Before the Hearings Panel
At Wellington City Council

Under Schedule 1 of the Resource Management Act 1991

In the matter of the Proposed Wellington City District Plan

Statement of evidence of Dr Michael Donn on behalf of Wellington City Council in the matter of the Effects of Buildings on Pedestrian Wind

Date: 26 *May 2023*

INTRODUCTION:

1 My full name is Michael Robert Donn. I am employed as Associate Professor for Building Environments .

2 I have prepared this statement of evidence on behalf of the Wellington City Council (the **Council**) in respect of technical related matters arising from the submissions and further submissions on the Proposed Wellington City District Plan (the **PDP**).

3 Specifically, this statement of evidence relates to the matters in the Wind Chapter of Part 2 and Appendices 8 and 14 of Part 4 of the PDP.

4 I am authorised to provide this evidence on behalf of the Council.

QUALIFICATIONS AND EXPERIENCE

5 I hold a PhD in Building Performance Design, and have 40 years experience in assisting with the formulation of the Council's Wind Rules, and assessing reports demonstrating compliance with them.

6 I have worked for te Herenga Waka Victoria University of Wellington for 45 years, and have been a consultant to the Council on the effects of buildings on the wind for 43 of 45 those years.

7 I am a member of the International Building Performance Simulation Association.

Code of conduct

8 I have read the Code of Conduct for Expert Witnesses set out in the Environment Court's Practice Note 2014. I have complied with the Code of Conduct in preparing my evidence and will continue to comply with it while giving oral evidence before the Environment Court. My

qualifications as an expert are set out above. Except where I state I rely on the evidence of another person, I confirm that the issues addressed in this statement of evidence are within my area of expertise, and I have not omitted to consider material facts known to me that might alter or detract from my expressed opinions.

SUMMARY

9 My name is Michael Donn.

10 I have been asked by the Council to provide evidence in relation to the appeal on the Wind Chapter, and Appendices 8 and 14 in the Proposed District Plan (PDP), which primarily relates to the aerodynamics of buildings as they affect the comfort and safety of pedestrians.

11 My statement of evidence addresses the following issues in relation to submissions received by Wellington City Council in relation to the relevant objectives, policies, rules, definitions and appendices of the Wellington City Proposed District Plan particularly as they apply to the implementation of the content of:

11.1 The Wind Chapter;

11.2 Appendix 8 Quantitative Wind Study and Qualitative Wind Assessment – Modelling and Reporting Requirements (Appendix 8); and

11.3 Appendix 14 Wind Chapter Best Practice Guidance Document (Appendix 14).

INVOLVEMENT WITH THE PROPOSED PLAN

12 I have been involved in the development of the Wind Chapter of the PDP since May 2020. The brief that governed that involvement was:

12.1 “Minimising adverse wind effects from new developments or additions and/or alterations to buildings

12.2 Stopping the progressive degradation of wind conditions

12.3 Maintaining comfortable wind conditions in important public parks and spaces

12.4 Encouraging early consideration of wind effects during design and minimizing off-site mitigation.”

SCOPE OF EVIDENCE

13 My statement of evidence addresses the following matters:

13.1 Early consideration of Wind in design;

13.2 The relevance of the 20m/s (72km/hr) safety limit;

13.3 The inclusion of provisions in the Wind Chapter to apply to the Medium Density Residential Zone (MRZ) and High Density Residential Zone (HRZ);

13.4 Whether the provisions in the Wind Chapter should have a focus on maintaining and enhancing the comfort of public space;

13.5 Coordination of the height trigger in the Wind Chapter rules across the City Centre Zone (CCZ), the Medium Density Residential Zones (MRZ) and High Density Residential Zones (HRZ);

13.6 Whether or not the Wind Chapter rules should apply to the Special Purpose Tertiary Education Zone (TEDZ); and

14 Early consideration of Wind in design.

14.1 Too often, when I am asked to review a wind assessment, or a wind tunnel test for a proposed building, I am faced with a wind tunnel test which looks at the completed design proposed for the site, and then examines small scale additions such as verandahs stuck onto the base building. Worse, wind breaks are proposed on Council property to solve the effect of the building. This is demonstrable evidence that consideration of the safety and well-being of passers-by is an afterthought.

