



FUSION STUDENTS

DEANSGATE SOUTH

WIND MICROCLIMATE PROOF OF EVIDENCE

MARCH 2022

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WIND MICROCLIMATE PROOF OF EVIDENCE

MARCH 2022

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1 INTRODUCTION, EXPERIENCE AND SCOPE OF EVIDENCE

1.1 Introduction and Experience

- 1.1.1 I have a Bachelor of Science degree with Honours in Environmental Science from the University of Bournemouth (2003). I became a fully qualified member of the Energy Institute (MEI) and Chartered Environmentalist (CEnv) in 2016.
- 1.1.2 I am a Technical Director in the firm of Wardell Armstrong LLP and am responsible for Energy and Climate Change services across all 15 Wardell Armstrong offices. I have worked for Wardell Armstrong for 18 years.
- 1.1.3 I have a background in renewable energy including site selection and wind modelling to locate wind turbine generators (WTG's). These skills have also been employed in the assessment of wind effects from tall buildings on the pedestrian wind environment since 2015.
- 1.1.4 I have experience of wind microclimate assessment within numerous cities in the UK as well as co-ordination and management of the EIA process. Working with my clients, colleagues and other consultants I was involved in the preparation of the wind microclimate chapter of the EIA for the application that is now subject to this appeal.

1.2 Scope of Evidence

- 1.2.1 The Planning Officers report (hereafter referred to as the POR) has 6 reasons for refusal. My evidence, alongside that presented separately by GreenBlue Urban on the specifics of planting street trees, addresses the 6th reason, namely:

Reason 6

The proposed building by reason of its scale, massing and height would have a detrimental impact upon the wind environment around the building, requiring mitigation. The applicant has failed to demonstrate that the mitigation measures put forward are capable of implementation and no alternatives have been put forward. Therefore, it is considered that the proposed building, by reason of its scale, massing and height, could have a detrimental impact on the safety and comfort of pedestrians and cyclists, thereby being contrary to policies EN2 and DM1 of the Manchester Core Strategy.

- 1.2.2 In addition, the Statement of Case by Manchester City Council (hereafter referred to as the SOC) expands on this and widens the scope to wind environment itself alongside the feasibility of the mitigation. At paragraph 7.11 it states:

7.11 The Council will show that insufficient information has been given by the appellant to show that the proposed wind mitigation measures of planting street trees within the pavement on Bridgewater Viaduct would be effective or can be adequately or feasibly implemented, given the likelihood of obstructions to this, such as the presence of underground services. No alternatives have been put forward for consideration and the Council will contend that any alternative measures may have material implications on the appearance of the building and surrounds and/or on the usability of the public highway. The level of harm caused to the wind environment would be significant and would result in public safety issues and is therefore a fundamental issue in terms of whether this scheme is acceptable. If the proposed mitigation measures would not be effective and cannot be implemented, then the appeal should be dismissed. The mitigation measures should therefore be fully understood at this stage.

- 1.2.3 Based on the relevant extracts from the POR and SOC replicated above, I will cover the following matters in this proof:
- The effect of the proposals on the wind micro climate, having regard to modelling assessments and whether the proposals would lead to acceptable conditions in terms of safety and comfort within the surrounding wind environment; and
 - Assessment of the need for , feasibility , nature and effect of a scheme of mitigation.
- 1.2.4 As outlined above a separate proof is being provided by Greenblue Urban to cover issues relating to the feasibility of the proposed mitigation measures.
- 1.2.5 This proof will cover issues relating to both safety and comfort of pedestrians and cyclists.
- 1.2.6 I reserve the right, however, to deal with any new issues that are raised in evidence.
- 1.2.7 I confirm that, insofar as the facts stated in my evidence are within my own knowledge, I have made clear what they are, and I believe them to be true; and that

the opinions I have expressed represent my true and complete professional opinion irrespective of by whom I am instructed.

2 COMMUNICATION DURING THE APPLICATION PROCESS

- 2.1.1 No communication, requests for data or comment was received from Manchester City Council with regards to wind microclimate prior to the release of the committee report.
- 2.1.2 Specifically, no opportunity was provided to prove the mitigation proposed was deliverable or respond to concerns

3 CHANGES TO MODELLING

- 3.1.1 While putting together this proof it has come to light that there were some errors in some of the meshes used in the original assessment. In particular the refinement process used to increase accuracy in areas of interest did not pick up the bridge over the A56 in all cases. This has slightly altered the outputs of the modelling for some wind directions and as such a revised ES chapter is included as appendix 1 to this proof, to correct the position.
- 3.1.2 In summary, under the safety scenario, slightly higher windspeeds are observed in the 70 degree wind direction and slightly lower windspeeds are observed in the 30 and 60 degree wind directions.
- 3.1.3 Under the comfort scenario windspeeds are generally lower across the board but with slightly higher windspeeds again observed in the 70 degree wind direction.

4 ASSESSMENT METHODOLOGY AND THE USE OF SIGNIFICANCE CRITERIA

- 4.1 Guidance
 - 4.1.1 The assessment references the significance criteria and CFD guidance detailed in the 'Wind Microclimate Guidelines for Developments in the City of London produced by City of London Corporation and RWDI, August 2019'.

