



WIND MICROCLIMATE ASSESSMENT REPORT

Victoria House, Manchester

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1 INTRODUCTION

This report outlines the results of a wind microclimate analysis for the proposed Victoria House development in Manchester, UK.

1.1 SUMMARY

Wind microclimate conditions for the proposed development of Victoria House were assessed using high resolution CFD.

When tested with existing surrounds, and in the absence of wind mitigation measures, there is a region of potential wind safety risk at the western corner of the proposed development.

When the neighbouring Heyrod Street scheme (127317/FO/2020) is included, this safety exceedance is eradicated.

Comfort conditions are suitable for the intended use.

When the Heyrod Street scheme is taken into consideration, the proposed wind mitigation on the south of the development (600m deep fins and trees at ground level) is no longer required to achieve suitable conditions.

1.2 BACKGROUND

This study was concerned with the wind microclimate conditions around the proposed development in the presence of the neighbouring Heyrod Street development (127317/FO/2020)..

At the time of the wind assessment submitted with the planning application, the Heyrod Street development was not consented.

At the time of writing, the Heyrod Street scheme has the ground floor cast and core up to level 4, so it is reasonable to expect it to be complete either prior to or around the same time as the proposed development.

The purpose of this assessment is to consider whether the wind mitigation measures included within the consented scheme are still necessary in the presence of the Heyrod Street scheme.

1.3 GUIDANCE

The assessment was performed using the LDDC variant of the Lawson Comfort Criteria. The Lawson Criteria are well-established in the UK for quantifying wind conditions in relation to build developments and, although not a UK 'standard', the criteria are recognised by local authorities as a suitable benchmark for wind assessments. The Lawson Criteria have been adopted for this assessment.

Planning Practice Guidance 6th March 2014. The Department for Communities and Local Government (DCLG) web based Planning Practice Guidance resource includes a section on design and sets out how a building's size and shape can affect the wind microclimate. The section addressing Design - How should buildings and the spaces between them be considered? 'Consider scale' Paragraph O26, states that: "Account should be taken of local climatic conditions, including daylight and sunlight, wind, temperature and frost pockets."

2 METHOD

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

2.1 ASSESSMENT METHODOLOGY

The assessment was performed using GIA's high-resolution Computational Fluid Dynamics (CFD) modelling.

CFD is a digital modelling technique, which simulates the effect of wind for the built environment. The air is divided into hundreds of millions of "cells", within which the equations of motion are solved. GIA uses cloud computing from Amazon Web Services (AWS) to run the simulations, to ensure vast scalability and appropriate resource availability for any project.

A full description of the test methodology is included in Appendix 01.

On-site and local wind speeds were combined with wind statistics from 30 years of data recorded at Manchester International Airport corrected for variations in terrain between the airport and the site, to obtain annual and seasonal frequency and magnitude of wind speeds across the model. This allows the 'grading' of the pedestrian level winds according to the Lawson Comfort Criteria, which are explained later in this report.

The correction factors between the airport (measured 10m above ground) and the Site (at a reference height of 120m) are shown in Table 1. It should be noted that the terrain analysis has been performed using sectors of 30°, which is presented here.

The wind microclimate effects are assessed annually, for the winter months (December, January and February) and for the summer months (June, July, August). Winter conditions are reported as this is the season when the strongest winds are expected, summer conditions are reported as this is the season when pedestrian usage of outdoor spaces is expected to be highest.

2.2 ESTABLISHING MICROCLIMATE CONDITIONS

Microclimate conditions were established using a high resolution CFD model, extending 600m radius from the Site.

A model of the Development was included within the CFD model and tested to determine the conditions at and around the Site. The model used is shown in Figure 1, Figure 2, and Figure 3.

The model was run at full scale from 18 wind angles, spaced using 10° or 30° increments such that no sector contributes more than 10% of the annual wind. The wind angles which were run are indicated in Appendix 01.

Wind speeds were measured at 1.5m above any surfaces expected to be used for pedestrian activity.

Table 01: Site Wind Correction Factors

DIRECTION (°N)	0°	30°	60°	90°	120°	150°	180°	210°	240°	270°	300°	330°
Corr. Factor	1.56	1.48	1.48	1.44	1.35	1.32	1.32	1.32	1.32	1.29	1.42	1.40



