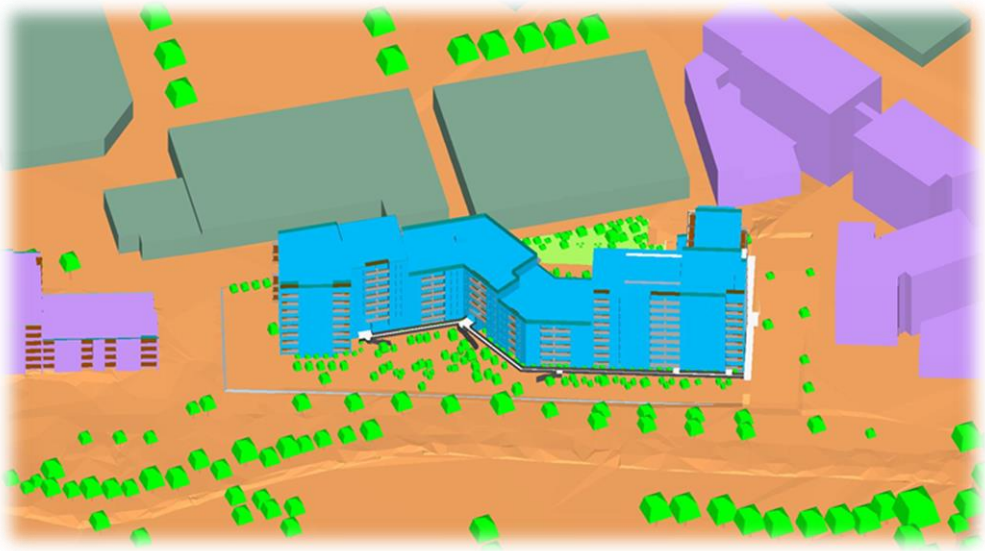
Phase 1 – Corrib Causeway - Dyke Road

Wind Microclimate Study



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Simulation Report	Harshad Joshi CFD Consultancy Manager		Colin Rees Associate Director, VE Consultancy
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P1-01	15/02/2024	First Draft of the Initial Study	Colin Rees
P1-02	23/02/2024	Full report of the Initial Study	Colin Rees
P2-01	25/07/2024	Full report of All Phases and Phase 1	Colin Rees
P2-02	26/07/2024	Updates to the Full report All Phases and Phase 1	Colin Rees
P3-01	08/01/2025	Updates to the Boardwalk	Colin Rees
P3-02	24/03/2025	Updates to the Report P3-01 based on the comments received	Colin Rees
P3-03	24/03/2025	Updates to the Report P3-02 addressing update to some wordings	Colin Rees

1 Contents

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1 Development Description

The proposed development will consist of the construction of a new residential development of 219 no. apartment units and a childcare facility (approx. 241 sq m) in the form of 1 no. new residential block (5 - 9 storeys over lower ground floor level) with associated car parking, bicycle parking, public and communal open spaces, and all ancillary works on a site area of 1.144 ha.

The proposed development will provide for:

- 219 no. residential apartment units (109 no. 1-bedroom units, 100 no. 2-bedroom units and 10 no. 3-bedroom units) each with an associated private open space area in the form of a balcony/terrace.
- A raised pedestrian boardwalk along the western elevation of the proposed building.
- Open Space (approx. 2,778 sq m) is proposed in the form of (a) public open space (approx. 1,183 sq m) to the west of the proposed building fronting on to Dyke Road accommodating outdoor seating, planting, a sunken garden and pedestrian pathways and connections; and (b) communal open space (approx. 1,605 sq m) to the east of the proposed building in the form of a courtyard including outdoor seating, planting, a children's play area and outdoor sports equipment.
- A childcare facility (approx. 241 sq m) at ground floor level with dedicated external play area (approx. 61 sqm) at surface level.
- A total of 33 no. new car parking spaces at surface level to serve the proposed residential development (including 2 no. accessible spaces). In addition, 2 no. set down / drop off spaces are proposed to serve the childcare facility.
- A total of 465 no. bicycle parking spaces to include 330 no. standard residential spaces, 100 no. visitor spaces, 25 no. cargo bicycle spaces and 10 no. bicycle parking spaces dedicated for the childcare facility staff, all at surface / lower ground floor level.
- Vehicular access to serve the development is proposed via Dyke Road at 2 no. new locations along the western site boundary (to the north west and south west of the main development site). Pedestrian and Cyclist access is also proposed throughout the site via Dyke Road and a new pedestrian crossing is also delivered at Dyke Road. The proposed development will extinguish the existing pedestrian connection between Galway Retail Park and the subject site as part of wider proposals for local improvements to permeability.
- The removal of 389 no. existing car parking spaces (311 no. from Car Park 1 and 78 no. from Car Park 2) is proposed to provide for the new development. An overall total of 165 no. existing car parking spaces will be maintained in Car Park 2.
- The extinguishment of the main existing vehicular entrance serving Car Park 1 and Car Park 2 at Dyke Road with provision made for a new vehicular access point (to the south of the main development site) to facilitate continued access to existing Car Park 2 and the remaining car parking spaces (165 no.).
- The removal of existing bring bank facilities including 2 no. clothing banks and 8 no. bottle banks from Dyke Road.
- 2 no. telecommunications lattice towers (overall height 6.45 m and 7.67 m) affixed to the rooftop supporting 9 no. 2m 2G/3G/4G antennas; 9 no. 0.8m 5G antennas; 6 no. 0.3m microwave transmission links; together with all associated telecommunications equipment and cabinets. The proposed overall building height including the telecommunications towers is approx. 38.18 m (+43.18 AOD).

The development will also provide for all associated site development works, infrastructure, excavation and clearance works including decommissioning the existing Black Box Theatre waste water pumping station, provision for a new pumping station complete with below ground emergency storage, all boundary treatment/retaining walls, public lighting, internal roads and pathways, ESB substations, switch rooms, water tank rooms, cleaner store and WC, meter rooms, facilities management office, parcel store, comms rooms, plant room, generator room / associated plant space, bin storage, bicycle stores, hard and soft landscaping, play equipment, below ground attenuation tanks, nature based SUDs features, green roofs, roof plant, new and replacement site services and connections for foul drainage, surface water drainage and water supply.

This planning application is accompanied by an Environmental Impact Assessment Report and Natura Impact Statement.

2 Executive Summary

IES Consulting have been commissioned to investigate the potential impact from wind around the proposed residential development located at Dyke Road, Terryland, Galway. The Proposed Development is part of an overall three phased development framework which will deliver a residential-led, mixed-use development. Phase 2, an existing car park south of the site, is intended to be redeveloped for civic, commercial and cultural uses. Should the existing Black Box theatre situated to the north be relocated, the site may be repurposed into an additional residential block, designated as Phase 3.

The analysis was carried out for the assessment scenario 1 – The proposed development Phase 1. The analysis was also carried out for the assessment scenario 2 – The proposed development Phase 1 plus Phase 2 and Phase 3 of the Corrib Causeway Development Framework .

For the analysis, 8 steady state Computational Fluid Dynamics (CFD) simulations were performed for the main wind directions (N, NE, E, SE, S, SW, W and NW) and annual average wind speed obtained from the Galway weather data set. The results obtained from the simulations were extrapolated along the annual weather data to obtain the most probable local air speed for each hour of the year. Statistical analysis was performed on this dataset to check compliance against the Lawson's Pedestrian Comfort criterion.

The following table provides values for the Lawson's Pedestrian Comfort Assessment criteria for various activities.

Category	Pedestrian Activity	Threshold mean hourly wind speed not to be exceeded for more than 5% of the time (m/s)
C1	Business Walking	10
C2	Leisurely Walking	8
C3	Standing	6
C4	Sitting	4

The following table provides values for Lawson's Pedestrian Safety Assessment criteria.

Category	Pedestrian Type	Threshold mean hourly wind speed not to be exceeded more than once per annum [2](m/s)
S1	Typical Pedestrian	20
S2	Sensitive Pedestrian	15

The results are presented in the form of false colour contour images of the percentage of year that the local air speed is likely to exceed a certain value at every point on the locations of interest. The air speed threshold value is mentioned in the title of the colour legend at the top right corner of each image. Do note that the scale for the images for results of the comfort criteria goes from 0.1% to 100%, and the scale for images for results of the safety criteria goes from 0.001% to 1%.

The median wind speed recorded was 5.6 m/s for Galway's climatic conditions. That means, for 50% of year, the wind speed is higher than 5 m/s. The Lawson's Sitting Criterion requires the local air speed

be more than 4 m/s for no more than 5% of the year. Thus, the Lawson's Sitting Criterion presents a task of being 10 times better than the climatic conditions at location of interest.

2.1 Results: All Phases

This section includes the results of the proposed development Phase 1 plus Phase 2 and Phase 3 of the Corrib Causeway Development Framework. Figure 1 show the site location of Phase 1 including Phase 2 and Phase 3. Figure 2 show the building massing used for Phase 1 including Phase 2 and Phase 3.

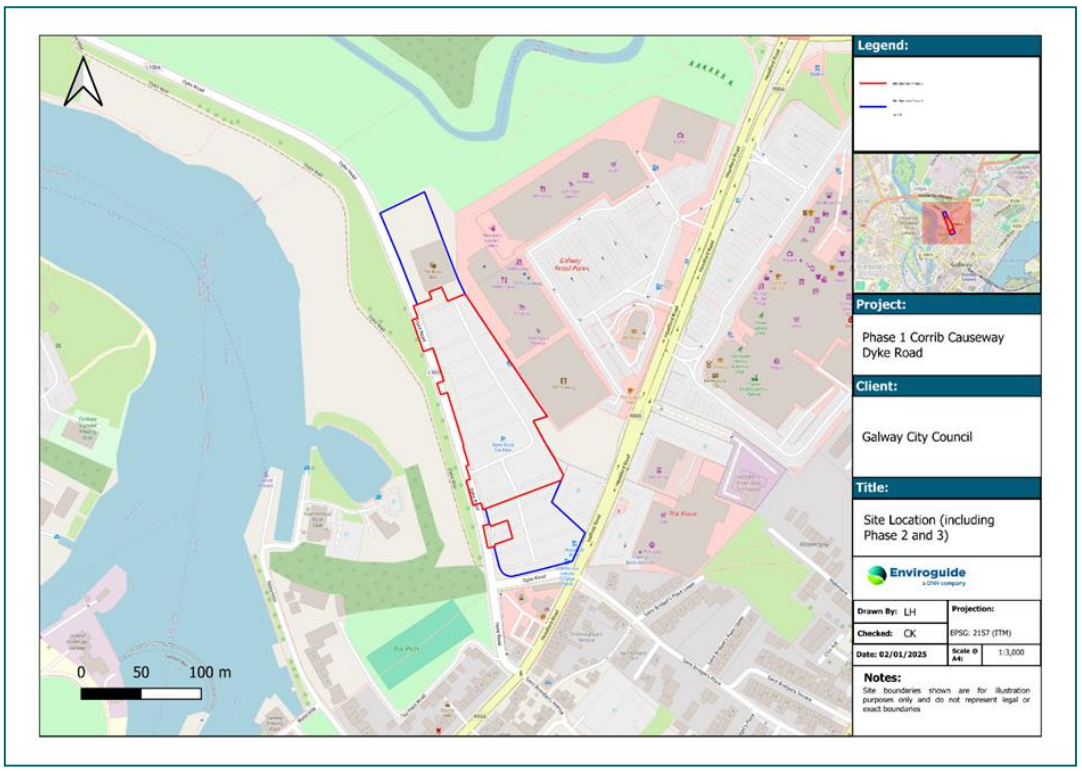

Figure 1: Site Location Map: Phase 1 Including Phase 2 and Phase 3

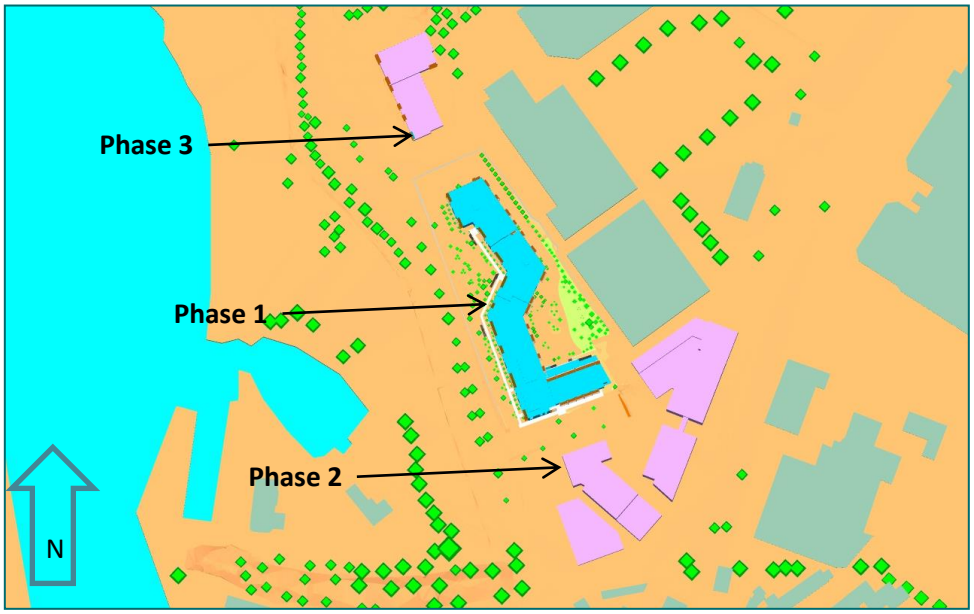

Figure 2: Plan view of the building massing: Phase 1 including Phase 2 and Phase 3

2.1.1 Collective Results

Figure 3 show the collective results of wind comfort for the 5% threshold. These results were summed to calculate the total number of hours that a given pedestrian activity class exceeds the 5% yearly threshold based on hierarchy of wind speed. The sitting comfort represents that the wind was lower than 4m/s and rest of the classes were above it. It must be noted that when a space is classified under a certain activity class, the space will also achieve all activity classes above it in the hierarchy scale e.g. if a space was comfortable for sitting activity then that space was also comfortable for standing and walking activities.

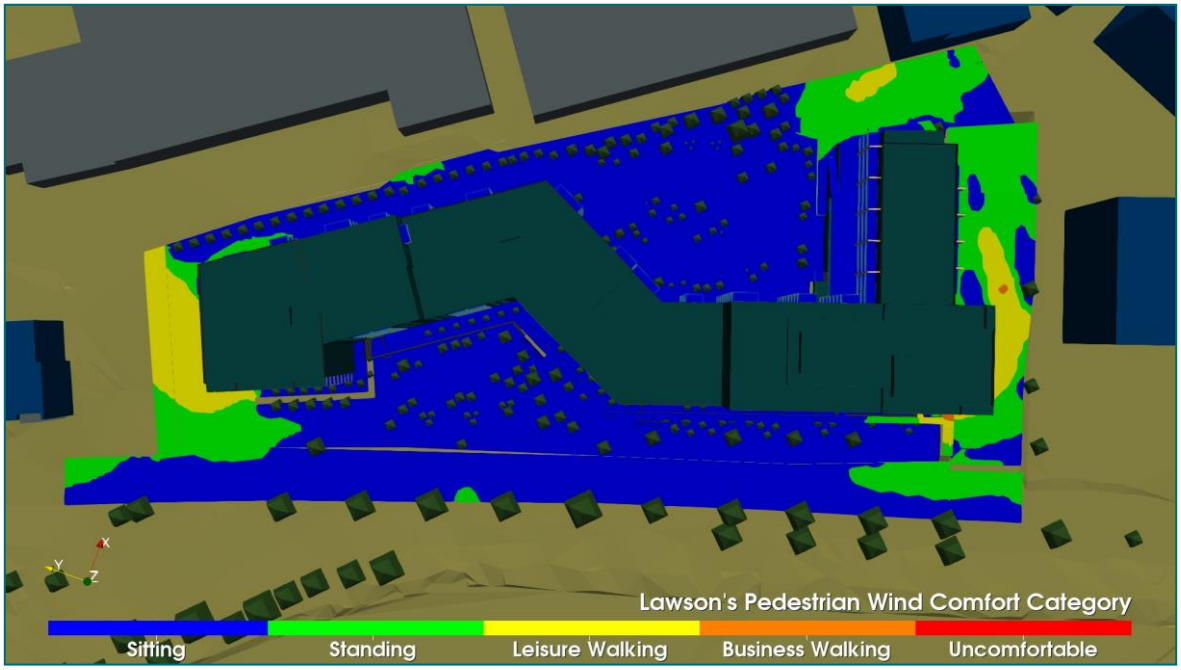

Figure 3: Collective Results: 5% Threshold

The following spaces around the main Block showed good compliance with the Sitting, Standing and Walking activities.

- Public Open Spaces
- Courtyard
- Creche Play Space
- Raised Board Walk
- Building Core Entrances (Upper Ground)
- Lower Ground Floor Entrances

The Building core entrances at the south are also comfortable for Standing and Walking activities.

It must be noted that a pedestrian activity class is only a statistical assessment of the local wind climate. When a region is classified as a certain class, this does not mean that one can never do a that activity for a long time. It only means that for more than 5% of the time (per year), the wind speed for this activity could result in an uncomfortable surrounding. However, during the remaining times of a given year, this activity can be classified as comfortable.

It is important to note the Galway climate is largely responsible for the exceedance of the given comfort classes, especially when buildings are located close to the coast and there is little to no obstruction of the wind coming off the coast as is the case for this development. Furthermore, the time of the year excessive wind speeds are experienced are during the winter months when weather conditions are generally not favorable for using the outdoor spaces. Also, the wind speed threshold for a certain pedestrian class is only meant to provide guidance on where to locate certain areas where a certain type of activity is expected to be performed. In practice, the experience of the outdoor climate depends on more than just wind speed. Other factors such as clothing, air temperature, solar irradiation, age and relative humidity must also be considered.

2.1.2 Sitting and Standing Comfort Criteria

The Lawson's Sitting Comfort Criterion states that the local air speed at designated locations should not exceed 4 m/s for more than 5% of the duration analysed. The Lawson's Standing Comfort Criterion states that the local air speed at designated locations should not exceed 6 m/s for more than 5% of the duration analysed.

2.1.2.1 Balcony Spaces

Figure 4 to Figure 11 show the results of sitting and standing comfort on the balconies. Results show excellent compliance and fully met the requirements of the Lawson's Sitting and Standing Comfort Criterion for full year. The wind speed is generally lower than 4m/s for more than 95% of the year as per the criterion's requirement. There are unlikely to be effects on the balcony spaces, with no further mitigation measures required.

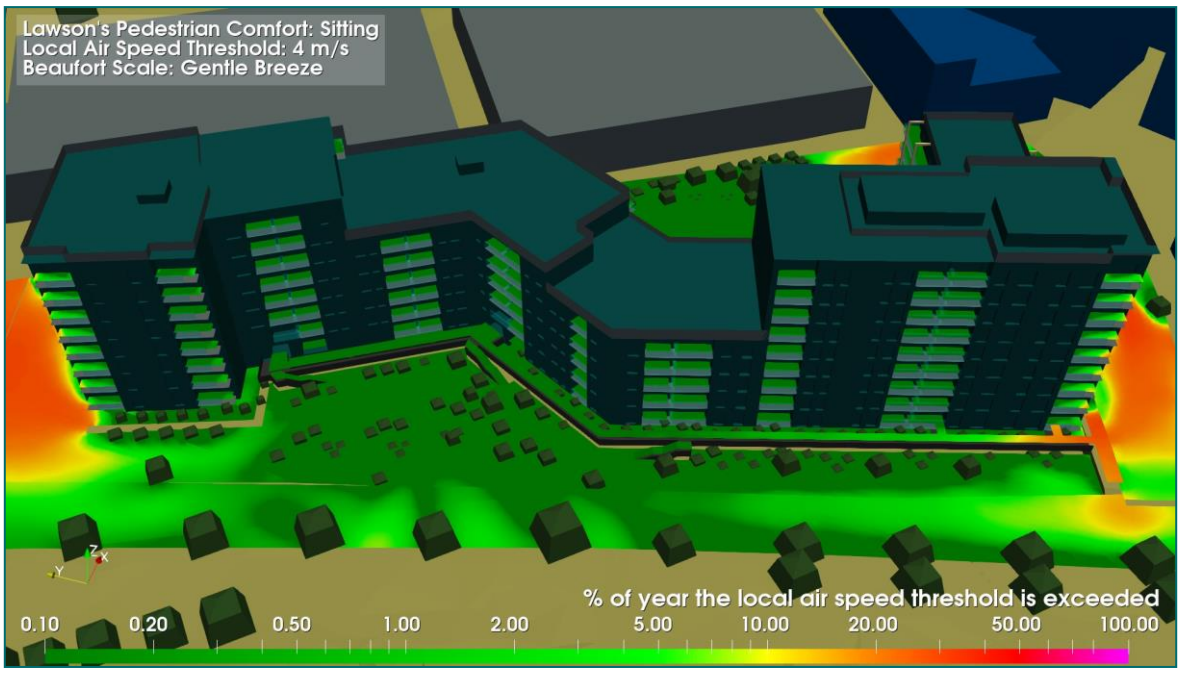

Figure 4: Sitting Comfort Criterion: Balconies: West Façade

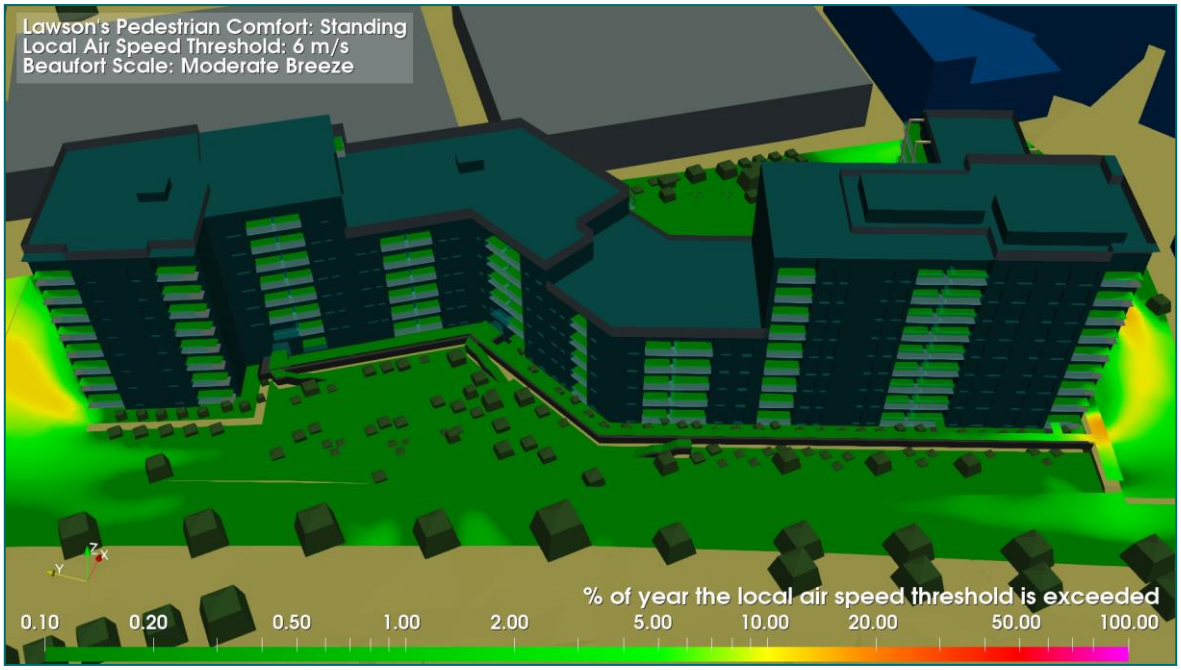

Figure 5: Standing Comfort Criterion: Balconies: West Façade

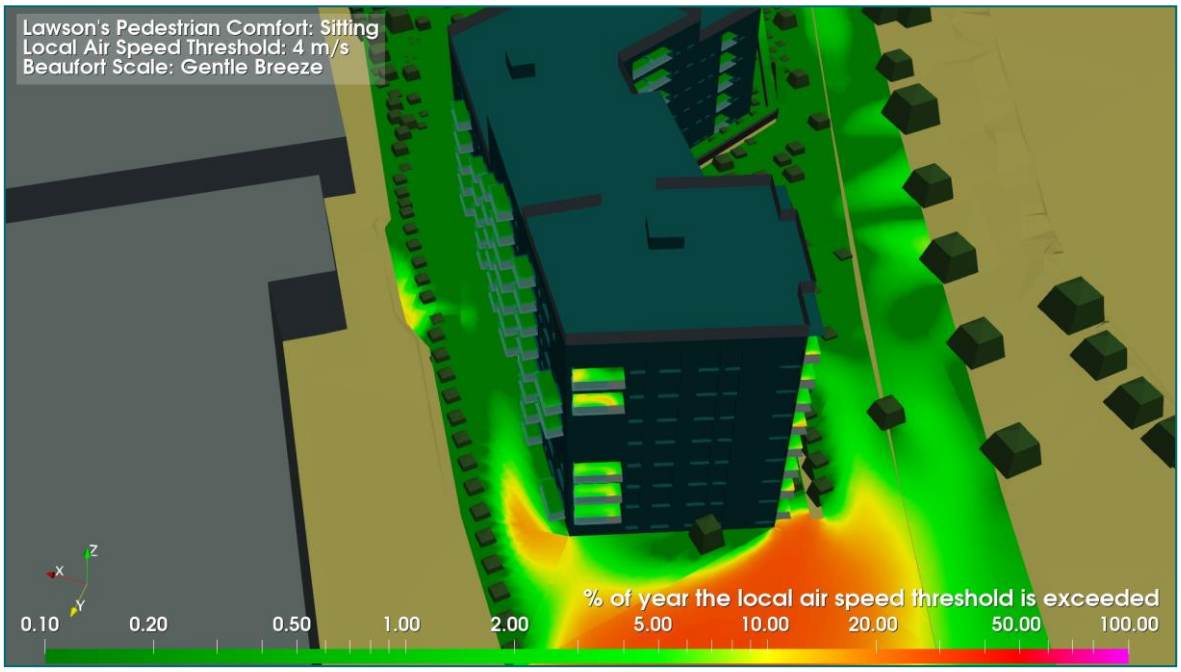

Figure 6: Sitting Comfort Criterion: Balconies: North Façade

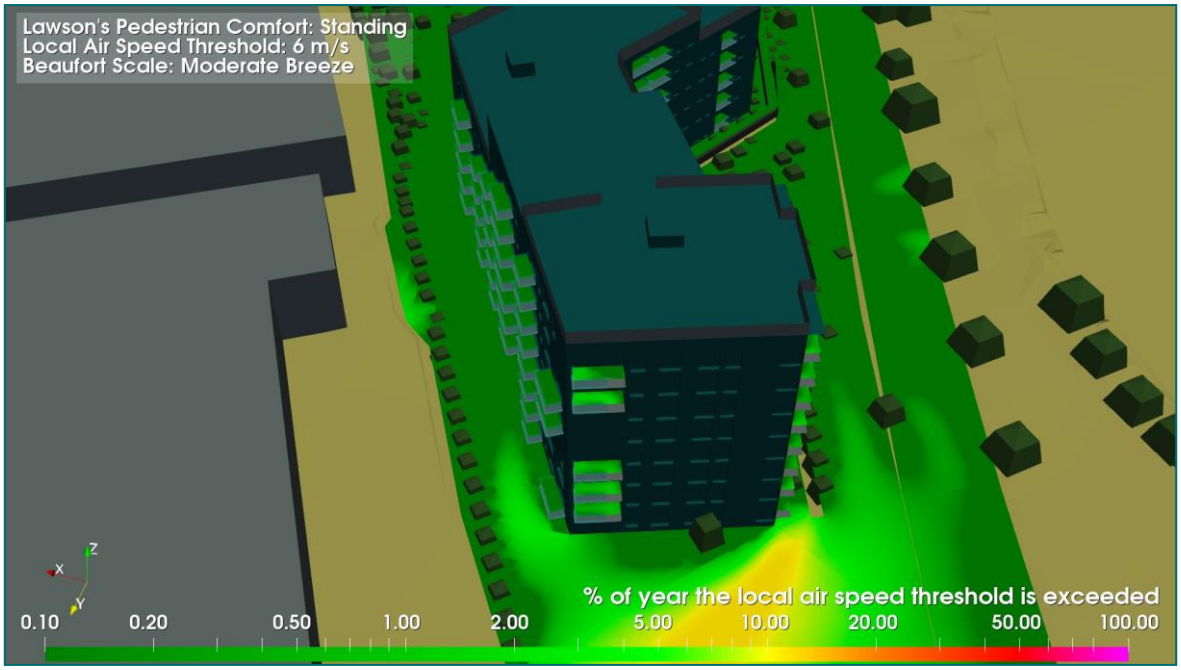

Figure 7: Standing Comfort Criterion: Balconies: North Façade

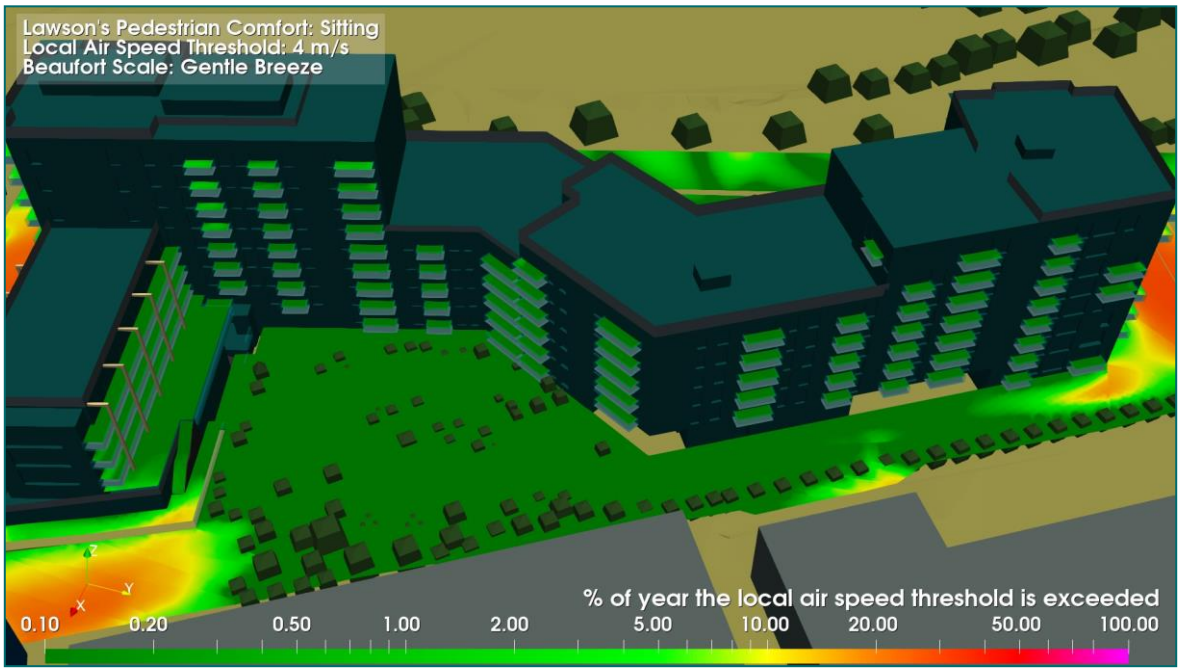

Figure 8: Sitting Comfort Criterion: Balconies: East Façade

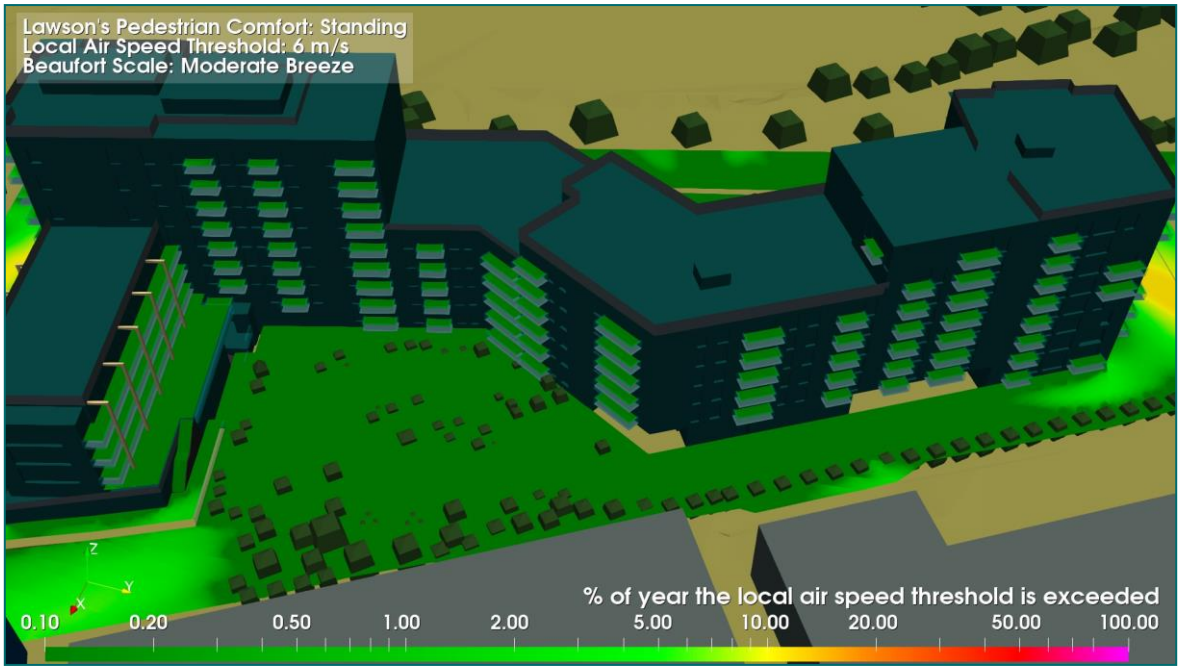

Figure 9: Standing Comfort Criterion: Balconies: East Façade

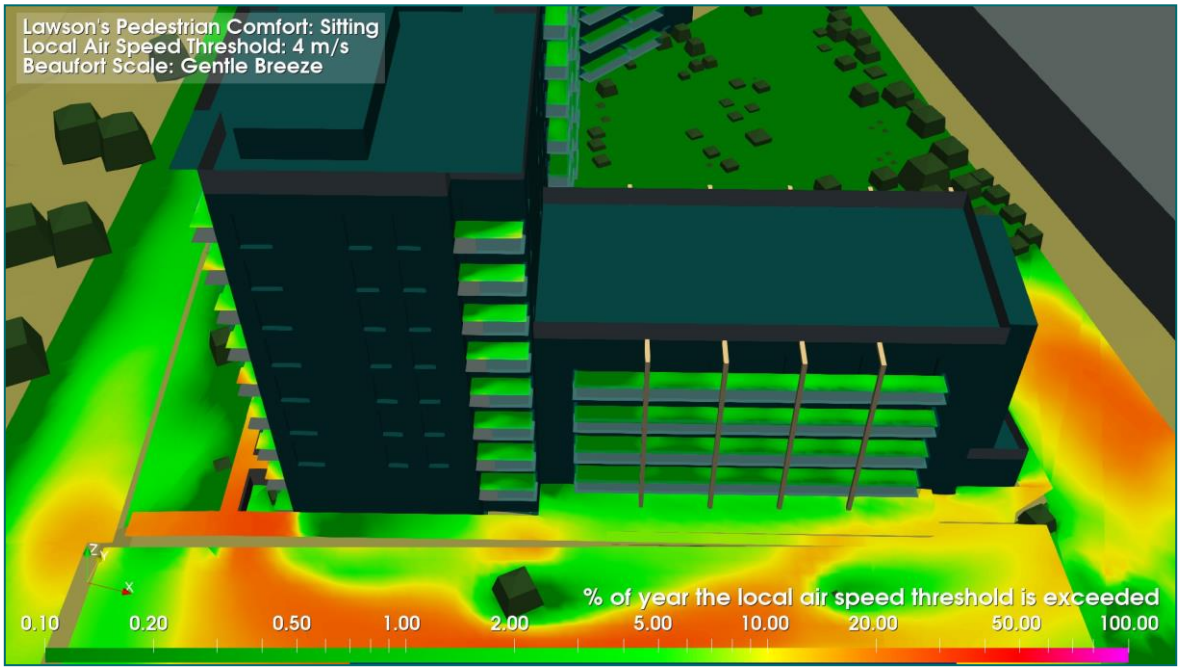

Figure 10: Sitting Comfort Criterion: Balconies: South Façade

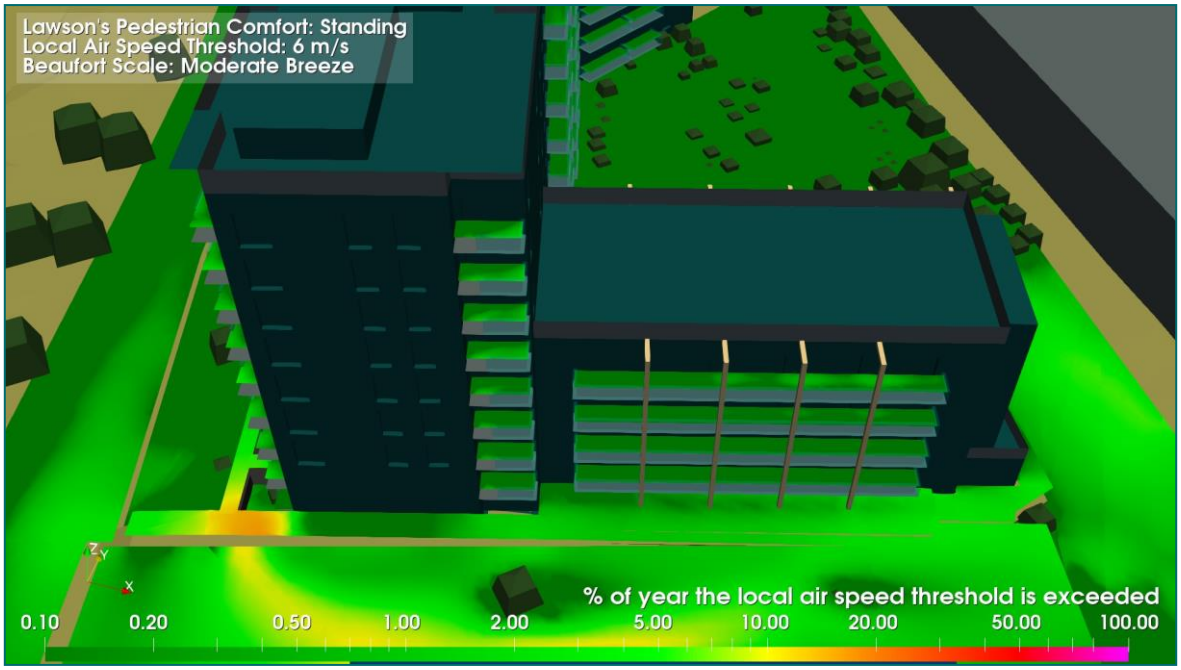

Figure 11: Standing Comfort Criterion: Balconies: South Façade

2.1.2.2 Ground Amenities

2.1.2.2.1 Public Open Space

Figure 12 and Figure 13 below show the results of sitting and standing comfort on the public open spaces marked in white.

The results show excellent compliance with the requirements of the Lawson's Sitting and Standing Comfort Criterion. The wind speed is generally lower than 4m/s for more than 95% of the year as per the criterion's requirement. There are unlikely to be effects on the public open spaces, with no further mitigation measures required.