4.2 Assessment Methodology

- 4.2.1 To identify the likely effects of the Proposed Development on the pedestrian level wind environment, a 3D Computational Fluid Dynamic (CFD) model of the Proposed Development and surrounding wider area were created.
- 4.2.2 Wind directions always indicate the direction that the wind blows from. For instance, a wind direction of 90 degrees (°) denotes a wind blowing from the east.
- 4.2.3 Simulations of the microclimate were conducted using OpenFOAM CFD software. CFD simulation of likely wind patterns requires the generation of a three-dimensional computer model of the site and surrounding buildings.
- 4.2.4 A 3D model of the Proposed Development and terrain was provided by Gordan Ingram Associates (GIA).
- 4.2.5 Porous structures and vegetation were excluded from the safety and comfort modelling. However, these were discussed as part of mitigation strategy.
- 4.2.6 OpenFOAM CFD software has been used to obtain a solution to the fundamental equations of fluid motion as applied to each cell in the model through intensely computational numerical processing. A computational 'mesh' has been 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.
- 4.2.7 The dependent variables are as follows:
- **Velocities in the three co-ordinate directions (X, Y, Z);**
 - **Pressure (P);**
 - **Turbulence Kinetic Energy (k);**
 - **Turbulence Dissipation Rate (ϵ); and**
 - **Turbulence Specific Dissipation (ω).**
- 4.2.8 Full details of the assessment methodology are available in the ES chapter (Appendix 1) and a list of the CFD parameters utilised in the modelling are given in appendix 2.
- 4.2.9 Wind data was obtained from the Met Office using their virtual met mast dataset. This is a site centred dataset that uses the Met Office climate forecasting model to accurately model historic windspeeds in cells as small as 10m over the previous 30 years. This model is considered to be extremely accurate and is far more reliable

than using surface roughness to translate wind speeds from a wind monitoring site. The wind data is provided as a 30 year 10 minute time series. Summary statistics from the wind data are provided in appendix 2.

4.3 Significance Criteria

- 4.3.1 The Lawson Criteria provide threshold wind speeds which should not be exceeded 95% of the time for given pedestrian activities to be carried out comfortably. This assessment has used the London Docklands Development Corporation (LDDC) version of the criteria, as outlined in the City of London planning advice note, which are reproduced in Table 4-1 and Table 4-2 below.

Table 4-1 – Lawsons LDDC Criteria - Comfort

Comfort Category	Threshold (m/s)	Description
Frequent Sitting	2.5	Acceptable for frequent outdoor sitting use, e.g. restaurant, cafe
Occasional Sitting	4	Acceptable for occasional outdoor seating, e.g. general public outdoor spaces, balconies and terraces intended for occasional use, etc.
Standing	6	Acceptable for entrances, bus stops, covered walkways or passageways beneath buildings
Walking	8	Acceptable for external pavements, walkways
Uncomfortable	>8	Not comfortable for regular pedestrian access

- 4.3.2 In addition, a safety threshold is set for the wind speed exceeded twice per year or 0.022% of the time from any wind direction.

Table 4-2 – Lawsons LDDC Criteria - Safety

Comfort Category	Threshold (m/s)	Description
Unsafe	>15	Winds above this threshold will pose safety risks, particularly for more vulnerable pedestrians (elderly, cyclists, etc.)

- 4.3.3 The significance criteria to measure the impact on pedestrians from wind microclimate are presented below in Table 4-3

- 4.3.4 Effects that are classified as moderate or above are considered to be **significant**. Effects classified as below moderate are considered to be **not significant**.

Table 4-3 – Significance Criteria

Effect	Trigger	Mitigation Required
Very Large	Conditions are 'unsafe' or 'uncomfortable'	Yes
Large	Conditions are 3 categories windier than desired	Yes
Moderate	Conditions are 2 categories windier than desired	Yes
Slight	Conditions are 1 category windier than desired	No
Neutral	Conditions are calmer than required for the intended pedestrian use (by at least one comfort category).	No

4.4 Interpreting the Significance Criteria

- 4.4.1 It should be understood that the threshold for the safety criteria is an extremely high bar. To ensure that the worst-case scenario was modelled the assessment used the windspeed exceeded 0.22% of the time for windiest year in the entire 30 year record.
- 4.4.2 To put this into context these wind speeds would only have been exceeded for only 2 hours over the entire 30 year data period.
- 4.4.3 This wind speed is then used for all 36 wind directions tested, even if winds of that speed have never been recorded from the direction being modelled.
- 4.4.4 The reference wind speed for safety is set at 15m/s which corresponds to 33mph. These wind speeds do not automatically indicate that there is a risk of harm to pedestrians or cyclists. There are numerous locations within Manchester and elsewhere where the safety criteria are routinely exceeded without any harm being caused. Two specific examples, one relating to baseline safety exceedances at NOMA in Manchester¹ and another relating to Newcastle² are referenced below. They are also included in the CD library.

¹ Buro Happold Engineering, NOMA Plot L, Wind Microclimate Assessment, December 2014.