Fig. 01: 3D View of Proposed Development and Heyrod Street Scheme



Fig. 02: Proposed Development in Existing Surrounds



Fig. 03: Proposed Development in Existing Surrounds plus Heyrod Street Scheme

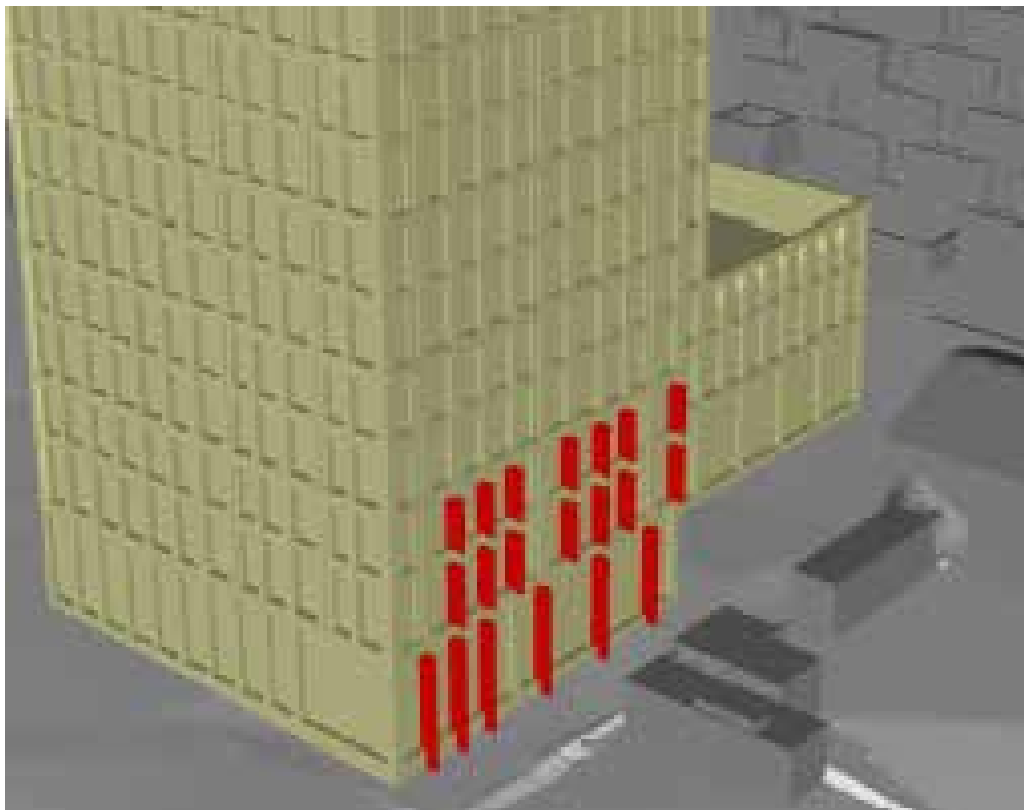


Fig. 04: Wind Mitigation Screens as Consented

2.3 **TARGET CONDITIONS**

For a mixed-use urban area within which the Site is located, the desired wind microclimate would typically need to have areas acceptable for sitting, standing (including at entrances of buildings) and walking use. A description of the comfort categories to classify wind conditions in accordance with is given below.

Any areas which show up as either unsafe (annually) or uncomfortable (for winter) will require mitigation, unless they are in locations where pedestrian access can be controlled in the event of strong winds. This applies to all thoroughfares (for pedestrians) and roads (for cyclists) around the Development.

The target conditions for the building entrances is to be suitable for standing in any season.

The target condition for the amenity space (the proposed public square to the south of the proposed development) is to be suitable for a mixture of sitting and standing in summer.

2.4 **TEST SCENARIOS**

The purpose of these tests was to assess the conditions around the site with and without the neighbouring Heyrod Street scheme.

The following scenarios were tested:

- Proposed Development with Existing Surrounds (shown in Figure 2)
- Proposed Development with Existing Surrounds plus the Heyrod Street scheme (shown in Figure 3)

The Proposed Development was tested without the following consented mitigation measures, to assess whether they are still necessary:

- 600mm deep fins on the southern facade of the building (shown in Figure 4).
- Landscaping at ground level.

2.5 **LIMITATIONS AND ASSUMPTIONS**

The accuracy of the results is dependent upon the accuracy of the CAD used to construct the model.

There is an inherent assumption that on-site wind speeds will scale linearly with the measured wind speeds at the airport.

There is an inherent assumption that the wind speed statistics for the past 30 years will remain applicable for the foreseeable future.

Table 02: Lawson Comfort Criteria (LDDC variant)

KEY	COMFORT CATEGORY	MEAN WIND SPEED (5% EXCEEDANCE)	DESCRIPTION
	Sitting	4 m/s	Acceptable for outdoor sitting use (e.g. cafes, benches, balconies and terraces)
	Standing	6 m/s	Acceptable for main building entrances, pick-up / drop-off points and bus stops
	Walking (leisure)	8 m/s	Acceptable for strolling
	Walking (business)	10 m/s	Acceptable for external pavements, walking purposefully without lingering
	Uncomfortable	>10 m/s	Not comfortable for regular pedestrian access

Table 03: Lawson Safety Criteria (LDDC variant)

KEY	SAFETY CATEGORY	MEAN WIND SPEED (0.022% EXCEEDANCE)	DESCRIPTION
	No Safety Exceedance	<15 m/s	
	S15 (Distress)	>15 m/s	Unsafe for frail individuals, or cyclists
	S20 (Safety)	>20m/s	Wind conditions considered unsafe for all users

3 RESULTS

3.1 SAFETY CONDITIONS

Annual safety for the proposed development with existing surrounds is shown in Figure 5.

Annual safety for the proposed development with existing surrounds plus the Heyrod Street scheme is shown in Figure 6

For the proposed development in existing surrounds, there is a significant region of safety exceedance at the western corner of the proposed development. This is an S15 exceedance, which would pose a risk to the safety of vulnerable individuals or cyclists during strong winds,

When the Heyrod Street scheme is included, this exceedance is eradicated.

3.2 WINTER CONDITIONS

Winter Comfort for the proposed development with existing surrounds is shown in Figure 7.

Winter Comfort for the proposed development with existing surrounds plus the Heyrod Street scheme is shown in Figure 8

For both options, conditions range between suitable for sitting, standing and leisure walking, with a localised region of business walking.

The region of business walking is located at the western corner of the building when tested with the existing surrounds, and at the south east corner of the building when the Heyrod Street scheme is included.