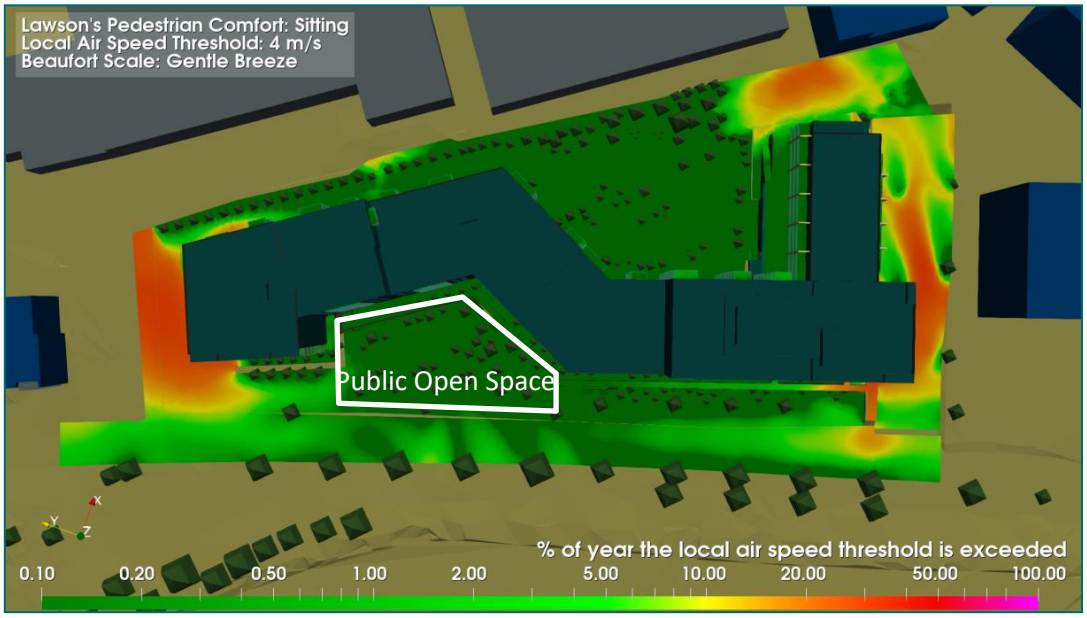

Figure 12: Sitting Comfort Criterion: Ground Amenities: Public Open Space

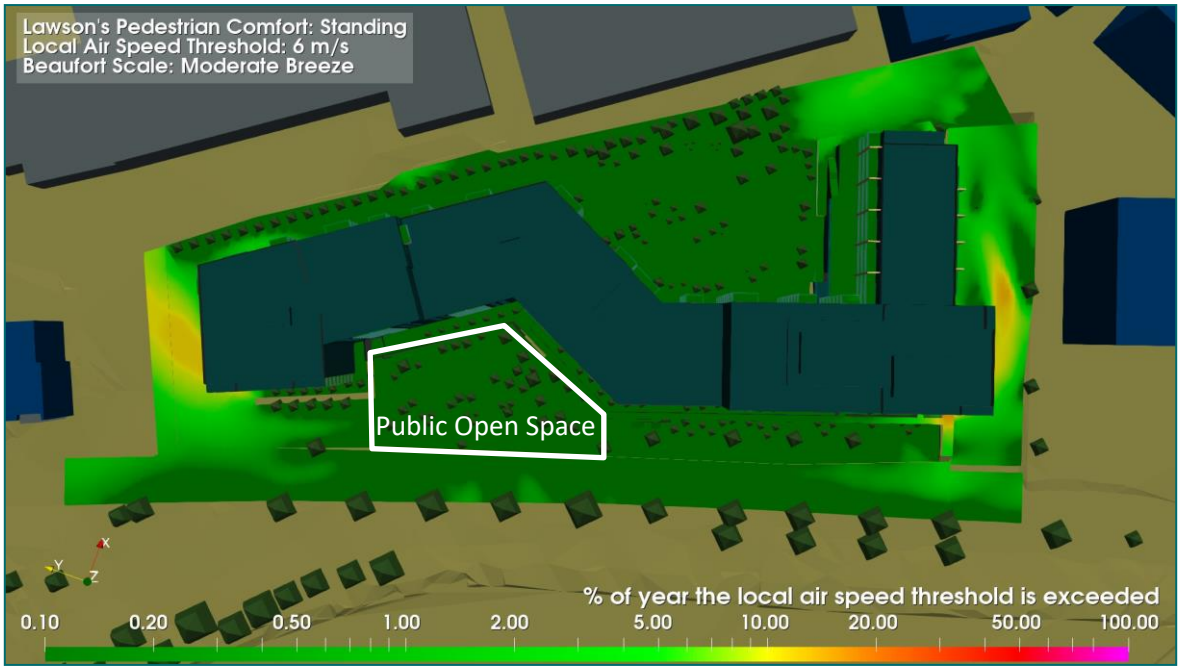

Figure 13: Standing Comfort Criterion: Ground Amenities: Public Open Space

2.1.2.2.2 Courtyard

Figure 14 and Figure 15 below show the results of sitting and standing comfort on the courtyard marked in white.

The results show excellent compliance with the requirements of the Lawson's Sitting and Standing Comfort Criterion. The wind speed is generally lower than 4m/s for more than 95% of the year as per the criterion's requirement. There are unlikely to be effects on the courtyard, with no further mitigation measures required.

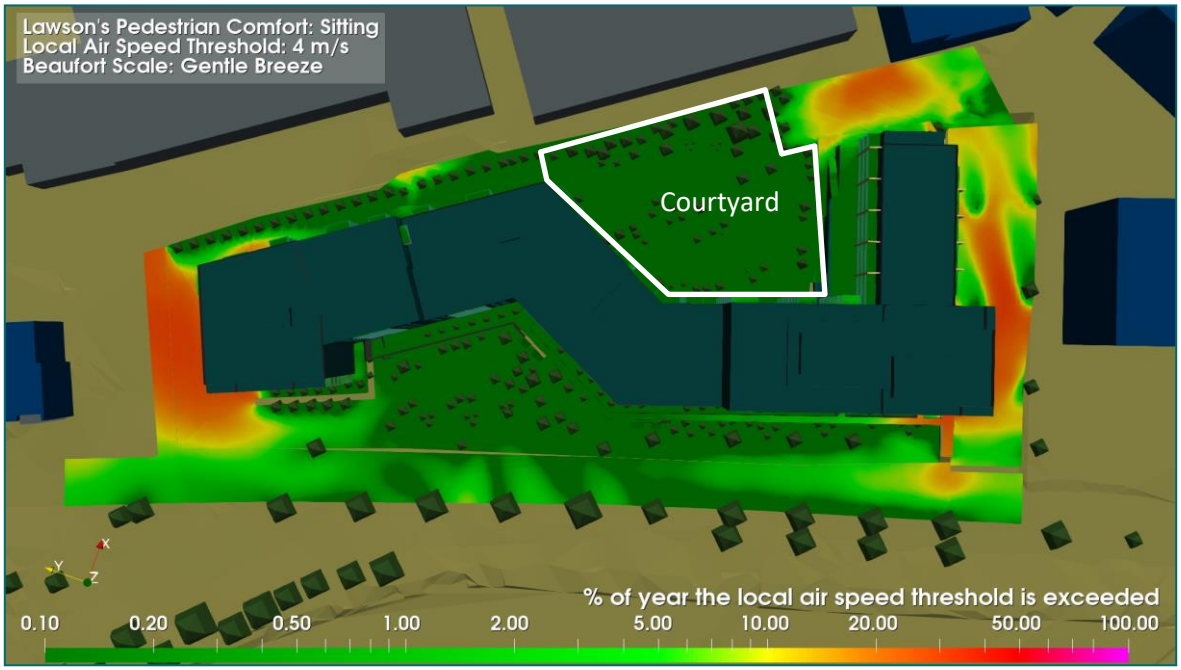

Figure 14: Sitting Comfort Criterion: Ground Amenities: Courtyard

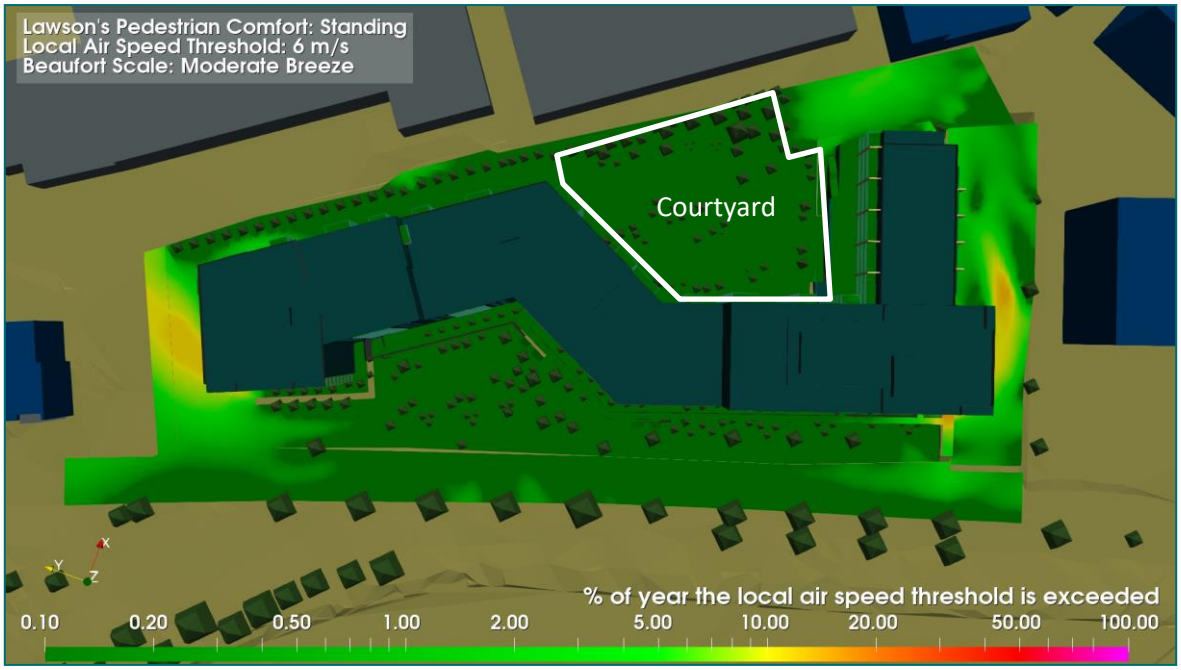

Figure 15: Standing Comfort Criterion: Ground Amenities: Courtyard

2.1.2.2.3 Creche Play Spaces

Figure 16 and Figure 17 below show the results of sitting and standing comfort on the creche play spaces marked in white.

The results show excellent compliance with the requirements of the Lawson's Sitting and Standing Comfort Criterion. The wind speed is generally lower than 4m/s for more than 95% of the year as per the criterion's requirement. There are unlikely to be effects on the creche play spaces, with no further mitigation measures required.

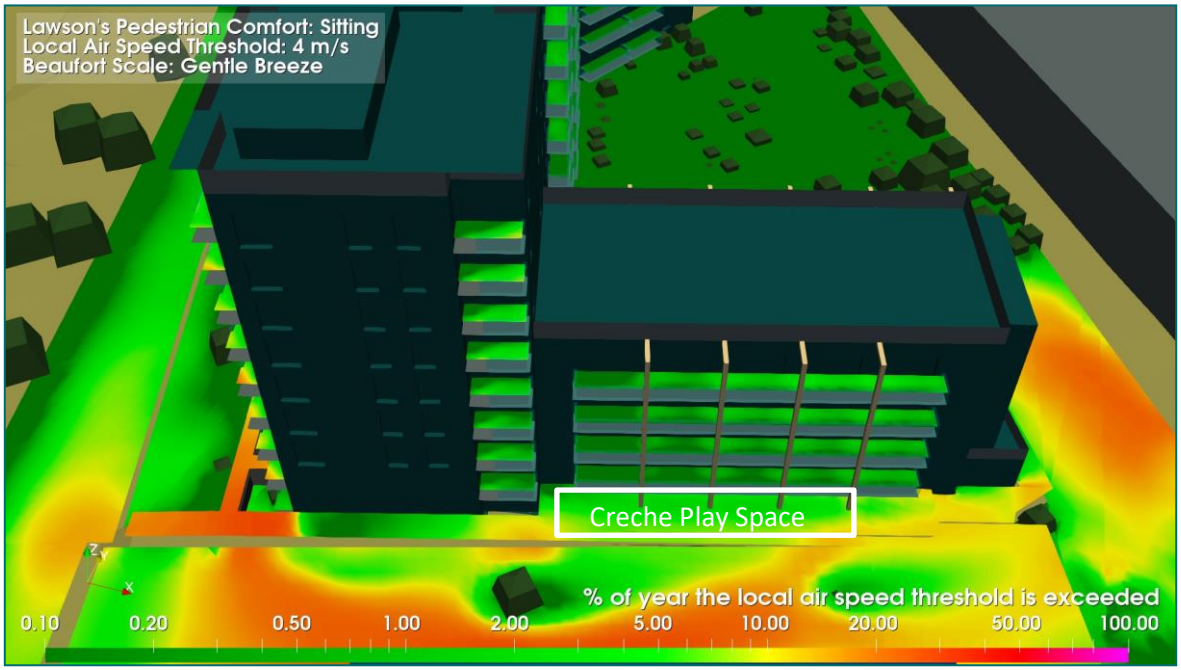

Figure 16: Sitting Comfort Criterion: Ground Amenities: Creche Play Spaces

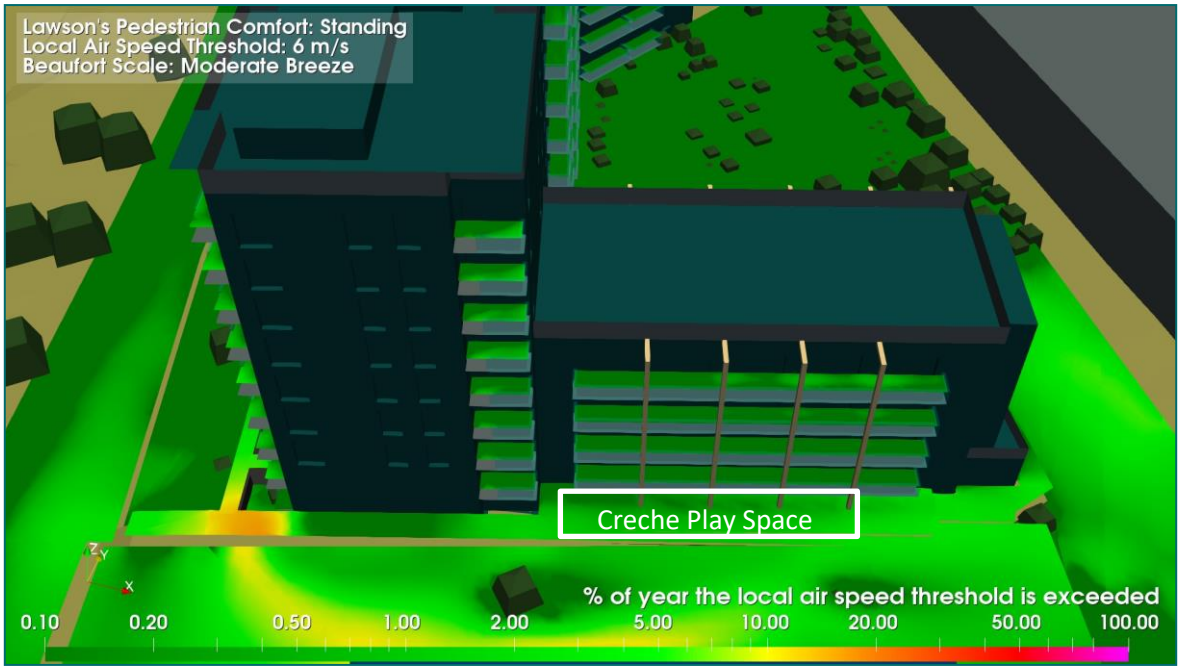

Figure 17: Standing Comfort Criterion: Ground Amenities: Creche Play Spaces

2.1.2.2.4 Ground Amenities towards South

Figure 18 and Figure 19 below show the results of sitting and standing comfort on the ground amenities towards south. These are marked in white.

The results show good compliance with the requirements of the Lawson's Sitting and Standing Comfort Criterion for the full year. The wind speed is generally lower than 4m/s for more than 95% of the year as per the criterion's requirement.

Some spaces with yellow and orange color contouring show limited compliance to the Lawson's sitting comfort. The local air speed is likely to exceed 4m/s for up to 20% of the year at these locations. These spaces are impacted due to unobstructed wind flowing from prevailing westerly and south westerly wind. Also, wind gets accelerated due to the narrow passage between the main block and the adjacent block towards south.

When comparing these results with the Lawson's Standing Comfort Criterion results, they show excellent compliance, i.e. the local air speed does not exceed 6 m/s for more than 5% of the year, see Figure 19. For the 20% of the year when the local air speed exceeds 4 m/s, three quarters of the collective time (i.e. 15% of the year) it does not exceed 6 m/s. The local air speed on balconies will be less than 4m/s for 80% of the year and between 4-6 m/s for 15% of the year. Any exceedance noted can be considered very marginal and will not result in an unpleasant environment is to use. The local air speed will only be greater than a gentle breeze but more frequently less than a moderate breeze. Such conditions are unlikely to have any impact on usability of the space for recreation.

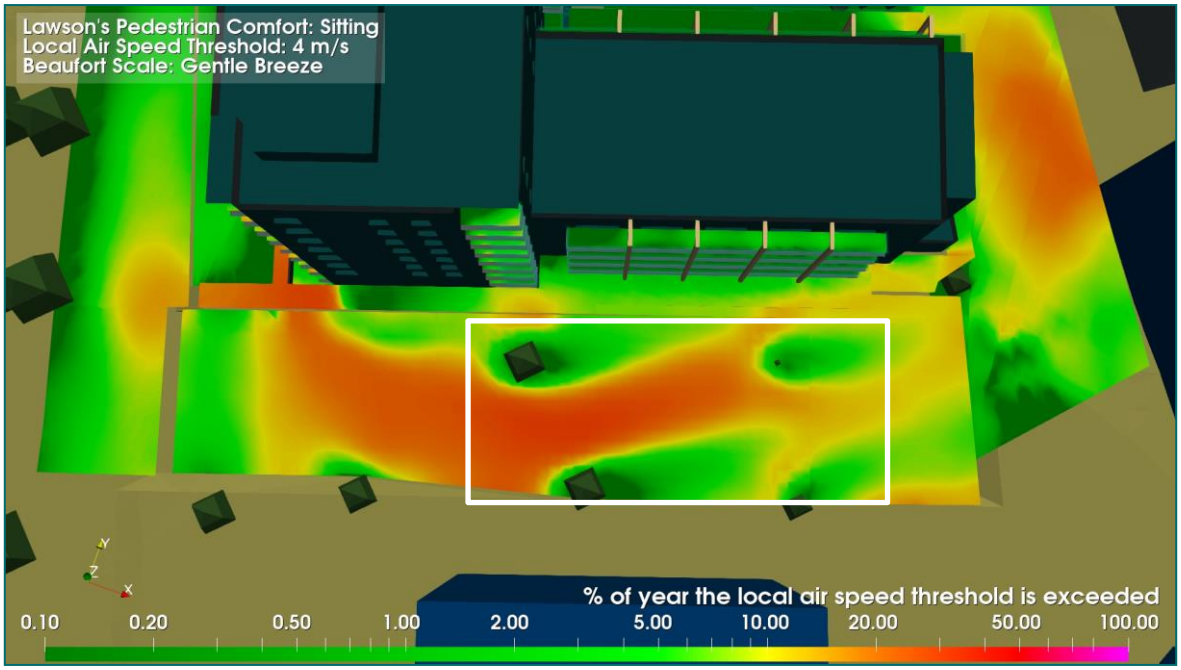

Figure 18: Sitting Comfort Criterion: Ground Amenities: Towards South

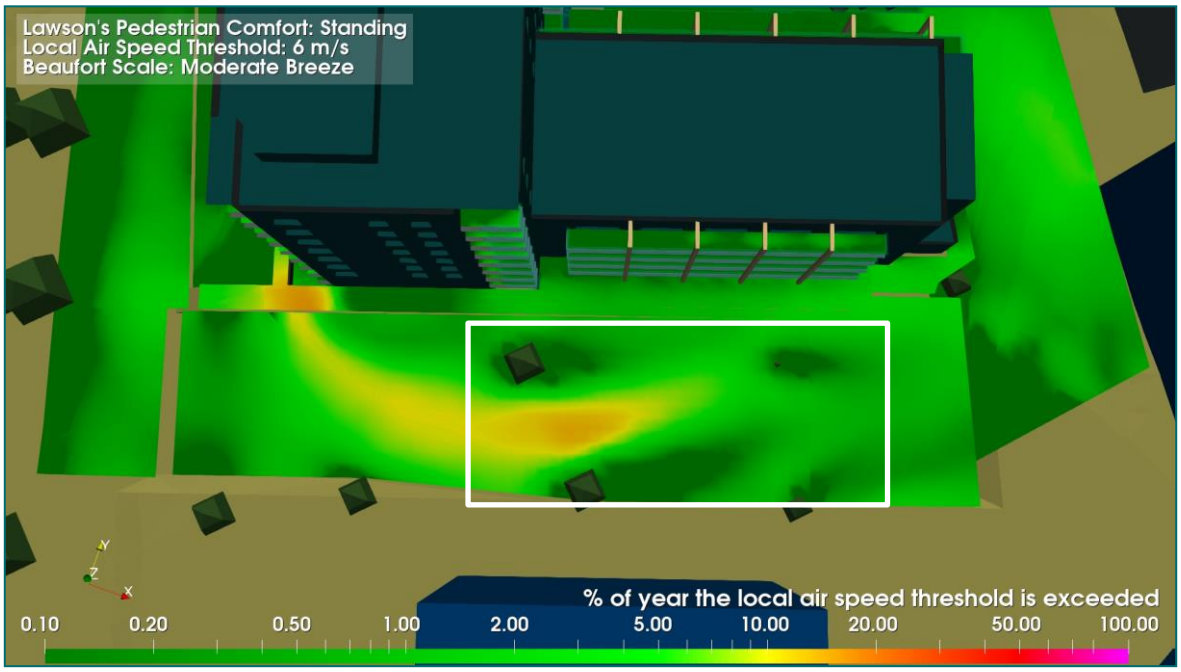

Figure 19: Standing Comfort Criterion: Ground Amenities: Towards South

2.1.2.2.5 Ground Amenities towards North

Figure 20 and Figure 21 below show the results of sitting and standing comfort on the ground amenities towards north. These are marked in white.

The results show good compliance with the requirements of the Lawson's Sitting and Standing Comfort Criterion for the full year. The wind speed is generally lower than 4m/s for more than 95% of the year as per the criterion's requirement.

Some spaces with yellow and orange color contouring show limited compliance to the Lawson's sitting comfort. The local air speed is likely to exceed 4m/s for up to 20% of the year at these locations. These spaces are impacted due to unobstructed wind flowing from prevailing westerly and south westerly wind.

When comparing these results with the Lawson's Standing Comfort Criterion results, they show excellent compliance, i.e. the local air speed does not exceed 6 m/s for more than 5% of the year, see Figure 21. For the 20% of the year when the local air speed exceeds 4 m/s, three quarters of the collective time (i.e. 15% of the year) it does not exceed 6 m/s. The local air speed on balconies will be less than 4m/s for 80% of the year and between 4-6 m/s for 15% of the year. Any exceedance noted can be considered very marginal and will not result in an unpleasant environment is to use. The local air speed will only be greater than a gentle breeze but more frequently less than a moderate breeze. Such conditions are unlikely to have any impact on usability of the space for recreation.

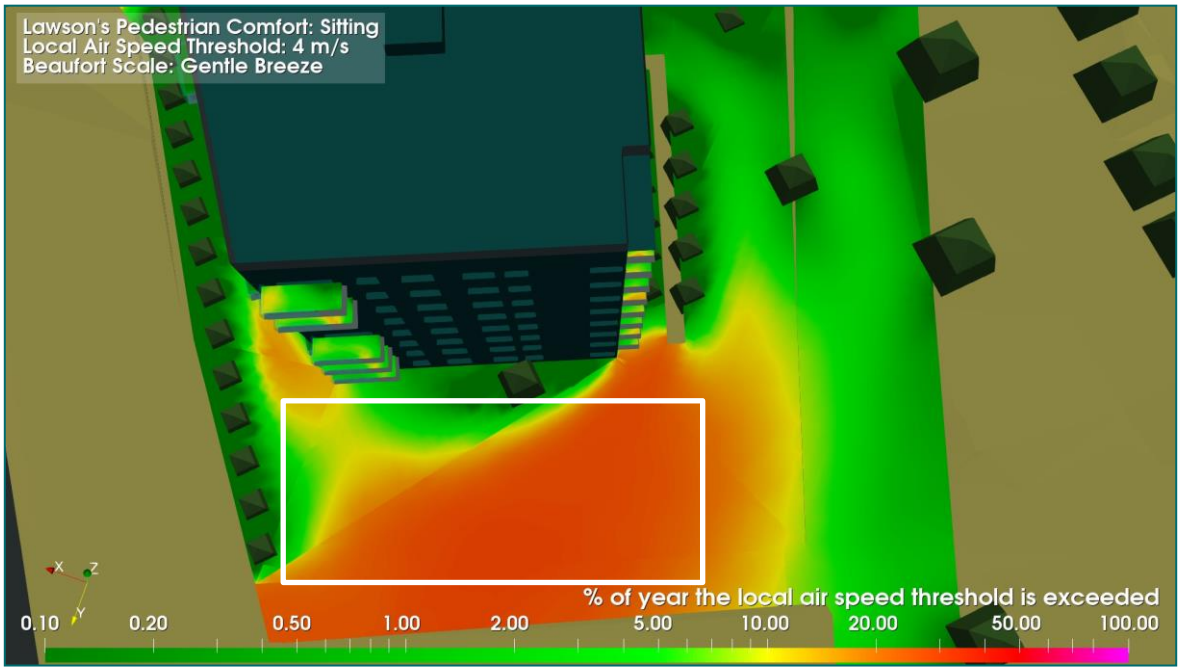

Figure 20: Sitting Comfort Criterion: Ground Amenities: Towards North

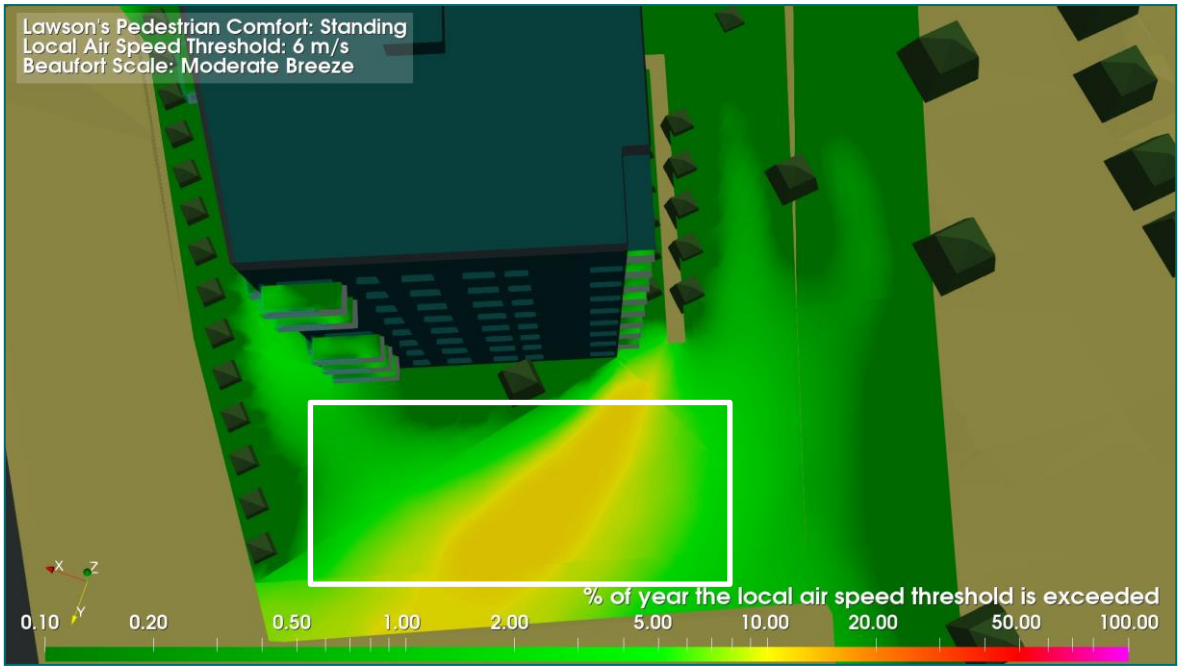

Figure 21: Standing Comfort Criterion: Ground Amenities: Towards North

2.1.2.3 Raised Boardwalk

Figure 22 and Figure 23 below show the results of sitting and standing comfort on the raised boardwalk near the west façade of the building. The results show excellent compliance with the requirements of the Lawson's Sitting and Standing Comfort Criterion. The wind speed is generally lower than 4m/s for more than 95% of the year as per the criterion's requirement. There are unlikely to be effects on the boardwalk, with no further mitigation measures required.

The boardwalk entrances towards south and north show limited compliance with the Lawson's Sitting Comfort Criterion. The local air speed is likely to exceed 4m/s for more than 20% of the year at these locations. These are impacted due to the wind flowing from the prevailing westerly and south-westerly direction.

When comparing the results for these balconies to Lawson's Standing Comfort Criterion results, they show good compliance, i.e. the local air speed does not exceed 6 m/s for more than 5% of the year, see Figure 23. For the 20% of the year when the local air speed exceeds 4 m/s, three quarters of the collective time (i.e. 15% of the year) it does not exceed 6 m/s. The local air speed on balconies will be less than 4m/s for 80% of the year and between 4-6 m/s for 15% of the year. Any exceedance noted can be considered very marginal and will not result in an unpleasant environment is to use. The local air speed will only be greater than a gentle breeze but more frequently less than a moderate breeze. Such conditions are unlikely to have any impact on usability of the space for recreation.

There is not be any sitting activity designed on the boardwalk. It is mainly designed for the walking activity to move in and out from the building. There are unlikely to be effects on the boardwalk, with no further mitigation measures required.

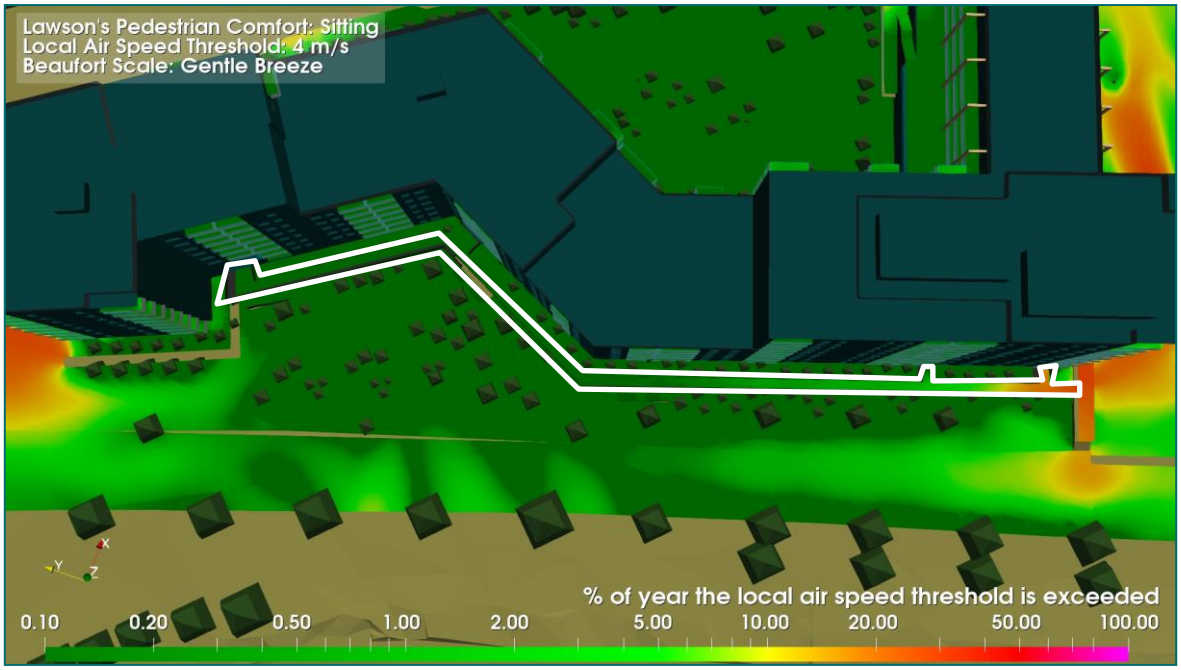

Figure 22: Sitting Comfort Criterion: Ground Amenities: Raised Boardwalk

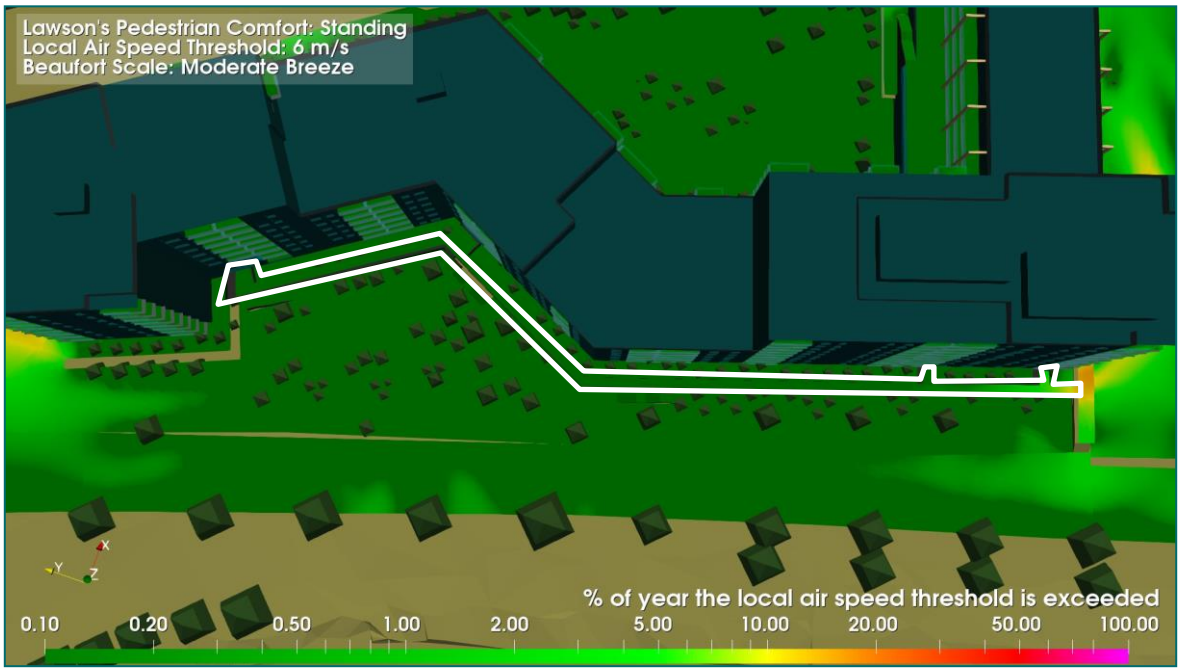

Figure 23: Standing Comfort Criterion: Ground Amenities: Raised Boardwalk

2.1.2.4 Building Entrances

Figure 24 to Figure 27 below show the results of sitting and standing comfort on the building entrances marked in white.

The results show excellent compliance with the requirements of the Lawson's Sitting and Standing Comfort Criterion. The wind speed is generally lower than 4m/s for more than 95% of the year as per the criterion's requirement. There are unlikely to be effects on the creche play spaces, with no further mitigation measures required.

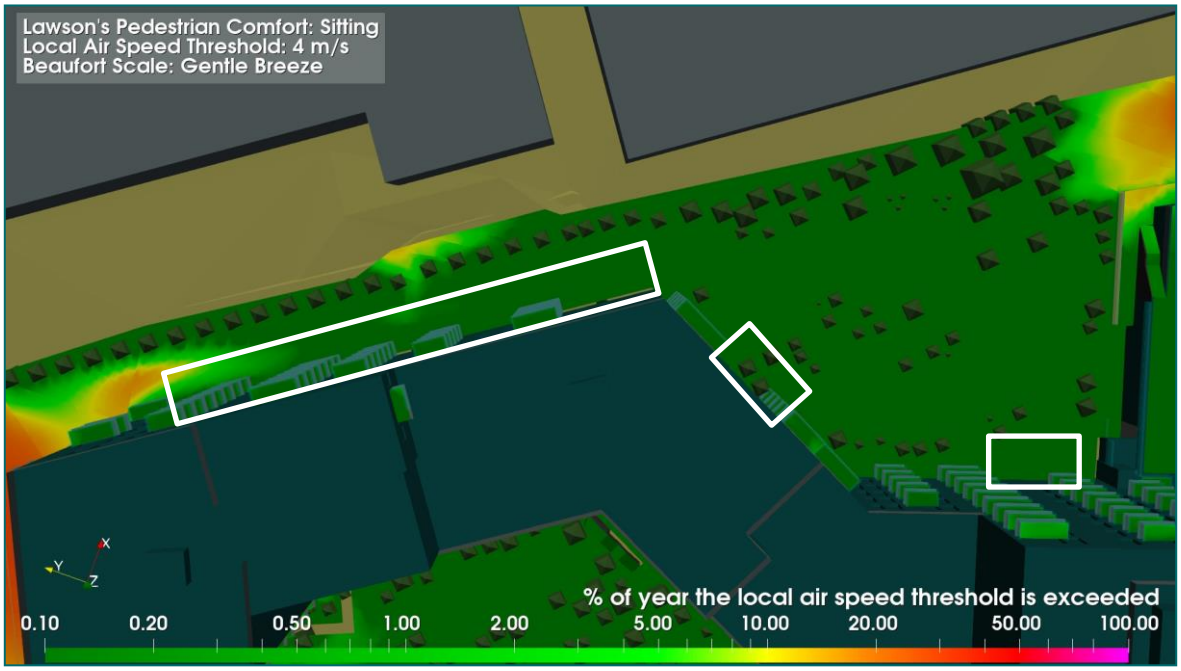

Figure 24: Sitting Comfort Criterion: Lower Ground Floor Entrances

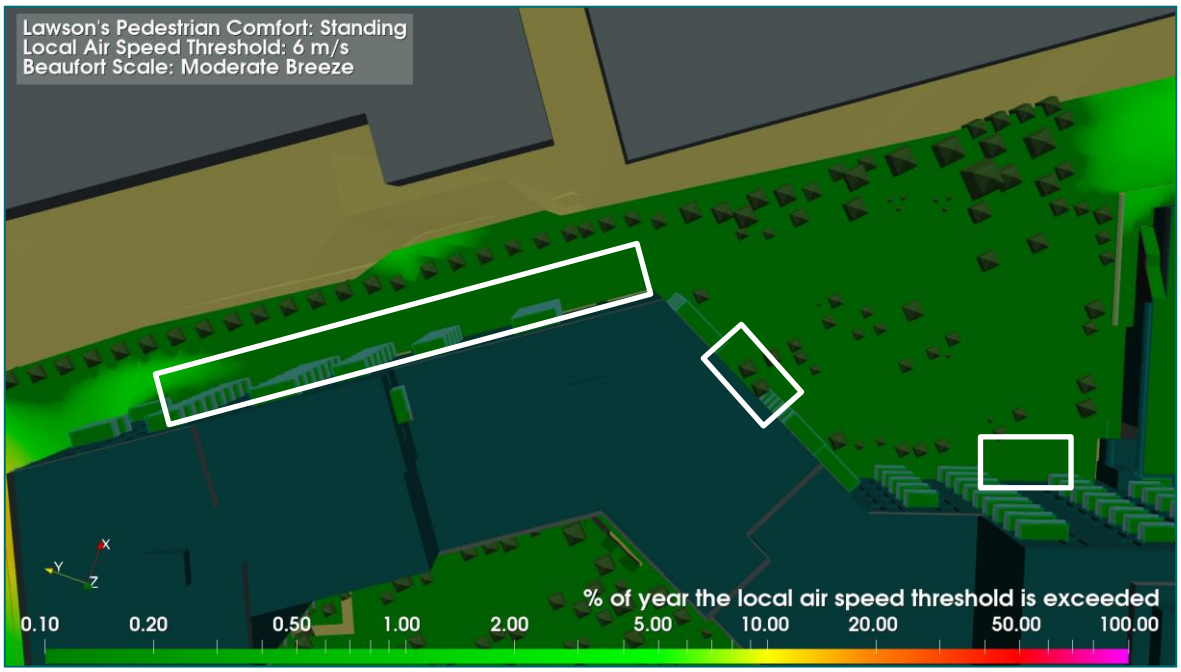

Figure 25: Standing Comfort Criterion: Lower Ground Floor Entrances

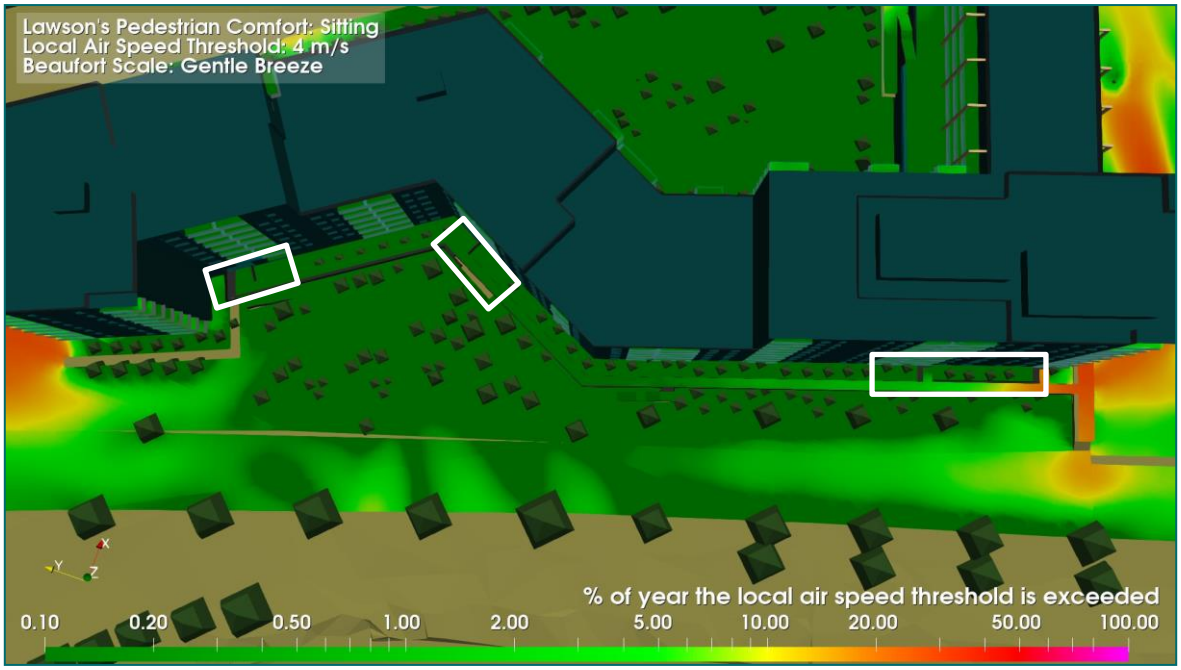

Figure 26: Sitting Comfort Criterion: Building Core Entrances (Upper Ground)

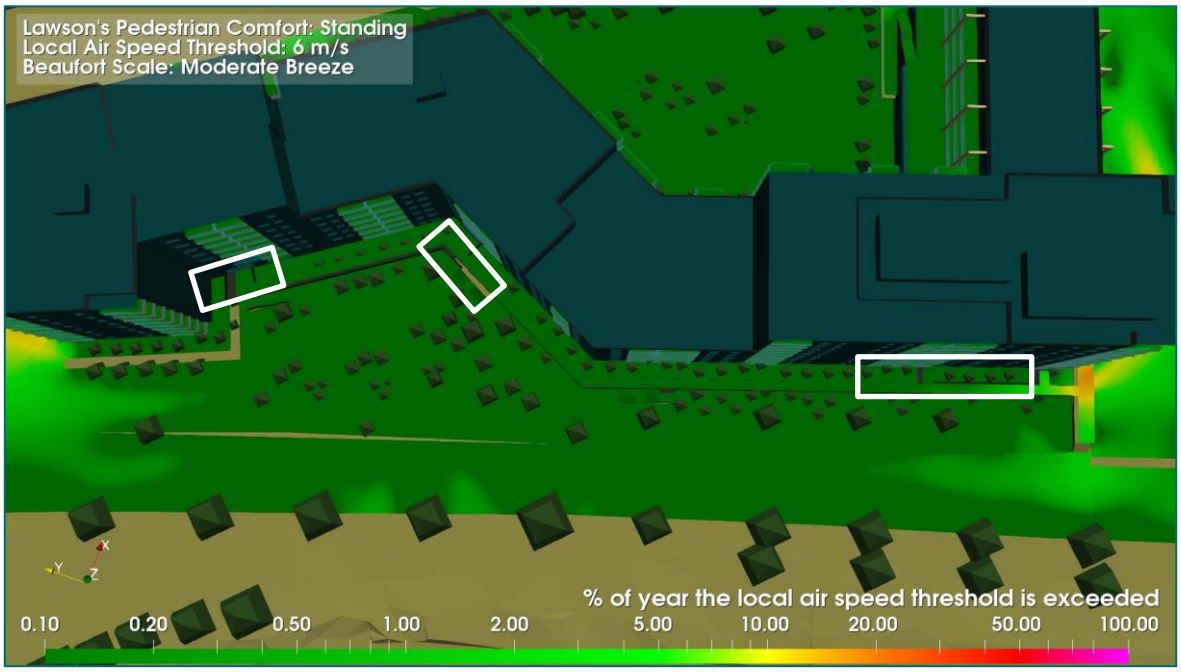

Figure 27: Standing Comfort Criterion: Building Core Entrances (Upper Ground)

2.1.3 Walking Comfort

The Lawson's Leisure Walking Comfort Criterion states the local air speed at designated locations should not exceed 8 m/s for more than 5% of the duration analysed, on the various paths around the development. Additionally, the Lawson's Business Walking Comfort Criterion states the local air speed at designated locations should not exceed 10 m/s for more than 5% of the duration analysed, on the various paths around the development. These show excellent compliance with the requirements of the Lawson's Business Walking Comfort Criterion. The local air speed does not exceed 8 m/s and 10 m/s for more than 5% of the year, respectively. Figure 28 and Figure 29 below shows the results of walking comfort criteria.