² GIA Chartered Surveyors, Wind Microclimate Assessment Study, Quayside West, Newcastle, August 2020

- 4.4.5 It should also be born in mind that these criteria were developed in London, the least windy city in the UK. We have worked in many coastal cities including Liverpool, Edinburgh, Plymouth and Southampton where the input windspeed into the safety model exceeds 15m/s before the effect of the building is modelled. In these cases the wind arriving from across the sea under the safety criteria can be as high 20m/s (45mph) with pedestrians and cyclists sill routinely using the coastal amenity space without harm being caused.
- 4.4.6 As part of the production of this proof we have modelled the baseline in the directions that showed safety and comfort exceedances. The results show that the safety criteria are already being exceeded on the A56 and as far as we are aware no wind microclimate issues have been reported by the public.

5 BASELINE CONDITIONS

5.1 Baseline Conditions for Safety

- 5.1.1 The assessment provided with the ES did not present the baseline conditions, instead using the fixed criteria to establish whether mitigation was required. To aid understanding, the baseline results are presented for the primary wind direction which exceeded the safety criteria below.

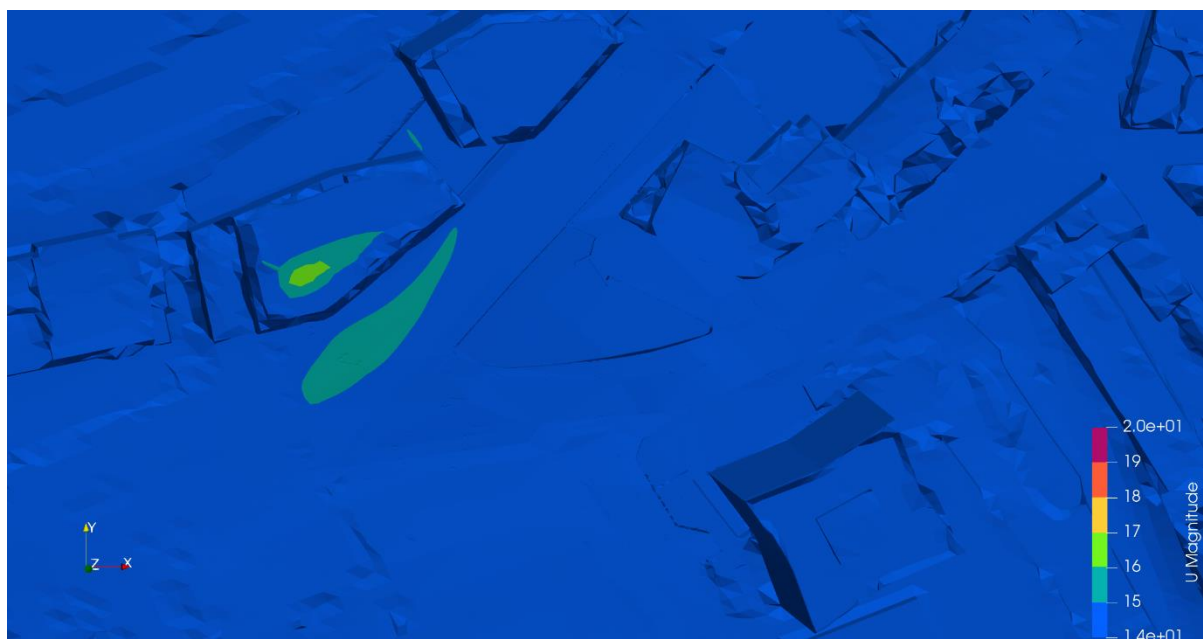


Figure 5-1 - Baseline Safety Results for the 70 degree Wind Direction

- 5.1.2 Figure 5-1 above shows that for the 70 degree direction wind speeds are already elevated above the safety criteria by 0.8m/s.
- 5.1.3 Downdraft is a negligible component of wind flows in the location of the scheme (although they do form an appreciable component of wind speeds relating to the buildings to the other side of the A56) which are dominated by winds being focussed between the buildings. In addition, winds being forced over the Bridgewater Viaduct on the A56 are also a key component of the baseline.
- 5.1.4 For this reason any building located on this very constrained plot would result in the very similar observed effects. This is because almost any building on this plot would need to be a very similar shape to the one proposed and would create a very similar barrier to wind flowing up and over the Bridgewater Viaduct from the direction of Deansgate road. The 2017 planning permission in relation to the site would also have resulted in similar effects to those described.

5.2 Baseline Conditions for Comfort

- 5.2.1 Similar to the safety modelling above, the baseline conditions for comfort in the 70 degree wind direction are where the largest exceedances have been modelled.