Conditions at the principal building entrances (marked "E" on Figure 7 and Figure 8) are suitable for either sitting or standing. For each scenario there is a single entrance (circled in the respective figures) which is close to a region of leisure walking, but in each case there is a thin region which is suitable for standing which provides the requisite buffer between internal and external conditions. This is suitable for the intended use.

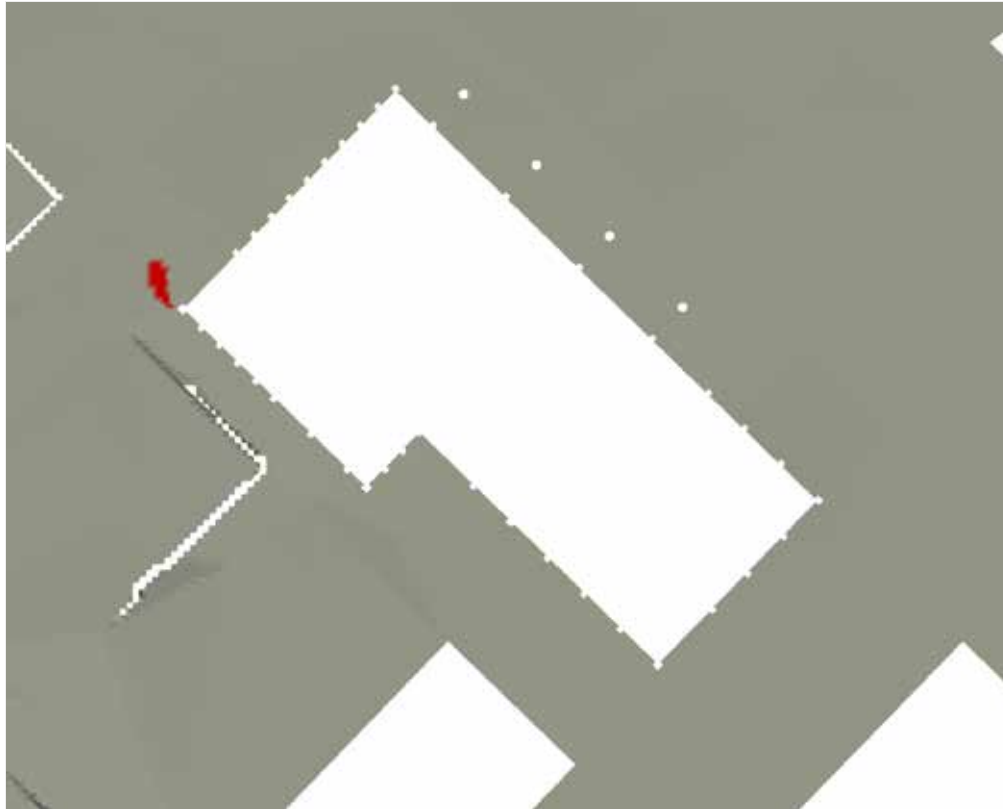
3.3 SUMMER CONDITIONS

Summer Comfort for the proposed development with existing surrounds is shown in Figure 9.

Summer Comfort for the proposed development with existing surrounds plus the Heyrod Street scheme is shown in Figure 10.

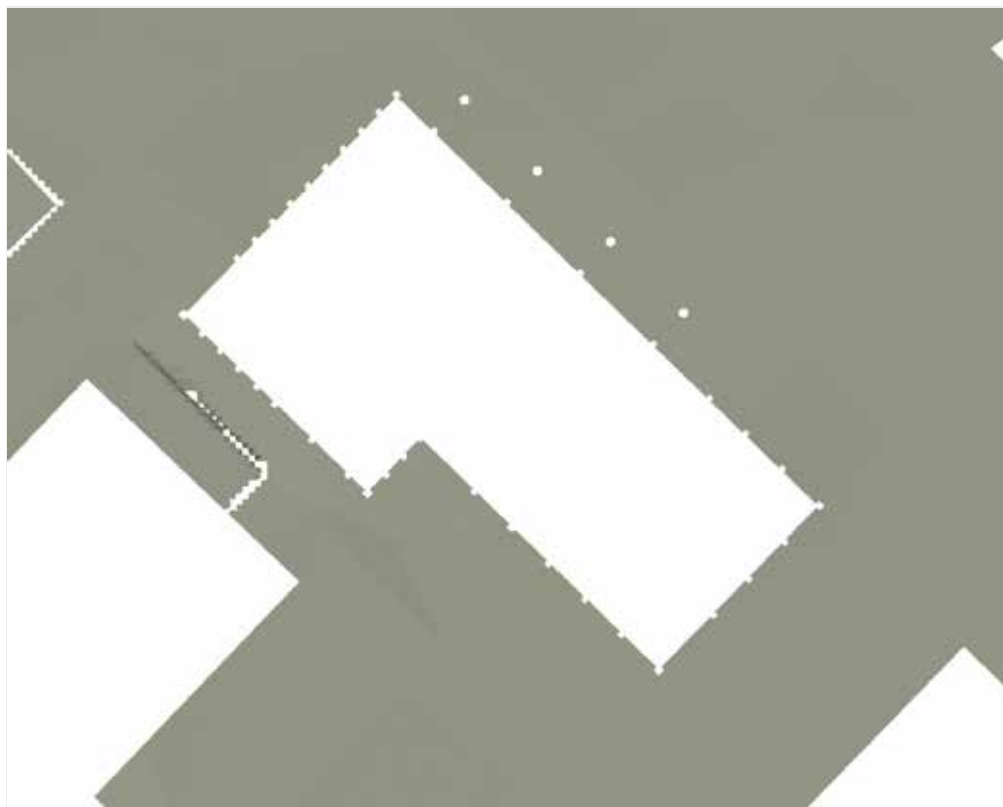
For both options, conditions range between sitting and standing, with some localised regions which are suitable for leisure walking.