14.2 The wind report process has worked for many decades now to reduce the worst effects of most proposed buildings. The PDP wind chapter proposals seeks:

a) To improve the clarity of who is responsible for change;
b) To ensure there is clarity in what needs to be done across the whole city in regards to wind;
c) To encourage quantitative design analysis at heights where the risks increase, but well below the trigger height for wind tunnel tests – for this last purpose, the Wind Design Guidance includes likely wind acceleration data for buildings of differing height and shape.

15 The relevance of the 20m/s (72km/hr) safety limit.

15.1 Wellington's Character Charitable Trust argues that increasing the 20m/s (72km/hr) safety limit is "unsafe for pedestrians". There is no proposed change in this limit. There are many different maximum wind speeds across the world. The limit currently in place in Wellington works to ensure that the pedestrian, even the most fit and prepared

against wind gusts, does not take that one step to stay upright that places them in front of passing vehicles.

15.2 A recent paper (Jordan et al. 2008) where people in a wind tunnel were subjected to simulated full scale wind gusts reports: "*Due to the significant displacements of some of the females at a speed of 15 m/s [54km/hr] it was decided in the interest of safety not to subject this particular group of individuals to wind speeds of the order of 20 m/s*.". There is no case for increasing the 20m/s (72km/hr) threshold.

16 Application of provisions in the Wind Chapter to the MRZ and HRZ;

16.1 Experience of wind tunnel tests of buildings in the Te Aro area that are significantly taller than their surroundings (e.g. Il Casino development circa 2008 at 27m) suggests that buildings of the height now to be approved in the MRZ and the HRZ will likely have the type of effect that enhanced Wellington's windy reputation after construction of the 1925 Hope Gibbons Building (Figure 1 - 30m).

Figure 1 Battling strong wind at the Taranaki Street (Hope Gibbons) intersection, Wellington. Using a rope handhold tied to a nearby pole. Photographed by an Evening Post staff photographer 28 August 1970

16.2 Wind experienced at street level in the city is a complex interaction between the wind flows over the city, the

geometry of the city and the geometry of the proposed building. If the wind at street level was merely a result of the height and shape of the building, the city could set simplistic height or restrictive form rules to achieve its wind environment goals. Because local buildings can shelter a new building, or channel wind so it is much worse than would be expected in the open, the City has sought to require careful analysis of the form of each building in context. For analysis of risk of danger, wind tunnel tests are still the most reliable means of completing this analysis. Two relatively recent buildings in the neighbourhood of Parliament illustrate this issue perfectly: the former Defence Building in Murphy Street and the nearby Kate Sheppard Apartments.

16.3 The now-demolished 7 storey Ministry of Defence building on the corner of Murphy Street and Aitken Street, at first glance, broke all the 'sensible' guidance in books on building aerodynamics aimed at pedestrian safety and comfort. It presented a severe flat plane façade to each street. However, it was a similar height to its neighbours and filled in what had previously been an open space into which the wind dropped as it struck the exposed façades of its neighbours. Filling in the gap 'healed' the air flow at street level. It also reduced the street level wind accelerations created by the nearby much taller Charles Fergusson building.

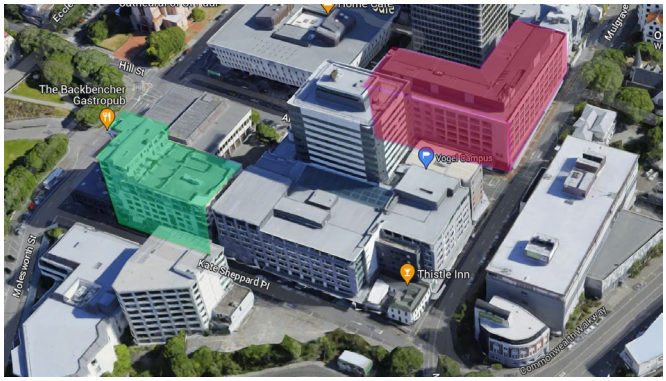

Figure 2 Wind Tunnel Tested Developments in Thorndon (Pink) now demolished Defence Building; (Green) Kate Sheppard Apartments

16.4 The similarly severe flat plane Southerly exposure of the 8 storey Kate Sheppard Apartments made sheltering of the adjacent footpath problematic. The street already had local wind accelerations, most likely due to the 8 storey Dept of Conservation across the road. This situation is exacerbated by the replacement of the recommended verandah on the South façade by trees provided by the developer but to be maintained by the city.