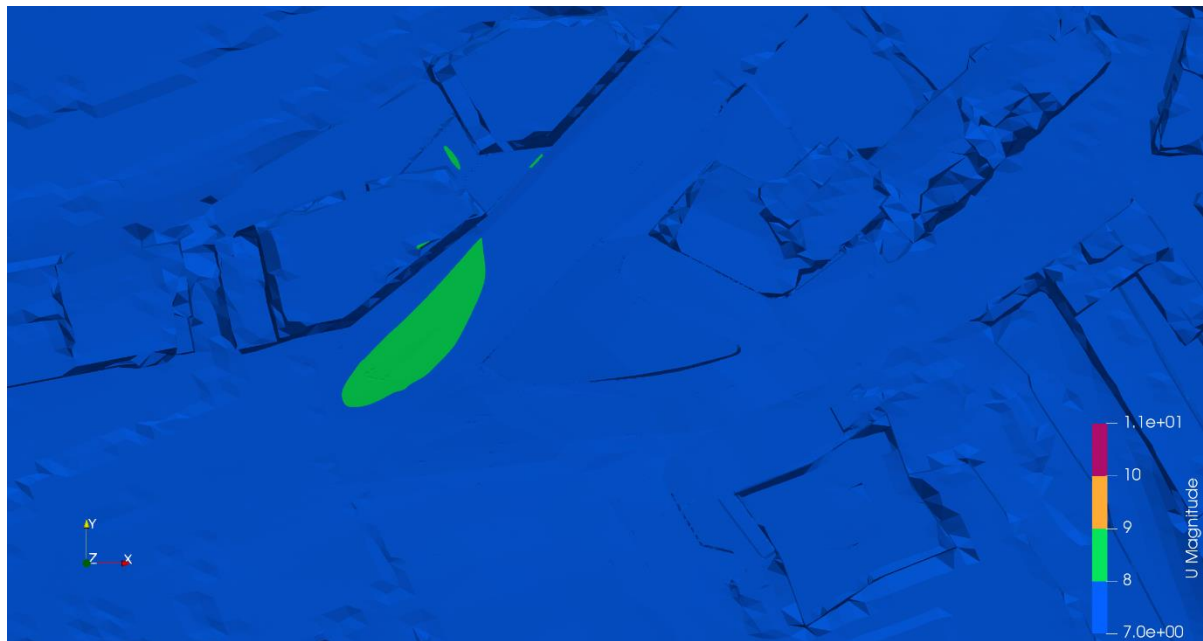


Figure 5-2 – Baseline Comfort Results for 70 degree Wind Direction

- 5.2.2 As with safety the comfort criteria are already exceeded in the baseline model. Wind speeds peak at 8.6m/s within the baseline.

6 MODELLING RESULTS

6.1 Safety

- 6.1.1 As per the revised ES chapter two wind directions, 60 and 70 degrees, show exceedances in the safety criteria. The exceedance for the 60 degree wind direction is very slight, covering a very small area and only reaching maximum speeds of 15.025m/s which is 0.025m/s above the significance criteria, a figure well within the margins of error for the modelling. A high-resolution contour plot of this exceedance is shown below in Figure 6-1. Due to the very slight nature of the exceedance no specific mitigation is considered to be required. In addition, the chances of wind speeds high enough to cause this exceedance actually occurring are almost negligible. This is covered in more detail below. Mitigation is discussed in more detail in chapter 8.

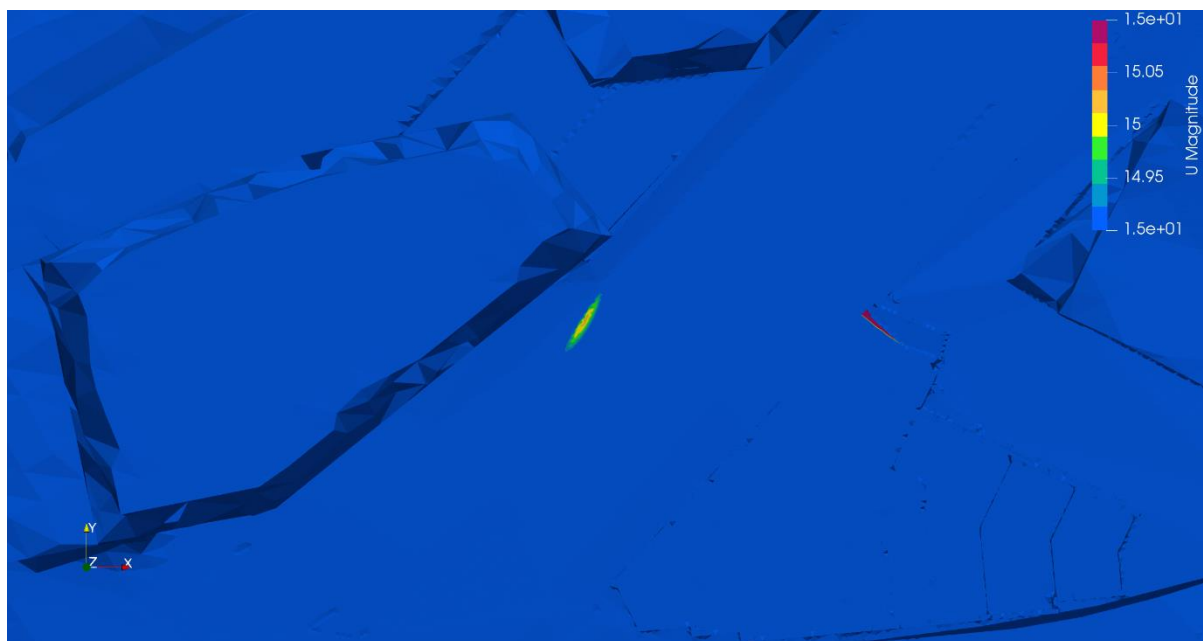


Figure 6-1 - Detailed Safety Contour Plot in the 60deg wind direction (Scale from 15 to 15.1m/s)