Conditions for the public square are suitable for a mixture of sitting and standing in each case. This is suitable for the intended use.



KEY	SAFETY CATEGORY
	No Safety Exceedance
	S15 (Distress)
	S20 (Safety)

Fig. 05: Annual Safety, Proposed Development in Existing Surrounds



KEY	SAFETY CATEGORY
	No Safety Exceedance
	S15 (Distress)
	S20 (Safety)

Fig. 06: Annual Safety, Proposed Development in Existing Surrounds plus Heyrod Street Scheme

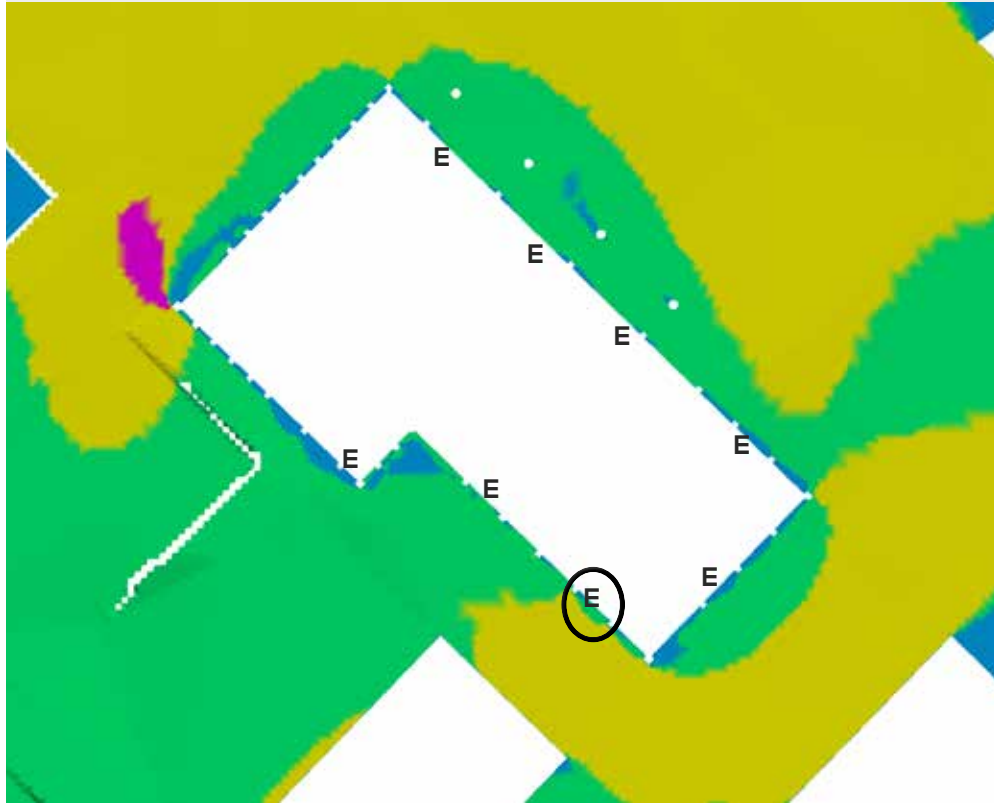
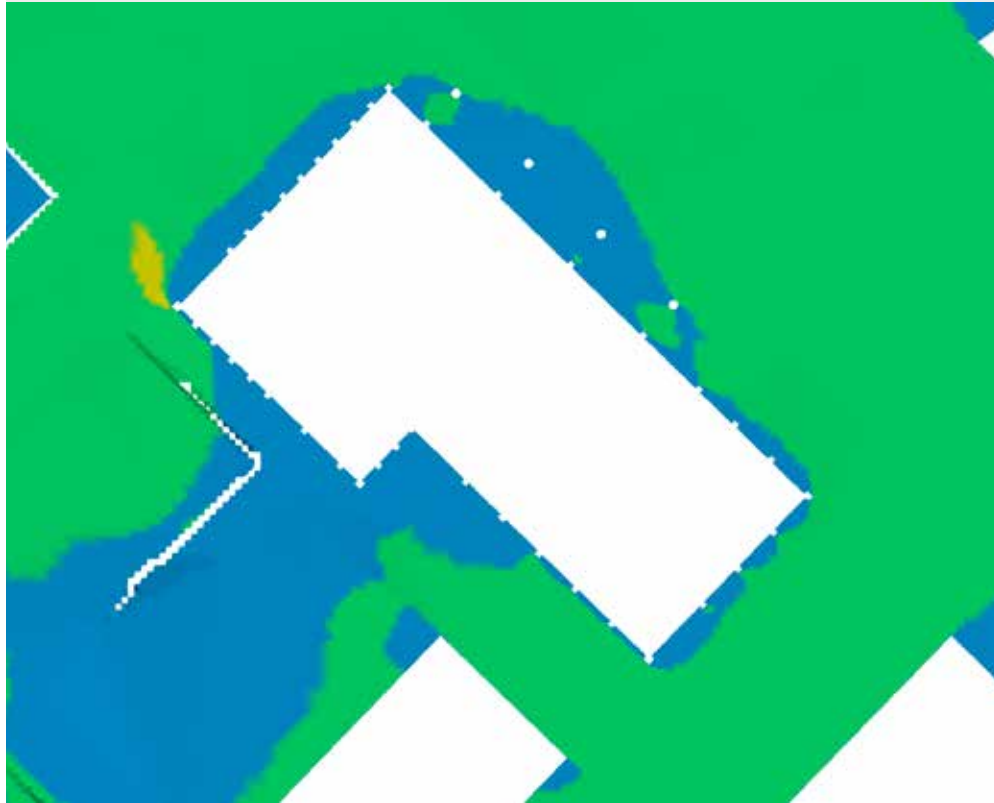


