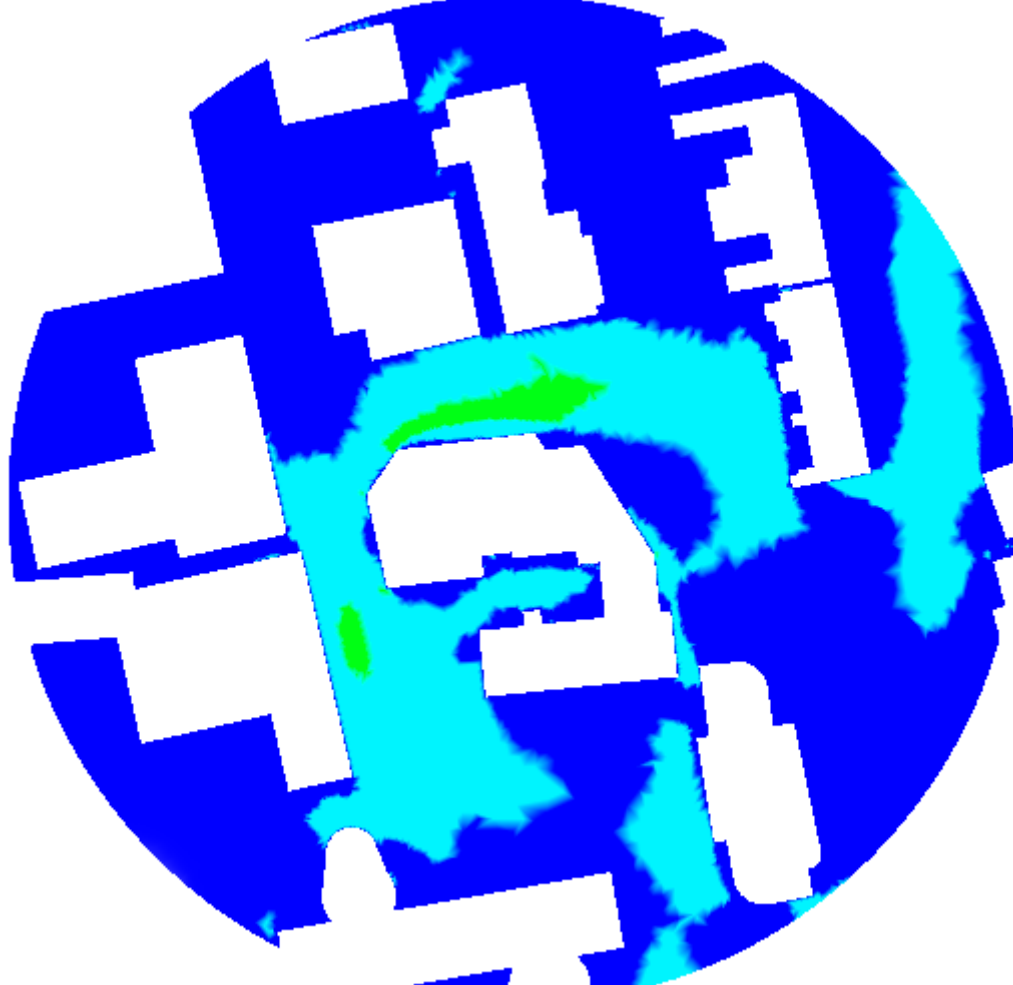
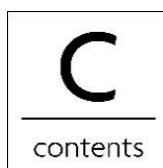


Figure 6.2: Lawson Comfort Plot - Proposed



7. Conclusions

7.1. Introduction

A new development is proposed for the Jessica Buttons Factory site, at 30-36 Clarendon Road as the first phase of a forthcoming wider masterplan. The proposed development will provide commercial space together with sustainable new homes, including affordable homes. The proposal rises to 12 stories, with balconies and roof terraces at several levels.

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Simulations show that the impact of the proposed massing on the pedestrian wind microclimate for either comfort or distress is likely to produce conditions that are acceptable, and therefore meets the policy test referenced previously.