- 6.1.2 In the 70 degree wind direction the exceedance is more marked and is caused by air being forced up over the Bridgewater Viaduct and around the proposed scheme where it joins already fast moving air in the A56 street canyon.
- 6.1.3 This is not caused by downdraft and as such any development over 2 stories tall on this plot would result in similar windspeeds. This includes the building consented in 2017. Windspeeds peak at 17.4m/s which is 1.6m/s above the baseline for this wind direction.
- 6.1.4 It should be noted that the maximum windspeed recorded in this direction in the 30-year wind speed dataset is 7.39m/s. This is 1.48m/s and 20% below the safety windspeed used for the modelling which occurred from due south at 180 degrees. As such the likelihood of these wind speeds occurring in practice are negligible.
- 6.1.5 Chapter 9 of this proof considers how climate change may affect the likelihood of potentially unsafe winds in future years.
- 6.1.6 In the very highly unlikely event these high windspeeds did occur in this wind direction then the conditions would be such that without mitigation some vulnerable pedestrians and cyclists would find them challenging. This is also true of the current situation as the safety criteria are also exceeded under the baseline conditions, although not by quite as much (baseline peak windspeeds is 15.8 m/s, peak modelled windspeed with the proposed development is 17.4m/s, see Figure 5-1).

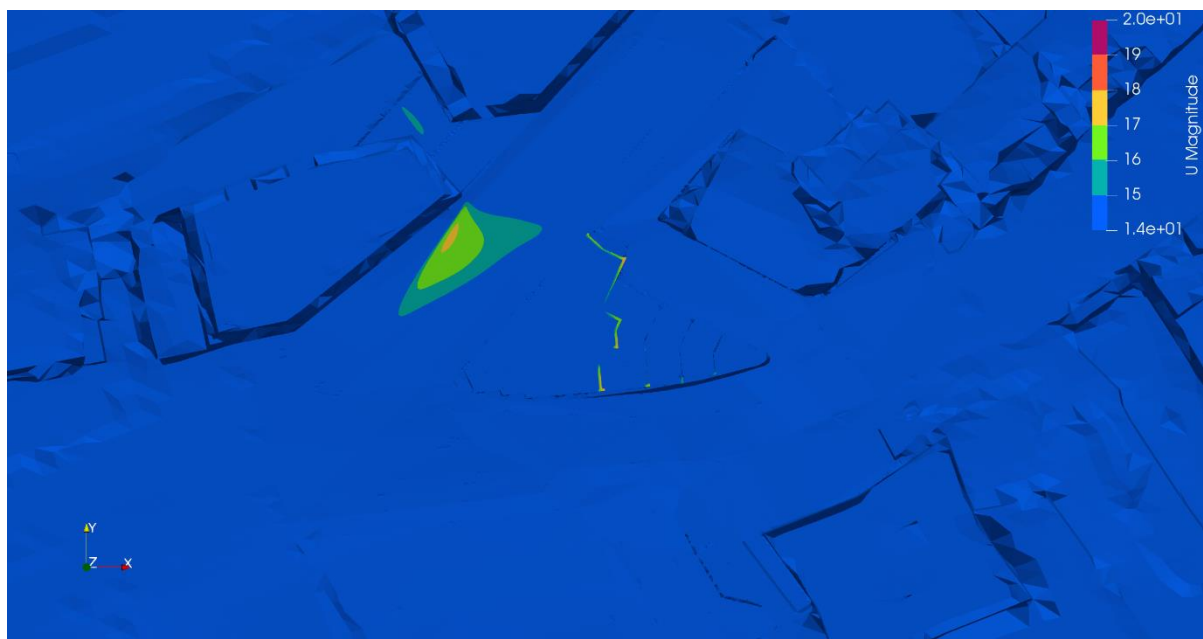


Figure 6-2 - Detailed Safety Contour Plot in the 70 degree Wind Direction (scale from 14 - 20 m/s)

6.2 Comfort

- 6.2.1 Comfort exceedances are predicted for the 70, 210 and 260 degree wind directions on the A56 and for the 260, 270 and 280 degree wind directions on Deansgate.
- 6.2.2 Due to a funnelling effect between the existing buildings, Bridgewater Viaduct itself and the Proposed Development, wind directions 70 and 210 degrees show wind speeds along the A56 Bridgewater Viaduct immediately to the north of the Proposed Development which could have an impact on pedestrian comfort.
- 6.2.3 Wind speeds in the 70 degree wind direction peak at just under 11 m/s. Therefore, in this direction wind speeds fall within the comfort criteria of Uncomfortable, meaning that these wind speeds may be uncomfortable for some users the intended pedestrian use of walking or cycling. The baseline modelling for the 70 degree wind direction also shows windspeeds above the comfort criteria although the windspeeds predicted are a lower overall and peak at 8.6m/s.
- 6.2.4 Although these effects can be considered Significant as they are worse than the current baseline, any other building on this plot would also result in similar effects to those modelled. In addition high winds from the east occur infrequently with the average wind speed in this direction being almost half the modelled wind speed.