Fig. 07: Winter Comfort, Proposed Development in Existing Surrounds

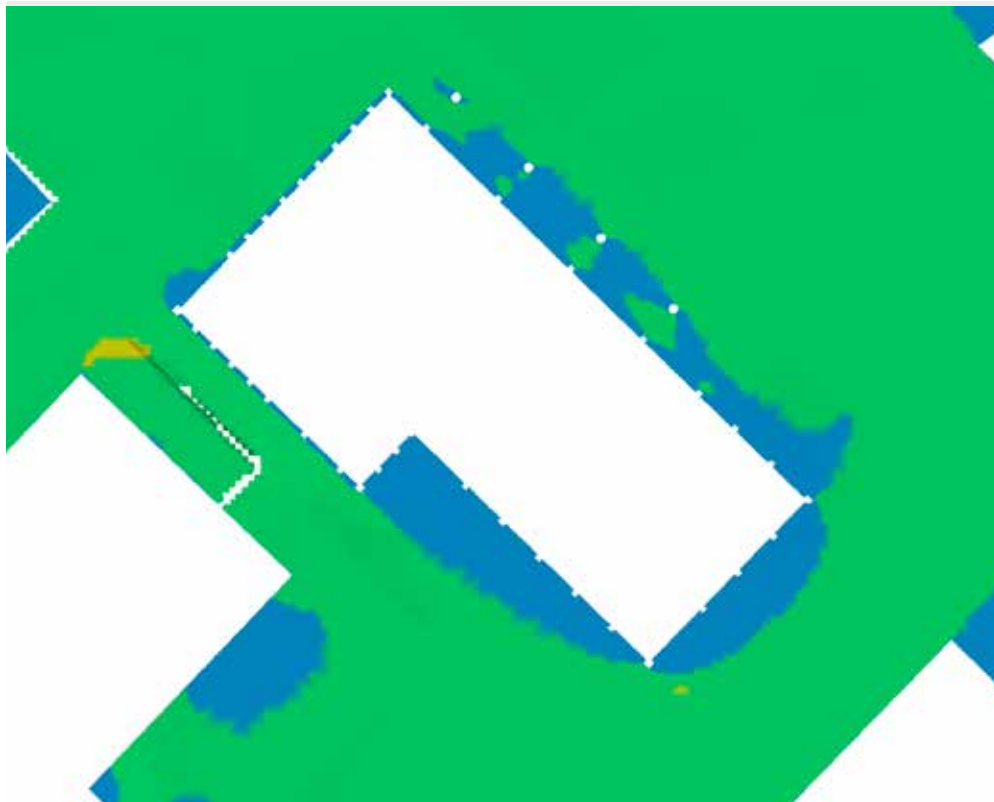


Fig. 08: Winter Comfort, Proposed Development in Existing Surrounds plus Heyrod Street Scheme



KEY	COMFORT CATEGORY
Blue	Sitting
Green	Standing
Yellow	Walking (leisure)
Pink	Walking (business)
Red	Uncomfortable

Fig. 09: Summer Comfort, Proposed Development in Existing Surrounds



KEY	COMFORT CATEGORY
Blue	Sitting
Green	Standing
Yellow	Walking (leisure)
Pink	Walking (business)
Red	Uncomfortable

Fig. 10: Summer Comfort, Proposed Development in Existing Surrounds plus Heyrod Street Scheme

4 CONCLUSIONS

Wind microclimate conditions for the proposed development of Victoria House were assessed using high resolution CFD.

When tested with existing surrounds, and in the absence of wind mitigation measures, there is a region of potential wind safety risk at the western corner of the proposed development.

When the neighbouring Heyrod Street scheme (127317/FO/2020) is included, this safety exceedance is eradicated.

Comfort conditions are suitable for the intended use.

When the Heyrod Street scheme is taken into consideration, the proposed wind mitigation on the south of the development (600m deep fins and trees at ground level) is no longer required to achieve suitable conditions.

APPENDIX 01

DETAILED METHODOLOGY

CFD METHODOLOGY

The CFD was performed using OpenFOAM.

Meshed using a hybrid mesh of hexahedral, polyhedral, tetrahedral and prismatic elements:

- On site building edge length: 0.05m – 0.25m
- Surrounding context edge length: 0.25m – 1m

Prismatic cells were used in the boundary layer region, with 4 layers of cells growing with an expansion ratio of 1.15 and aspect ratios between 0.1 and 0.4.

The total mesh size was 152 million cells. Mesh detail is shown in Figure 11 and Figure 12.

Buildings within 400m of the site were included.