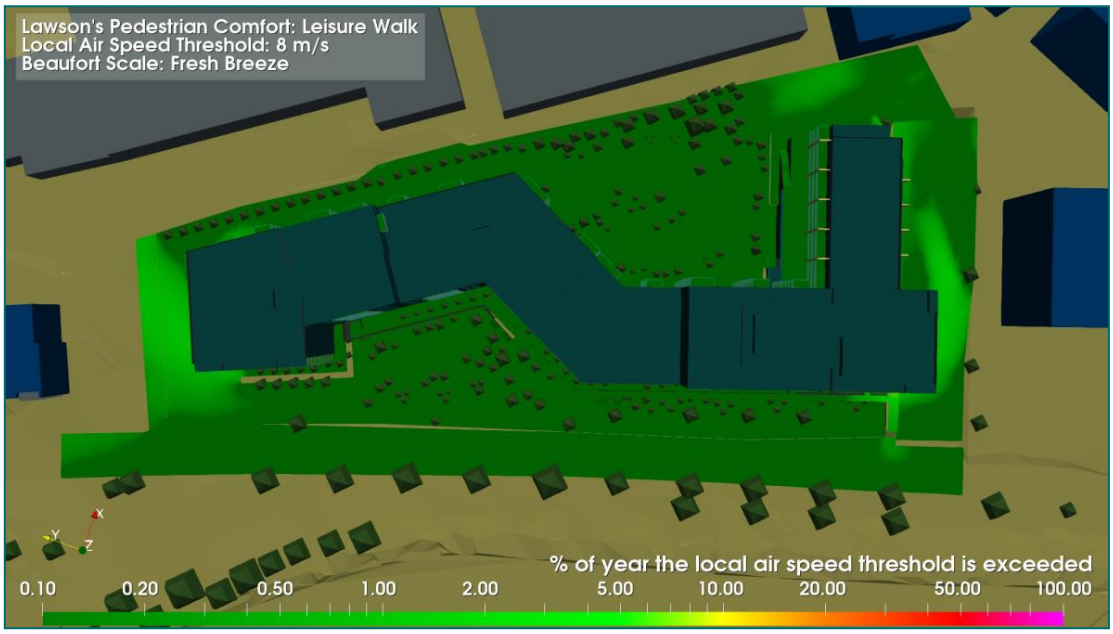

Figure 28: Leisure Walking Comfort Criterion: View form the Top

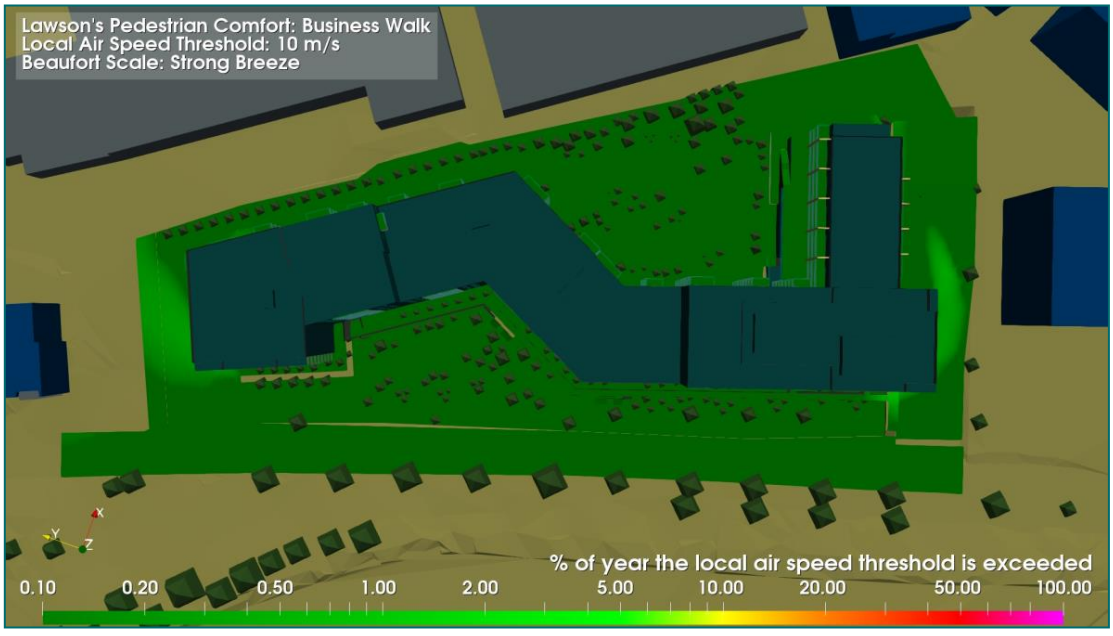

Figure 29: Business Walking Comfort Criterion: View form the Top

2.1.4 Safety Criteria

The Lawson's Normal Pedestrian Safety Criterion states the local air speed at designated locations should not exceed 20 m/s for more than 0.01% of the duration analysed. Additionally, the Lawson's Sensitive Pedestrian safety criteria states the local air speed at designated locations should not exceed 15 m/s for more than 0.01% of the duration analysed. The Sensitive Pedestrian safety criterion applies to the vulnerable population such as pensioners and children. Note the limit of the criterion is 0.01% and not 5% as with the comfort criterion.

These criteria are also intended for various paths and grounds around the development, as access is always required irrespective of weather conditions to enter or exit the various buildings. Figure 30 and Figure 31 show the results of safety criteria assessment. The results of the normal pedestrians and sensitive pedestrians are observed to be below 0.1% of the year.

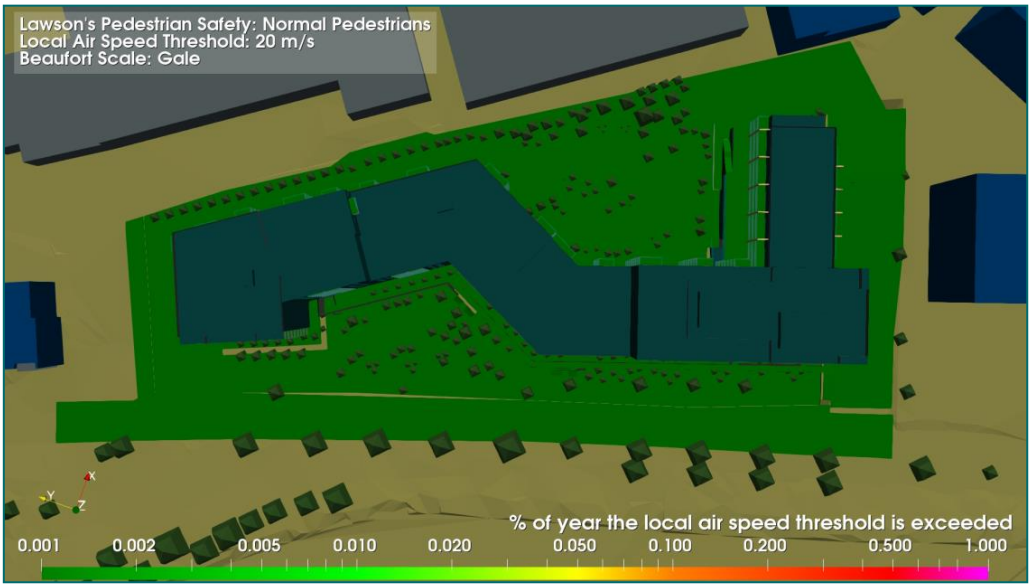

Figure 30: Normal Pedestrian Safety Criterion: View of the entire site

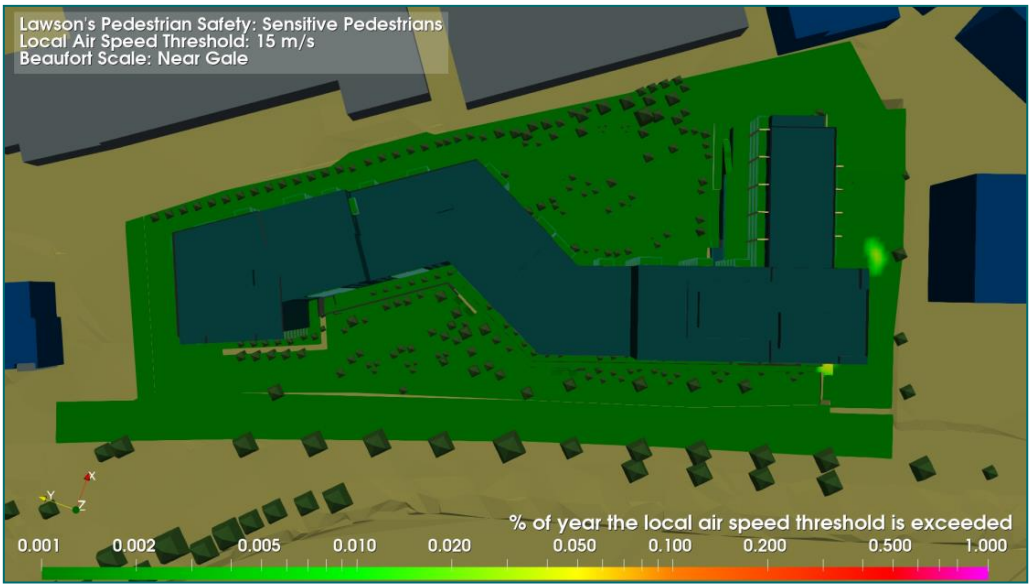

Figure 31: Sensitive Pedestrian Safety Criterion: View of the entire site

2.2 Results: Phase 1

This section includes the results of the proposed development Phase 1.

2.2.1 Collective Results

Figure 32 show the collective results of wind comfort for the 5% threshold. These results were summed to calculate the total number of hours that a given pedestrian activity class exceeds the 5% yearly threshold based on hierarchy of wind speed. The sitting comfort represents that the wind was lower than 4m/s and rest of the classes were above it. It must be noted that when a space is classified under a certain activity class, the space will also achieve all activity classes above it in the hierarchy scale e.g. if a space was comfortable for sitting activity then that space was also comfortable for standing and walking activities.

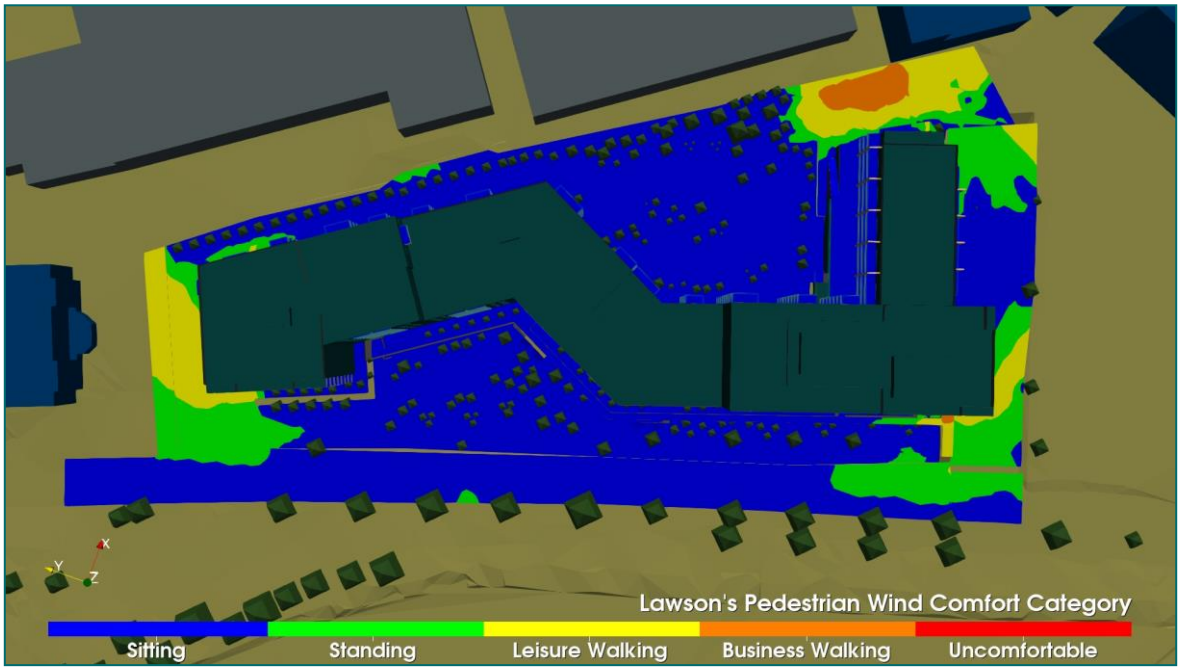

Figure 32: Collective Results: 5% Threshold

The following spaces around the main Block showed good compliance with the Sitting, Standing and Walking activities.

- Public Open Spaces
- Courtyard
- Creche Play Space
- Raised Board Walk
- Building Core Entrances (Upper Ground)
- Lower Ground Floor Entrances

The Building core entrances at the south are also comfortable for Standing and Walking activities.

It must be noted that a pedestrian activity class is only a statistical assessment of the local wind climate. When a region is classified as a certain class, this does not mean that one can never do a that activity for a long time. It only means that for more than 5% of the time (per year), the wind

speed for this activity could result in an uncomfortable surrounding. However, during the remaining times of a given year, this activity can be classified as comfortable.

It is important to note the Galway climate is largely responsible for the exceedance of the given comfort classes, especially when buildings are located close to the coast and there is little to no obstruction of the wind coming off the coast as is the case for this development. Furthermore, the time of the year excessive wind speeds are experienced are during the winter months when weather conditions are generally not favorable for using the outdoor spaces. Also, the wind speed threshold for a certain pedestrian class is only meant to provide guidance on where to locate certain areas where a certain type of activity is expected to be performed. In practice, the experience of the outdoor climate depends on more than just wind speed. Other factors such as clothing, air temperature, solar irradiation, age and relative humidity must also be considered.

2.2.2 Sitting and Standing Comfort Criteria

The Lawson's Sitting Comfort Criterion states that the local air speed at designated locations should not exceed 4 m/s for more than 5% of the duration analysed. The Lawson's Standing Comfort Criterion states that the local air speed at designated locations should not exceed 6 m/s for more than 5% of the duration analysed.

2.2.2.1 Balcony Spaces

Figure 33 to Figure 40 show the results of sitting and standing comfort on the balconies. Results show excellent compliance and fully met the requirements of the Lawson's Sitting and Standing Comfort Criterion for full year. The wind speed is generally lower than 4m/s for more than 95% of the year as per the criterion's requirement. There are unlikely to be effects on the balcony spaces, with no further mitigation measures required.

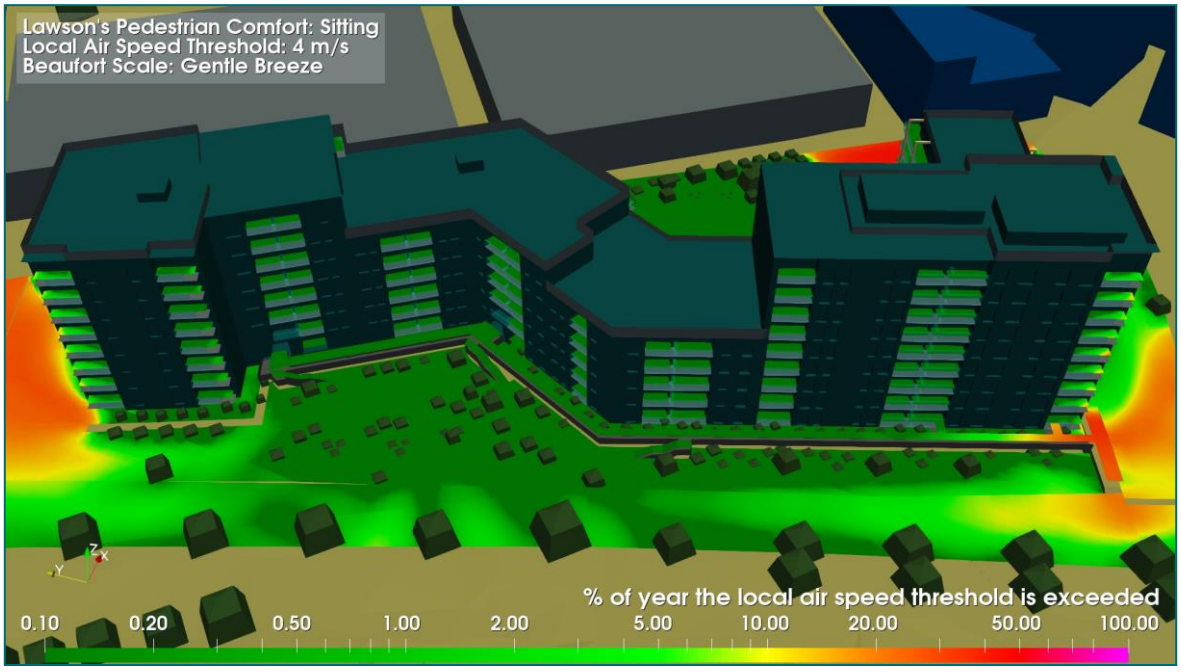

Figure 33: Sitting Comfort Criterion: Balconies: West Façade

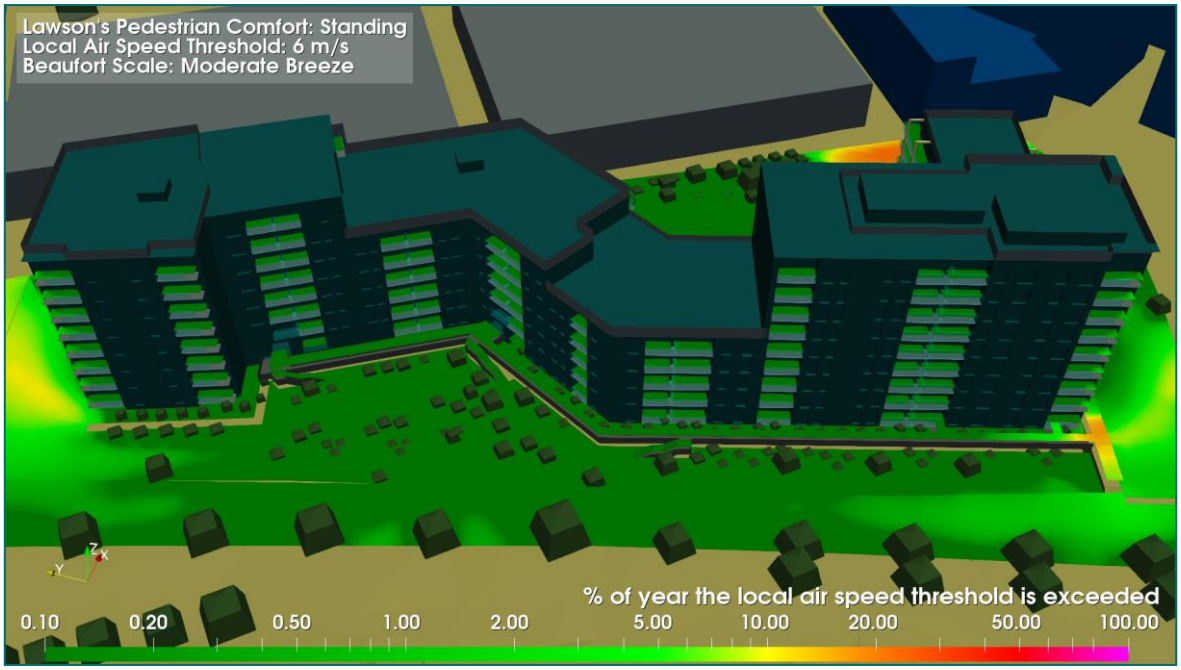

Figure 34: Standing Comfort Criterion: Balconies: West Façade

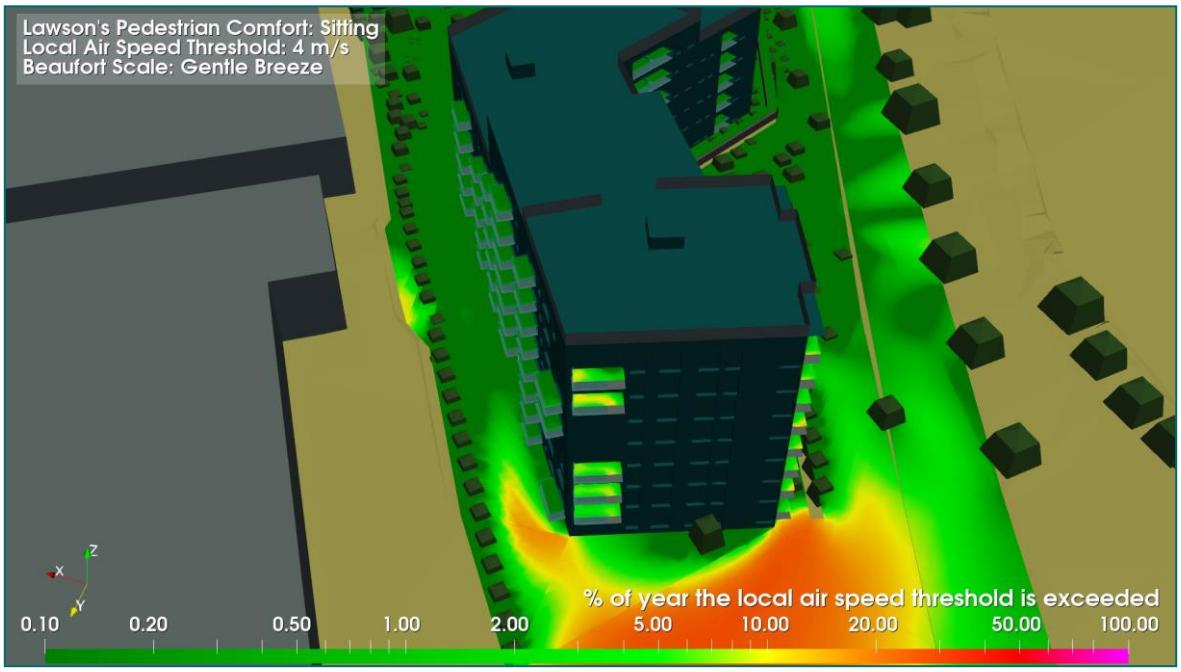

Figure 35: Sitting Comfort Criterion: Balconies: North Façade

Figure 36: Standing Comfort Criterion: Balconies: North Façade

Figure 37: Sitting Comfort Criterion: Balconies: East Façade

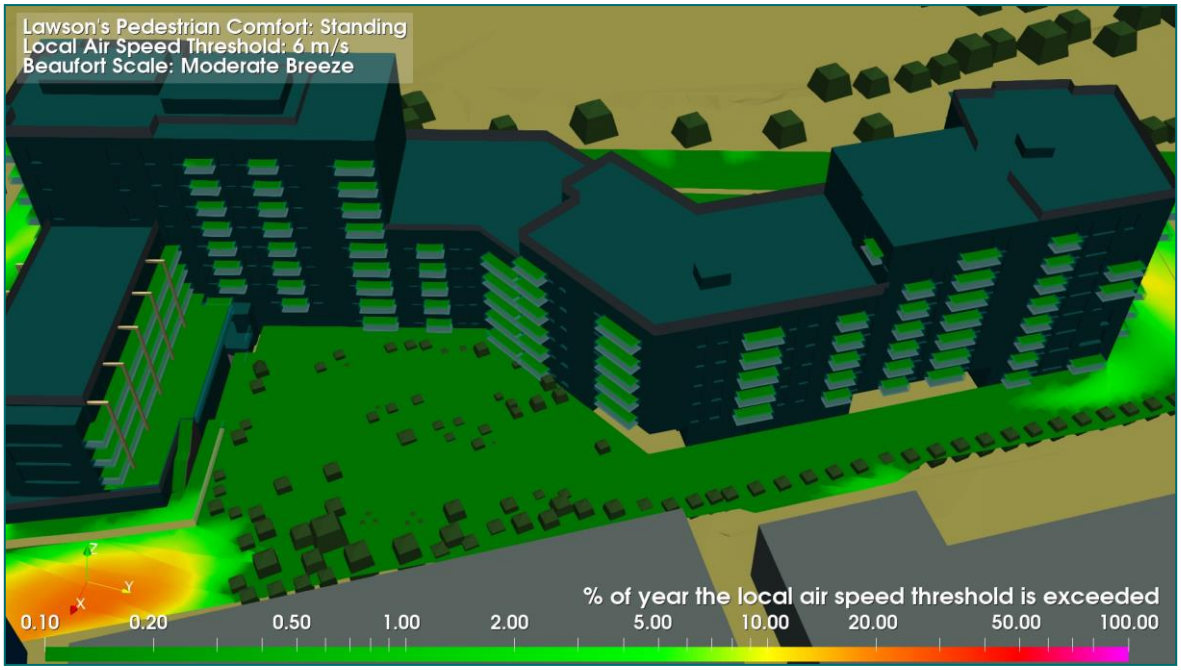

Figure 38: Standing Comfort Criterion: Balconies: East Façade

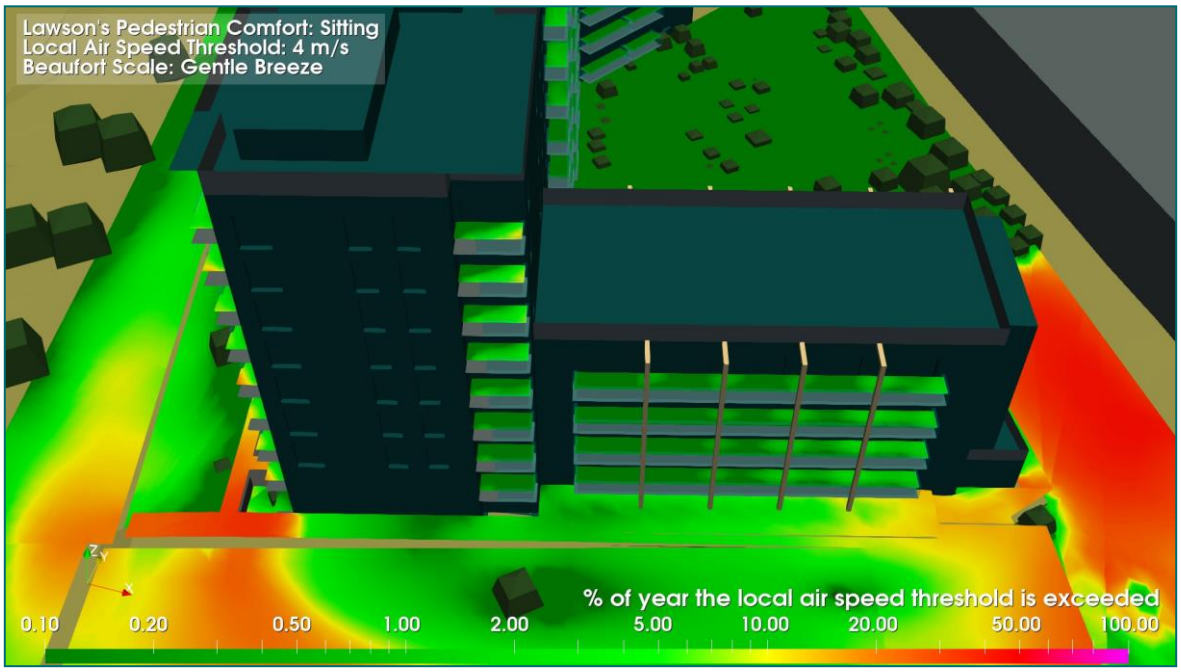

Figure 39: Sitting Comfort Criterion: Balconies: South Façade

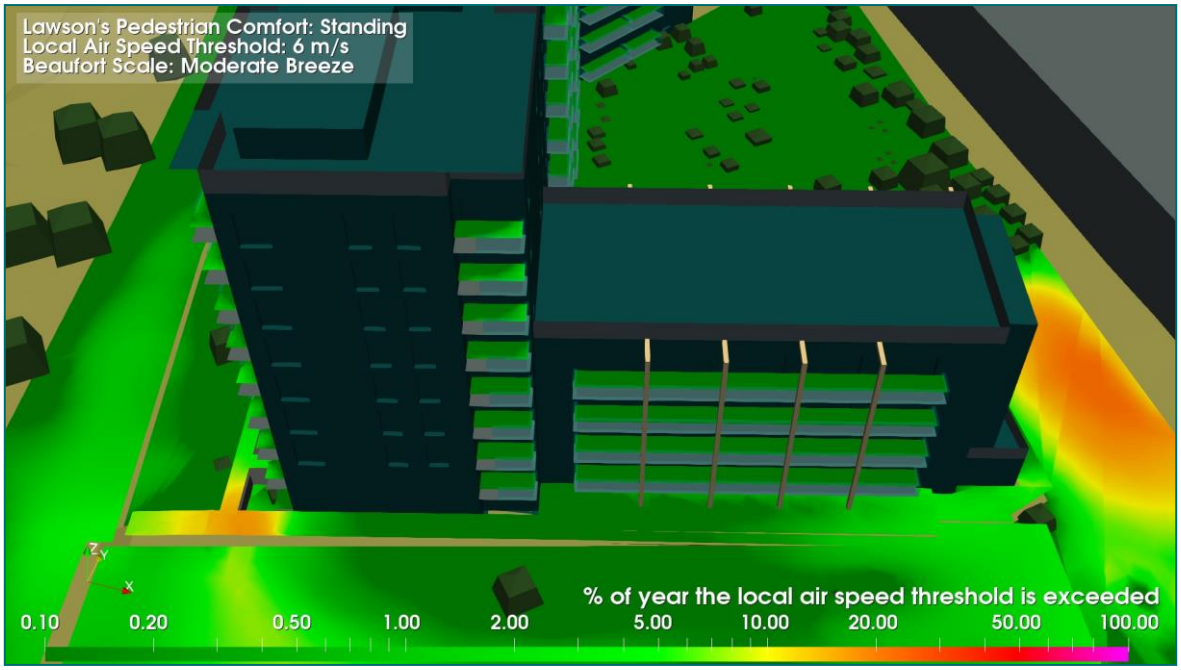

Figure 40: Standing Comfort Criterion: Balconies: South Façade

2.2.2.2 Ground Amenities

2.2.2.2.1 Public Open Space

Figure 41 and Figure 42 below show the results of sitting and standing comfort on the public open spaces marked in white.

The results show excellent compliance with the requirements of the Lawson's Sitting and Standing Comfort Criterion. The wind speed is generally lower than 4m/s for more than 95% of the year as per the criterion's requirement. There are unlikely to be effects on the public open spaces, with no further mitigation measures required.

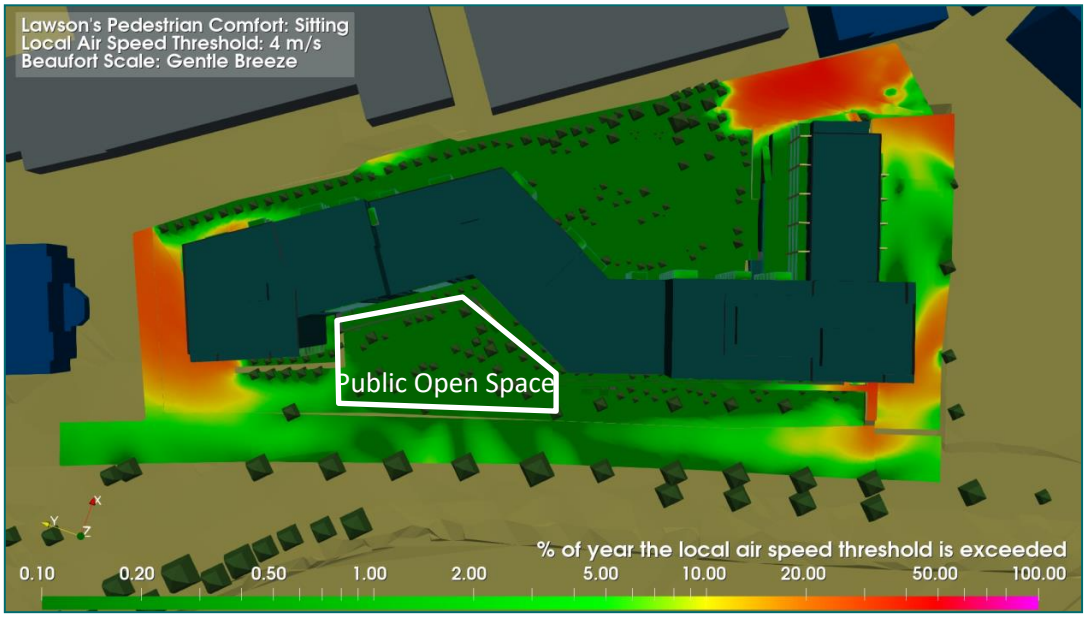

Figure 41: Sitting Comfort Criterion: Ground Amenities: Public Open Space

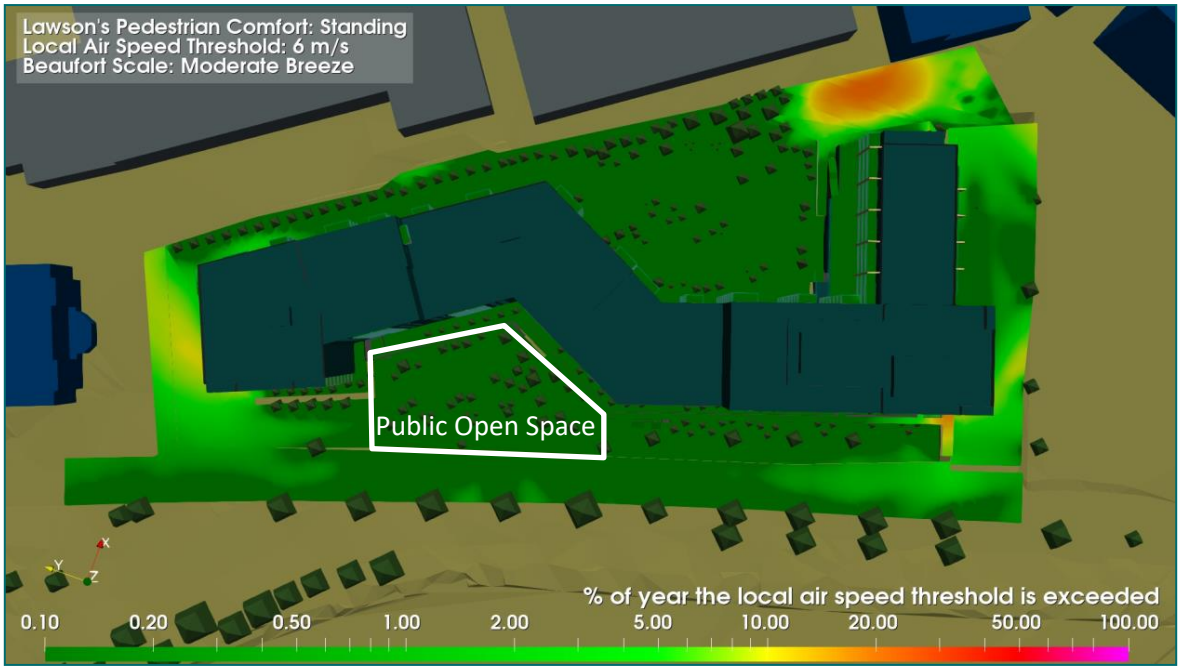

Figure 42: Standing Comfort Criterion: Ground Amenities: Public Open Space

2.2.2.2.2 Courtyard

Figure 43 and Figure 44 below show the results of sitting and standing comfort on the courtyard marked in white.

The results show excellent compliance with the requirements of the Lawson's Sitting and Standing Comfort Criterion. The wind speed is generally lower than 4m/s for more than 95% of the year as per the criterion's requirement. There are unlikely to be effects on the courtyard, with no further mitigation measures required.

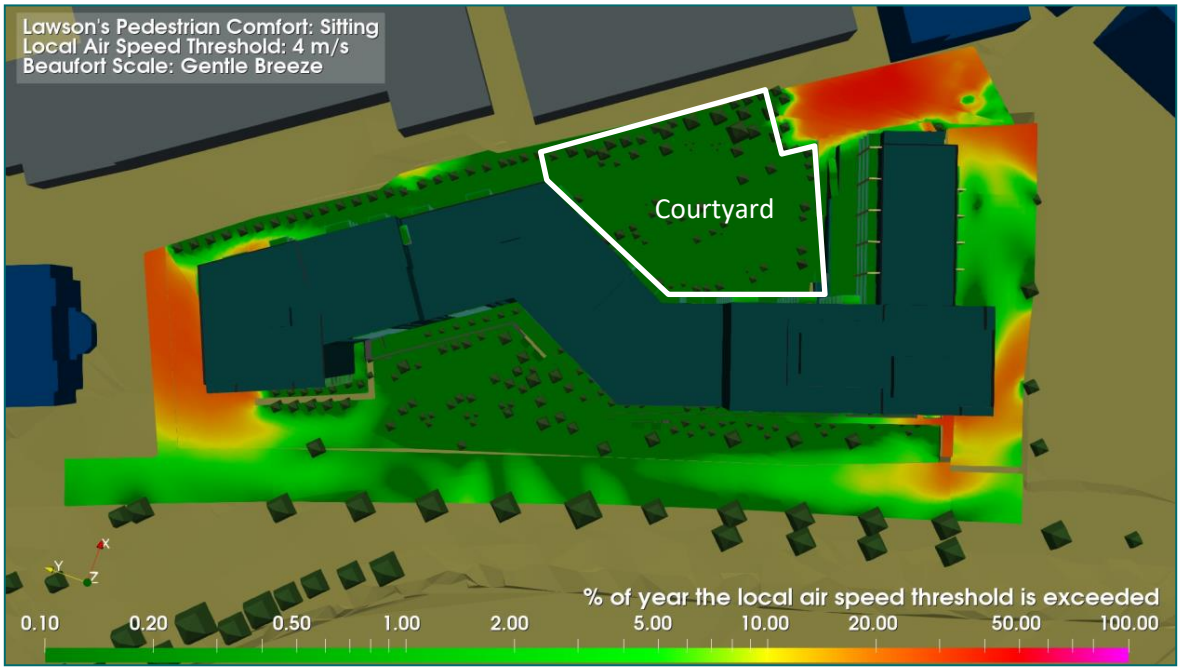

Figure 43: Sitting Comfort Criterion: Ground Amenities: Courtyard

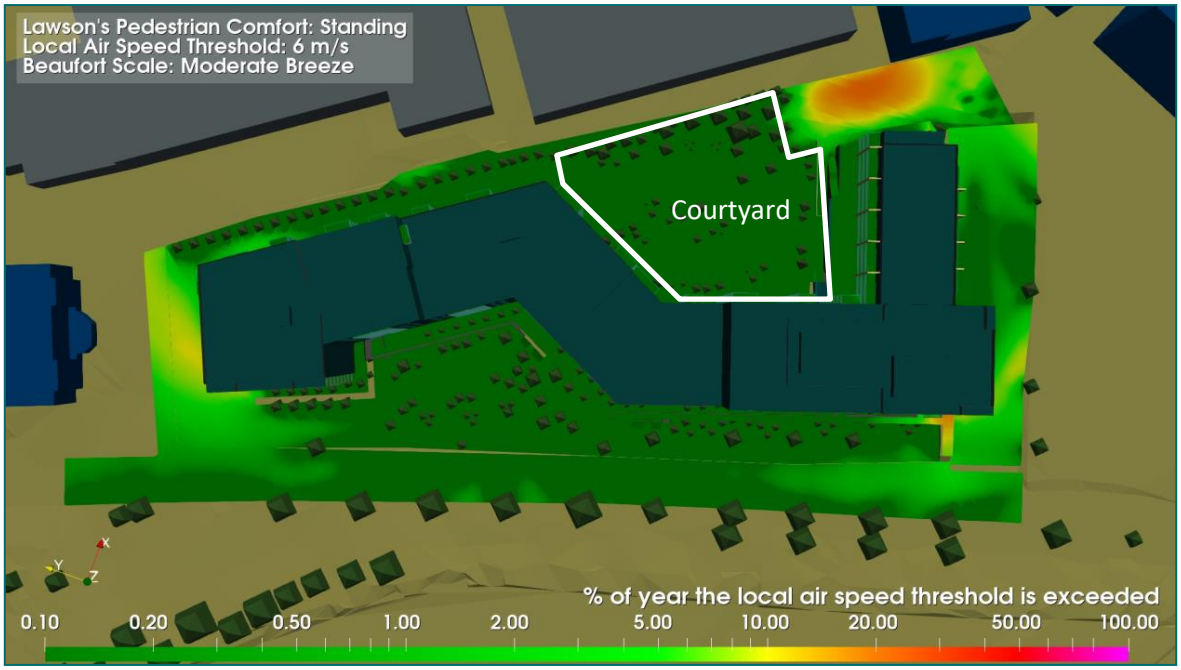

Figure 44: Standing Comfort Criterion: Ground Amenities: Courtyard

2.2.2.2.3 Creche Play Spaces

Figure 45 and Figure 46 below show the results of sitting and standing comfort on the creche play spaces marked in white.