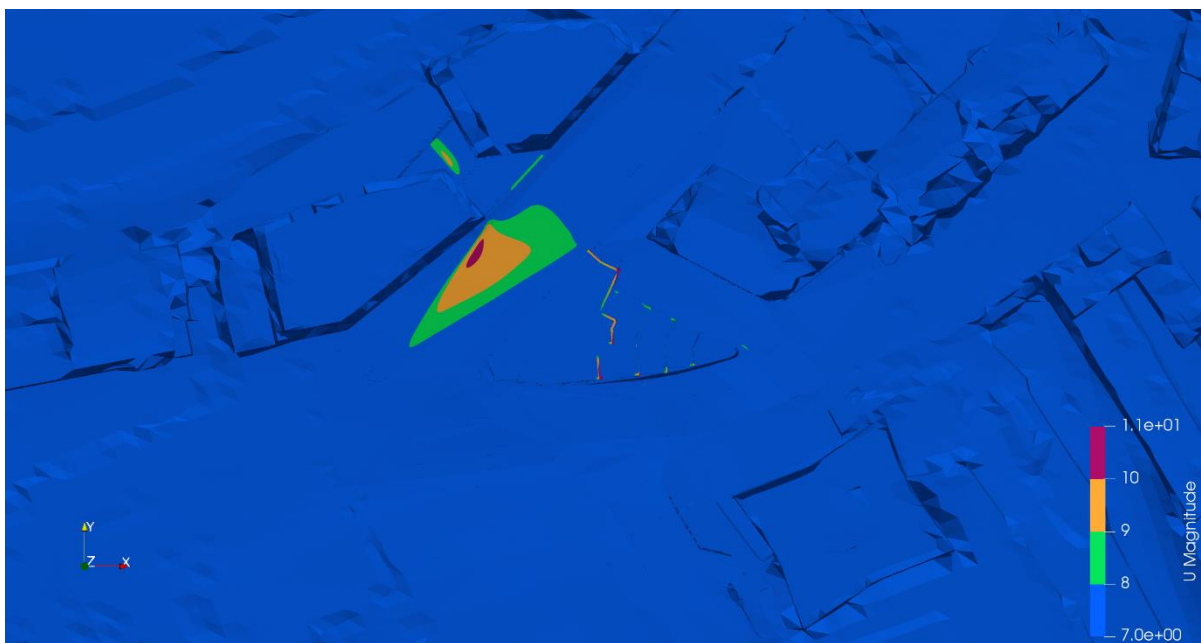


Figure 6-3 - Detailed Comfort Plot in the 70 Degree Wind Direction (scale 7-11m/s)

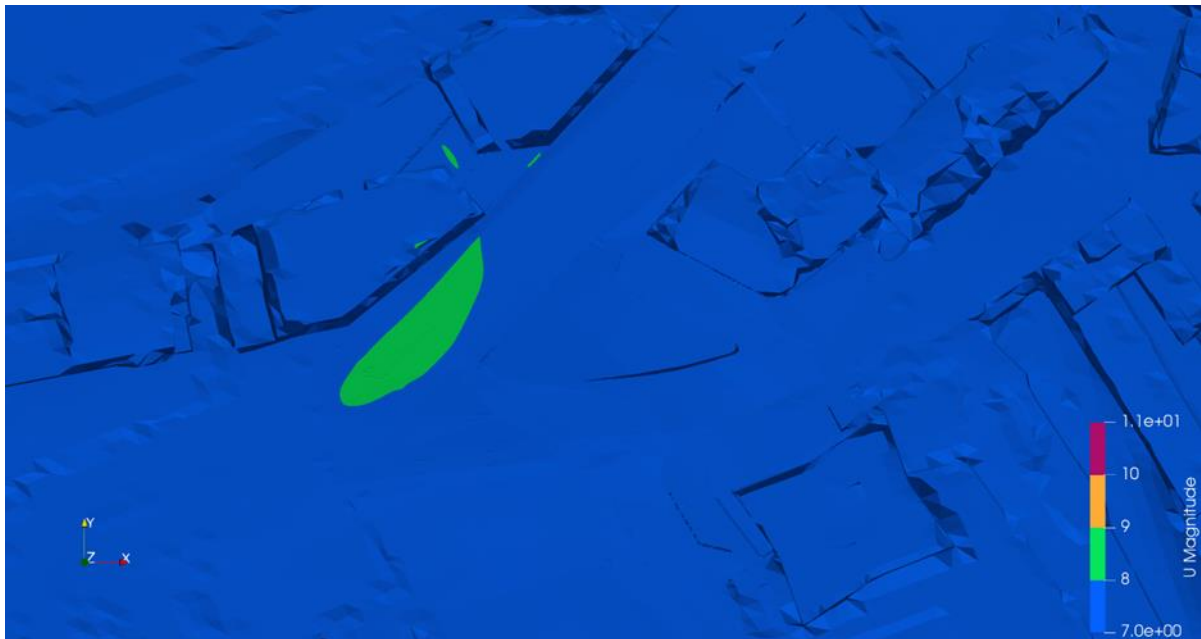


Figure 6-4 - Detailed Baseline Comfort Plot in the 70 Degree Wind Direction (Scale 7-11m/s)

- 6.2.5 The comfort exceedances for both the A56 and Deansgate Road in the 210 and 260 degree wind directions are extremely small and will be eliminated by the proposed mitigation.
- 6.2.6 In the 270 and 280 wind directions the comfort exceedances on Deansgate Road are more marked with wind speeds in both direction rising to just over 10m/s. Plots for the 270 degree wind direction are shown below. In both these directions mitigation has been suggested or is already in place. This is discussed further below.