The domain was 5000mx5000m, with a blockage ratio of 0.5%

The blockage ratio uses a “test section” of 600mx200m (within which detail is captured).

Run using the SST turbulence model with high Re wall functions to ensure mesh suitability.

The simulations were steady state and isothermal.

2nd order discretisation schemes were used.

Convergence was measured as the residuals of the continuity, x-velocity, y-velocity, z-velocity, k and omega equations all falling by at least 2 orders of magnitude, and by measured static pressure on the site buildings varying by less than 1% over the final 100 iterations.

The wind speed is corrected into a “gust-equivalent” mean. The gust-equivalent mean is calculated using an empirical relationship between the gust and mean ratios recorded at over 13,000 data points from wind tunnel tests. This method is found to give a significant correlation improvement over the more traditional methods based on the CFD turbulent kinetic energy field.

WIND CLIMATE METHODOLOGY

The simulations were performed from 18 wind directions, spaced such that no single direction contributed more than 10% of the annual winds.

The directions simulated were 0°, 30°, 60°, 90°, 120°, 150°, 170°, 180°, 190°, 200°, 210°, 220°, 240°, 260°, 270°, 280°, 300°, 330°.

Seasonal wind roses for Manchester International Airport are shown in Figure 13

Target wind profiles for the site, from each wind direction, were generated using sectoral analysis of the terrain surrounding the site and the local weather stations with ESDU 2010 Item 01008 ‘Computer program for wind speeds and turbulent properties: flat or hilly sites in terrain with roughness changes’. The target wind profiles, compared to the wind speeds measured from the CFD model are shown in Figure 14.