Figure 3 Trees replace verandah on the front face of Kate Sheppard Apartments

16.5 In the 1970s French researchers systematically tested buildings of varying shape, form and height. Their book about this research (Gandemer and Guyot 1981) is the basis for the PDP's wind design guidance document. They identified that there are accelerations due to the wind being diverted around a building – leading to what they designate the "corner effect". This is first of all an unavoidable effect of a building of any scale. However, their research pointed out that as buildings become taller, the height makes the corner accelerations more extreme. However, as reported in the wind design guidance, buildings shorter than 15m in height are unlikely to experience downwash acceleration (Figure 4).

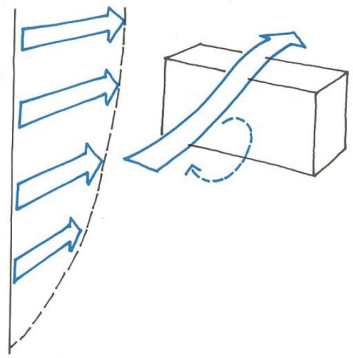

Figure 4 Below 15m height wind tunnel tests demonstrate that the natural increase of wind speed with building height does not lead to a downwash driven vortex at the windward face (from WCC Wind Design Guidance)

16.6 With the MRZ and HRZ height limits now set to be ~30% taller than this 15m height, and in the interests of consistency of consideration of building aerodynamics across the city, it is in my view sensible to require that all buildings over 15m in height provide a design analysis of the aerodynamics of the proposed building. Ideally, this analysis should be quantified by reference to the quantitative wind acceleration data in the Wind Best Practice Design Guidance document (Appendix 14 of the PDP). It would, for example: 1) compare the height of the proposed building relative to the average height of the neighbouring buildings; and 2) analyse the proposed form of the building vis-à-vis the good practice documented in the design guidance.

16.7 As an aside: the Council could convert the design analysis from a prediction of likely wind accelerations to a prediction of the likely actual wind gusts. This would require a major expense on the mapping of the wind across all areas of the city. At present, the wind guidance could be used to identify that the wind after the construction of a proposed building is likely to be accelerated. If it was, say

50%, and we knew that the existing annual wind gust speed in the area where the building is proposed was 15m/s (54 km/hr), then a 50% increase would be risk of an annual wind gust of 54 + 27 (=81) km/hr – well in excess of the 72km/hr safety limit.

16.8 This raises the question of what might be the trigger point for more detailed design analysis beyond 15m in MRZ and HRZ and consistent treatment relative to the CCZ. This trigger point is considered further in paragraph 18.

17 The focus of the provisions in the Wind Chapter on maintaining and enhancing the comfort of public space;

17.1 I note that the Retirement Villages Association submission seeks removal of reference to “Amenity” within the Rules in the Wind Chapter. My concern with this idea is based on experience with the early 1980s District Plan requirement for wind tunnel testing of any building over 4 storeys in height in what is now the CCZ. It rapidly became clear that merely requiring a test did not guarantee avoiding safety issues. It merely recorded the changes.

17.2 At the time, several buildings were proposed on the corner of Lambton Quay and Willis Street (Figure 5). None would consider a joint wind tunnel test of the combined effects of their proposals. It was clear that each new building would alter the environment experienced by the others. As the city then, as now, did not set comfort rules in public spaces, the setting of a maximum speed as a safety criterion in the wind rules, required a secondary provision to avoid creating a situation where the first few buildings in a street all are considered acceptable because they do not generate

dangerous winds, but each makes the situation significantly worse than before.

17.3 Ultimately the goal was, and remains, to ensure the amenity value that the next building in the area cannot be built as the wind speeds are so close to the safety limit. In the process we also work towards the goal of incremental improvement in the general windiness of the city.

Figure 5 Map highlighting the areas where new buildings were planned at the same time in the early 1980s

17.4 Over the decades, the City has moved to follow international practice and to incorporate some limited consideration of comfort into its wind rules. Unlike general international practice, the aim has been only to preserve or enhance the quality of comfort in the environment of public parks specifically identified in the District Plan. No guarantee is provided that comfort which is commonly understood as amenity in other cities will be achieved in Wellington's city streets. The increasing presence of footpath and parking space take-over as outdoor café space may eventually require that the Council look more rigorously at using international measures of outdoor comfort combining sun, wind and temperature predictions.

However, that is not the case at present. To undertake such an exercise in our much more windy than most environments would in my view require an exercise mapping and probably measuring all the public spaces in the city. This is well beyond the budget limits for development of the wind chapter in the PDP.