The results show excellent compliance with the requirements of the Lawson's Sitting and Standing Comfort Criterion. The wind speed is generally lower than 4m/s for more than 95% of the year as per the criterion's requirement. There are unlikely to be effects on the creche play spaces, with no further mitigation measures required.

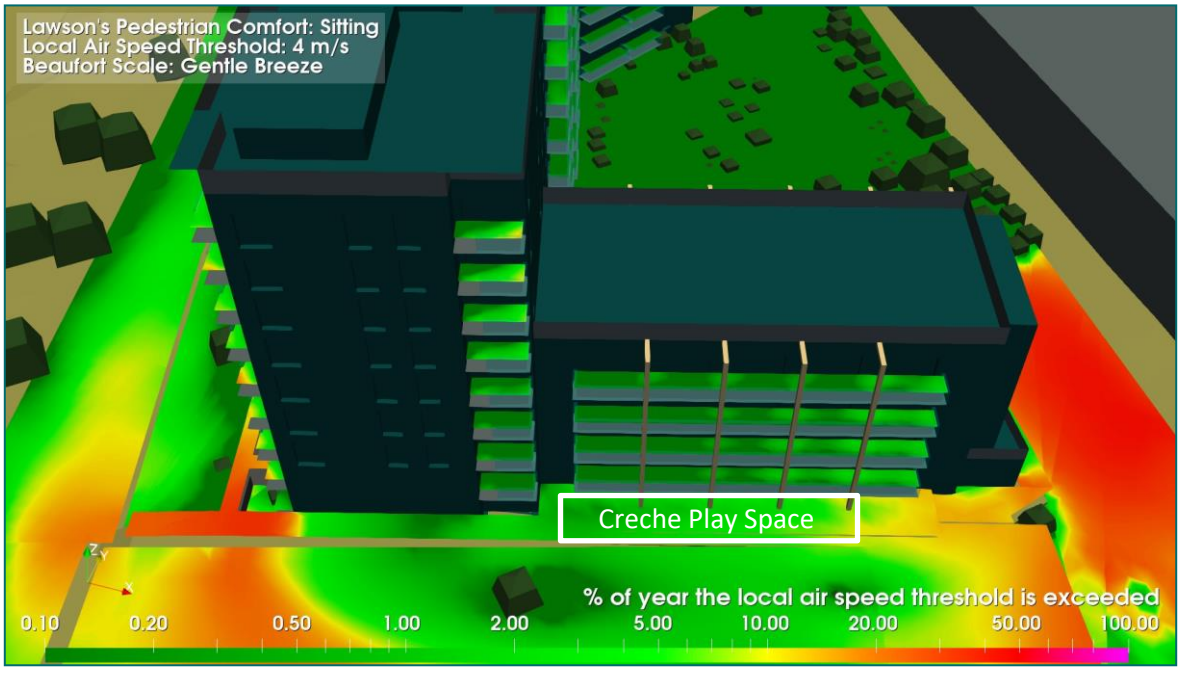

Figure 45: Sitting Comfort Criterion: Ground Amenities: Creche Play Spaces

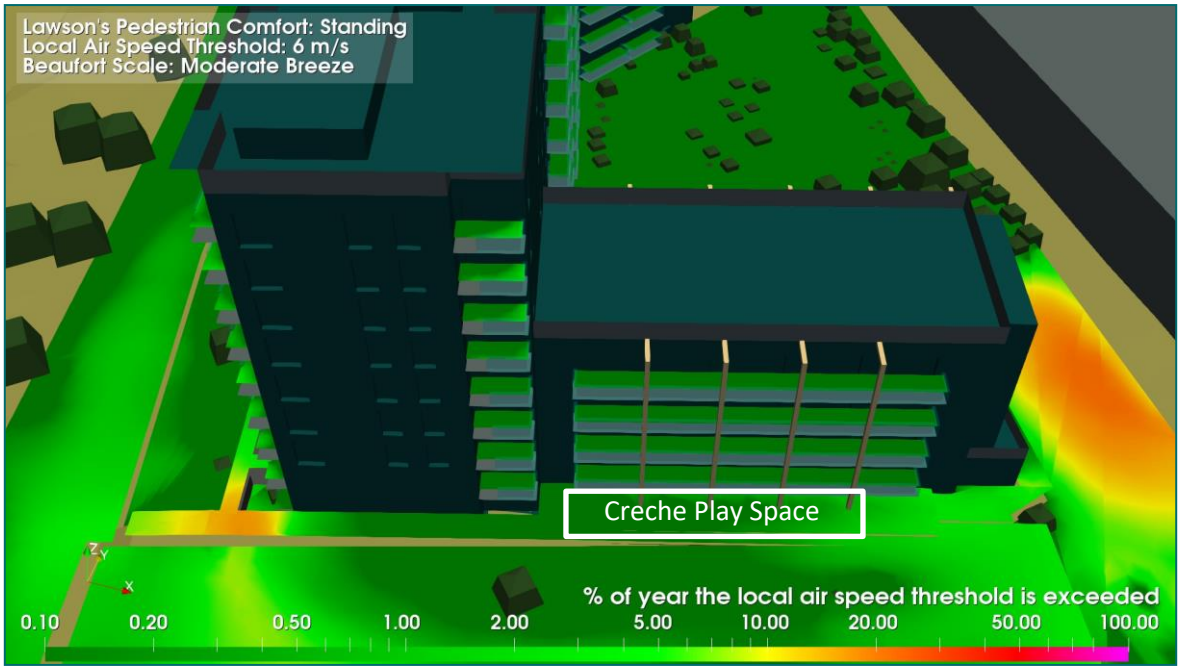

Figure 46: Standing Comfort Criterion: Ground Amenities: Creche Play Spaces

2.2.2.2.4 Ground Amenities towards South

Figure 47 and Figure 48 below show the results of sitting and standing comfort on the ground amenities towards south. These are marked in white.

The results show good compliance with the requirements of the Lawson's Sitting and Standing Comfort Criterion for the full year. The wind speed is generally lower than 4m/s for more than 95% of the year as per the criterion's requirement.

Some spaces with yellow and orange color contouring show limited compliance to the Lawson's sitting comfort. The local air speed is likely to exceed 4m/s for up to 20% of the year at these locations. These spaces are impacted due to unobstructed wind flowing from prevailing westerly and south westerly wind. Also, wind gets accelerated due to the narrow passage between the main block and the adjacent block towards south.

When comparing these results with the Lawson's Standing Comfort Criterion results, they show excellent compliance, i.e. the local air speed does not exceed 6 m/s for more than 5% of the year, see Figure 48. For the 20% of the year when the local air speed exceeds 4 m/s, three quarters of the collective time (i.e. 15% of the year) it does not exceed 6 m/s. The local air speed on balconies will be less than 4m/s for 80% of the year and between 4-6 m/s for 15% of the year. Any exceedance noted can be considered very marginal and will not result in an unpleasant environment is to use. The local air speed will only be greater than a gentle breeze but more frequently less than a moderate breeze. Such conditions are unlikely to have any impact on usability of the space for recreation.

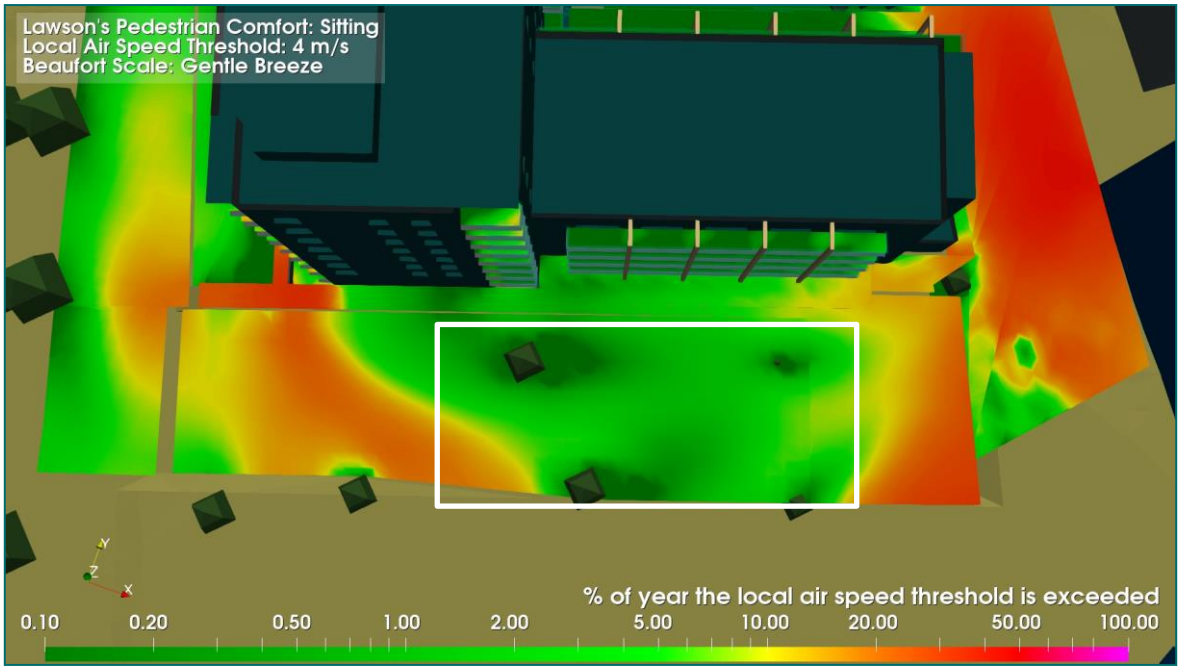

Figure 47: Sitting Comfort Criterion: Ground Amenities: Towards South

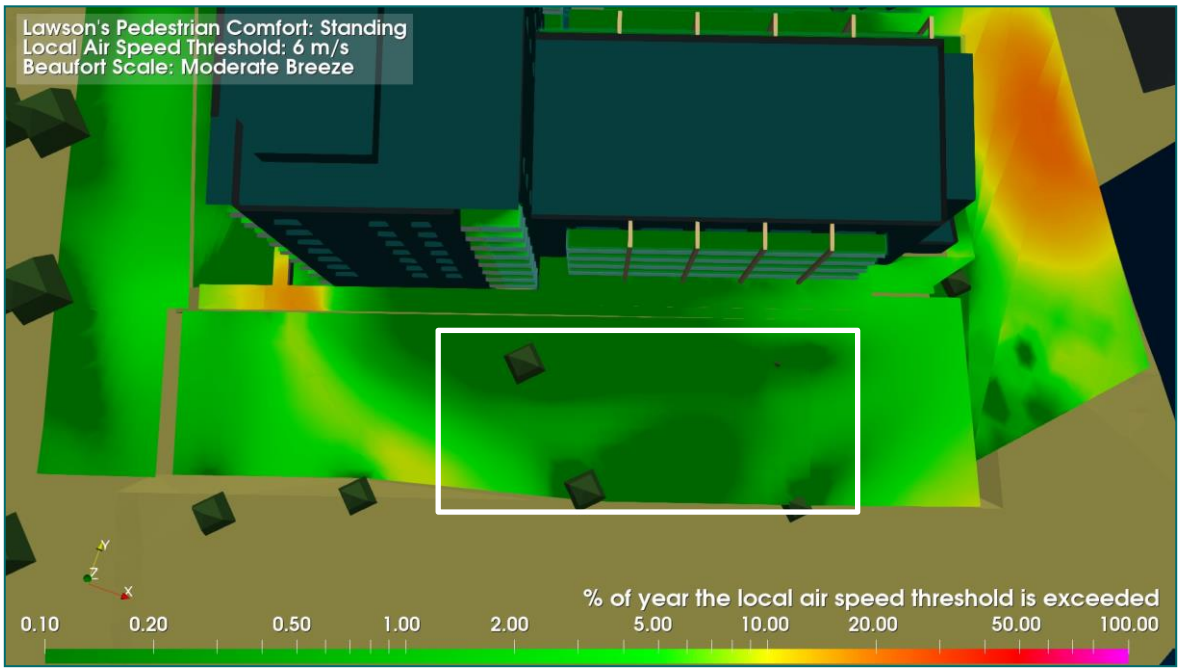

Figure 48: Standing Comfort Criterion: Ground Amenities: Towards South

2.2.2.2.5 Ground Amenities towards North

Figure 49 and Figure 50 below show the results of sitting and standing comfort on the ground amenities towards north. These are marked in white.

The results show good compliance with the requirements of the Lawson's Sitting and Standing Comfort Criterion for the full year. The wind speed is generally lower than 4m/s for more than 95% of the year as per the criterion's requirement.

Some spaces with yellow and orange color contouring show limited compliance to the Lawson's sitting comfort. The local air speed is likely to exceed 4m/s for up to 20% of the year at these locations. These spaces are impacted due to unobstructed wind flowing from prevailing westerly and south westerly wind.

When comparing these results with the Lawson's Standing Comfort Criterion results, they show excellent compliance, i.e. the local air speed does not exceed 6 m/s for more than 5% of the year, see Figure 50. For the 20% of the year when the local air speed exceeds 4 m/s, three quarters of the collective time (i.e. 15% of the year) it does not exceed 6 m/s. The local air speed on balconies will be less than 4m/s for 80% of the year and between 4-6 m/s for 15% of the year. Any exceedance noted can be considered very marginal and will not result in an unpleasant environment is to use. The local air speed will only be greater than a gentle breeze but more frequently less than a moderate breeze. Such conditions are unlikely to have any impact on usability of the space for recreation.

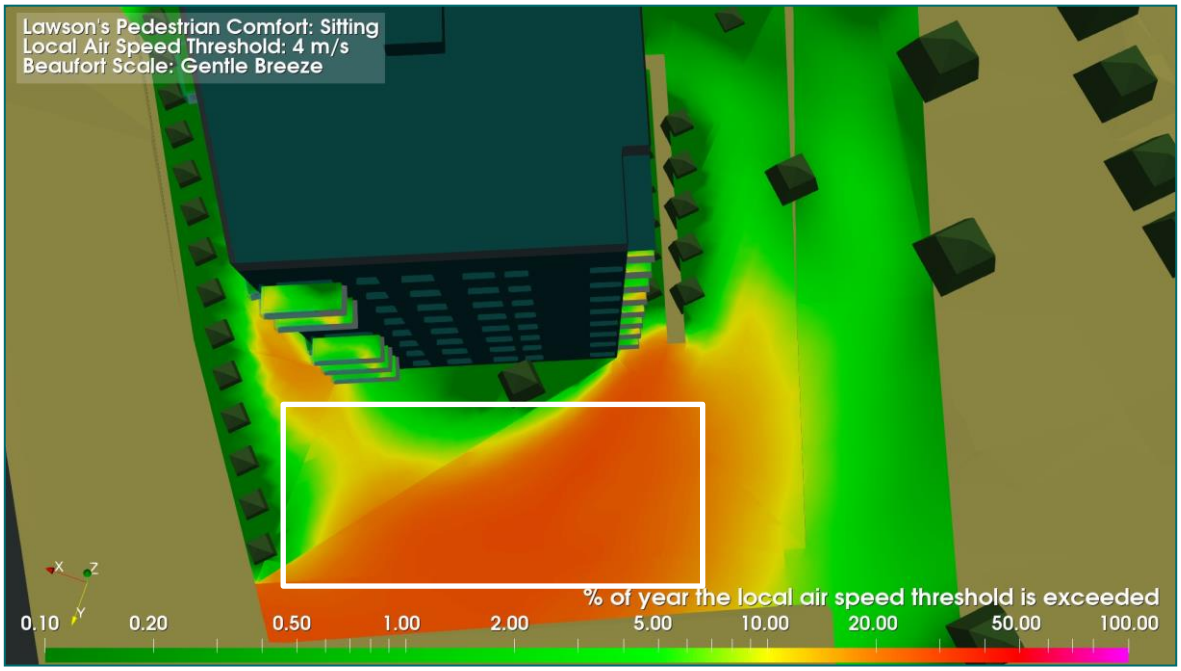

Figure 49: Sitting Comfort Criterion: Ground Amenities: Towards North

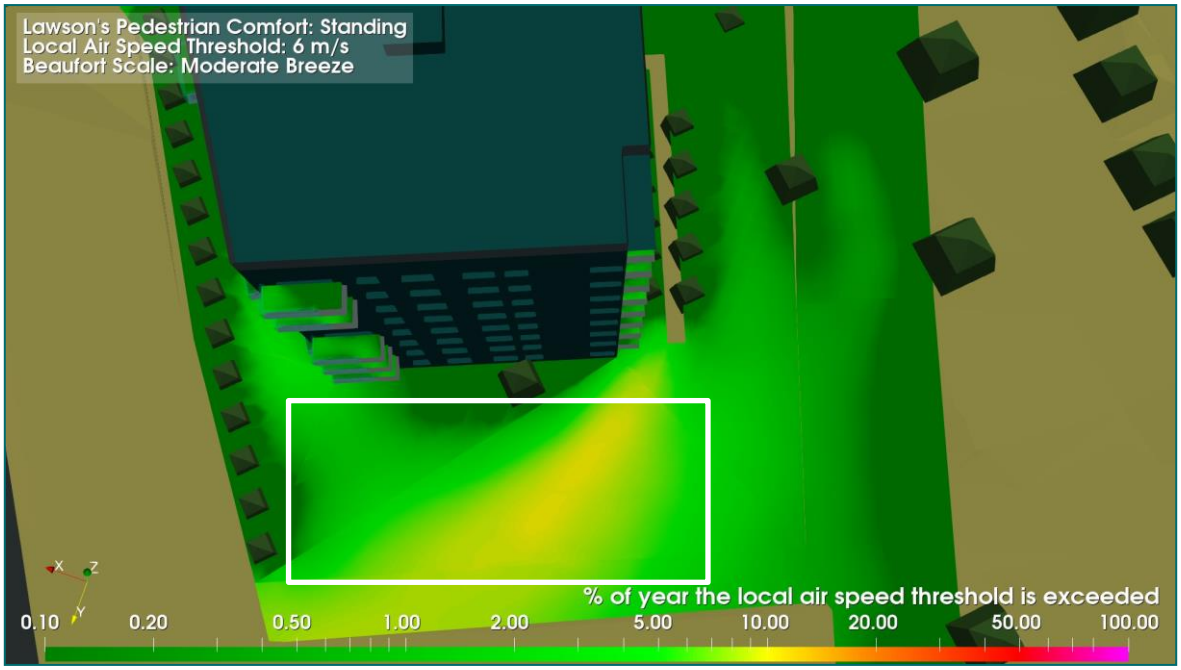

Figure 50: Standing Comfort Criterion: Ground Amenities: Towards North

2.2.2.3 Raised Boardwalk

Figure 51 and Figure 52 below show the results of sitting and standing comfort on the raised boardwalk near the west façade of the building. The results show excellent compliance with the requirements of the Lawson's Sitting and Standing Comfort Criterion. The wind speed is generally lower than 4m/s for more than 95% of the year as per the criterion's requirement. There are unlikely to be effects on the boardwalk, with no further mitigation measures required.

The boardwalk entrances towards south and north show limited compliance with the Lawson's Sitting Comfort Criterion. The local air speed is likely to exceed 4m/s for more than 20% of the year at these locations. These are impacted due to the wind flowing from the prevailing westerly and south-westerly direction.

When comparing the results for these balconies to Lawson's Standing Comfort Criterion results, they show good compliance, i.e. the local air speed does not exceed 6 m/s for more than 5% of the year, see Figure 52. For the 20% of the year when the local air speed exceeds 4 m/s, three quarters of the collective time (i.e. 15% of the year) it does not exceed 6 m/s. The local air speed on balconies will be less than 4m/s for 80% of the year and between 4-6 m/s for 15% of the year. Any exceedance noted can be considered very marginal and will not result in an unpleasant environment is to use. The local air speed will only be greater than a gentle breeze but more frequently less than a moderate breeze. Such conditions are unlikely to have any impact on usability of the space for recreation.

There is not be any sitting activity designed on the boardwalk. It is mainly designed for the walking activity to move in and out from the building. There are unlikely to be effects on the boardwalk, with no further mitigation measures required.

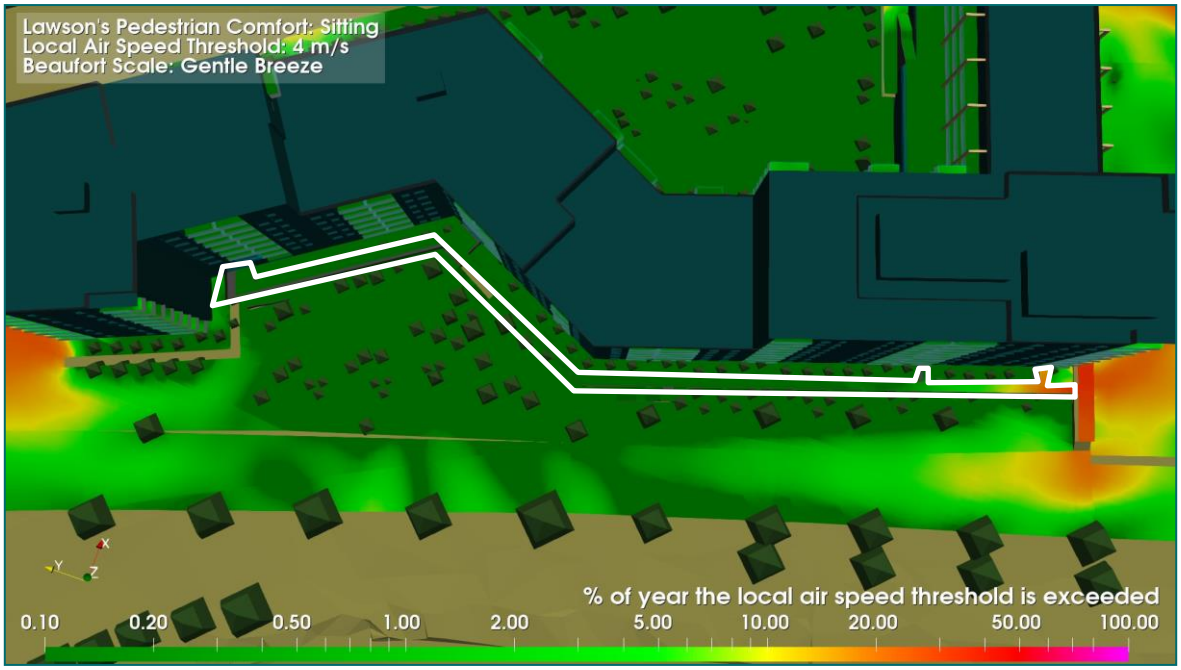

Figure 51: Sitting Comfort Criterion: Ground Amenities: Raised Boardwalk

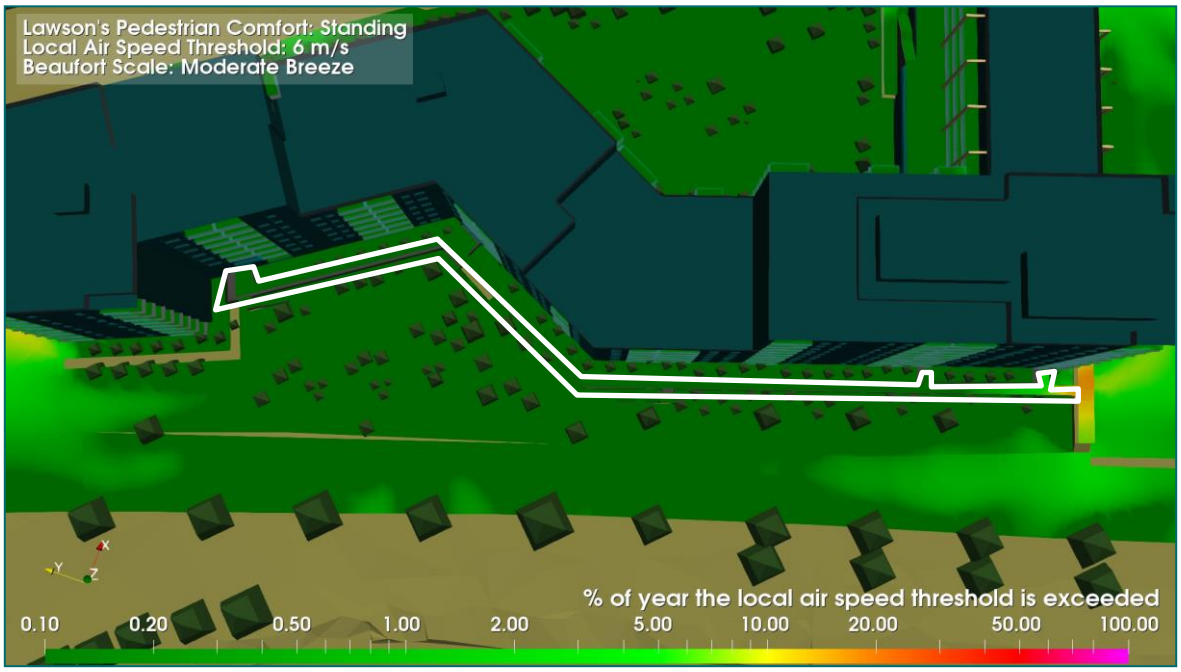

Figure 52: Standing Comfort Criterion: Ground Amenities: Raised Boardwalk

2.2.2.4 Building Entrances

Figure 53 to Figure 56 below show the results of sitting and standing comfort on the building entrances marked in white.

The results show excellent compliance with the requirements of the Lawson's Sitting and Standing Comfort Criterion. The wind speed is generally lower than 4m/s for more than 95% of the year as per the criterion's requirement. There are unlikely to be effects on the creche play spaces, with no further mitigation measures required.

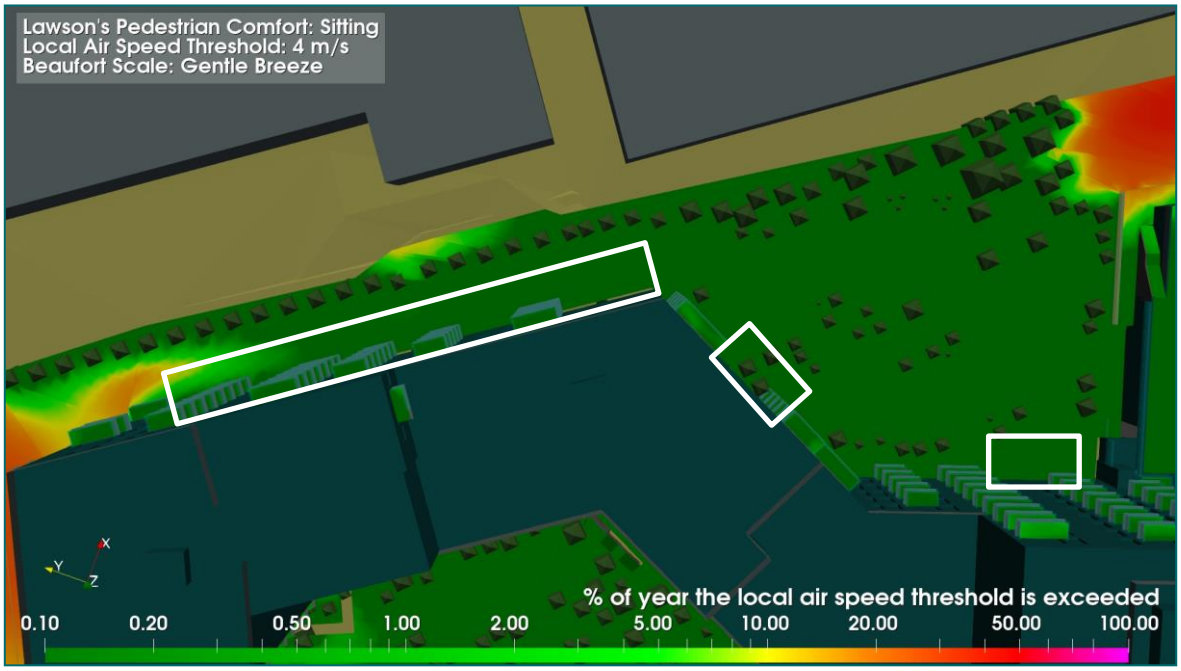

Figure 53: Sitting Comfort Criterion: Lower Ground Floor Entrances

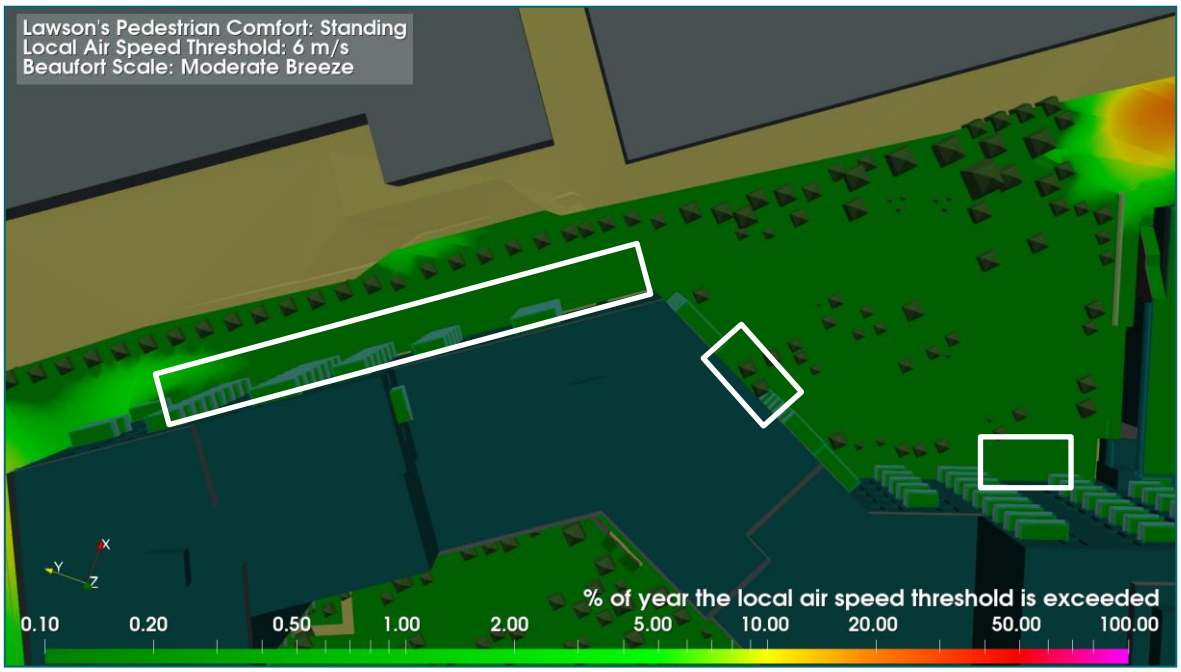

Figure 54: Standing Comfort Criterion: Lower Ground Floor Entrances

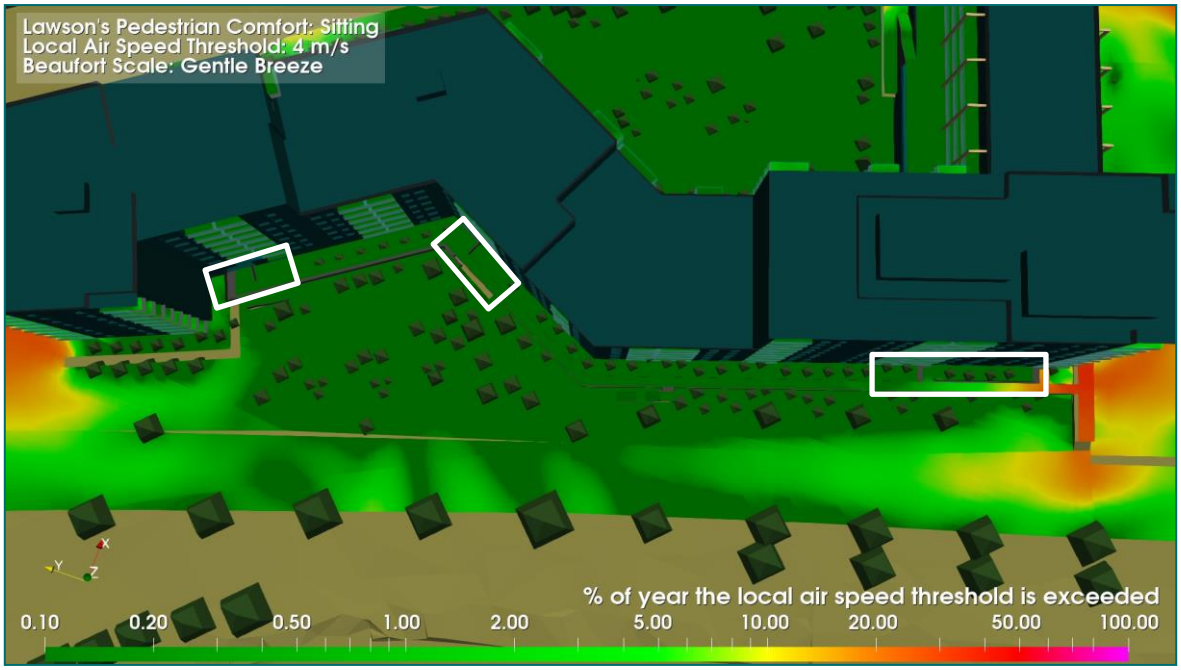

Figure 55: Sitting Comfort Criterion: Building Core Entrances (Upper Ground)

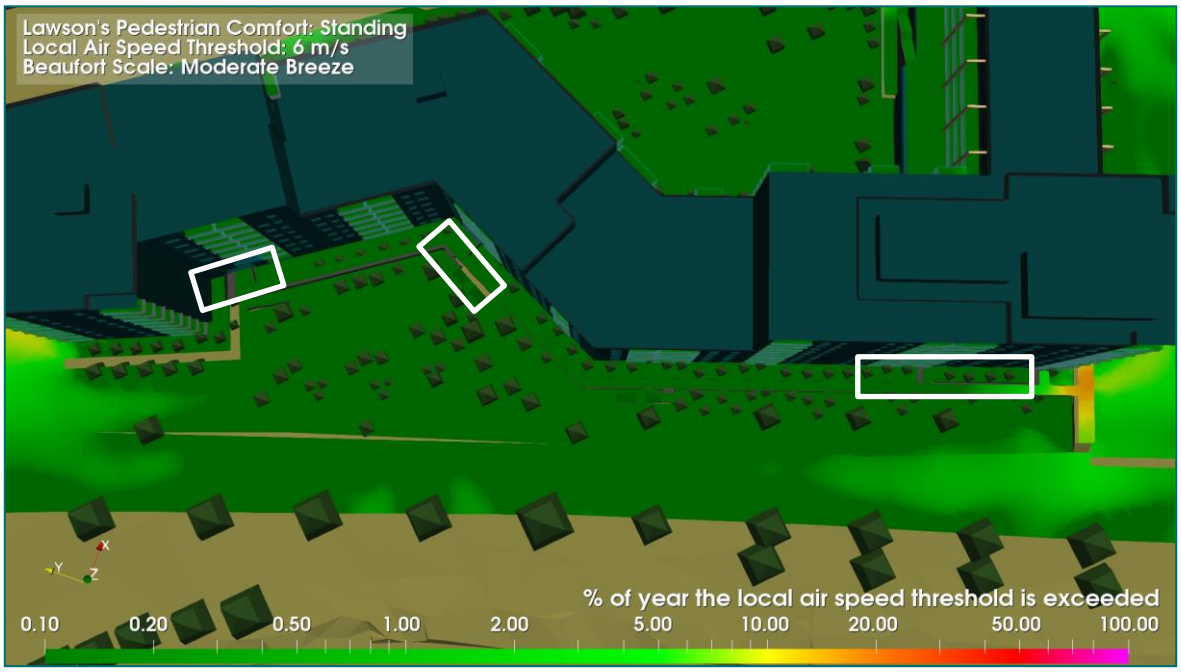

Figure 56: Standing Comfort Criterion: Building Core Entrances (Upper Ground)

2.2.3 Walking Comfort

The Lawson's Leisure Walking Comfort Criterion states the local air speed at designated locations should not exceed 8 m/s for more than 5% of the duration analysed, on the various paths around the development. Additionally, the Lawson's Business Walking Comfort Criterion states the local air speed at designated locations should not exceed 10 m/s for more than 5% of the duration analysed, on the various paths around the development. These show excellent compliance with the requirements of the Lawson's Business Walking Comfort Criterion. The local air speed does not exceed 8 m/s and 10 m/s for more than 5% of the year, respectively. Figure 57 and Figure 58 below shows the results of walking comfort criteria.

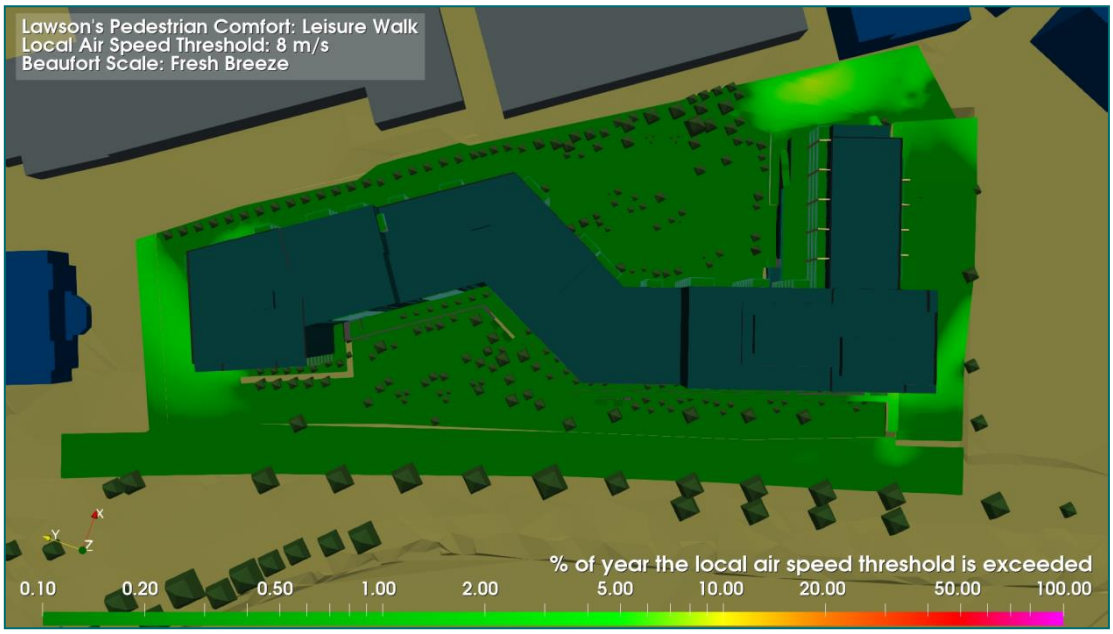

Figure 57: Leisure Walking Comfort Criterion: View form the Top

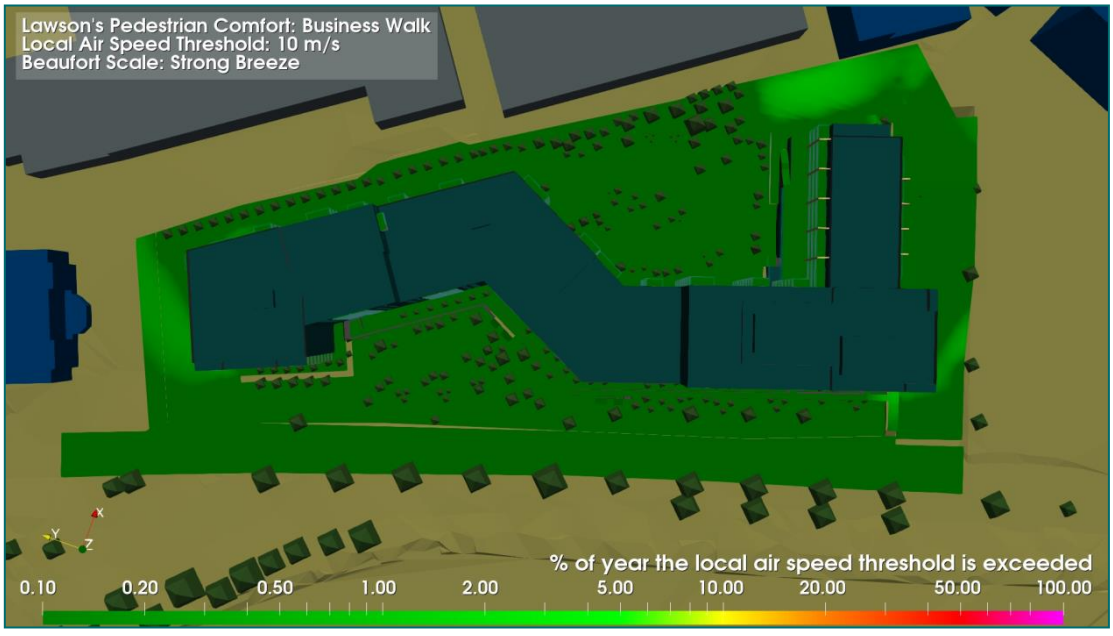

Figure 58: Business Walking Comfort Criterion: View form the Top

2.2.4 Safety Criteria

The Lawson's Normal Pedestrian Safety Criterion states the local air speed at designated locations should not exceed 20 m/s for more than 0.01% of the duration analysed. Additionally, the Lawson's Sensitive Pedestrian safety criteria states the local air speed at designated locations should not exceed 15 m/s for more than 0.01% of the duration analysed. The Sensitive Pedestrian safety criterion applies to the vulnerable population such as pensioners and children. Note the limit of the criterion is 0.01% and not 5% as with the comfort criterion.