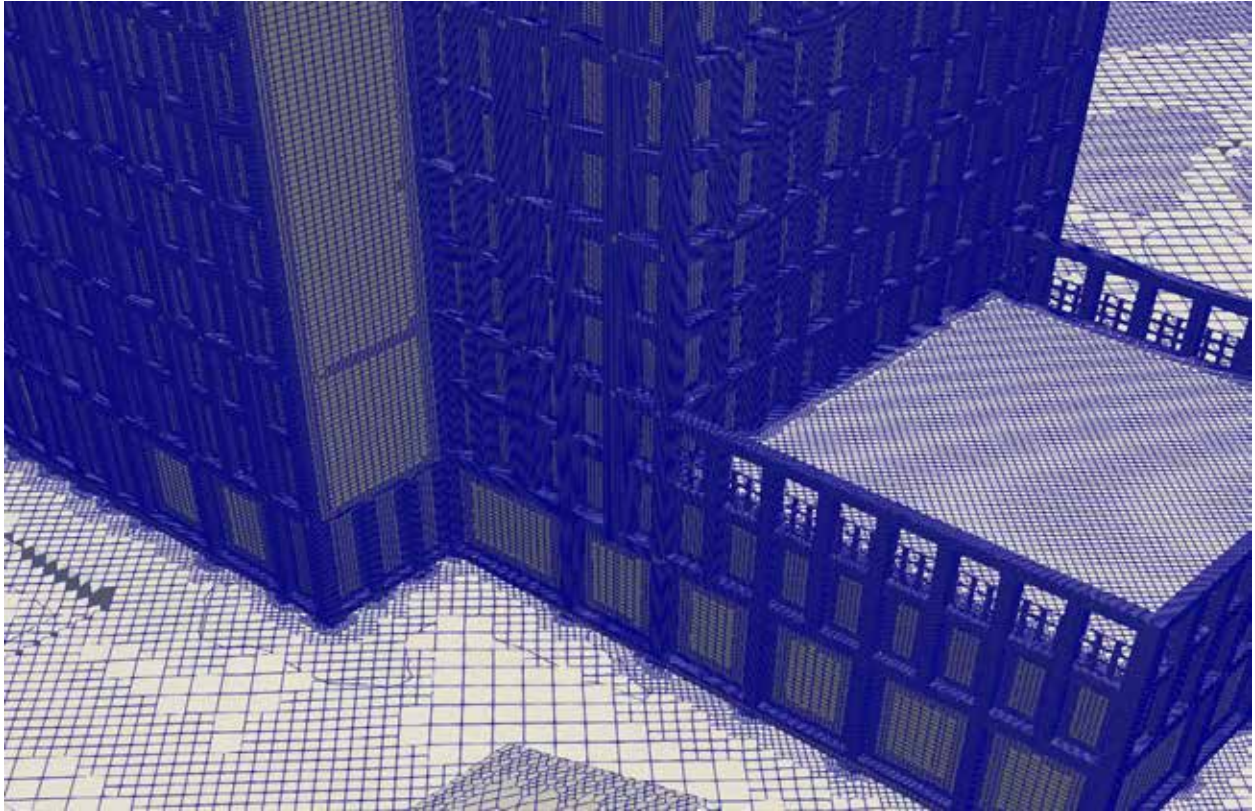


Fig. 11: Mesh Detail on Site Buildings

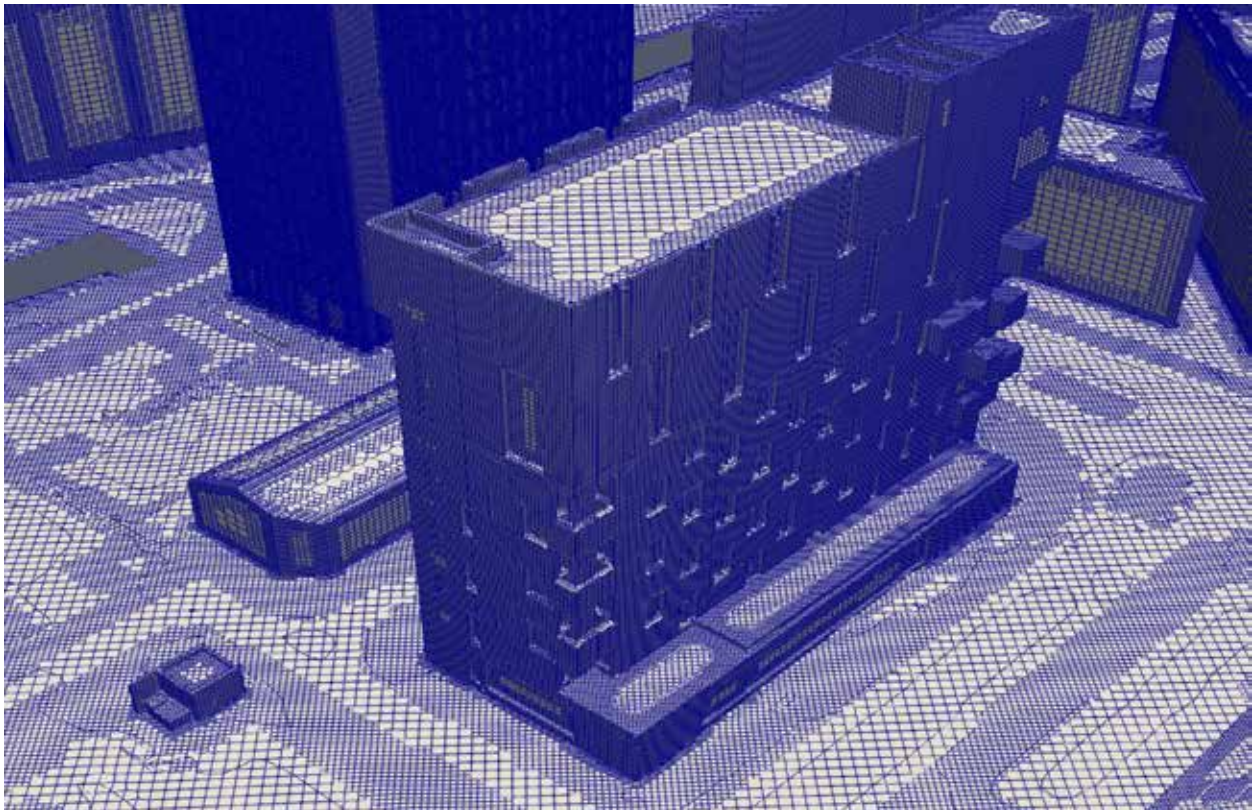


Fig. 12: Mesh Detail on Surrounds

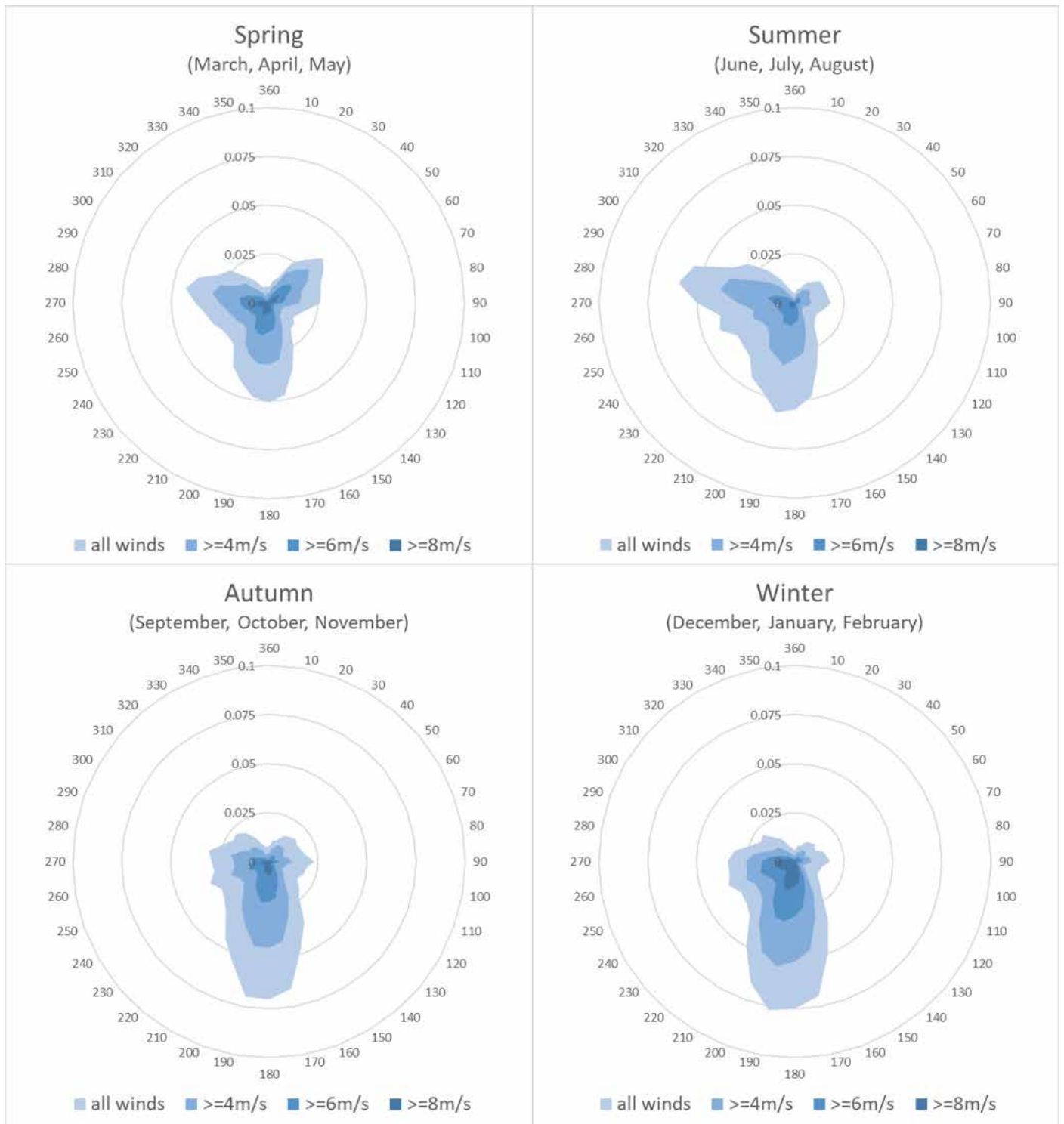