17.5 It is worth noting in this context that the concerns expressed by The Urban Activation Lab of Red Design Architects [420.5 (supported by Historic Places Wellington Inc)] about limited notification could only ever be about wind in city streets. The rules only apply to public spaces, not, as I read their concerns, to the backyards or adjacent private properties.

17.6 As a final note on the general subject of amenity, the Retirement Villages Association seek removal of the requirement to maintain and, where possible, enhance the comfort of public space. Recognising that comfort is technically only applicable to designated parks identified in the PDP, it is clear that where a space is already comfortable, the aim not to make the street worse is about retaining the current level of comfort. The Association argues that this requirement is inconsistent with the acknowledgement in Wind-01 that "*the existing wind in parts of Wellington is already windy*". In many other parts of the world that are less windy, the City sets absolute goals. Wellington has long recognised that the level of exposure to high winds is already very varied, and thus looks to improve on, or not make worse these existing conditions. In the event the situation already exceeds the safety criterion, the aim is to look to provide safe means of avoiding the situation. The option sought by the Association

would lead to a steady deterioration in wind speeds and eventually safety in City streets. In my personal opinion, like other campus situations, I believe that the average resident would expect that the City's wind rules apply to the spaces between buildings on a retirement community campus, when technically members of the Association are only required by the City's rules to address the wind on the surrounding public streets.

18 Coordination of the height trigger in the Wind Chapter rules across the CCZ, the MRZ and the HRZ:

18.1 The question of the need for a height trigger was made clear in the design guides and associated wind tunnel studies published by Jaques Gandemer and Alain Guyot in the 1970s that in isolation, a very tall building has much more risk of wind acceleration at ground level than a short building (Gandemer and Guyot 1981). Their work is the foundation of the Council's Wind Best Practice Design Guidance (Appendix 14 of the PDP). Section 5.3.2 of that guidance document notes in relation to pedestrian level wind adjacent to the corner of an isolated building:

- a 4-storey (15m) building, wider than it is tall, will cause a 20 percent increase in discomfort level
- a 10-storey (35m) building, wider than it is tall, a 50 percent increase
- a 15 storey (45m) building, taller than it is wide, a 40 percent increase
- a 35-storey (100m) building, taller than it is wide, a 120 percent increase.

18.2 However, it is rare that buildings are constructed in isolation. The Hope Gibbons building on the Corner of Dixon and Taranaki Streets is a clear demonstration of the issue in the Wellington context. The 1925 construction of the 30m building is described on the Wellington Heritage

Buildings website in this manner: (https://wellingtoncityheritage.org.nz/buildings/1-150/100-hope-gibbons-building) "*The building was originally designed without a verandah and the modern glazed canopy is a modern element that provides some amenity value to pedestrians but has no heritage value.*" An Evening Post article from 1936 illustrates the issue that this 30m tall and wide building became a notorious source of dangerous winds: "I*nglewood Place, near the junction of Dixon Street and Courtenay Place, was one-of the windiest spots in the city yesterday. …[her]… right wrist was broken and she sustained bruises and abrasions and shock.*" As can be seen in Figure 6, the building was originally significantly taller than its surroundings; a building in isolation because it is not sheltered by its neighbours. The Council response was initially to station people to assist those who felt the need to pass the risky site. It also placed ropes at the Taranaki Street intersection to help people to stay upright and to reduce the likelihood of stepping in front of passing traffic as they tried to stay stable. These ropes became less and less necessary as 1) the "no heritage value" verandah was added; and 2) the surrounding buildings rose to a similar height and reduced the exposure of the building to the wind.

Figure 6 Hope Gibbons building under construction: National Library NZ PAColl-0125-01 (1924-1927)

18.3 The most advanced wind design rules outside of Wellington developed for the City of London by the wind tunnel test company RWDI in 2020, and adopted by several other cities since recognise this issue. They propose the following trigger rules around height and requirements for wind tests:

Building Height	Recommended Approach to Wind Microclimate Studies
Similar or lower than the average height of surrounding buildings **Up to 25m in CoL**	Wind studies are not required, unless sensitive pedestrian activities are intended (e.g. around hospitals, transport hubs, etc.) or the project is located on an exposed location (e.g. edge of Thames, near a tall building)
Up to double the average height of surrounding buildings **25m to 50m in CoL**	Computational (CFD) Simulations **OR** Wind Tunnel Testing
Up to 4 times the average height of surrounding buildings **50m to 100m for CoL**	Computational (CFD) Simulations **AND** Wind Tunnel Testing
High Rise **Above 100m**	**Early Stage Massing Optimization:** Wind Tunnel Testing OR Computational (CFD) Simulations **Detailed Design:** Wind Tunnel Testing **AND** Computational (CFD) Simulations to demonstrate the performance of the final building design