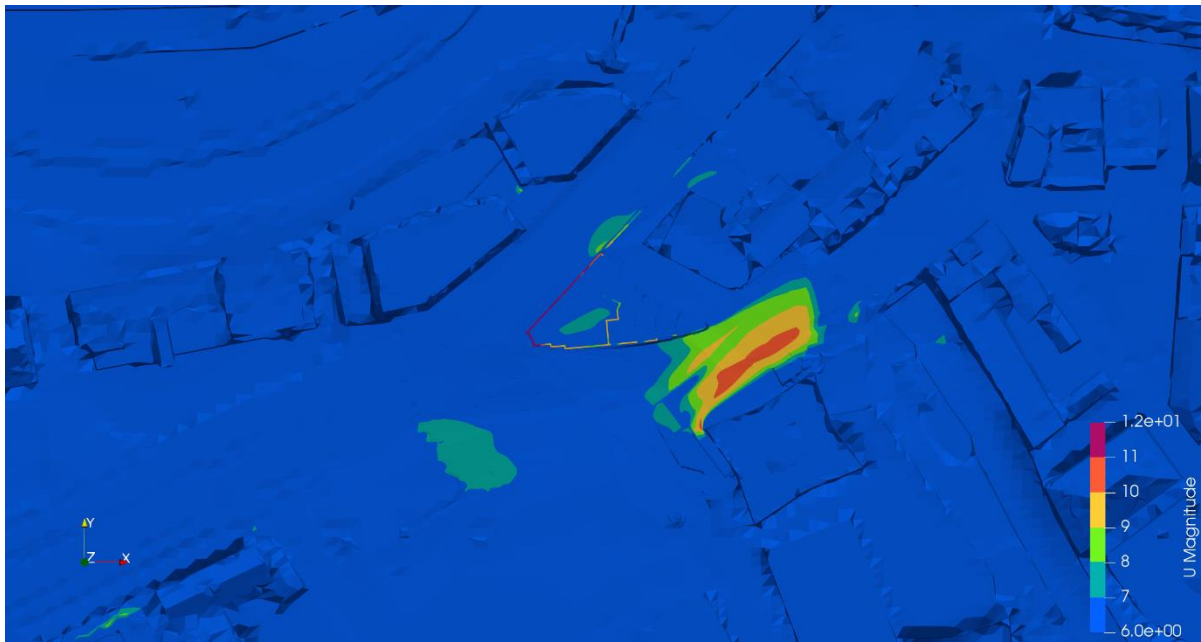


Figure 6-5 - Detailed Comfort Plot in the 270 Degree Wind Direction (Scale 6 -12m/s)

7 MITIGATION

- 7.1.1 Embedded mitigation has been considered along the pavement immediately to the north of the Proposed Development in the form of tree planting with four new trees. To the south on Deansgate Road three trees are proposed to improve the ones that are currently in place. There is also mitigation already in place in the form of a number of trees, vegetation and a small porous screen located immediately to the north of the Deansgate Square development.
- 7.1.2 The effectiveness of this mitigation has not been modelled as trees and natural features are extremely challenging to model using CFD. In addition, the very small scale nature of some of the existing landscape elements is beyond the resolution of the modelling. Higher resolution modelling becomes increasingly impractical due to the computer time required to reach. As such the effectiveness of the proposed mitigation has been estimated based on experience and efficacy elsewhere.
- 7.1.3 The trees to the north on the A56, will help to reduce windspeeds observed in the 60, 70 and 260 degree directions. As the 60 and 260 degree exceedances, for safety and comfort respectively, are extremely marginal the mitigation should eliminate these entirely. For the safety and comfort exceedances in the 70 degree wind direction the wind speed will remain above the safety and comfort criteria with the

mitigation in place. They will also remain above the current baseline, which in itself also exceeds the significance criteria.

- 7.1.4 On Deansgate, the mitigation already in place for Deansgate Square should dramatically reduce the windspeeds modelled. This assumes it is working as designed, and we are not aware of any evidence to suggest otherwise. When combined with the proposed mitigation in the form of the improved street trees to the north of the road this should eliminate the comfort exceedances observed in the 270 and 280 degree wind directions on Deansgate.
- 7.1.5 The 210 degree exceedance is marginal, only exceeding the criteria by just 0.25m/s or 0.5mph and it is likely that the proposed mitigation will reduce this to below the comfort threshold.
- 7.1.6 The 260 degree exceedances will be mitigated by the strategies adopted for the other wind directions as they occur almost on top of the mitigation planting on the A56 and just beyond on Deansgate Road.
- 7.1.7 The viability of the proposed mitigation is discussed in a separate proof provided by GreenBlue Urban, experts in the delivery of urban street trees.