Fig. 13: Seasonal Wind Roses for Manchester International Airport (1990–2020)

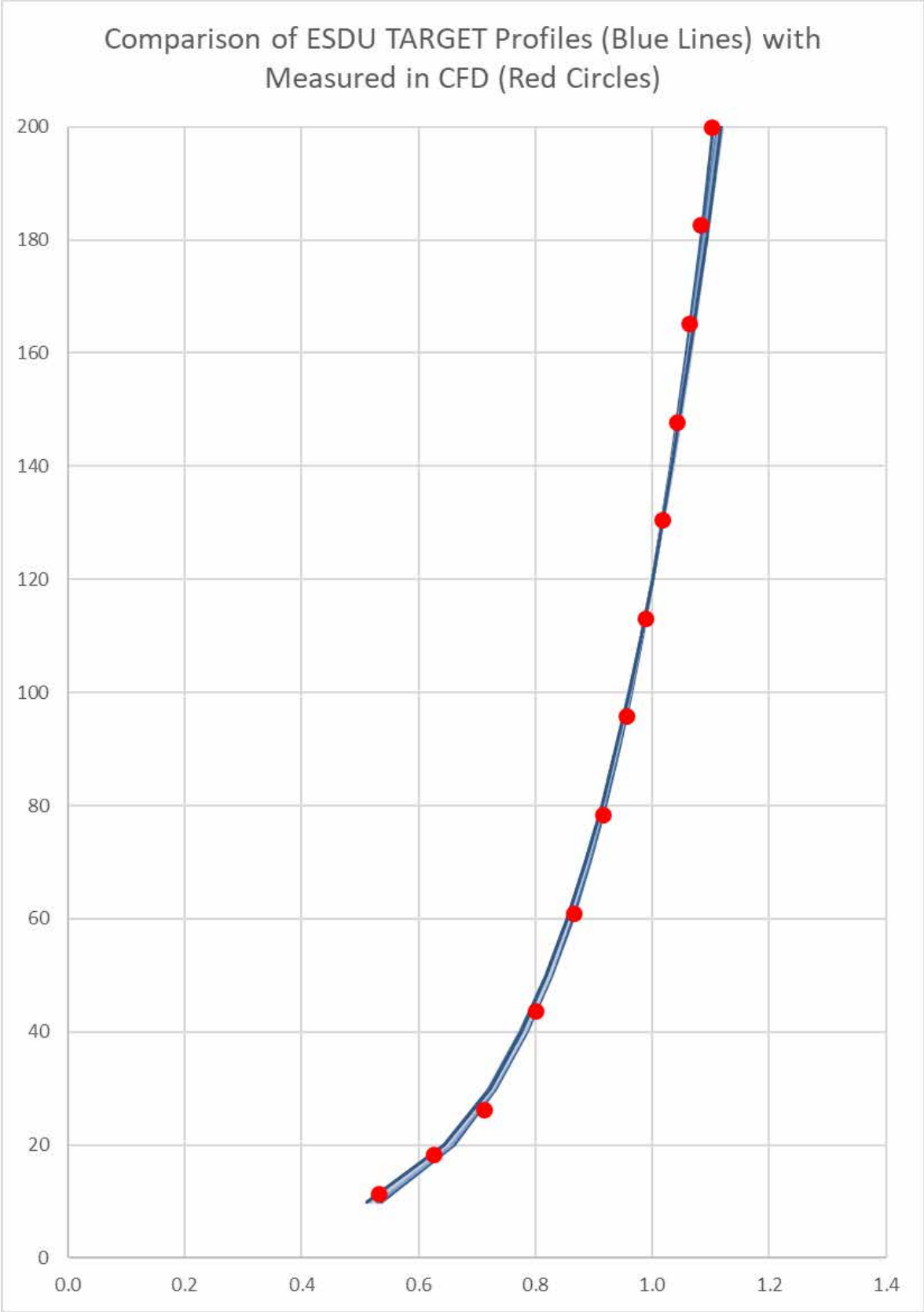


Fig. 14: Wind Profile for Victoria House



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