Figure 7 Building trigger heights setting action levels for developments from the City of London's Wind Microclimate Guidelines

18.4 The basis for these heights is risk based on average wind speeds in London. These wind speeds are half those experienced in Wellington. If Wellington was to set its goals

based on the same wind speeds at street level, then the equivalent trigger heights would be 1 storey - around 5m[1]. What is far more relevant to Wellington is the relationship noted to the surrounding building heights. Plugging a gap in the city fabric by, say, placing a building on a site that was previously an open car park can cause increase in wind speeds on adjacent footpaths by channelling wind along the street that previously dissipated harmlessly across the open area. In Wellington, the trigger point for wind tunnel tests in the early wind rules was buildings over 4 storeys in height. This was based on an assumption that (as per Gandemer's research) this was likely the onset of height related issues. It was also a pragmatic decision that expensive wind tunnel tests would be more justifiable on larger buildings.

18.5 This 4-storey trigger point morphed in the 1990s into an urban design interpretation of 4 storeys as 18.6m. As I understand it, this was an urban design intention to provide a simple-to-manage height whilst encouraging a generous ground floor entry level. In many cases, it seems it actually encouraged 5 very mean storey heights!

18.6 In the initial Council PDP discussions around the future of the 18.6m trigger point for wind tunnel tests of buildings in the CCZ, there was agreement that rounding the oddly precise 18.6m to 20m would not significantly increase the risks to pedestrians.

[1] assuming local driving force wind speed is 2 x London's and the Power Law relationship describing the relationship between height and speed has a reference height of 250m and the Power Law Coefficient is 0.35

18.7 There was some concern that historically, this arbitrary height has encouraged some designers to present this height trigger as the point below which there was no need to consider wind. As evidenced by the proposal by Dawid Wojasz, this has led to the general impression that the trigger point is a level below which there is no or little effect of the building on the wind. His proposal is that the baseline against which new buildings should be compared is the wind test trigger height. As I understand it, it is also the submission of the Retirement Villages Association of New Zealand that wind effect analysis be limited only to the effect of the additional height. This idea immediately raises the proposition in planning discussions that a 1m increase above this trigger height will cause such a small extra problem that it can be ignored. This is of course an infinite process. It has been exploited in many ways.

18.8 For example, the developers of 24-32 Wigan Street originally proposed a 5 storey development that just satisfied the then 18.6m height trigger. Subsequently, they proposed an extra two storeys and were required to wind tunnel test the original site, the 5 storey 'variation' and the final 7 storey building. This situation only arose because the Council was aware of the future potential two storeys, so made the wind tunnel test a condition of approval of the 5 storey building. Had there been a 5 or 10 year period between the two proposals, then the argument would have been merely that the extra two storeys would only lead to a small change. In the application for the extra two storeys this is actually what was argued. The test, as required by the original planning consent reported the wind prior to the 5 storey building, with the 5 storey building and with the extra two storeys. It was argued that it was only possible to

make minor changes in design of the upper storeys and these would have only a small further effect at street level because these 5 storeys were not to be altered.

18.9 The recent wind tunnel tests of the Arlington Street Kainga Ora apartments demonstrate that, with few neighbouring buildings providing shelter, an 11-14m tall building can cause problematic issues at street level.

Figure 8 Arlington developments showing wind screen needed for ODP compliance between two towers

18.10 It is an unfortunate feature of the ODP that the ambition to encourage early design analysis of buildings only appears to be happening for buildings where the goal is to exceed the standard height and other limits on a site. For example, 39 Dixon Street in 2005 (and with an almost identical design proposal in 2022) demonstrated that a building constructed to the height limit for that CCZ zone makes Te Aro Park across the road less comfortable. The designers focused on small design modifications as the consideration of wind effects was compromising all the economic and other considerations that were now bottom lines for the project.

Early analysis of what might be a good aerodynamic design may have avoided this issue. The wind tunnel tests clearly show that the changes on the park would be smaller if the building were significantly shorter (roughly 20m not around 40m tall).