These criteria are also intended for various paths and grounds around the development, as access is always required irrespective of weather conditions to enter or exit the various buildings. Figure 59 and Figure 60 show the results of safety criteria assessment. The results of the normal pedestrians and sensitive pedestrians are observed to be below 0.1% of the year.

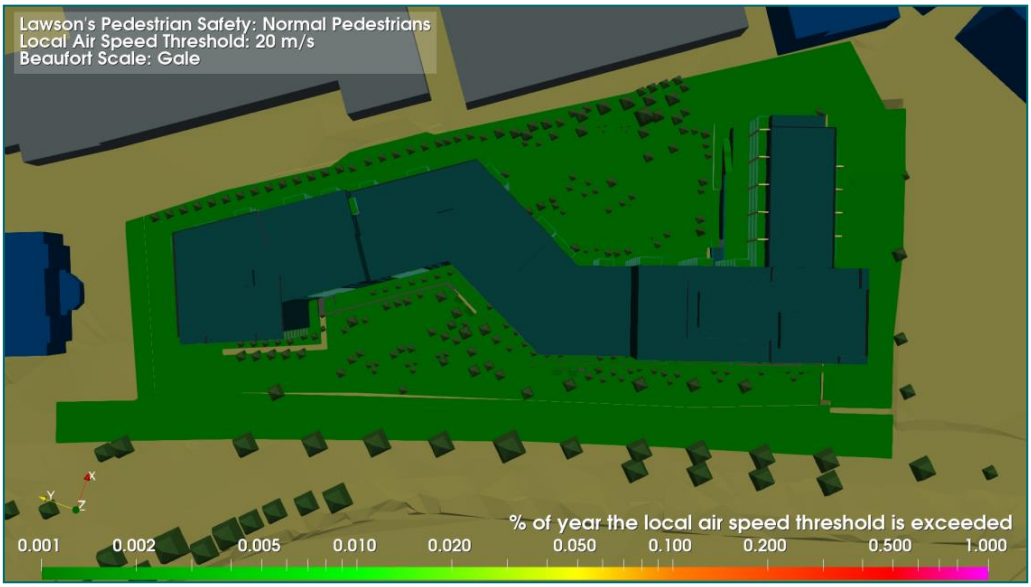

Figure 59: Normal Pedestrian Safety Criterion: View of the entire site

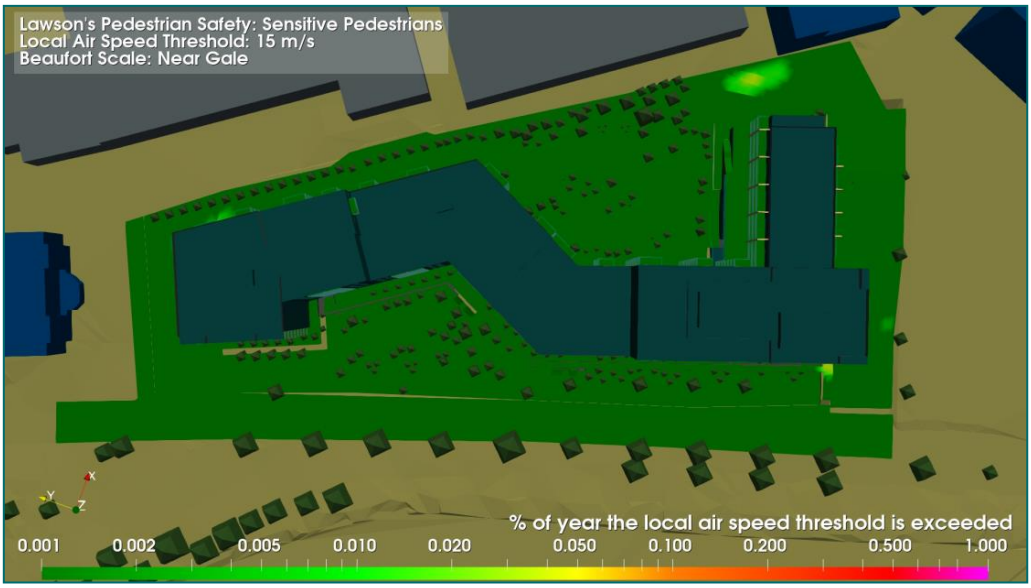

Figure 60: Sensitive Pedestrian Safety Criterion: View of the entire site

3 Introduction

IES Consulting have been commissioned to study the impact from wind around the proposed residential development located at Dyke Road, Terryland, Galway.

The analysis was carried out for the assessment scenario 1 – The proposed development Phase 1. The analysis was also carried out for the assessment scenario 1 – The proposed development Phase 1 plus Phase 2 and Phase 3 of the Corrib Causeway Development Framework.

The analysis is performed to study the effect from the building layout on pedestrian comfort as well as safety for people using the public and various amenity spaces around the site. The analysis will look at the air movement around the buildings for eight wind directions (SW, W, NW, N, NE, E, SE and S) with the wind velocity set to the mean value obtained from the weather file.

The following simulation report describes the modelling methodology used in the study, including assumptions made and calculations used to determine the boundary conditions and results obtained from the simulations.

4 Weather Data

The analysis is based on the 'IRL_NW_Galway.039640_TMYx.epw' weather file. The variation of wind speed recorded in the weather file is shown in Figure 61. Figure 62 shows the wind direction variation and Figure 63 shows the wind rose.

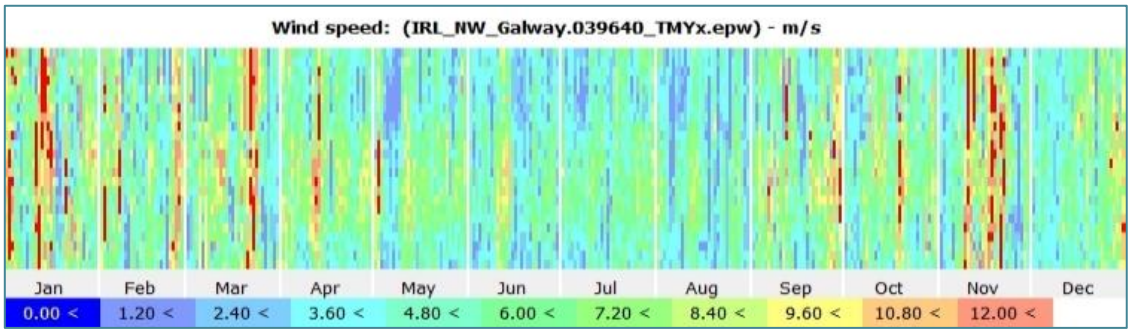

Figure 61: Wind speed variation as per IRL_NW_Galway.039640_TMYx.epw

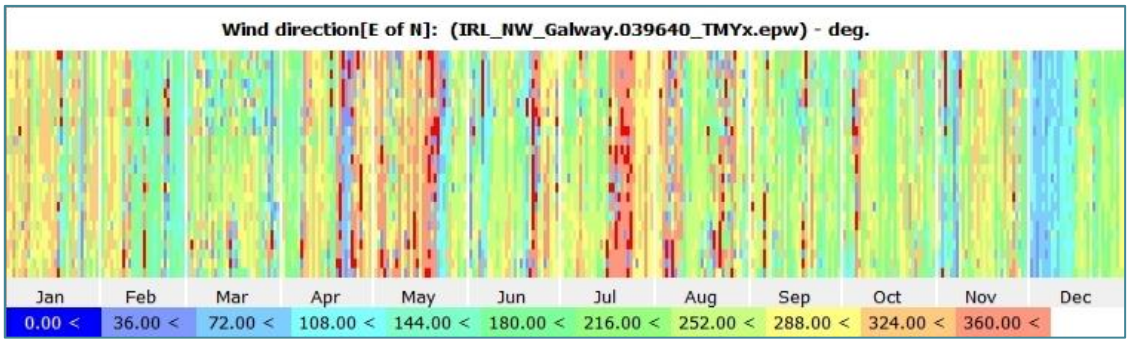

Figure 62: Wind direction variation as per IRL_NW_Galway.039640_TMYx.epw

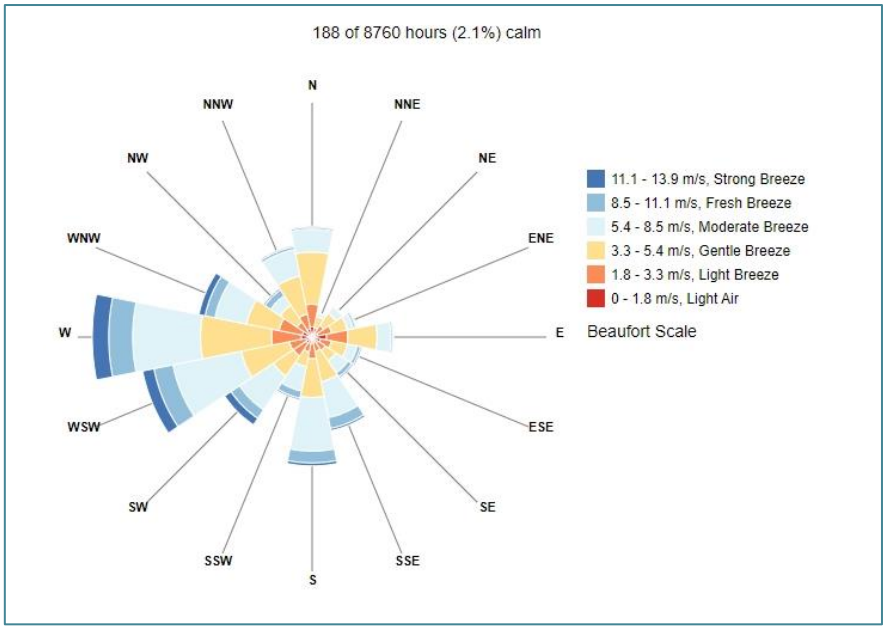

Figure 63: Wind rose as per IRL_NW_Galway.039640_TMYx.epw

Based on this, the mean wind speed recorded was **5.6m/s** with a westerly prevailing direction.

5 Wind Boundary Layer

In an atmospheric boundary layer, wind speed increases with height due to the influence of surface roughness (i.e. the presence of buildings, trees, roads etc. on the ground), see Figure 64.

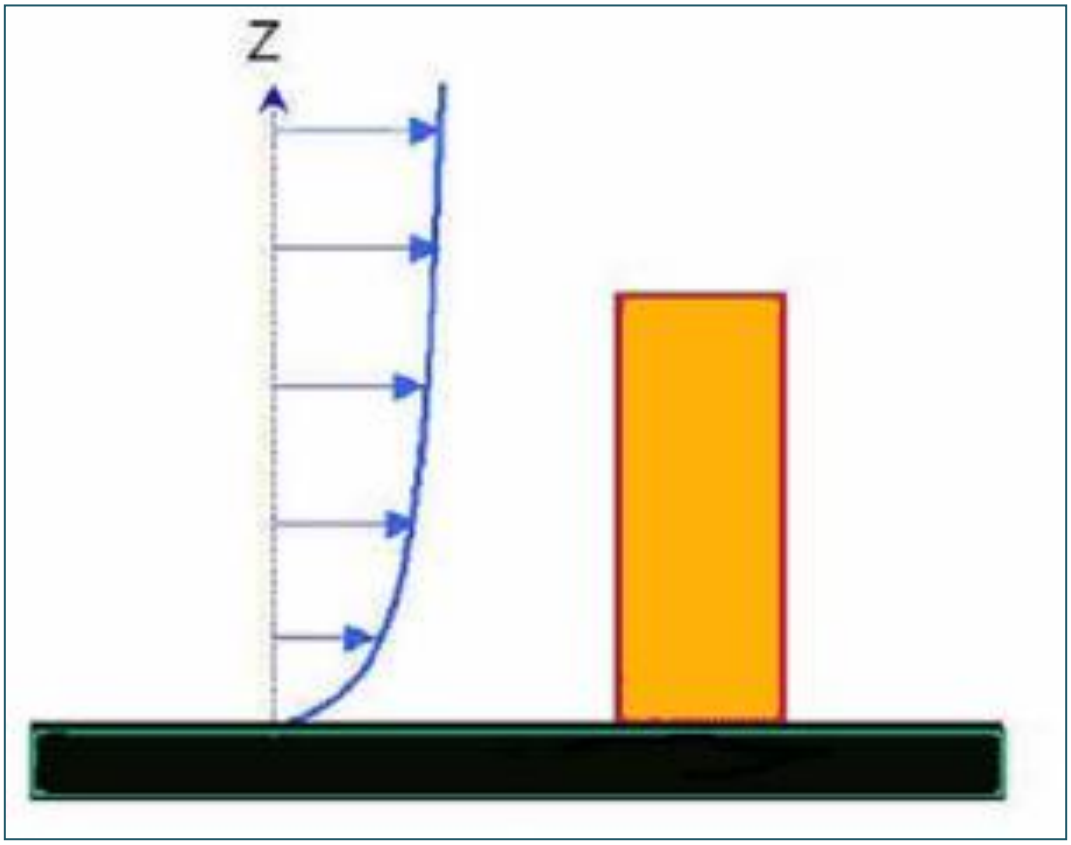

Figure 64: Typical velocity profile of an atmospheric boundary layer

In the current CFD modelling, the velocity profile was generated according to the parameterised ASHRAE methodology described below. This allows for different wind profiles across various terrain types: Open country; urban; and city centre.

The wind speed $\mathbf{U_H}$ at height **H** above the ground is given by:

$$U_H = U_{met}\left(\frac{\delta_{met}}{H_{met}}\right)^{a_{met}}\left(\frac{H}{\delta}\right)^{a} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (Eq.1)$$

Where,

a = Exponent in power law wind speed profile for local building terrain

δ = fully developed strong wind atmospheric boundary layer thickness (m)

$\mathbf{a_{met}}$ = Exponent for the meteorological station

δ_{met} = Atmospheric boundary thickness at the meteorological station (m)

H_{met} = Height at which meteorological wind speed was measured (m)

U_{met} = Hourly meteorological wind speed, measured at height H_{met} (m/s)

The parameters for different types of terrain are given as in table 1.

Table 1: Atmospheric boundary layer parameters

Terrain Category	Description	a	δ
1	Large city centres 50% of buildings above 21m over a distance of at least 2000m upwind.	0.33	460
2	Urban, suburban, wooded areas.	0.22	370
3	Open, with scattered objects generally less than 10m high.	0.14	270
4	Flat, unobstructed areas exposed to wind flowing over a large water body (no more than 500m inland).	0.10	210

For the current project, we used the atmospheric boundary layer corresponding to the terrain category 2, i.e. Large city centres type of site. The met data was taken on category 3 terrain at a height of 10m.

6 Methodology for Pedestrian Comfort Calculation

The methodology for the analysis was as follows:

1) The annual mean wind speed was determined from the 'IRL_NW_Galway.039640_TMYx.epw' weather file.
2) 8 steady state CFD simulations were performed corresponding to the 8 directions – SW, W, NW, N, NE, E, SE and S respectively.
3) The local air speed at various designated locations around the site was recorded for each of the simulations.
4) This value was compared to the meteorological wind speed used and the magnification factor at that location for the corresponding wind direction was determined.
5) The magnification factor was used to determine the air speed at the designated locations for the various recorded values of the wind speed and direction in the weather file, thus generating the local air speeds at designated locations for a year.
6) These recorded values were compared to the Lawson Pedestrian Comfort/Safety Criteria.

6.1 Lawson Pedestrian Comfort/Safety Criteria

The Lawson Criteria[1] was used as a reference to assess the wind effects. It is the most widely used reference for assessment of pedestrian comfort. It considers the air speed at the location as well as the frequency of the occurrence of this air speed. It consists of two assessment criteria:

1. The first criteria assess whether the air movement will be comfortable for the pedestrian for different types of activities.
2. The second criteria assess the feeling of safety or distress by the pedestrian at higher air speeds.

The following table gives the values for the Lawson's Pedestrian Comfort Assessment Criteria for various activities.

Category	Pedestrian Activity	Threshold mean hourly wind speed not to be exceeded for more than 5% of the time (m/s)
C1	Business Walking	10
C2	Leisurely Walking	8
C3	Standing	6
C4	Sitting	4

The following table gives the values for Lawson's Pedestrian Safety Assessment criteria.

Category	Pedestrian Type	Threshold mean hourly wind speed not to be exceeded more than once per annum[2](m/s)
S1	Typical Pedestrian	20
S2	Sensitive Pedestrian	15

[1]T. V. Lawson (2001) *Building Aerodynamics*, Imperial College Press, London.

[2]Once per annum means the safety threshold is not be exceeded 0.01% of the year.

The median wind speed recorded was 5.2 m/s for Galway's climatic conditions. That means, for 50% of year, the wind speed is higher than 5 m/s. The Lawson's Sitting Criterion requires the local air speed be more than 4 m/s for no more than 5% of the year. Thus, the Lawson's Sitting Criterion presents a task of being 10 times better than the climatic conditions at location of interest.

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7 CFD Model

The CFD model was created based on the CAD drawings provided.

7.1 Model Geometry: All Phases

This section includes the model geometry of the proposed development Phase 1 plus Phase 2 and Phase 3 of the Corrib Causeway Development Framework. Figure 65 to Figure 76 show the geometry as modelled.

Figure 65: Plan view of the site: All Phases

Figure 66: View of the site from the south: All Phases

Figure 67: View of the site from the west: All Phases

Figure 68: View of the site from the north: All Phases

Figure 69: View of the site from the east: All Phases

Figure 70: Closer view of the main block from the top: All Phases

Figure 71: Closer view of the main block from the south: All Phases

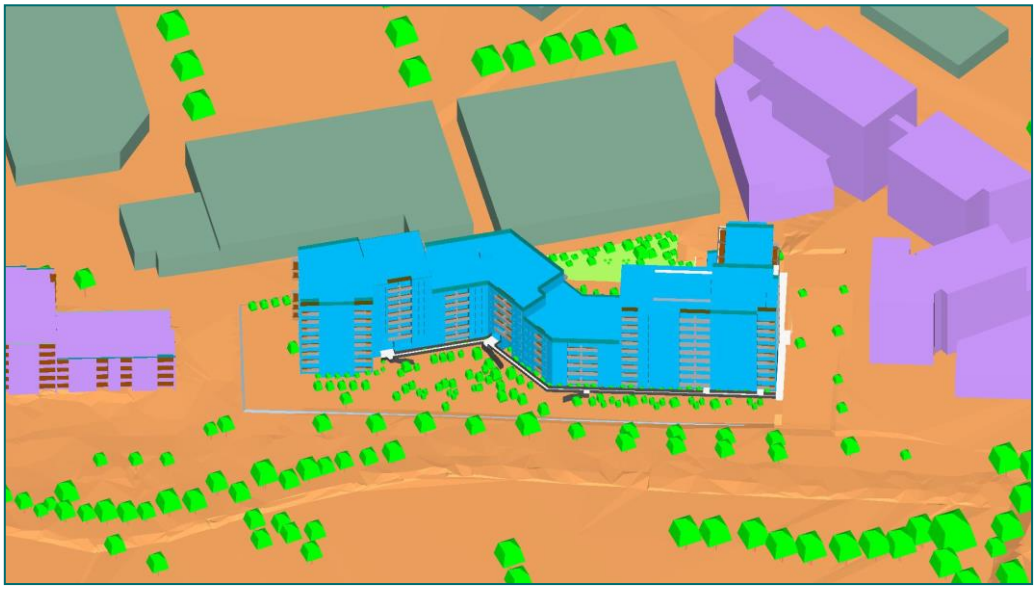


Figure 72 Closer view of the main block from the west: All Phases

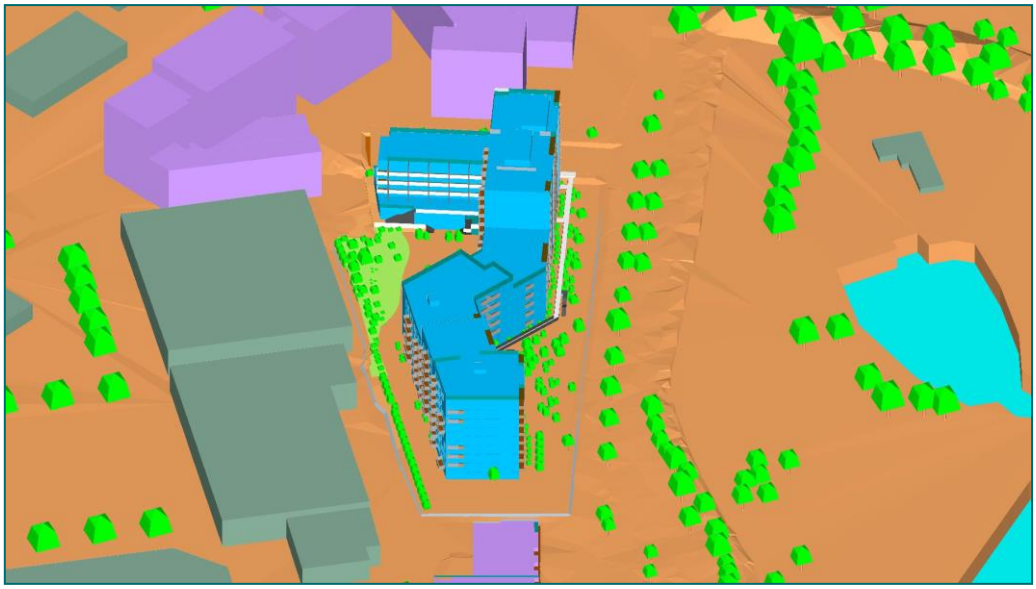


Figure 73: Closer view of the main block from the north: All Phases

Figure 74: Closer view of the main block from the east: All Phases

Figure 75: Closer view of the courtyard: All Phases

Figure 76: Closer view of the Boardwalk: All Phases

7.2 Model Geometry: Phase 1

This section includes the model geometry of the proposed development Phase 1. Figure 77 to Figure 88 show the geometry as modelled.

Figure 77: Plan view of the site: Phase 1

Figure 78: View of the site from the south: Phase 1

Figure 79: View of the site from the west: Phase 1

Figure 80: View of the site from the north: Phase 1

Figure 81: View of the site from the east: Phase 1

Figure 82: Closer view of the main block from the top: Phase 1

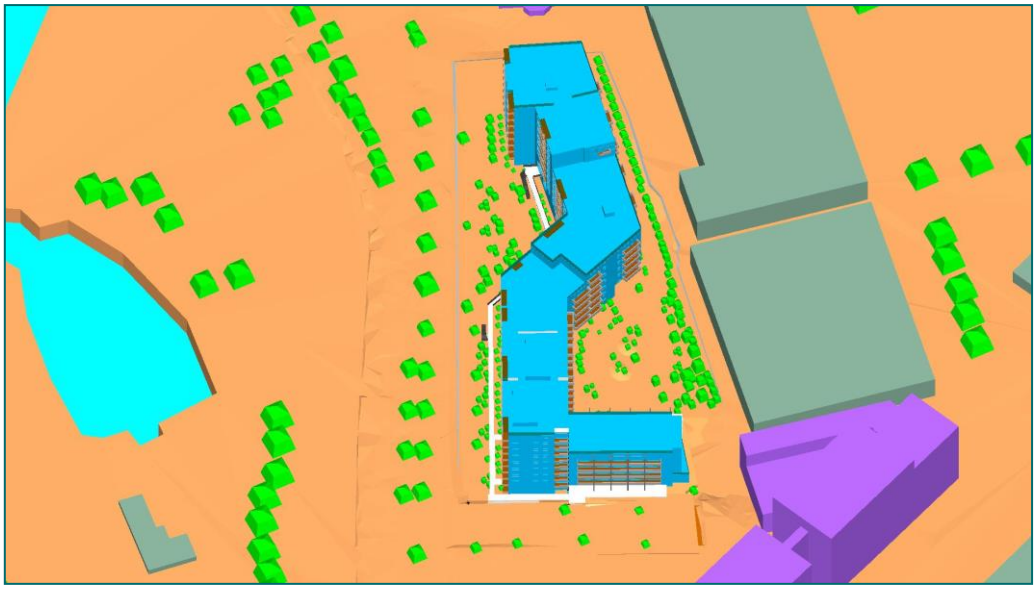


Figure 83: Closer view of the main block from the south: Phase 1

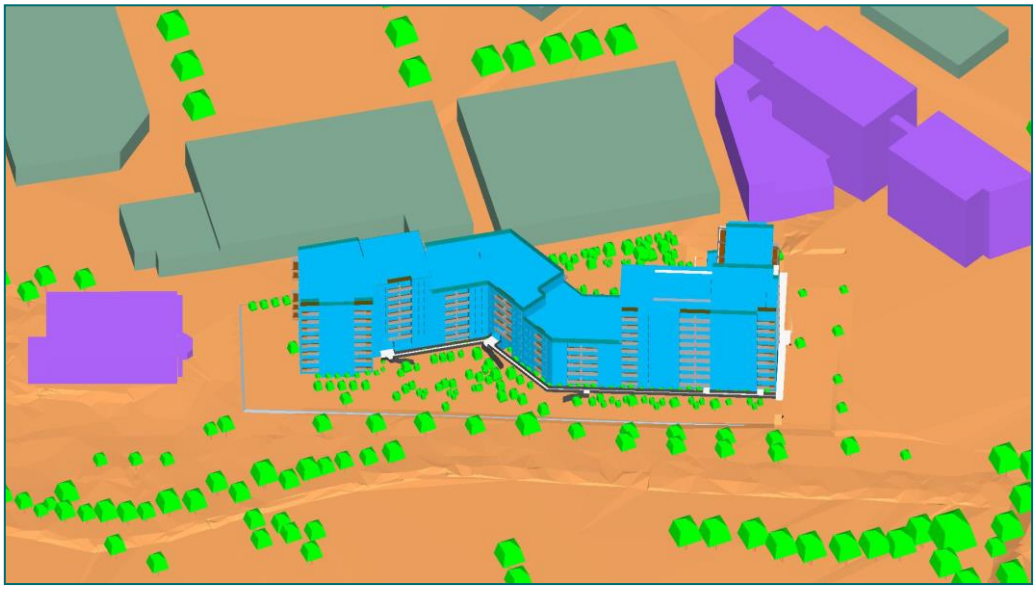


Figure 84 Closer view of the main block from the west: Phase 1

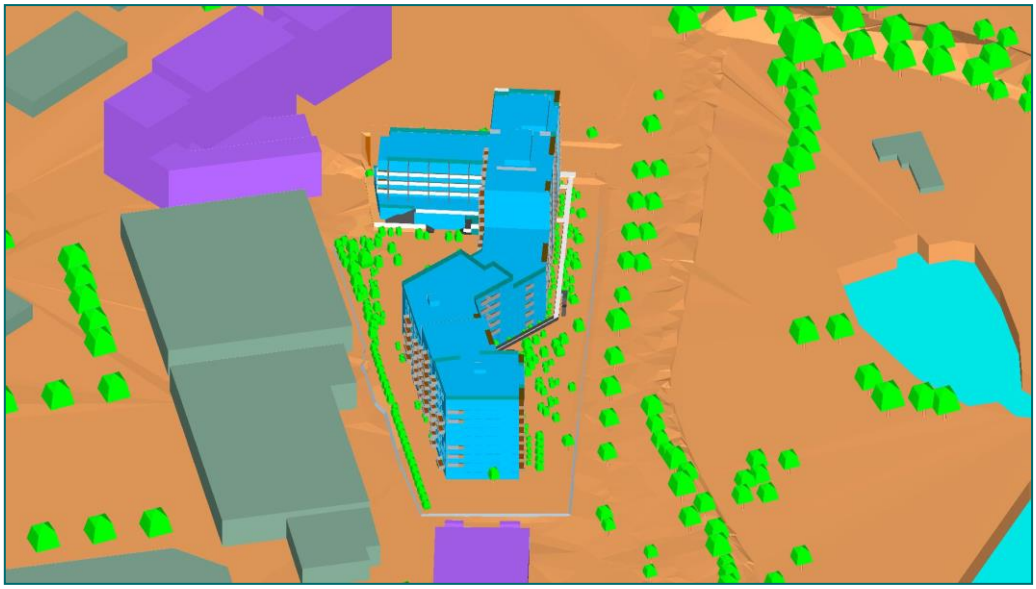


Figure 85: Closer view of the main block from the north: Phase 1

Figure 86: Closer view of the main block from the east: Phase 1

Figure 87: Closer view of the courtyard: Phase 1

Figure 88: Closer view of the Boardwalk: Phase 1

8 Results

8.1 All Phases

This section includes the results of the proposed development Phase 1 plus Phase 2 and Phase 3 of the Corrib Causeway Development Framework.

8.1.1 Comfort Criteria

Figure 89 to Figure 97 show the percentage of the year the hourly wind speed exceeds the threshold value for the comfort criteria such as Sitting, Standing, Leisurely Walking and Business Walking for all seasons. The threshold values are 4 m/s, 6 m/s, 8 m/s and 10 m/s respectively. The comfort results are shown around the residential blocks.