8 CLIMATE CHANGE AND WIND VARIABILITY

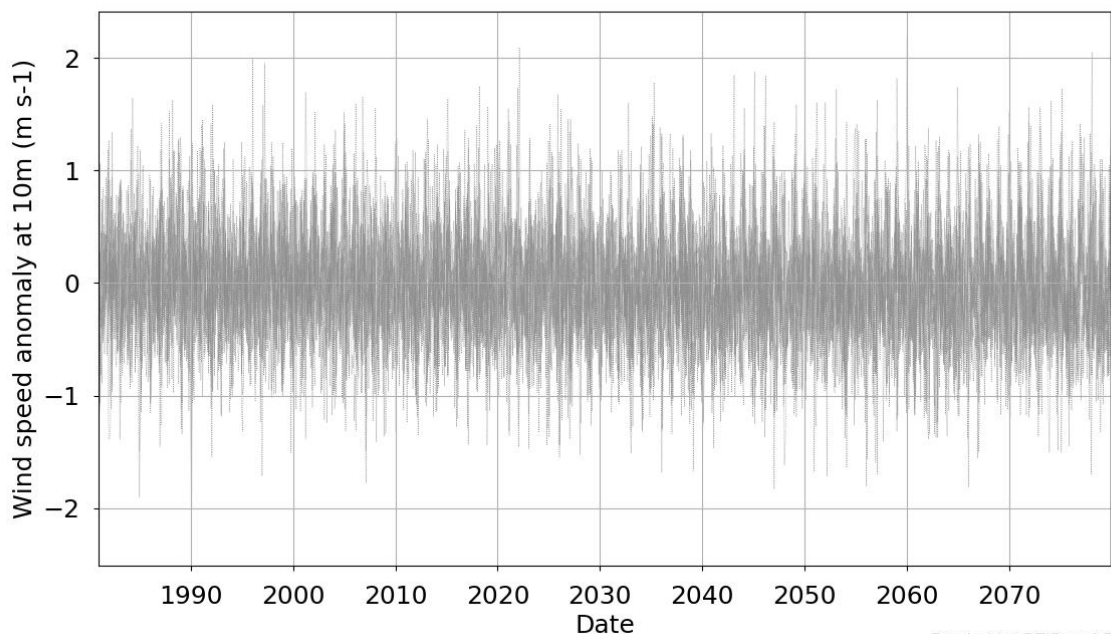
- 8.1.1 As discussed above, based on the 30 year historic dataset used for the modelling, the likelihood of the safety exceedances modelled occurring in the real world are negligible. The maximum windspeed observed in the 70 degree wind direction is some 20% lower than the speed used to model the safety results which occurs from due south or 180 degrees.
- 8.1.2 This is not unexpected as strong easterly winds are extremely rare in the UK, and when they do occur, they are considerably less energetic than their southerly and westerly counterparts.
- 8.1.3 Given that the climate is changing at an unprecedented rate I also want to explore the possibility that higher wind speeds may become more frequent, have higher peak velocities or a combination of both.
- 8.1.4 The Met Office provide a useful and very comprehensive set of data on the potential effects of climate change in the UK called the UKCP (UK Climate Projections) the latest of which was updated in 2018. Due to the difficulties in predicting changes in

wind patterns over a small area due to climate factors the met office provide wind predictions at the regional level (12km grid squares) and only using the RCP8.5 50% probability projection. RCP's or Residual Concentration Pathways are societal and technological predictions used to estimate atmospheric greenhouse gas concentrations under different scenarios.

- 8.1.5 RCP 8.5 is a worst case scenario that assumes greenhouse gas concentrations will rise unmitigated. The graph below shows the predicted variability in peak 'anomalous' windspeeds between 1981 and 2079. It shows that the variability in peak windspeeds will remain constant over this period even under extreme climate change scenarios in the central Manchester area. As such the likelihood of the safety criteria being exceeded even with worst case greenhouse gas emissions rises considered remain negligible.



Monthly average Wind speed anomaly at 10m (m s⁻¹) for years 1980 up to and including 2079, for grid square 378000, 402000, using baseline 1981-2010, and scenario RCP 8.5



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9 CONCLUSIONS

- 9.1.1 There are two safety exceedances modelled, both on the A56. When looking at the historic and future wind data the chances of these occurring can be considered negligible, eliminating any potential safety risks.

- 9.1.2 As a result I do not believe the proposed development would result in public safety issues to either pedestrians or cyclists as a result of elevated wind speeds.
- 9.1.3 There are 5 wind directions where the comfort criteria are exceeded. In two of these directions 210 and 260 degrees the exceedance is very low and will be comfortably mitigated by the proposed mitigation. In the 70 degree wind direction the comfort criteria area already exceeded in the baseline model but the proposed development will further elevate these wind by up to 2.3m/s over the baseline. Any building located on this plot would result in similar increases in windspeed in this location and this includes the 2017 planning permission.
- 9.1.4 The remaining 2 directions where the comfort criteria are exceeded are 270 and 280 degrees. The existing mitigation in place should already be significantly reducing wind speeds on Deansgate Rd, which when combined with the proposed improvements to the street trees to the north of the road should reduce wind speeds down to comfortable levels.
- 9.1.5 Based on the above I do not believe the proposed development will result in an appreciable change in comfort conditions relative to the conditions currently experienced except in the 70 degree wind direction. Given that this increase is just 2.3m/s above the baseline at its peak, and the fact that any building on this site would result in similar effects, I consider this to be an acceptable position. As previously mentioned, there are no safety concerns in this wind direction.
- 9.1.6 The deliverability of the mitigation proposed is covered in a separate proof by GreenBlue Urban.

APPENDICES

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