18.11 There has never been a rational connection between building height limits and the trigger points for wind tunnel tests. However, in reacting to submissions on wind analysis across the whole city, it seems that a consistent pattern relating risk to trigger point and local height limit is needed. The following proposal brings together the concerns of people like the Thorndon Residents' Association, and the Property Council. Both argue for a consistent treatment of the proposed "6 storey" height limit of 22m.

18.12 The Residents' Association submission seeks some form of aerodynamics assessment of 6+ storey buildings. However they seem to be under the erroneous view that wind performance assessments look at "adjacent properties".

18.13 The Property Council submission apparently seeks to increase the trigger point of 20m to 22m. The Property Council make the reasonable assertion that wind tunnel testing can cost from $20k to $25k. However, they add the frankly ludicrous assertion that wind tunnel testing can "*add approximately six to nine months to a project*". This would appear to be an exaggeration of the wait list for wind tunnel testing by the Wellington based WSP wind tunnel facility. It ignores the existence of competition: within the standard international distances between wind tunnel test facilities, there are 5 wind tunnels capable of performing the tests.

18.14 The following seems to provide a reasonable pattern that sets a trigger point for initial attention to wind issues, and then a much larger height as the trigger for testing. The minimum height for directing attention to design in a windy environment would be 15m, the likely height beyond which the wind at street level will be worsened by increasing building height. And then, across the city, the trigger point for wind tunnel testing would be :

- MRZ – the smaller of 25m or a proposed building that is taller than twice the average height of the neighbouring buildings. Minimum height = XX; maximum height = YY.

- HRZ - – the smaller of 25m or a proposed building that is taller than twice the average height of the neighbouring buildings Minimum height = XX; maximum height = YY.

- CCZ - requirement for wind tunnel test – 25m. Minimum height = XX; maximum height = YY.

19 Whether or not the Wind Chapter rules should apply to the Special Purpose Tertiary Education Zone (TEDZ)

19.1 Te Herenga Waka Victoria University of Wellington argues that the wind rules should not apply to the Tertiary Education Zone. This may again be a misunderstanding of the nature of the scope of the City's rules. It is my understanding that these rules typically apply to a concern about the effect of buildings on the wind in adjacent public streets. In such circumstances, the objection seems unreasonable.

19.2 However, my personal experience is that the tall buildings owned by the university have had historic wind safety issues on site for at least 5 decades. The Kelburn campus, for example, sits on a ridge exposed to winds from all directions. The effects of the Kirk and Easterfield buildings, for example have been reduced over time as the University has constructed wind shelter measures such as the "Hub". The huge wind sheltering entry to the Easterfield building was created on campus to minimise the potential safety issues arising from the transition from indoors through this high wind zone when exiting from the building.

Figure 9 Pre-prepared signs for windy days at the bookshop entry to the Easterfield building, te Herenga Waka, Kelburn Parade

19.3 The adjacent doors into the bookshop area have remained problematic as illustrated in these photographs: the signs are printed so as to be in regular use.

19.4 It is fair to say that the Massey University sits on one of the most exposed sites in or near the CCZ. I am unaware of any specific onsite issues, but the recent wind tunnel tests for developments at 1 Tasman Street illustrate that buildings of 6-10 storey height in this area of Mt Cook are likely to cause dangerous winds unless specific aerodynamic design is undertaken.

19.5 The development of the lower additions to the te Herenga Waka Commerce building opposite the Railway station has been accidentally beneficial to the safety and comfort of people in the neighbourhood. It has helped because the acknowledged issues of the original tall isolated building on site are now largely dissipated across the roofs of the lower buildings.

19.6 The egregious example of the Asteron building immediately across the road from the te Herenga Waka Law and Commerce Faculty buildings demonstrates clearly the issues that arise from ignoring the wind tunnel testing requirements. Huge changes in the size and shape of this building were required to solve the wind safety issues reported by the developer's own wind tunnel test. However, at a level above the ODP and the planning department these issues were ignored. It seems to me general common sense that the university be required within its own campuses to consider the issues of comfort and safety for those people who walk between its buildings.

Date: 15/05/2023

Gandemer, Jacques, and Alain Guyot. 1981. *La Protection Contre Le Vent*. Paris: CSTB.

Jordan, S. C., T. Johnson, M. Sterling, and C. J. Baker. 2008. "Evaluating and modelling the response of an individual to a sudden change in wind speed." Review of. *Building and Environment* 43 (9):1521-34.