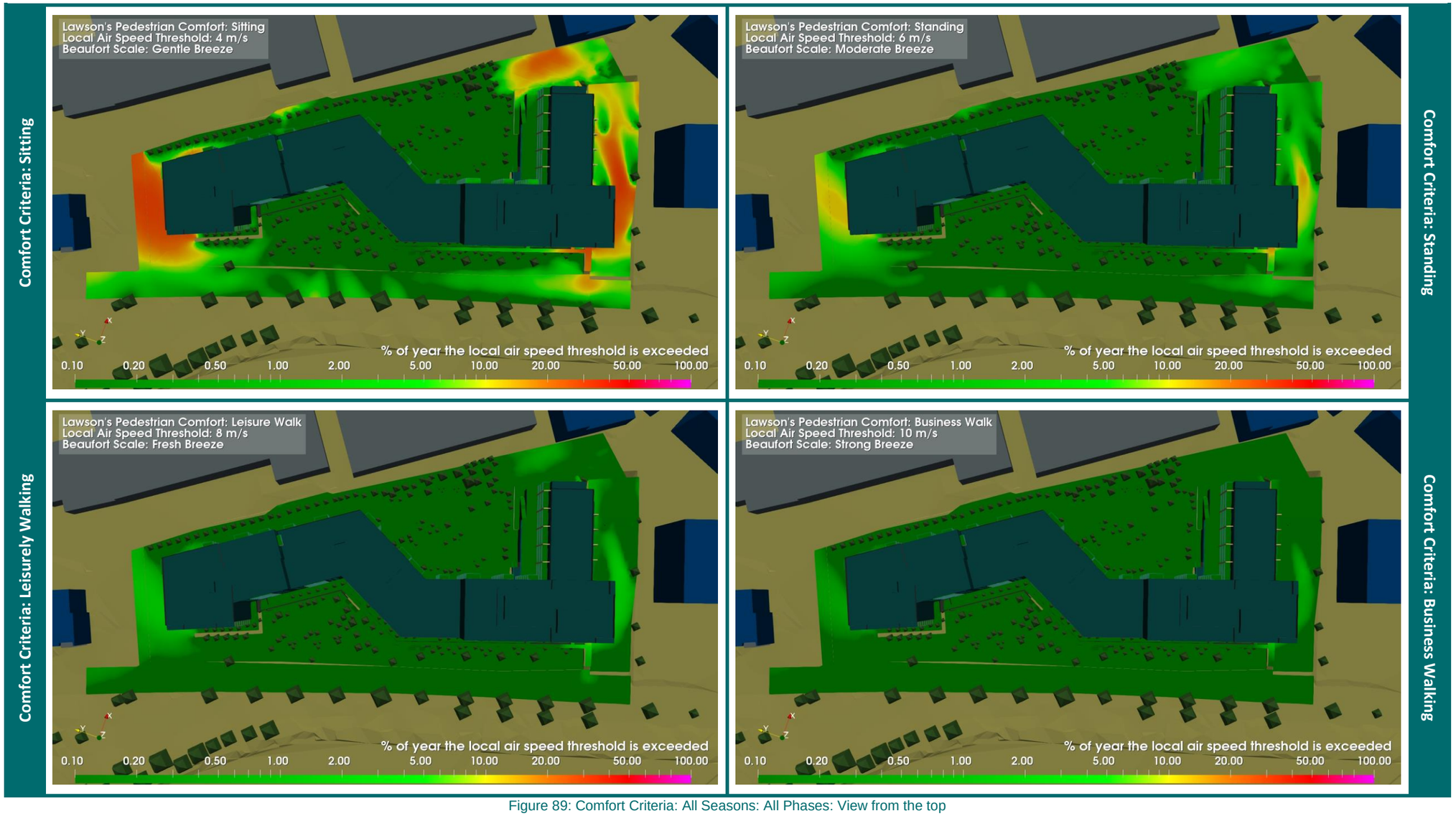


Figure 89: Comfort Criteria: All Seasons: All Phases: View from the top

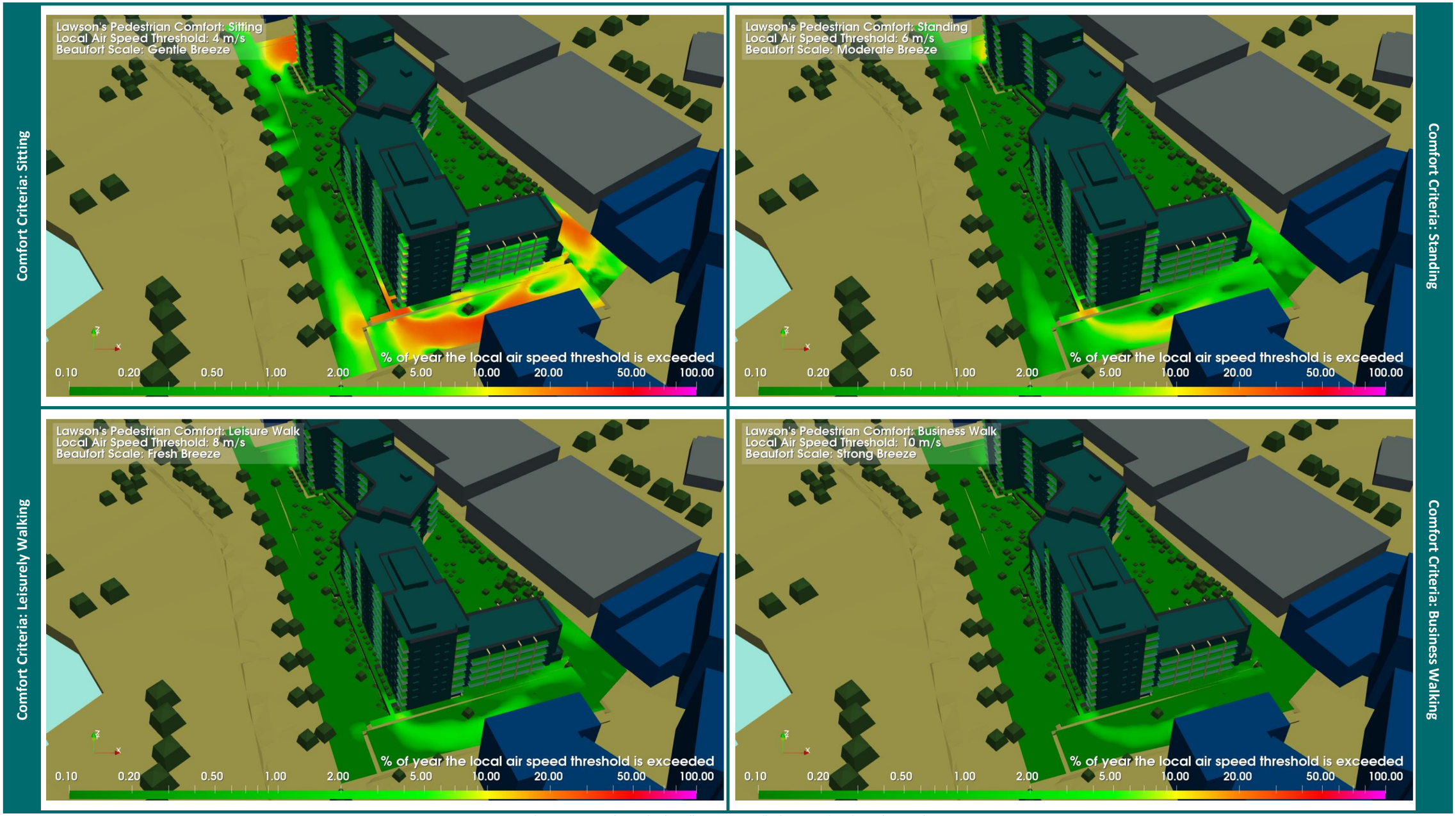


Figure 90: Comfort Criteria: All Seasons: All Phases: View from the south

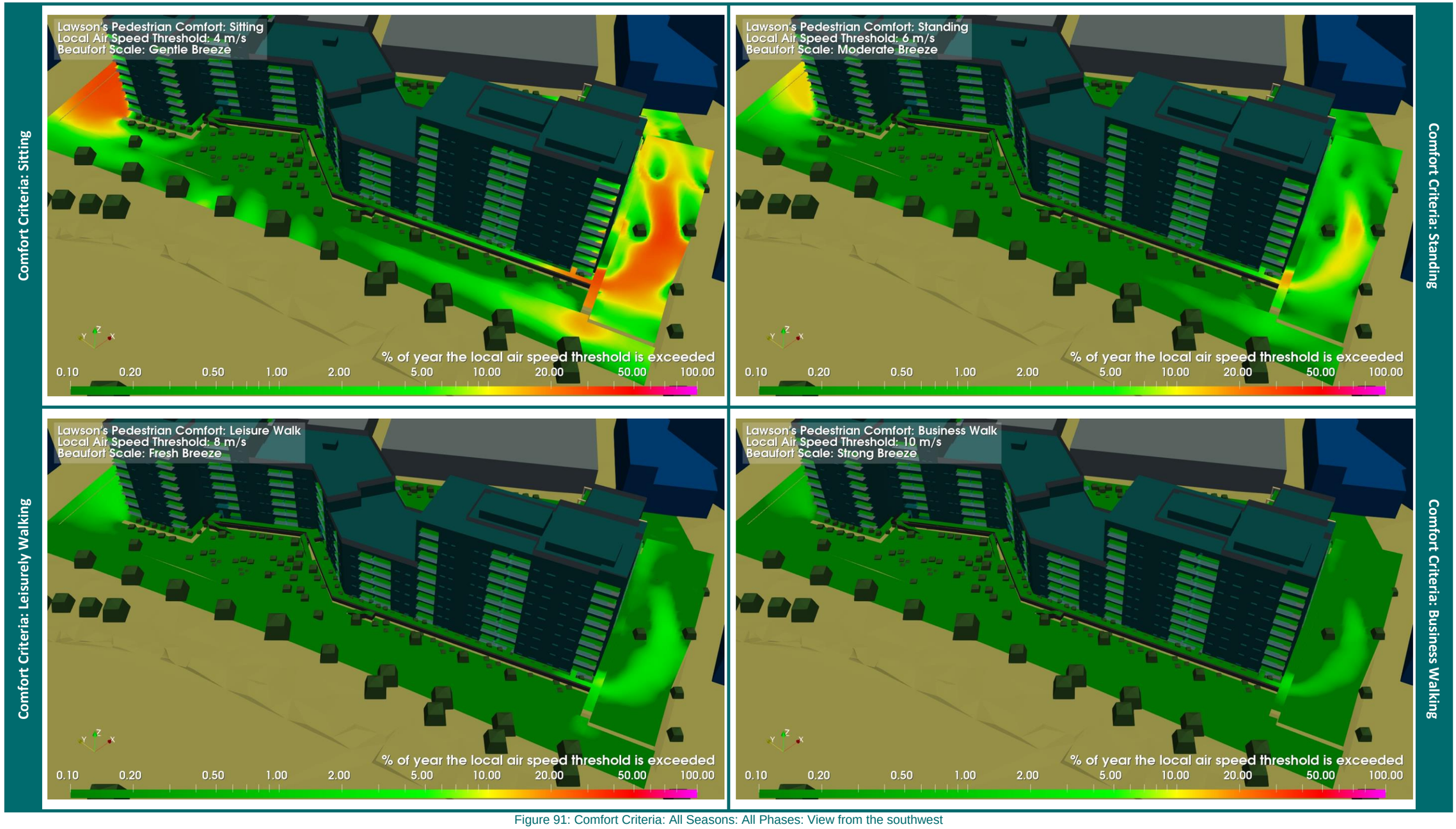


Figure 91: Comfort Criteria: All Seasons: All Phases: View from the southwest

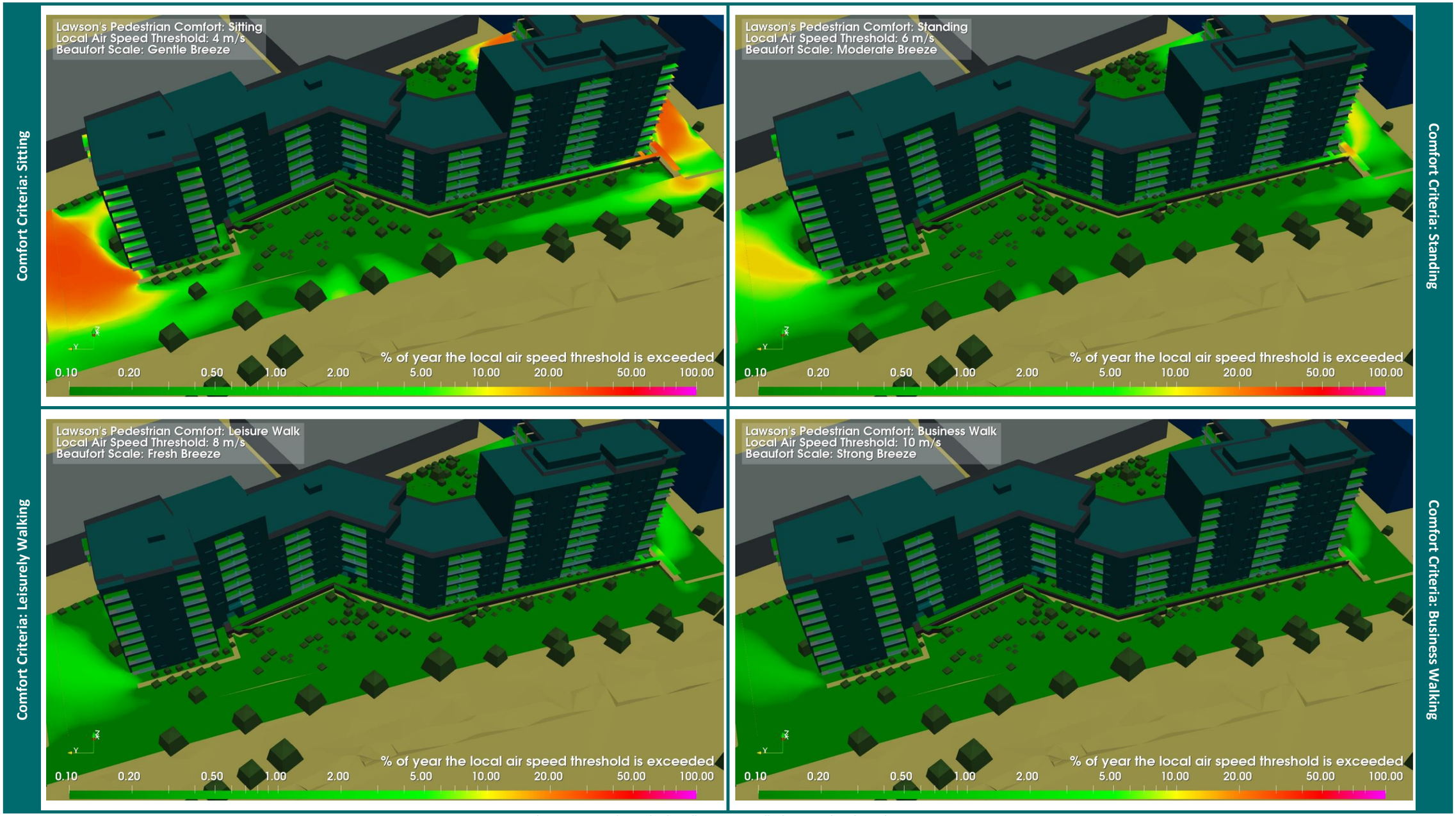


Figure 92: Comfort Criteria: All Seasons: All Phases: View from the west

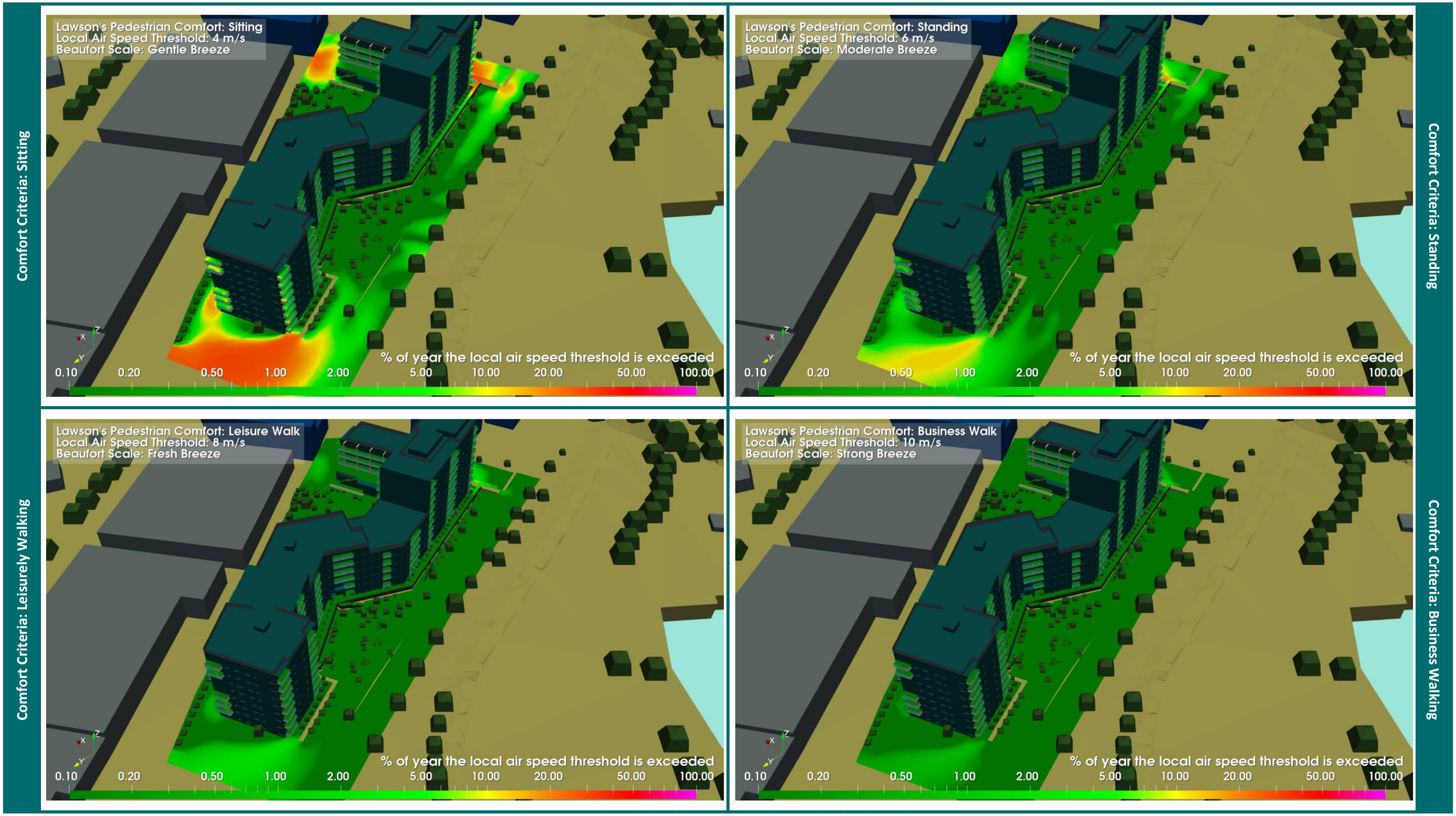


Figure 93: Comfort Criteria: All Seasons: All Phases: View from the northwest

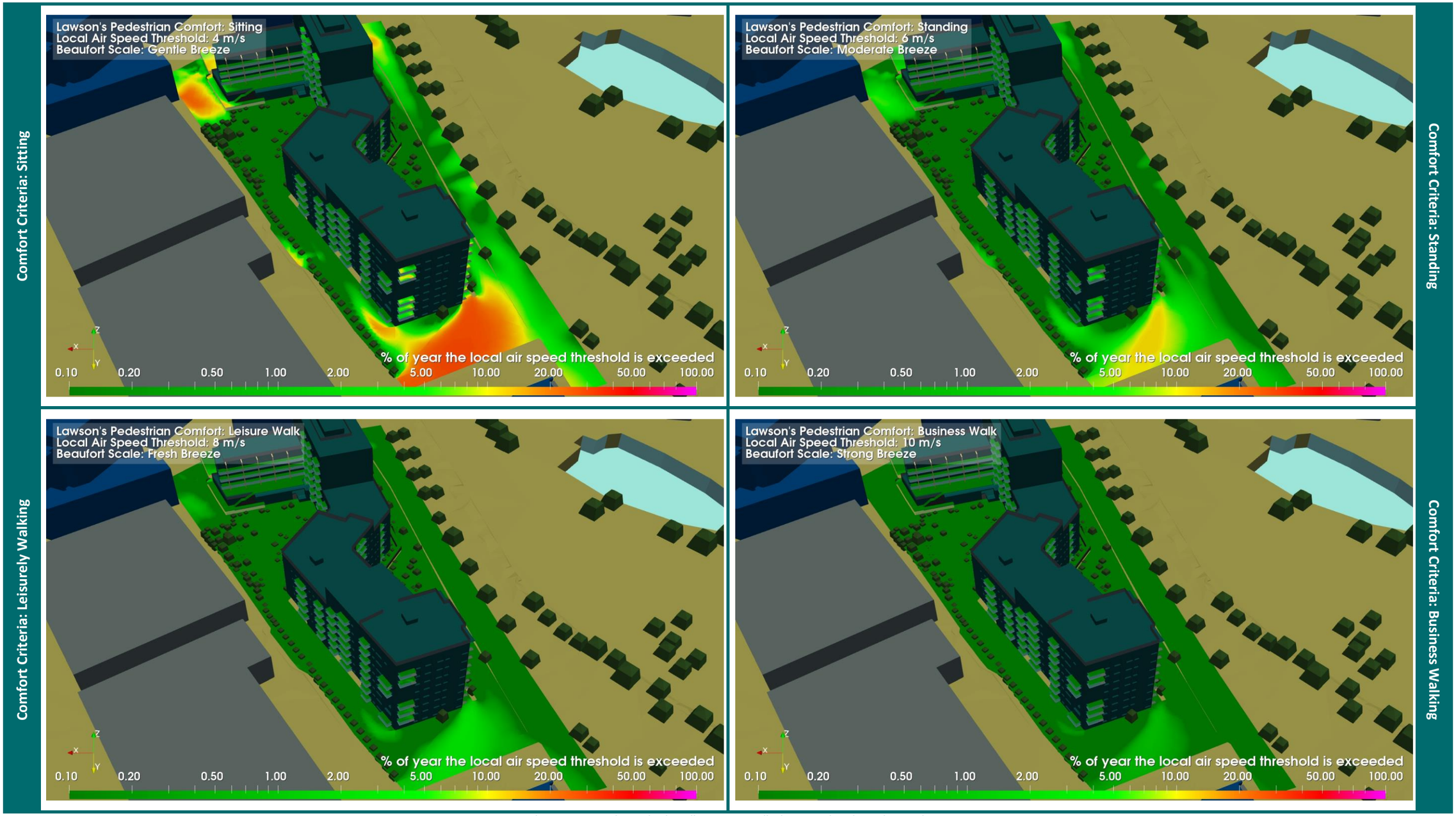


Figure 94: Comfort Criteria: All Seasons: All Phases: View from the north

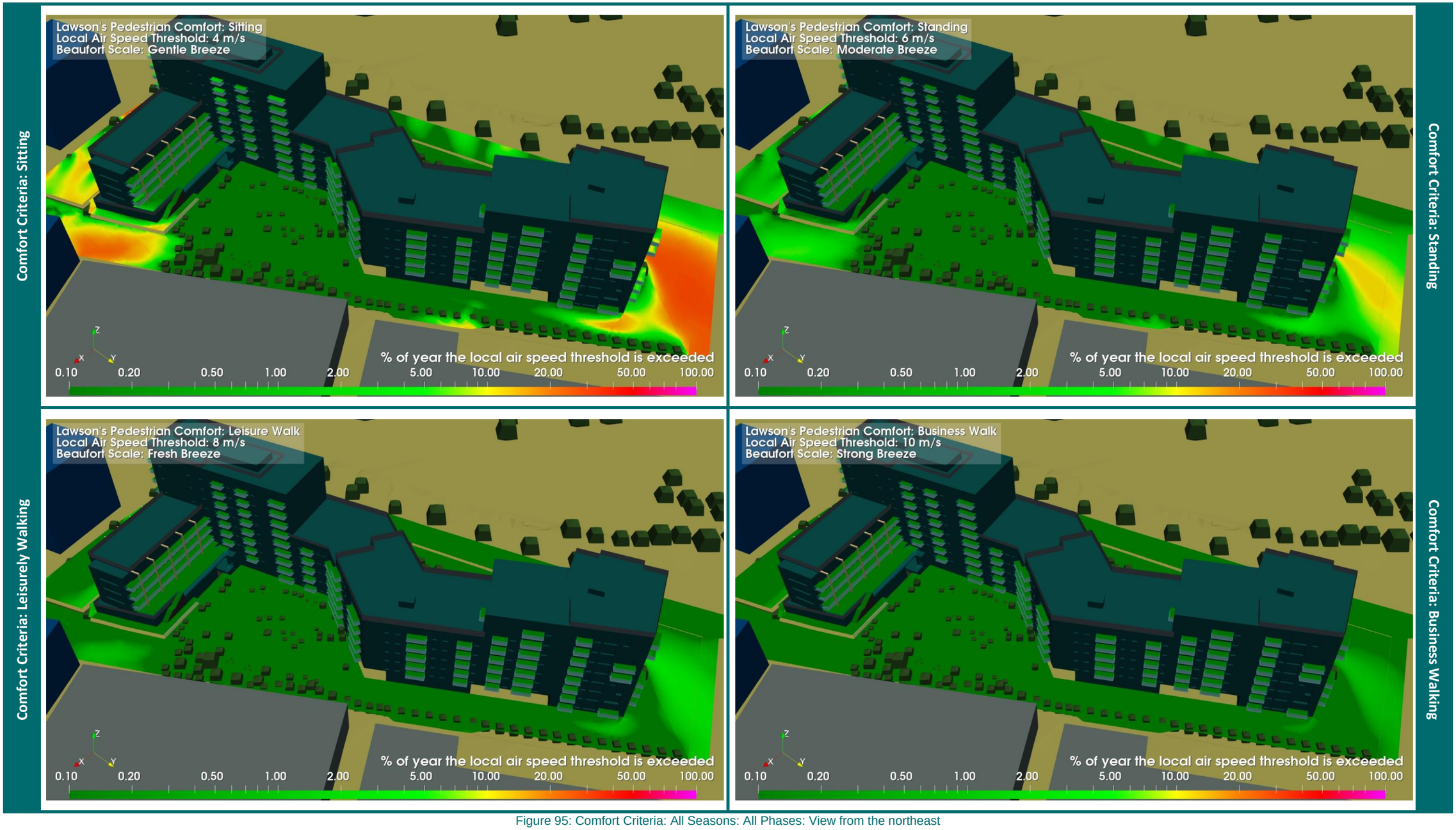


Figure 95: Comfort Criteria: All Seasons: All Phases: View from the northeast

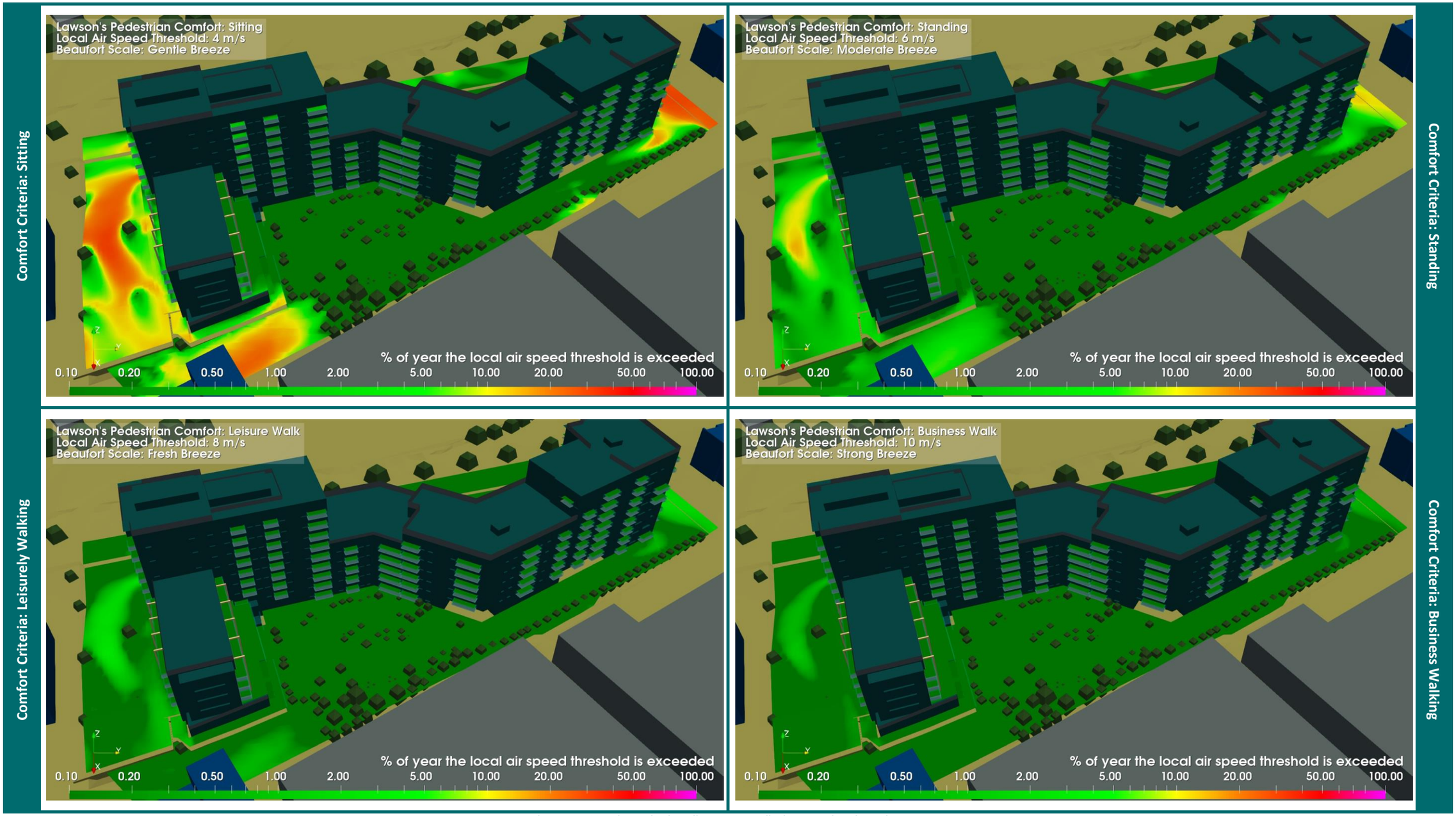
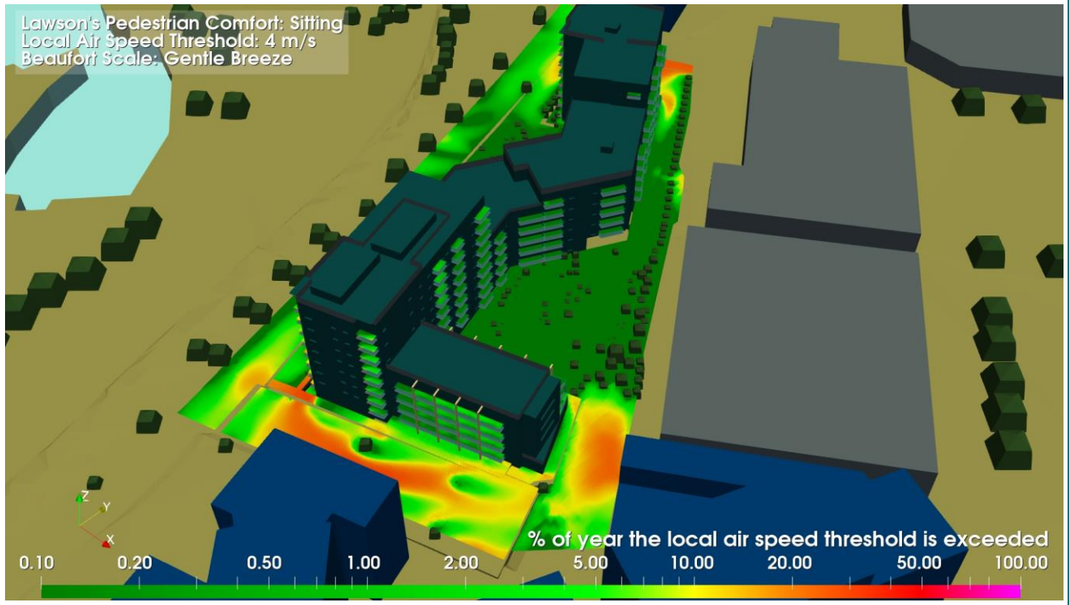
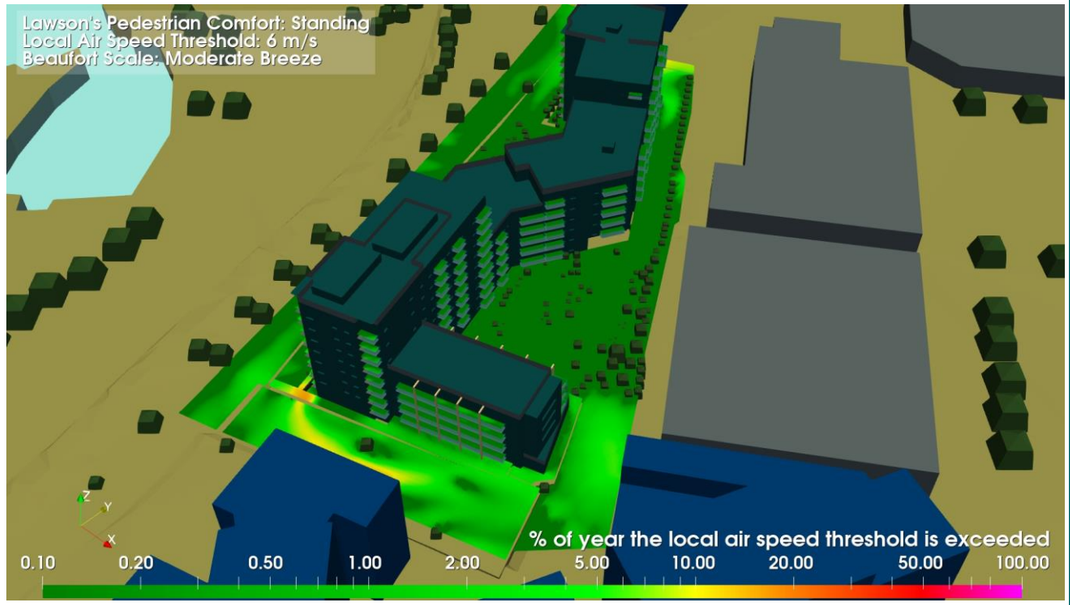


Figure 96: Comfort Criteria: All Seasons: All Phases: View from the east

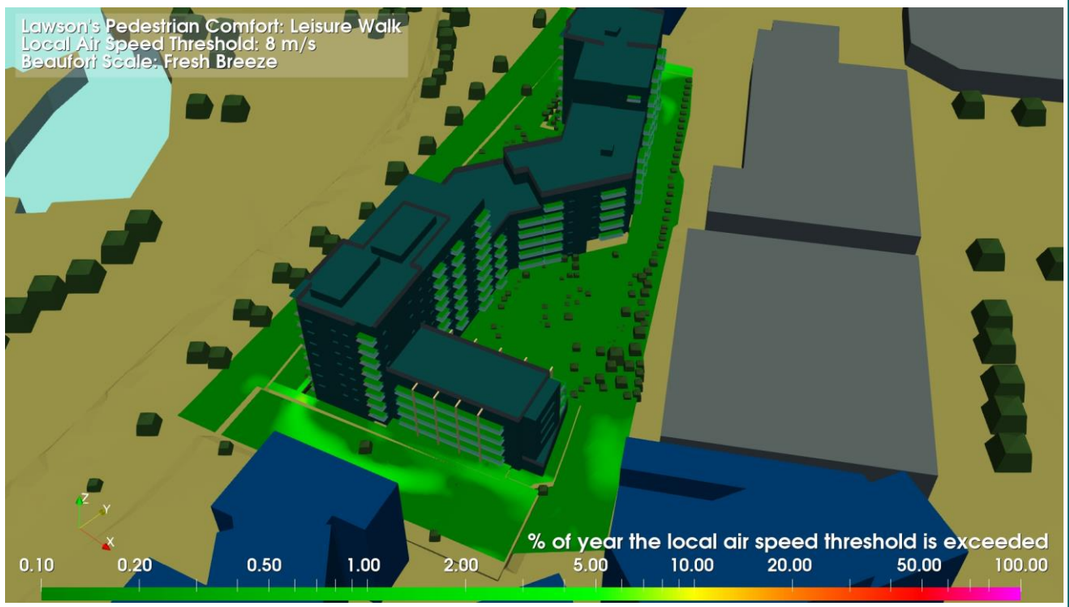
Comfort Criteria: Sitting

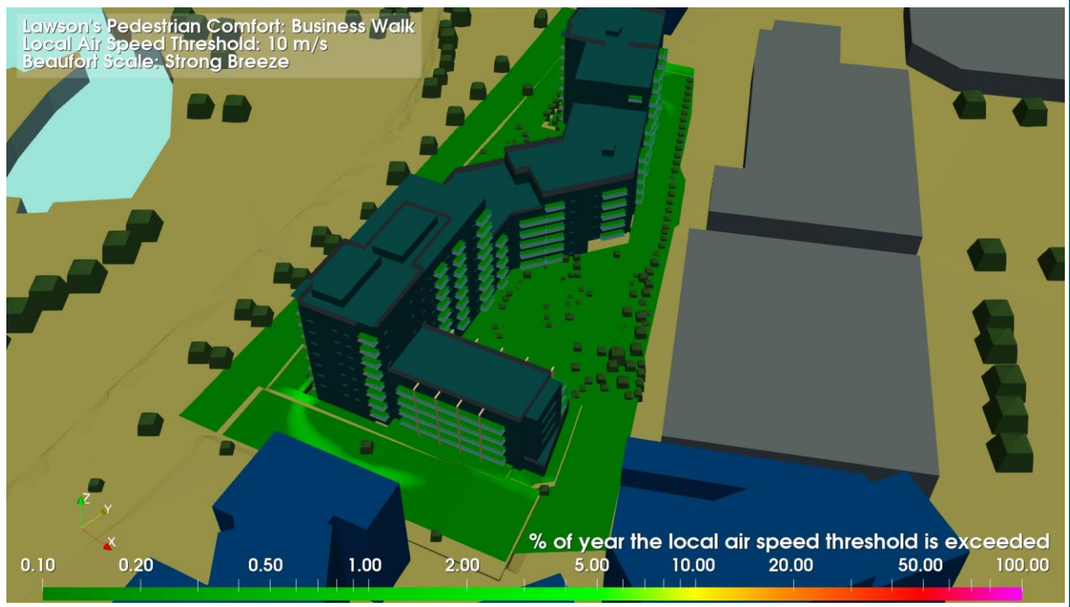




Comfort Criteria: Standing

Comfort Criteria: Leisurely Walking





Comfort Criteria: Business Walking

Figure 97: Comfort Criteria: All Seasons: All Phases: View from the southeast

8.1.2 Safety Criteria

Figure 98 to Figure 106 show the percentage of the year the hourly wind speed exceeds the threshold value for the safety criteria for all seasons. The threshold values are 20 m/s for normal pedestrian and 15 m/s for sensitive pedestrian. The safety results are shown around the residential blocks.

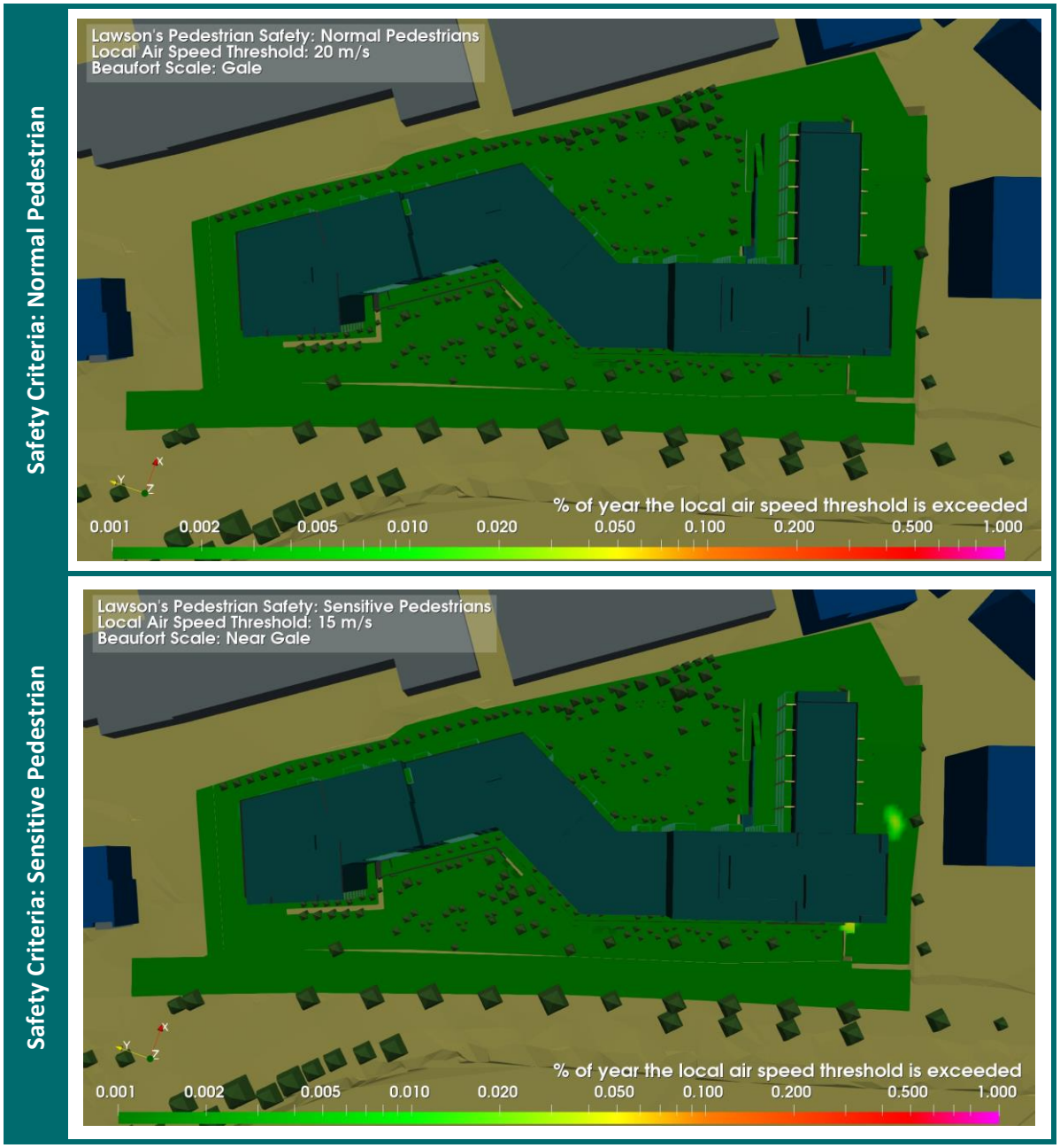


Figure 98: Safety Criteria: All Season: All Phases: View from the Top

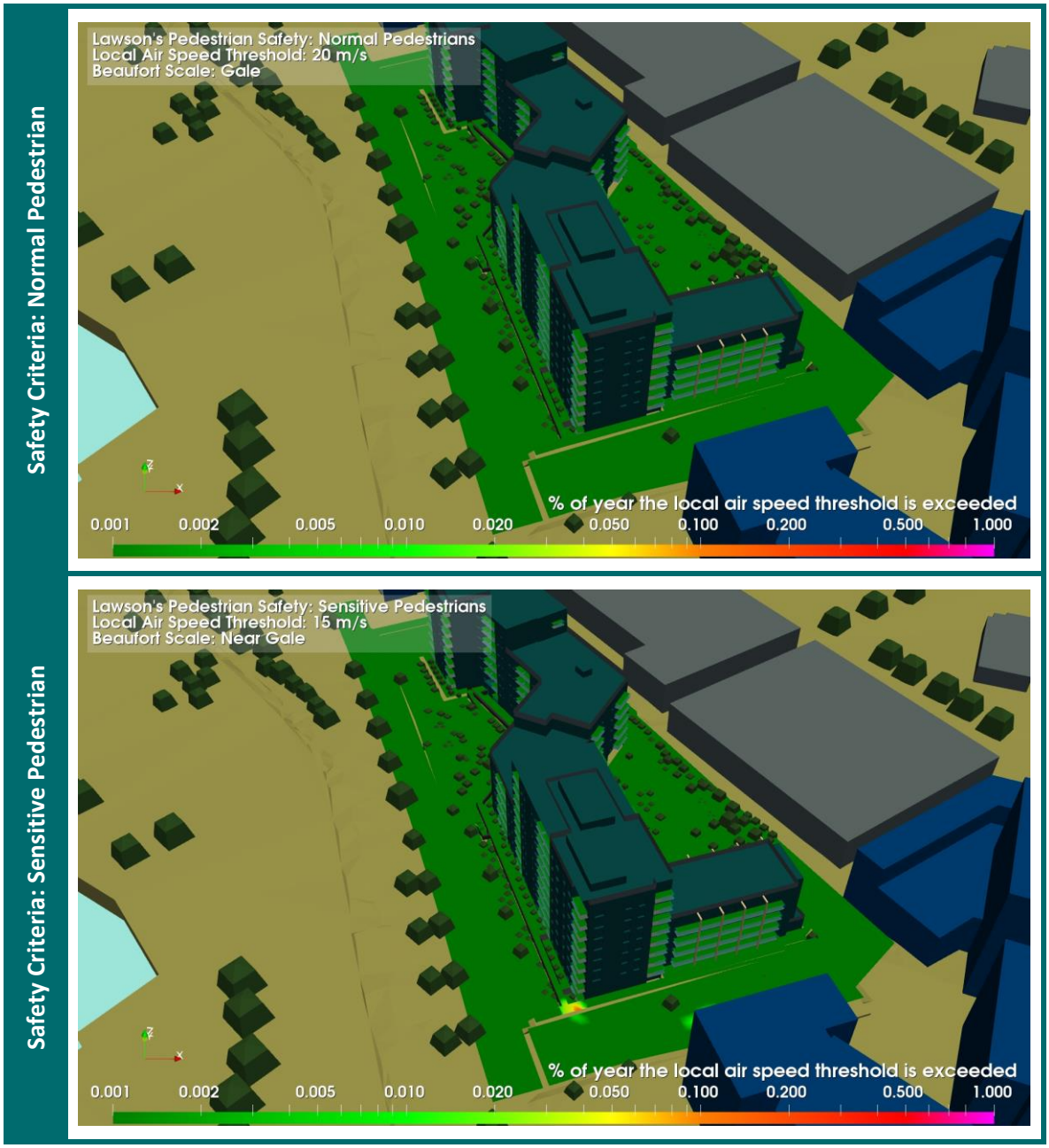


Figure 99: Safety Criteria: All Season: All Phases: View from the south

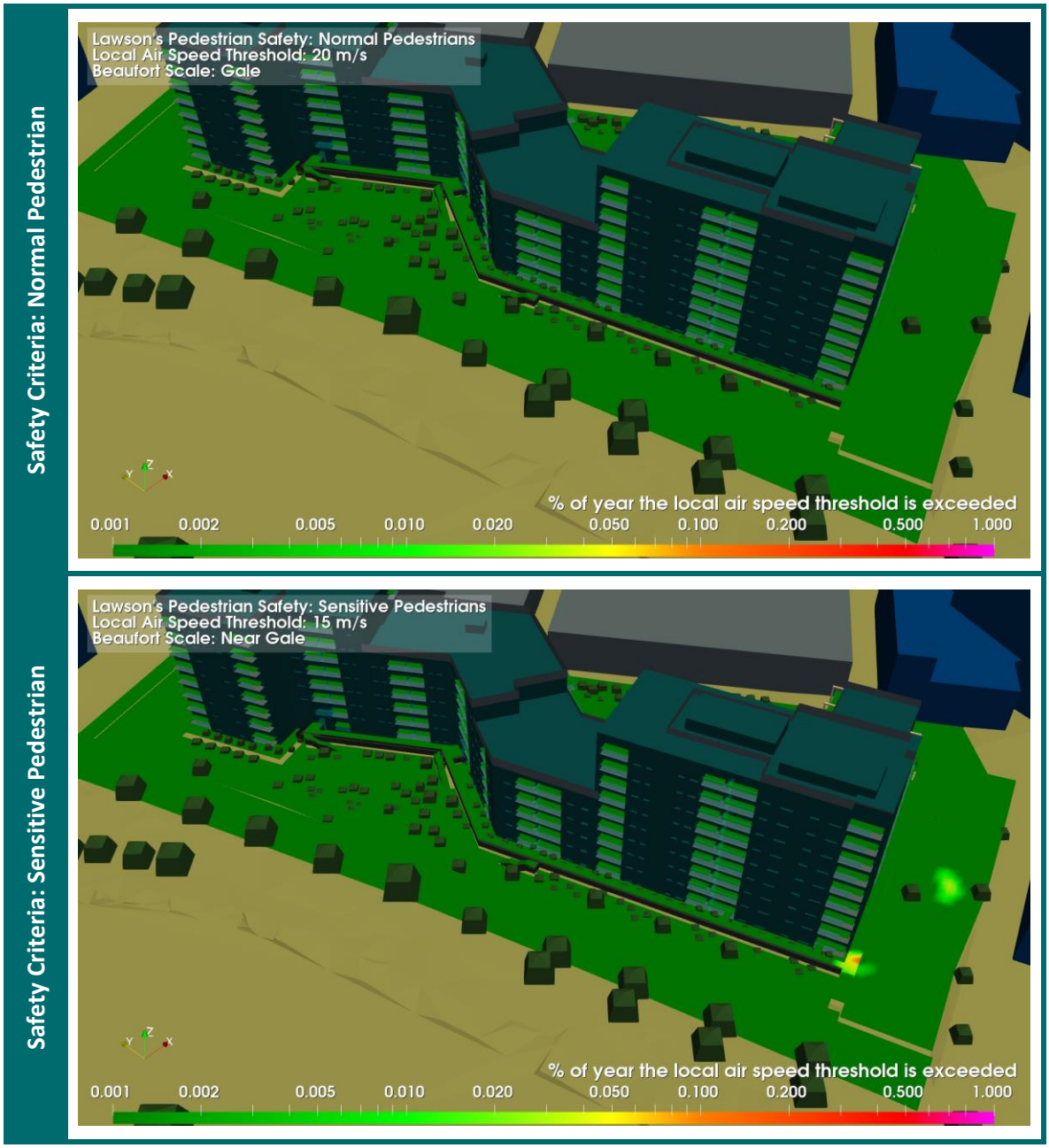


Figure 100: Safety Criteria: All Season: All Phases: View from the southwest

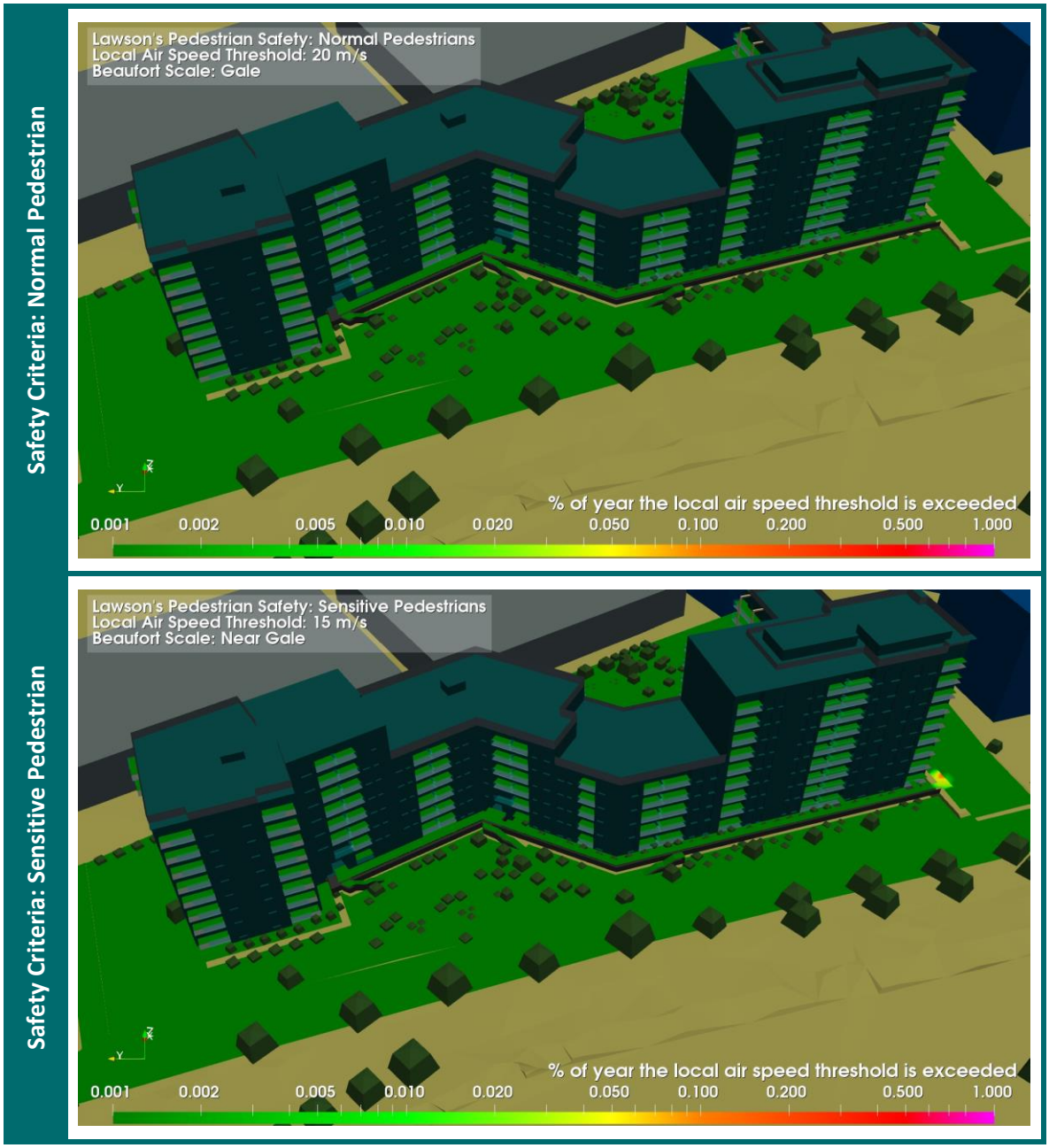


Figure 101: Safety Criteria: All Season: All Phases: View from the west

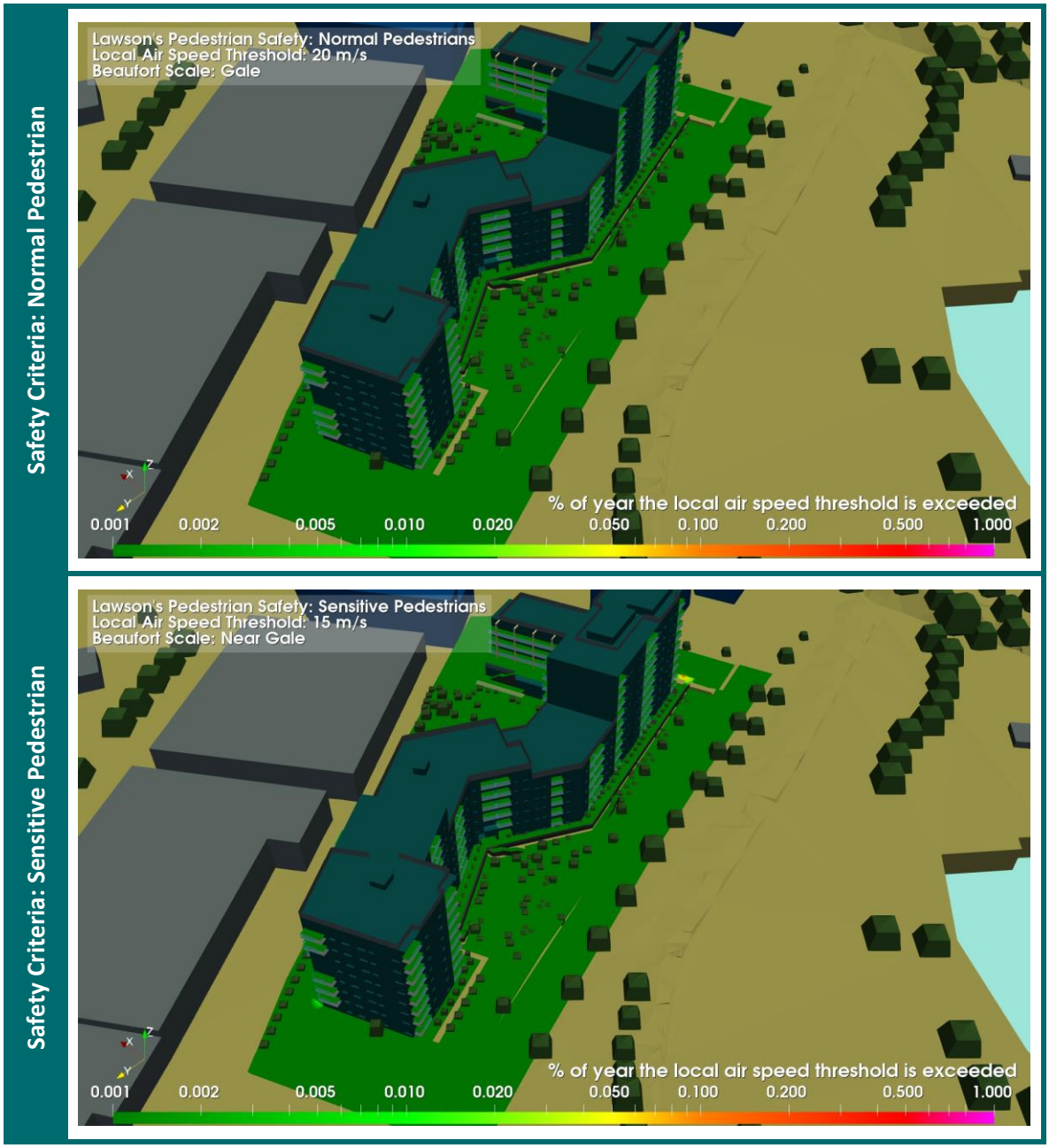


Figure 102: Safety Criteria: All Season: All Phases: View from the northwest

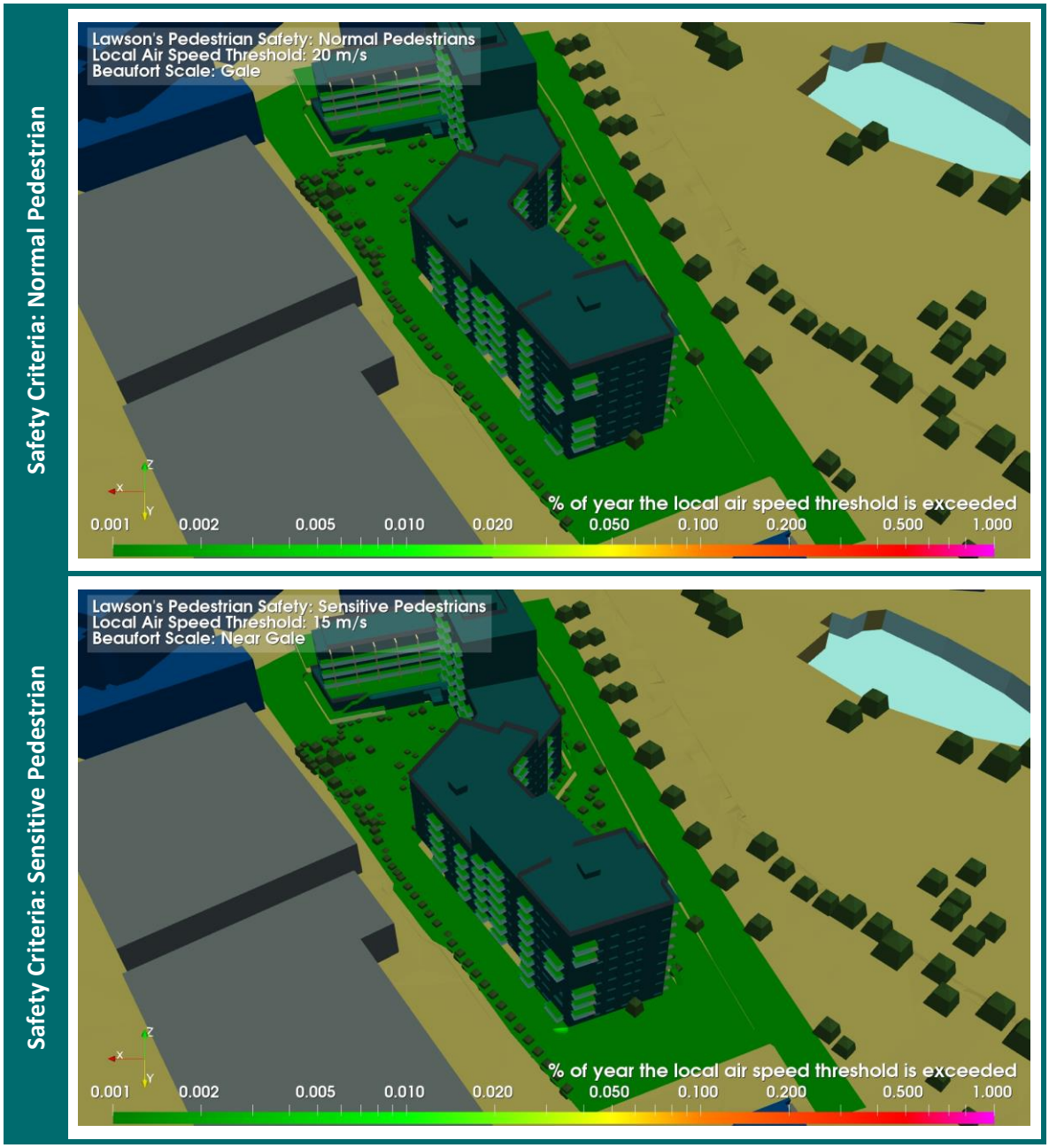


Figure 103: Safety Criteria: All Season: All Phases: View from the north

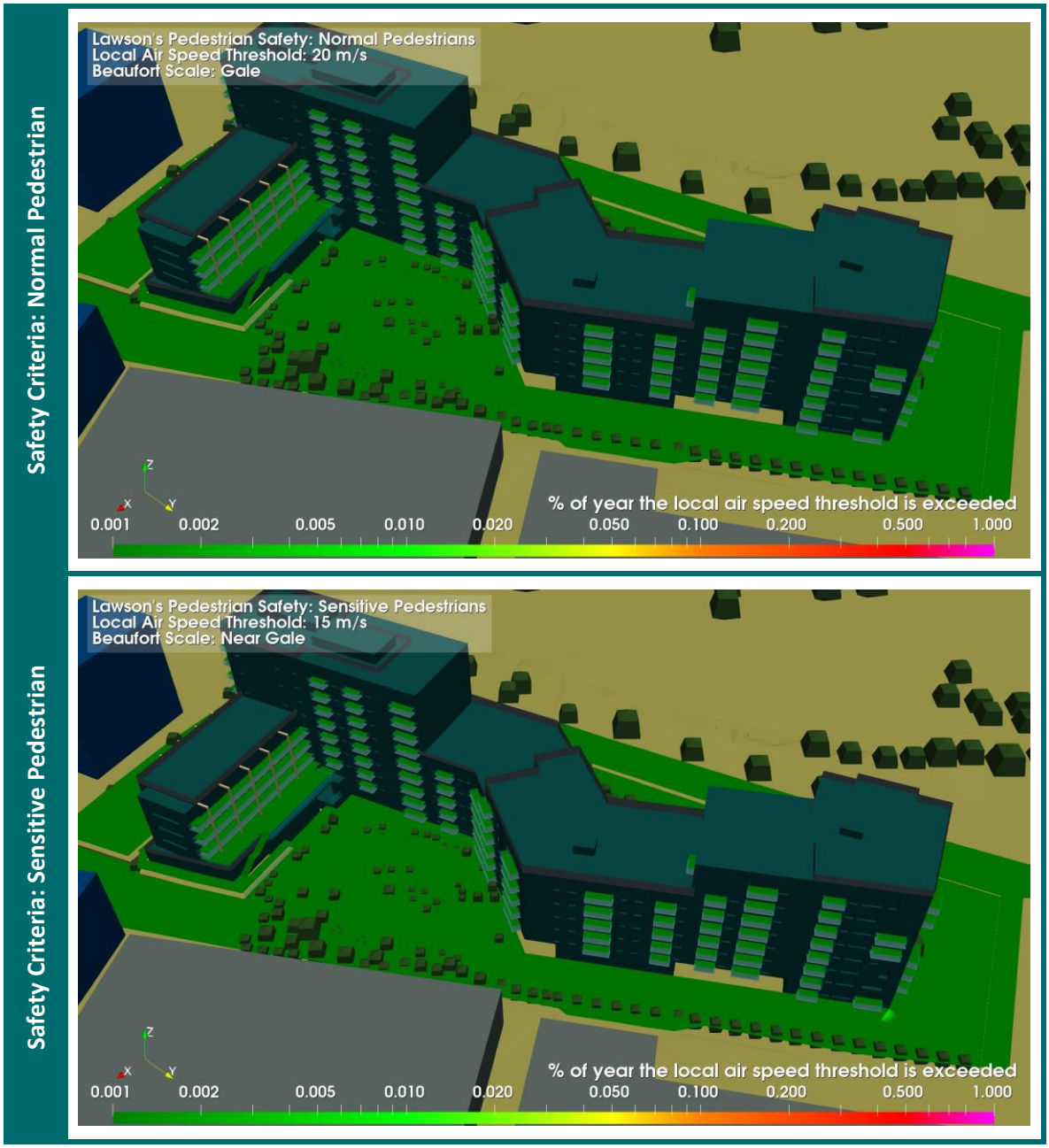


Figure 104: Safety Criteria: All Season: All Phases: View from the northeast

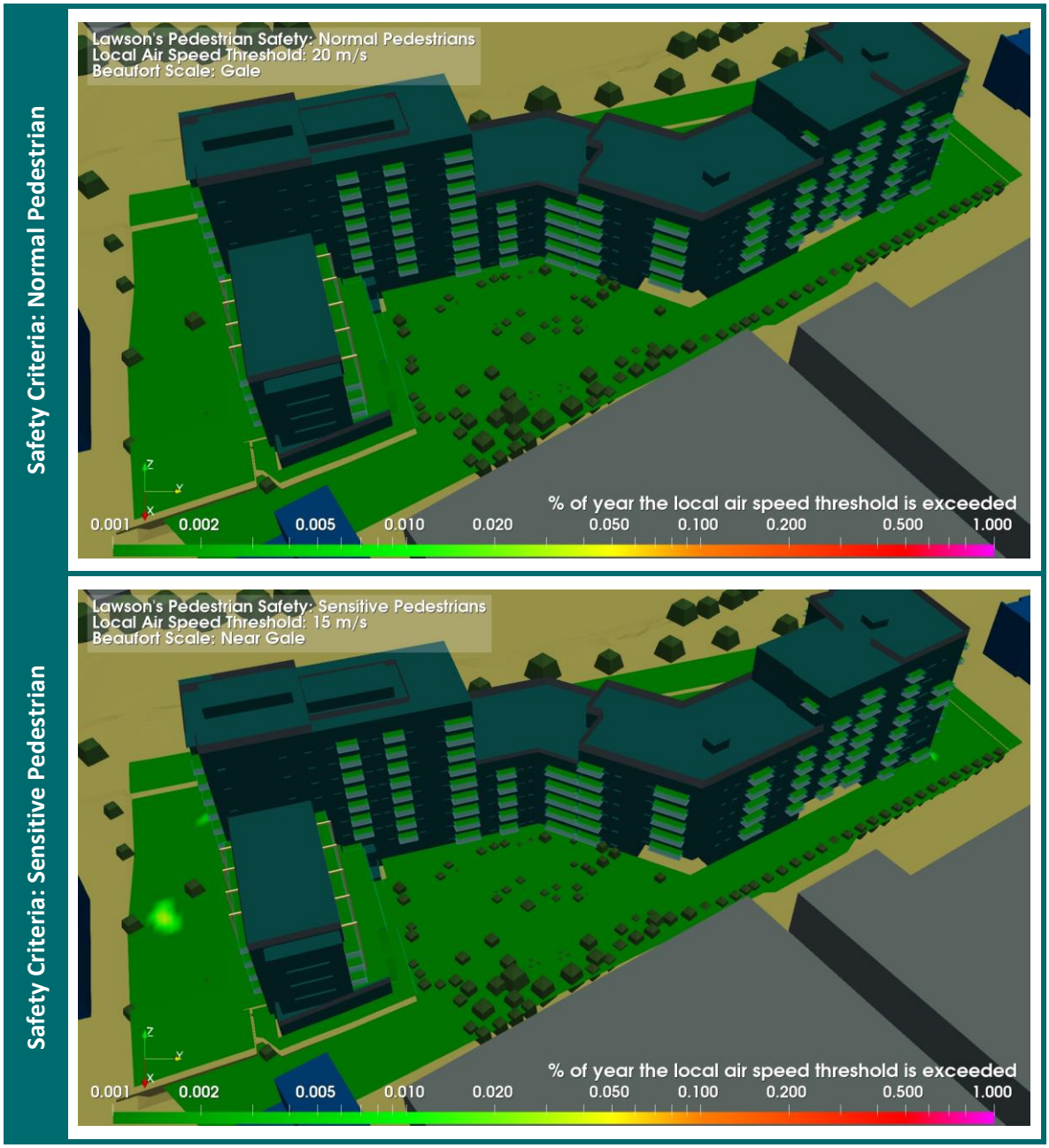


Figure 105: Safety Criteria: All Season: All Phases: View from the east

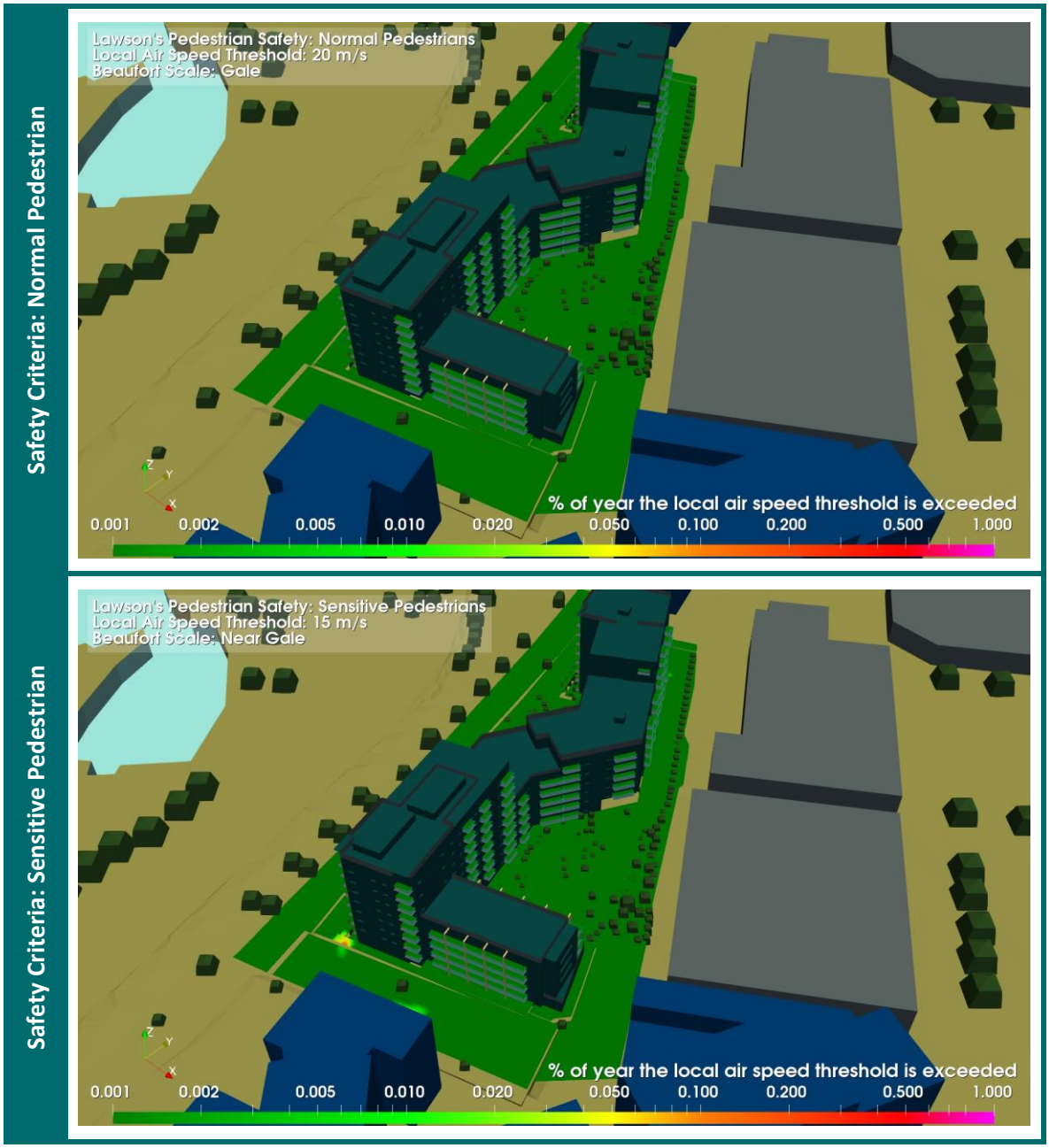


Figure 106: Safety Criteria: All Season: All Phases: View from the southeast

8.2 Phase 1

This section includes the results of the proposed development Phase 1 .

8.2.1 Comfort Criteria

Figure 107 to Figure 115 show the percentage of the year the hourly wind speed exceeds the threshold value for the comfort criteria such as Sitting, Standing, Leisurely Walking and Business Walking for all seasons. The threshold values are 4 m/s, 6 m/s, 8 m/s and 10 m/s respectively. The comfort results are shown around the residential blocks.

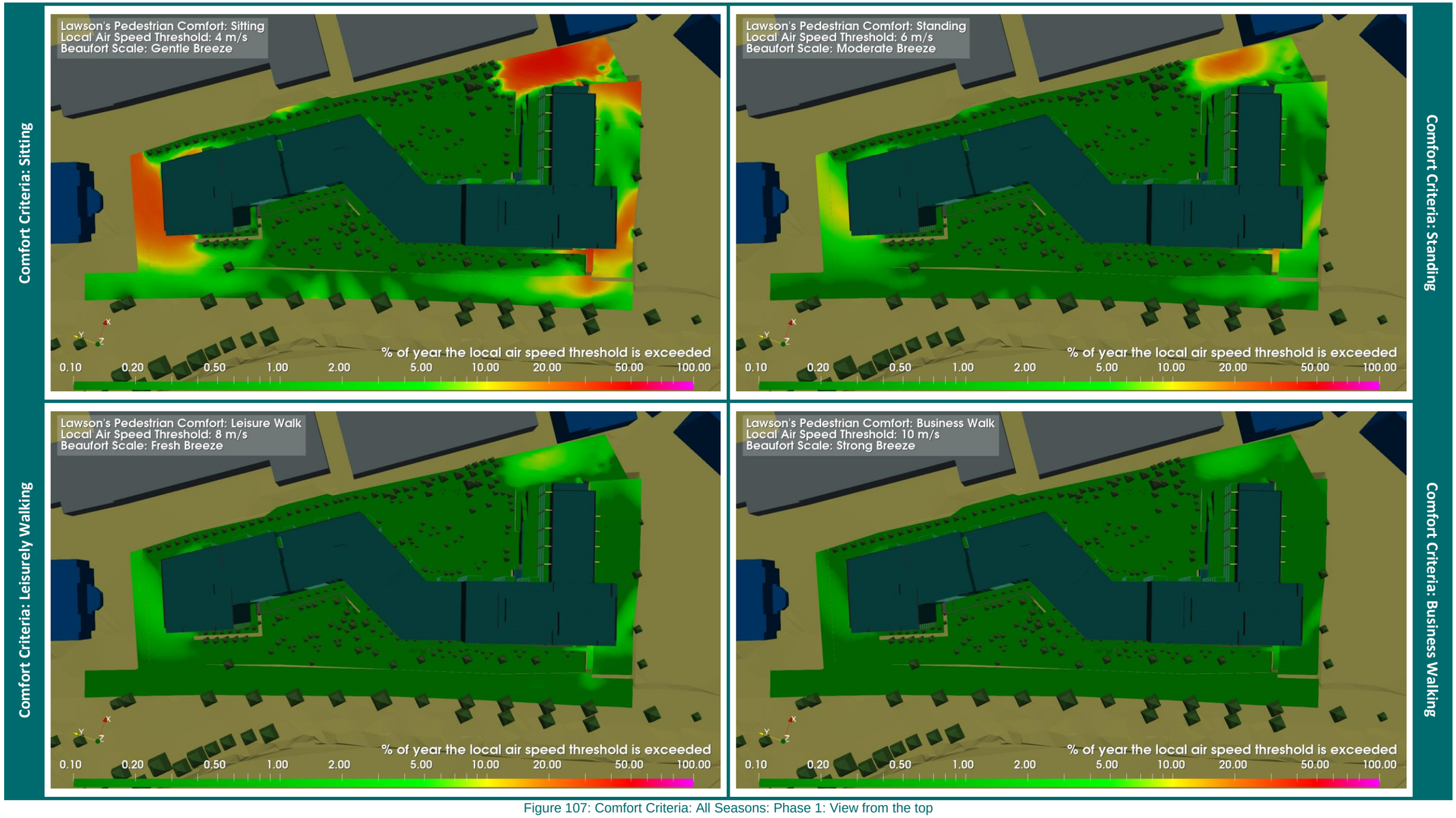


Figure 107: Comfort Criteria: All Seasons: Phase 1: View from the top

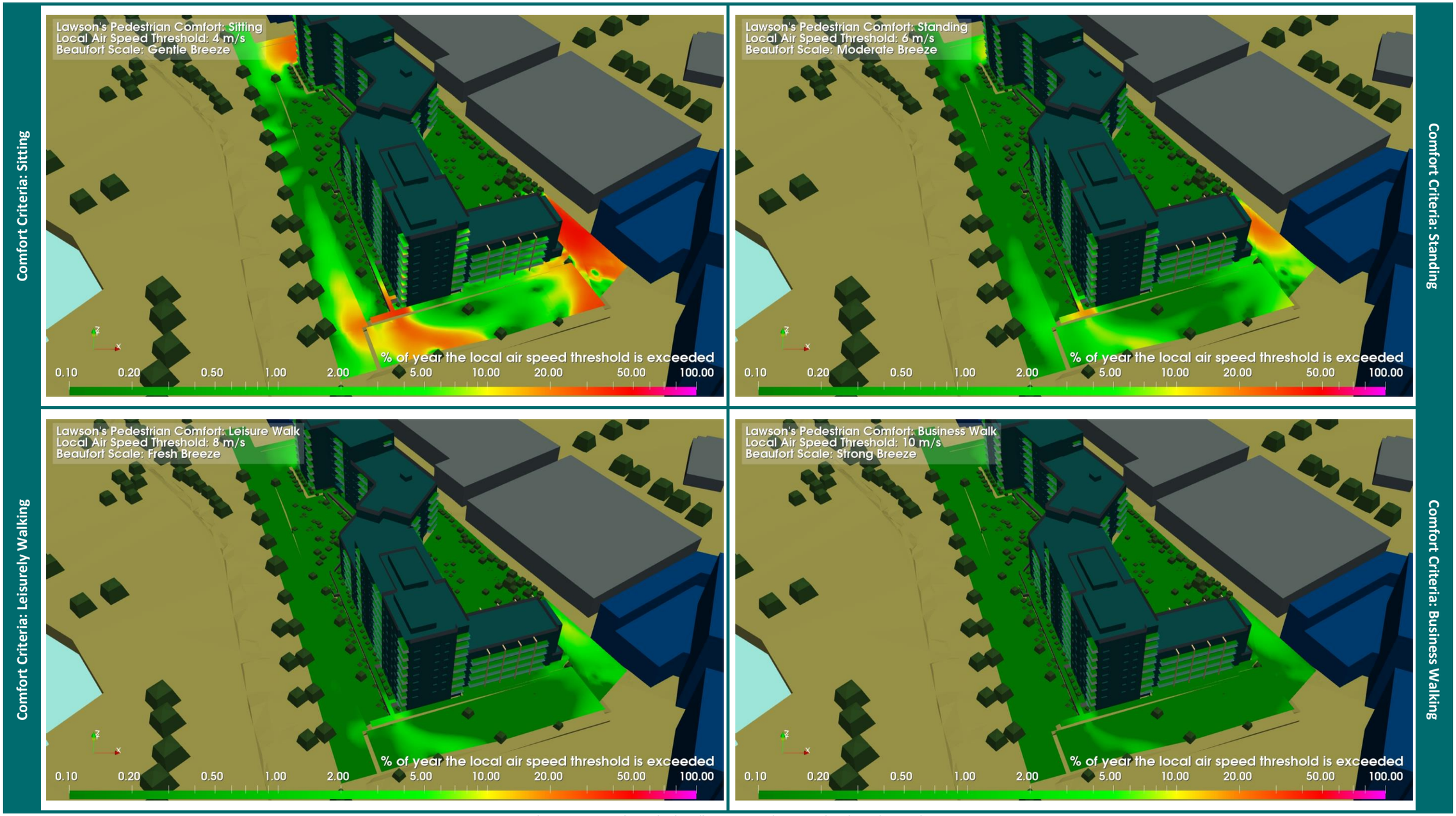


Figure 108: Comfort Criteria: All Seasons: Phase 1: View from the south

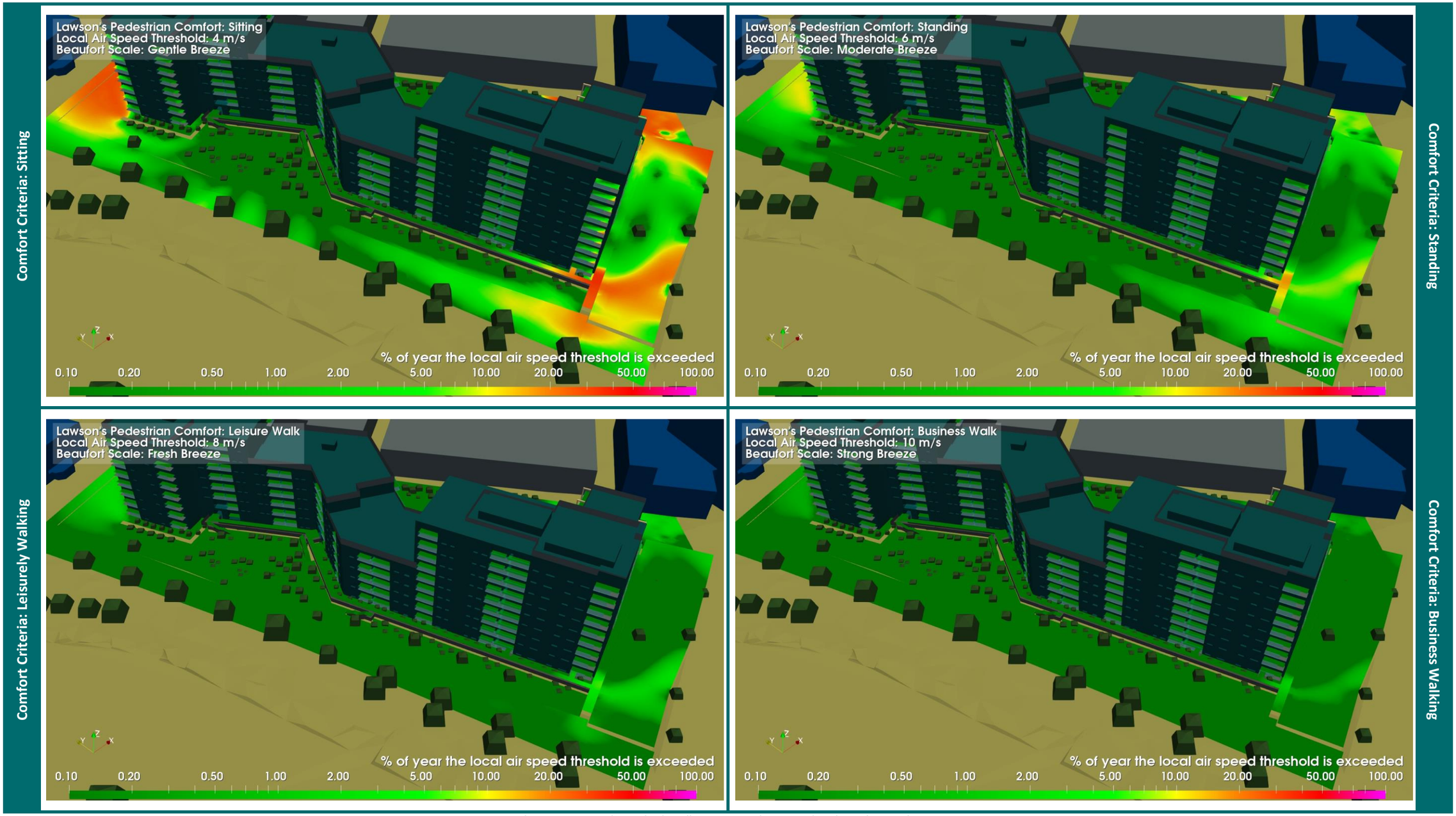


Figure 109: Comfort Criteria: All Seasons: Phase 1: View from the southwest

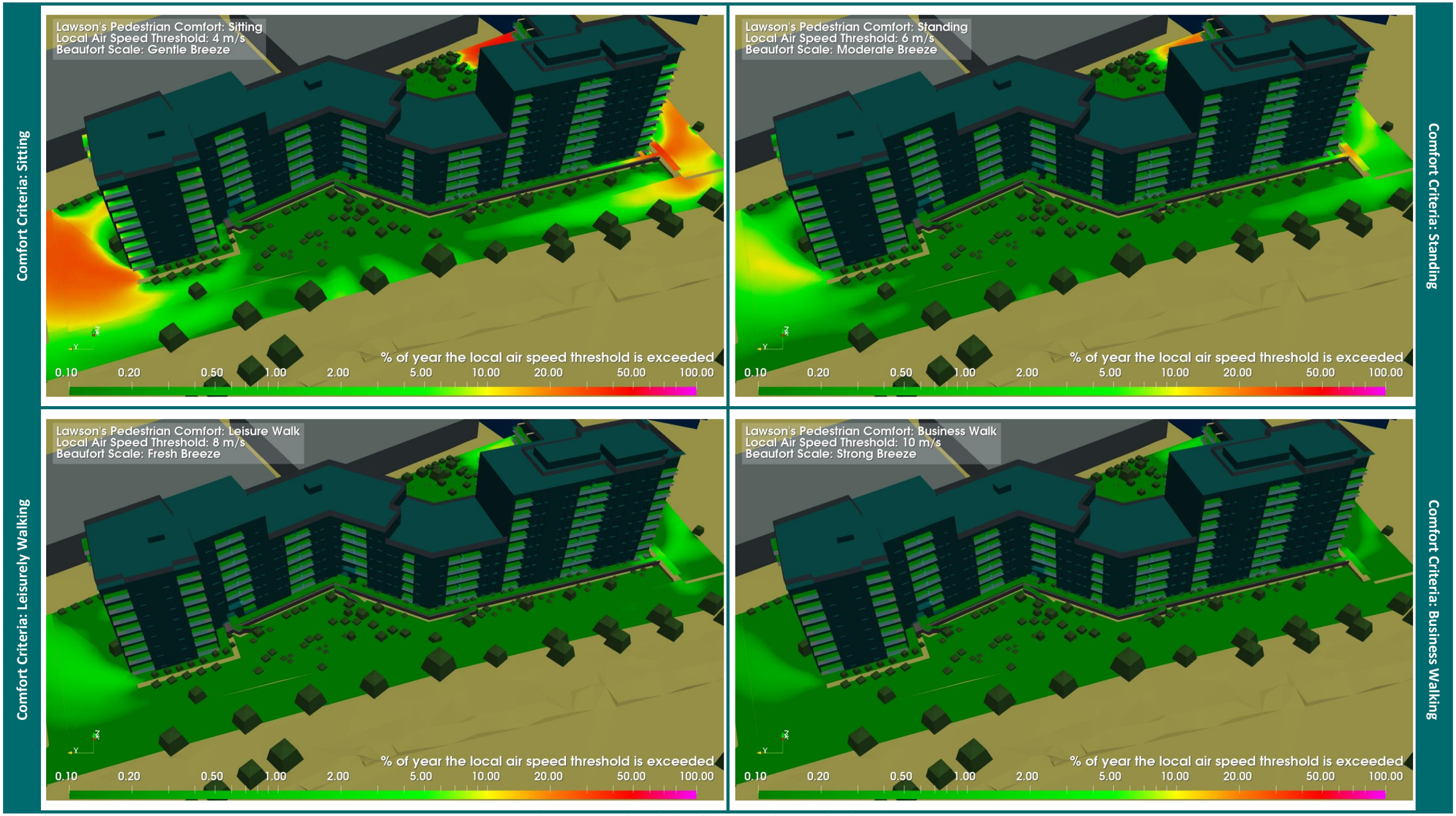


Figure 110: Comfort Criteria: All Seasons: Phase 1: View from the west

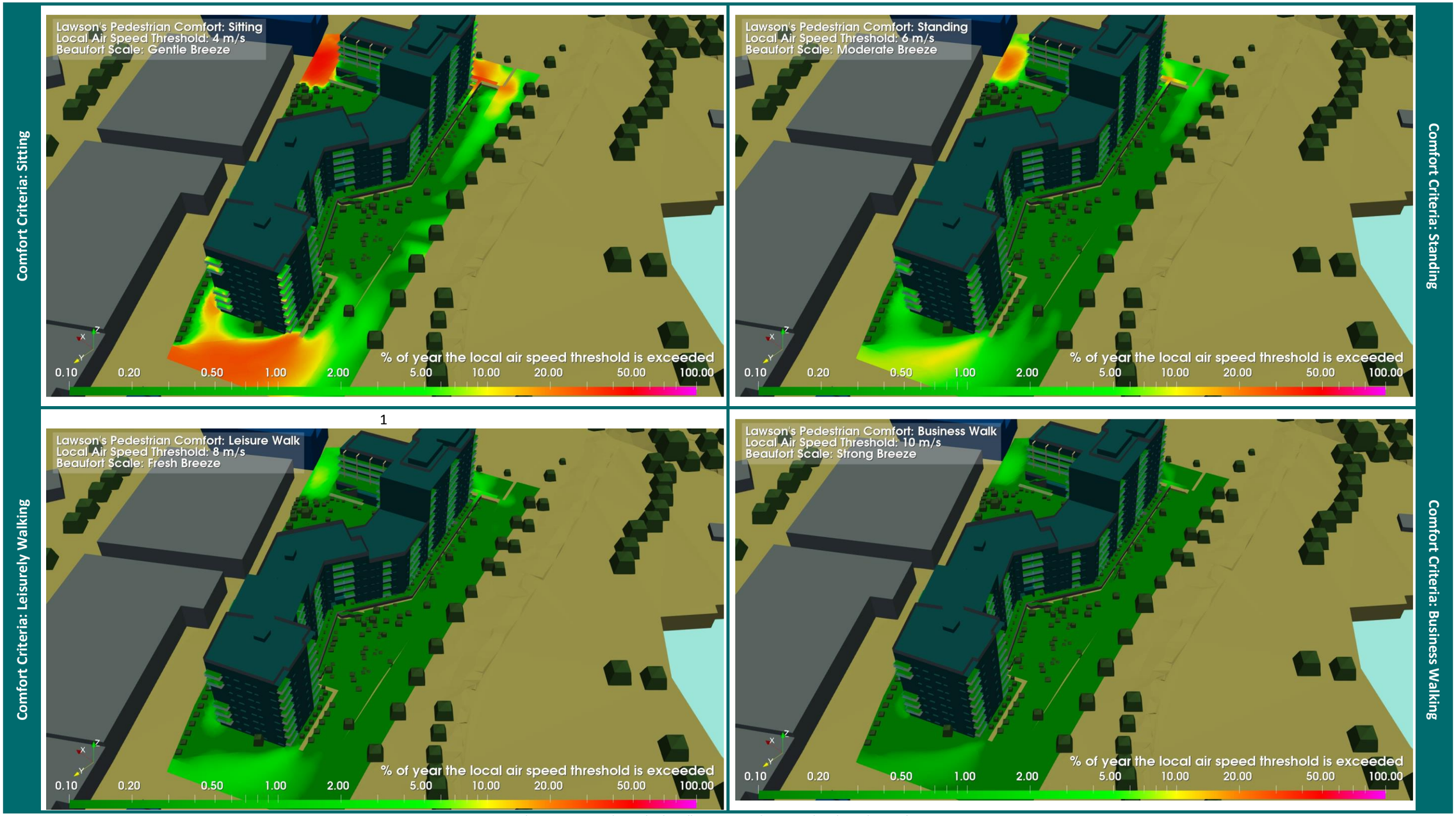


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Figure 111: Comfort Criteria: All Seasons: Phase 1: View from the northwest

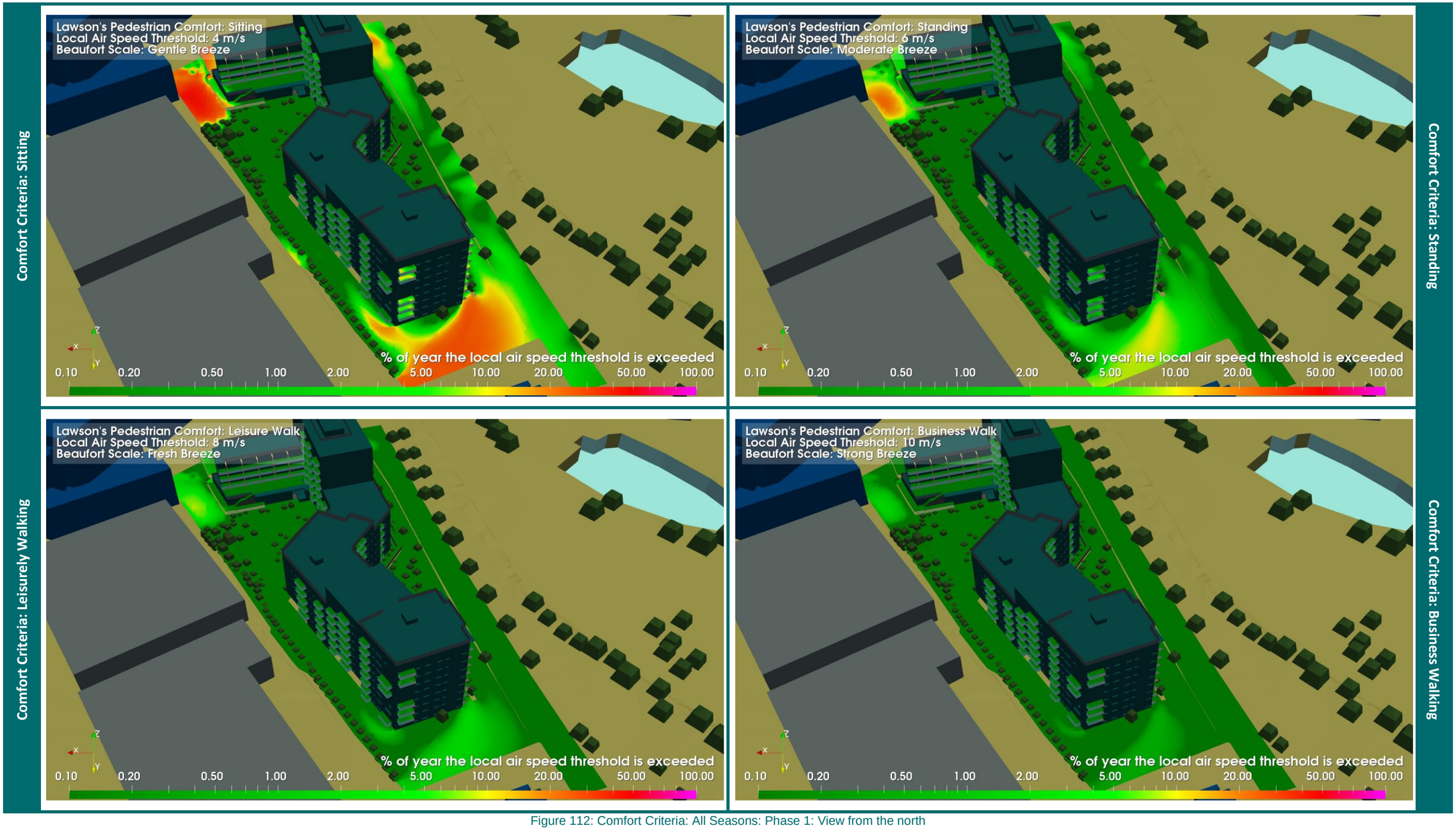

Figure 112: Comfort Criteria: All Seasons: Phase 1: View from the north

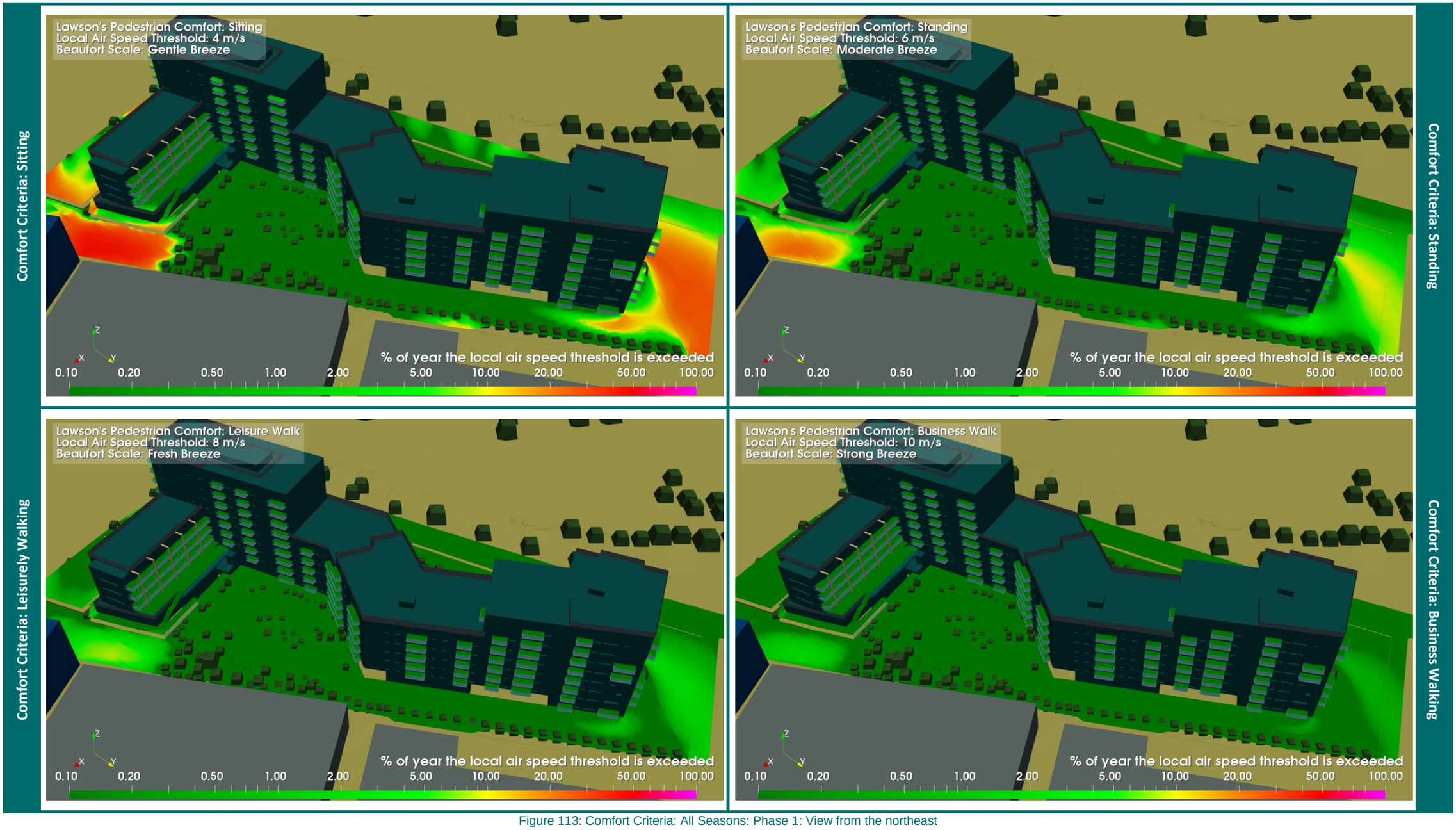

Figure 113: Comfort Criteria: All Seasons: Phase 1: View from the northeast

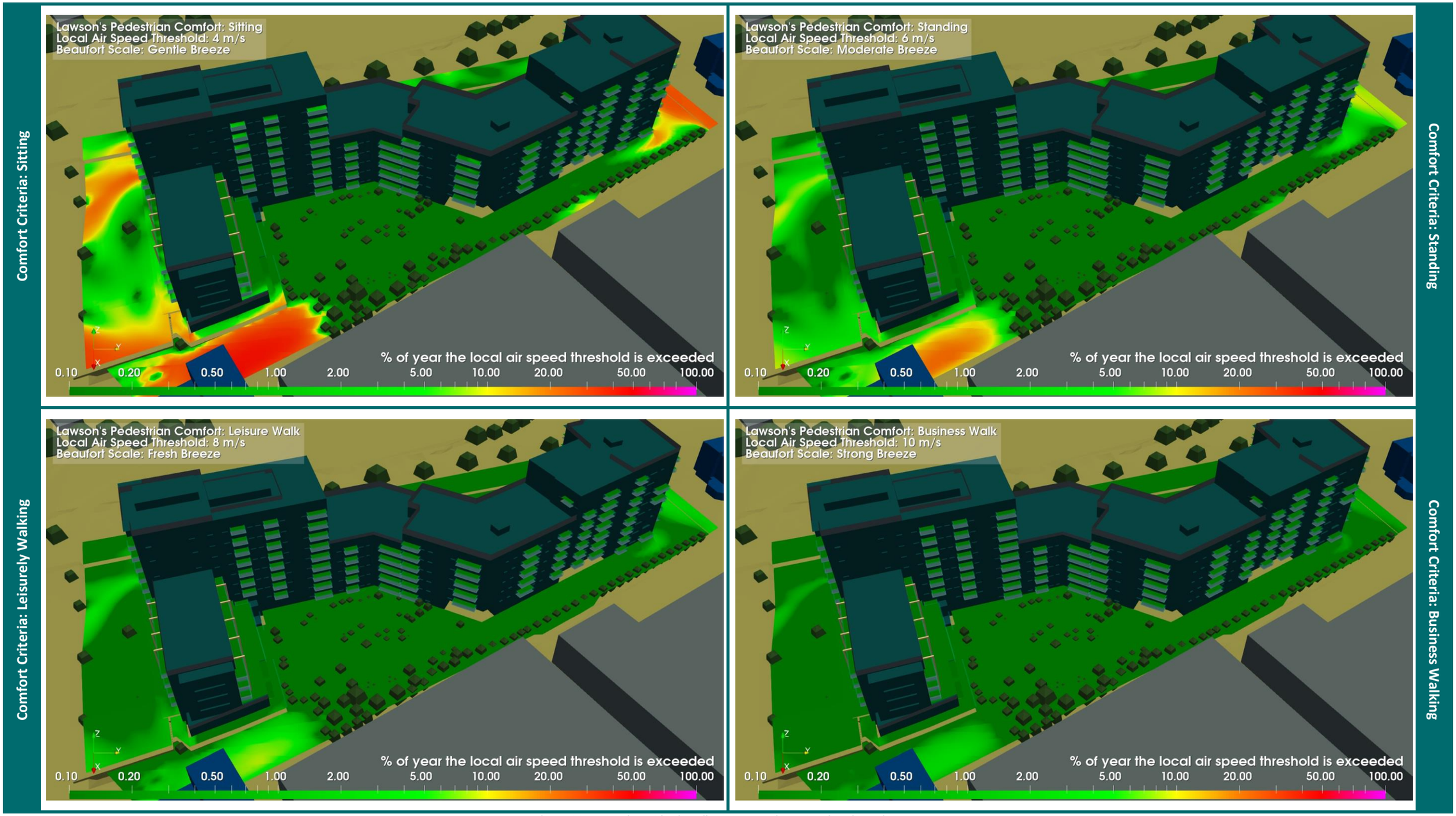

Figure 114: Comfort Criteria: All Seasons: Phase 1: View from the east

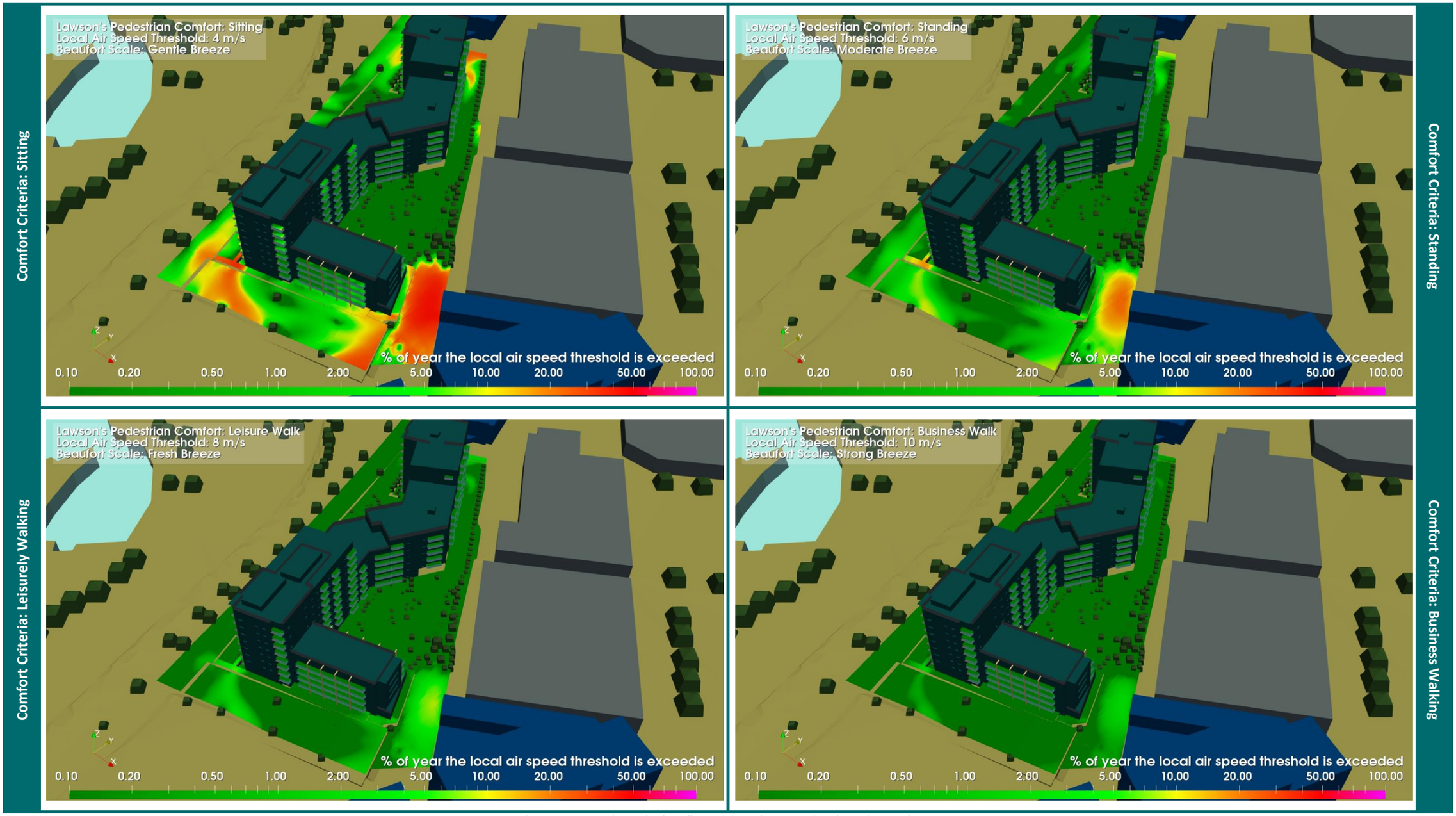

Figure 115: Comfort Criteria: All Seasons: Phase 1: View from the southeast

8.2.2 Safety Criteria

Figure 116 to Figure 124 show the percentage of the year the hourly wind speed exceeds the threshold value for the safety criteria for all seasons. The threshold values are 20 m/s for normal pedestrian and 15 m/s for sensitive pedestrian. The safety results are shown around the residential blocks.

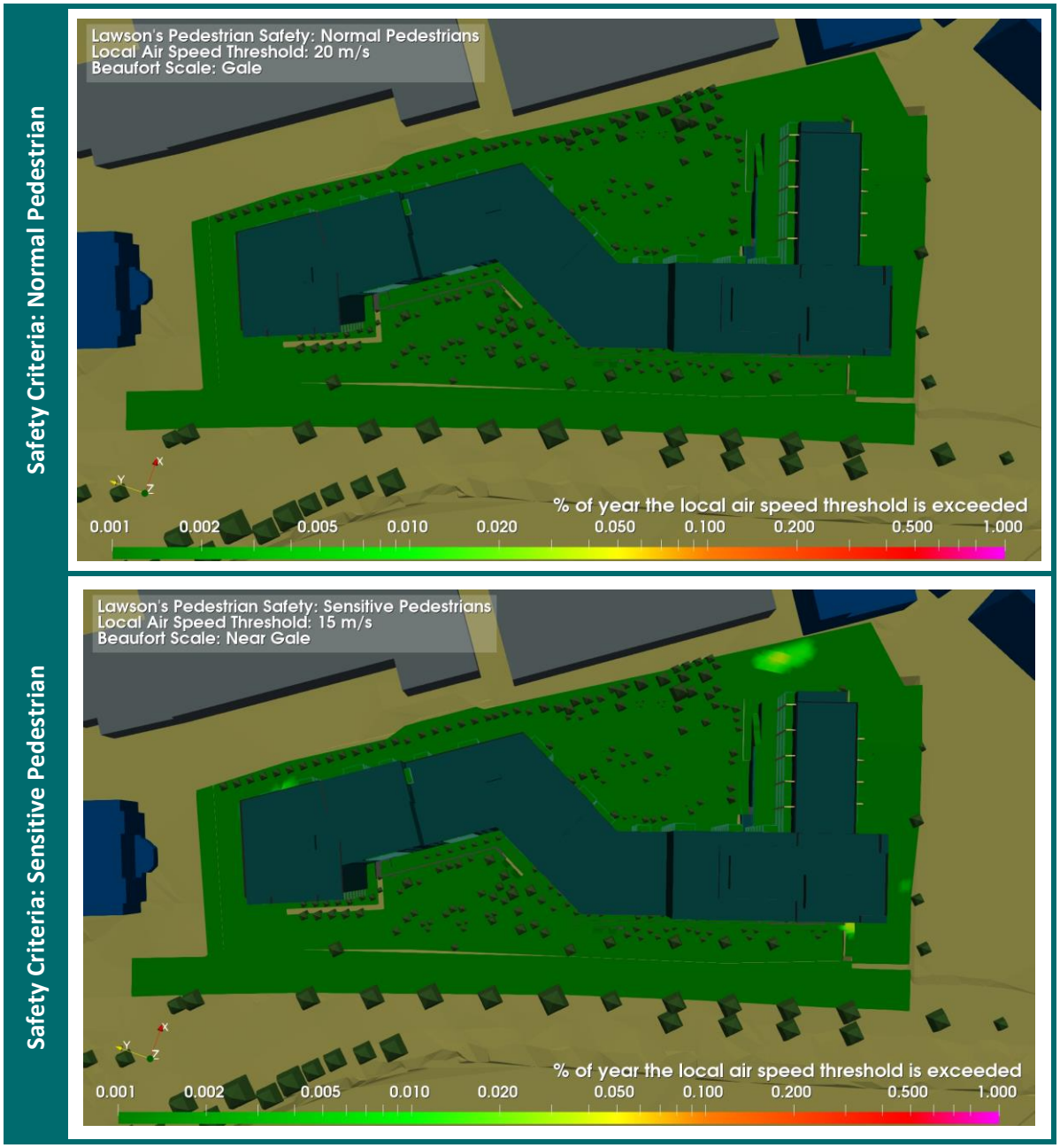

Figure 116: Safety Criteria: All Season: Phase 1: View from the Top

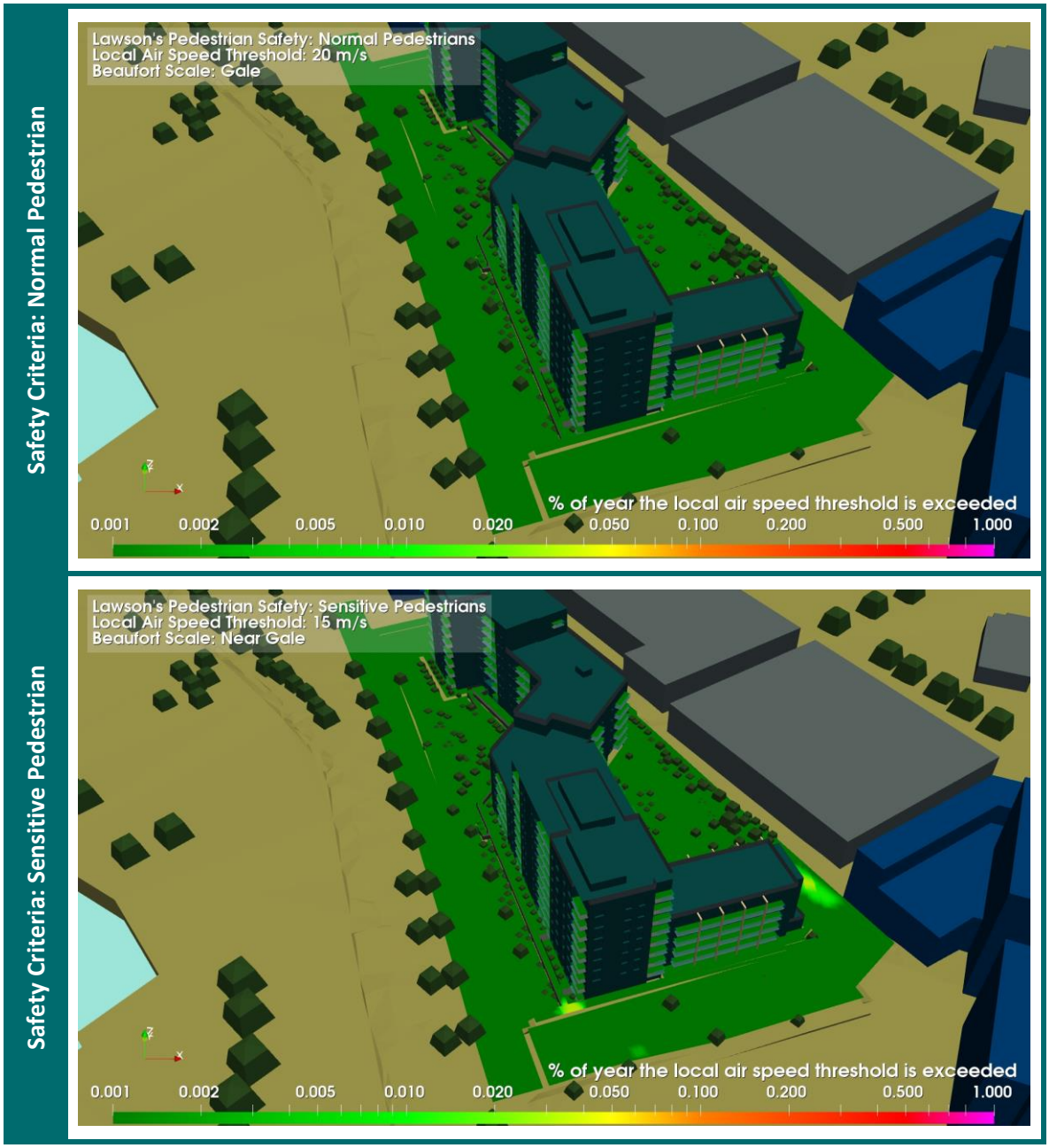

Figure 117: Safety Criteria: All Season: Phase 1: View from the south

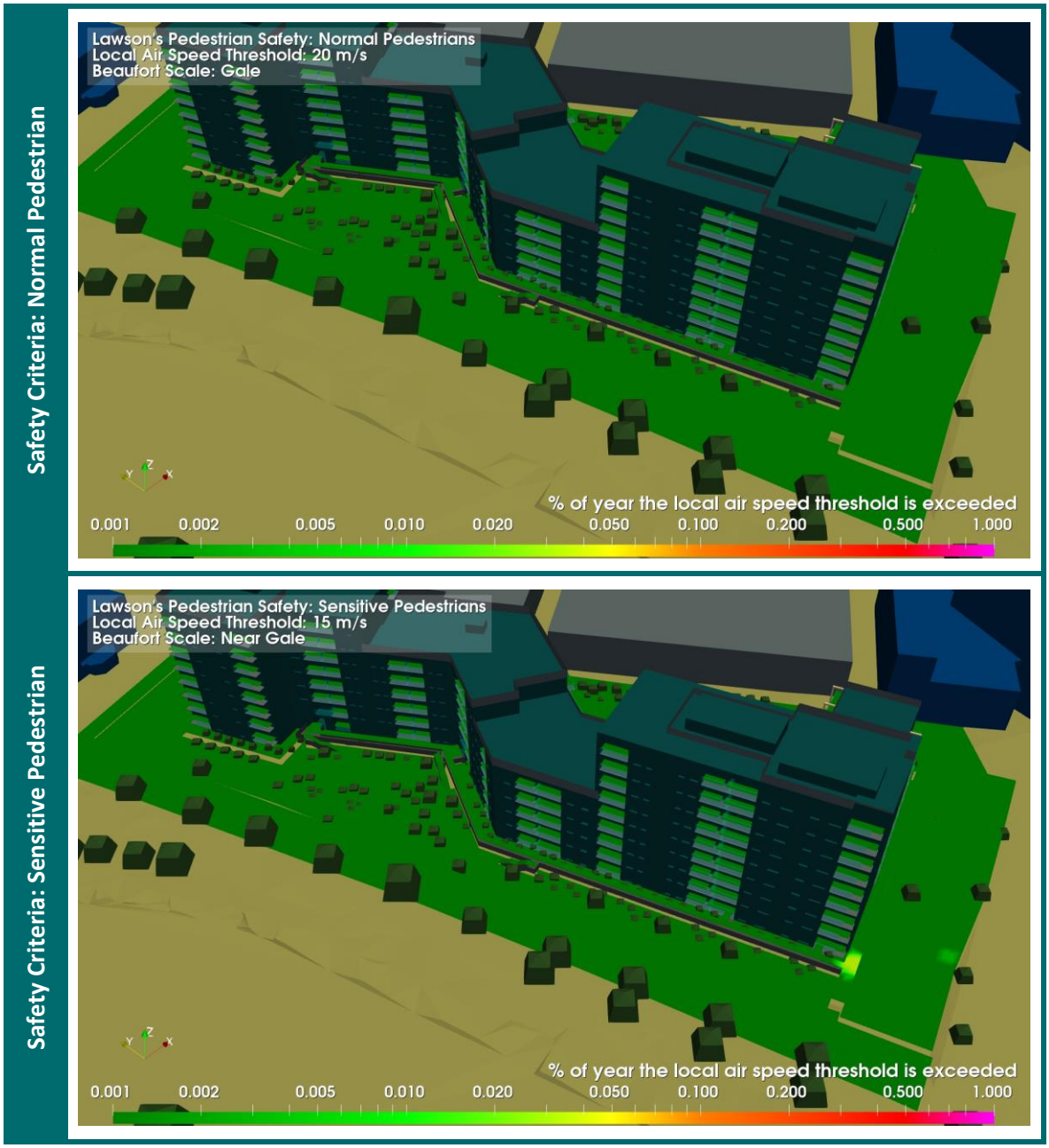

Figure 118: Safety Criteria: All Season: Phase 1: View from the southwest

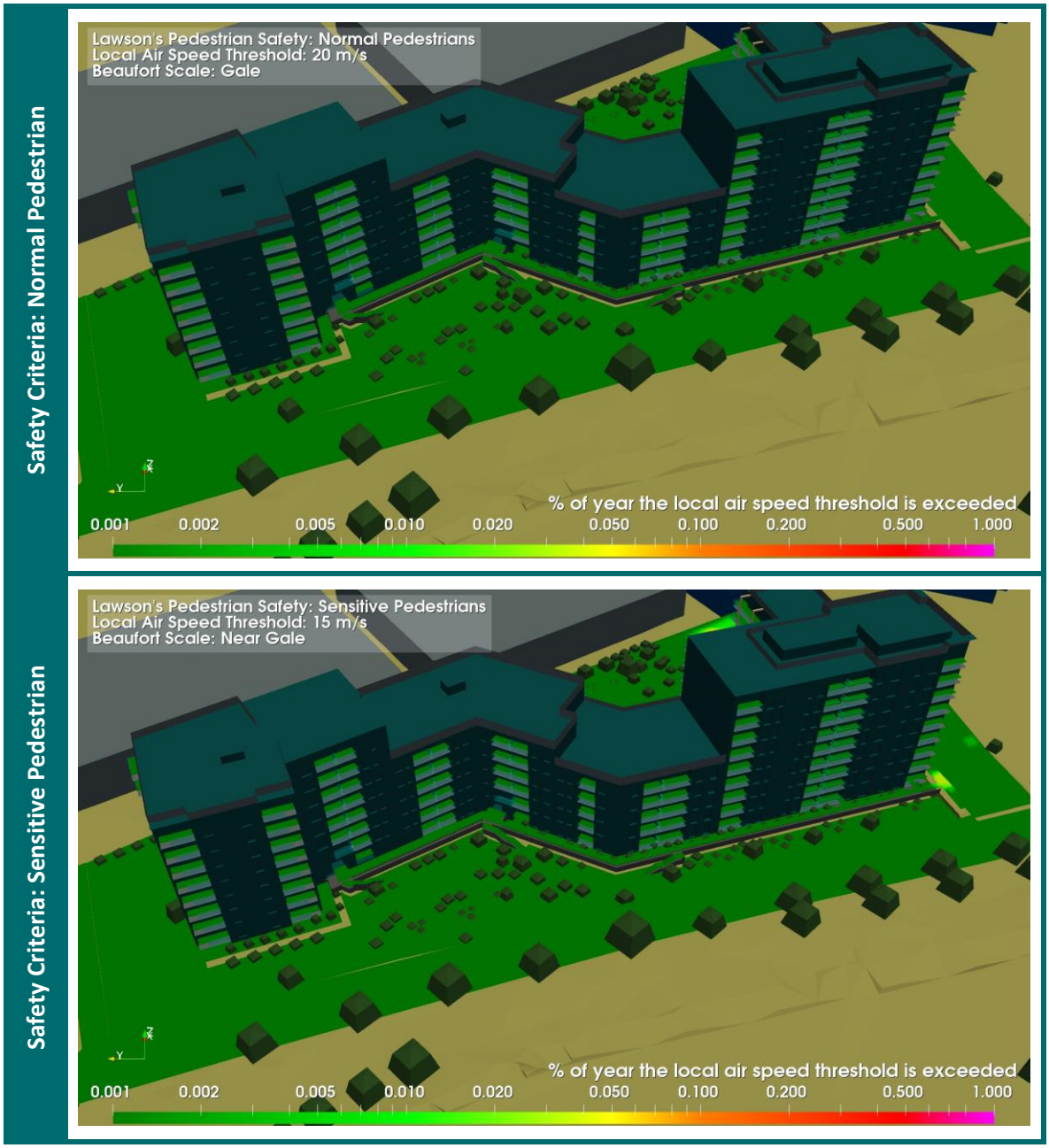

Figure 119: Safety Criteria: All Season: Phase 1: View from the west

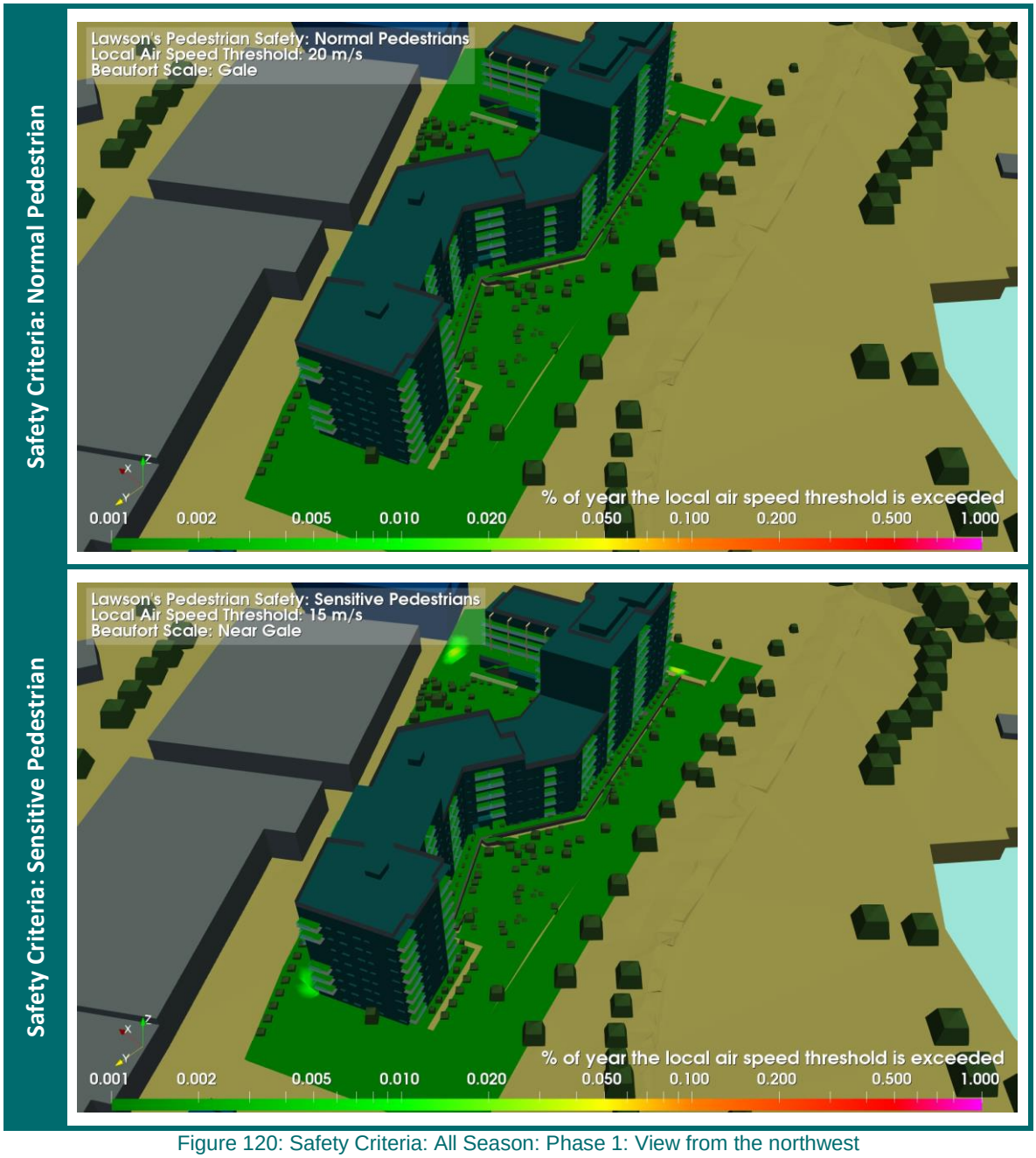

Figure 120: Safety Criteria: All Season: Phase 1: View from the northwest

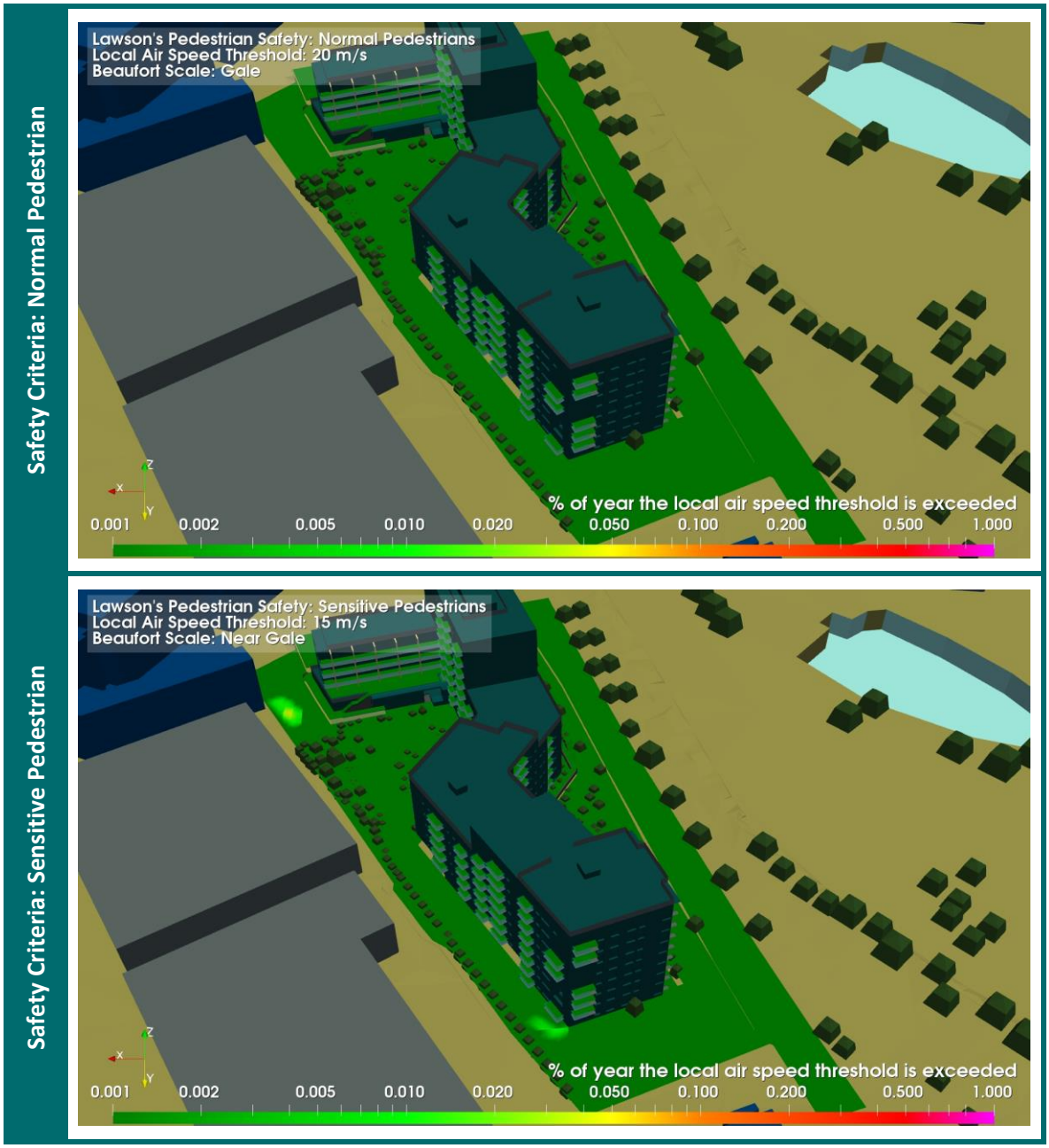

Figure 121: Safety Criteria: All Season: Phase 1: View from the north

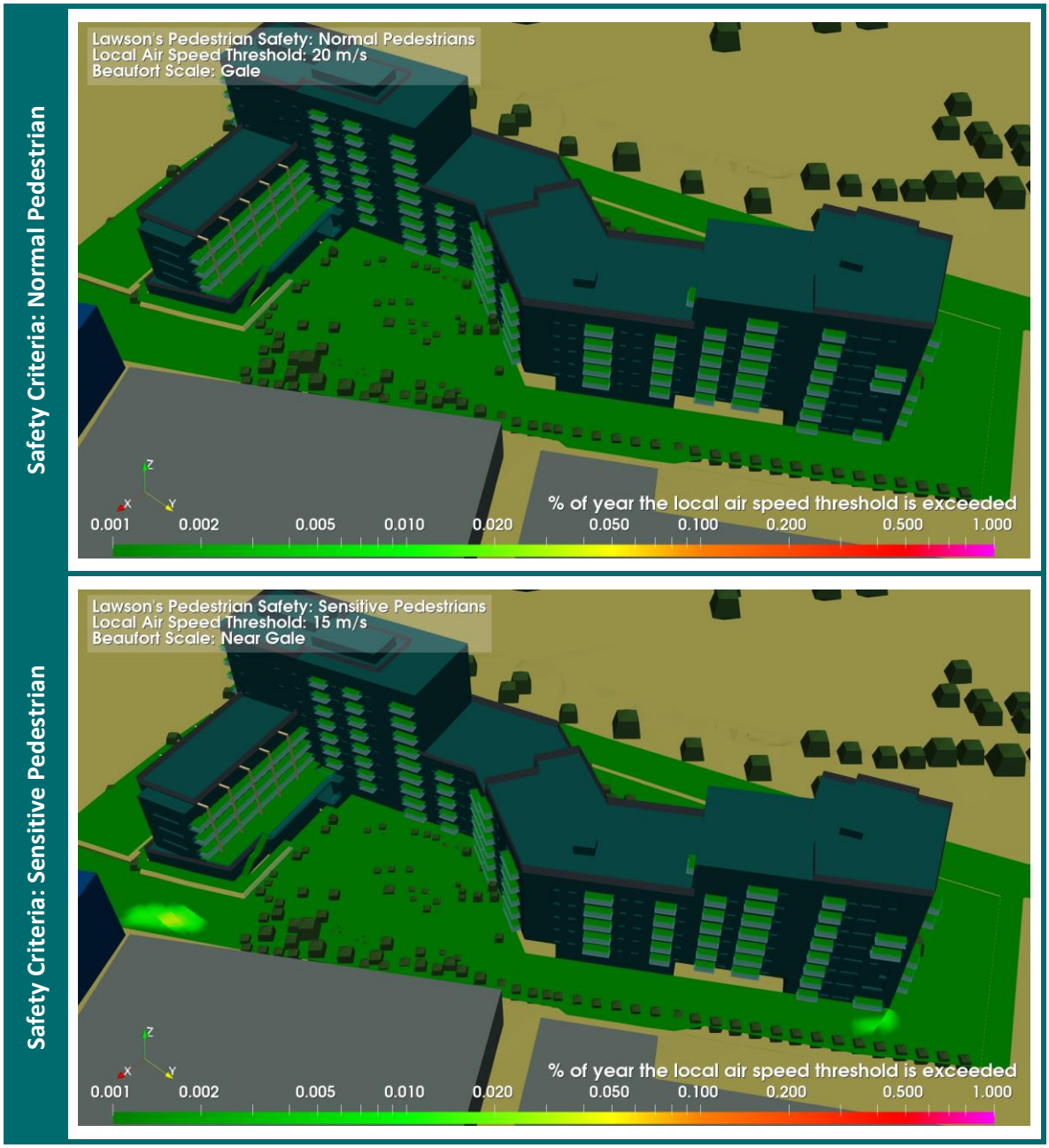

Figure 122: Safety Criteria: All Season: Phase 1: View from the northeast

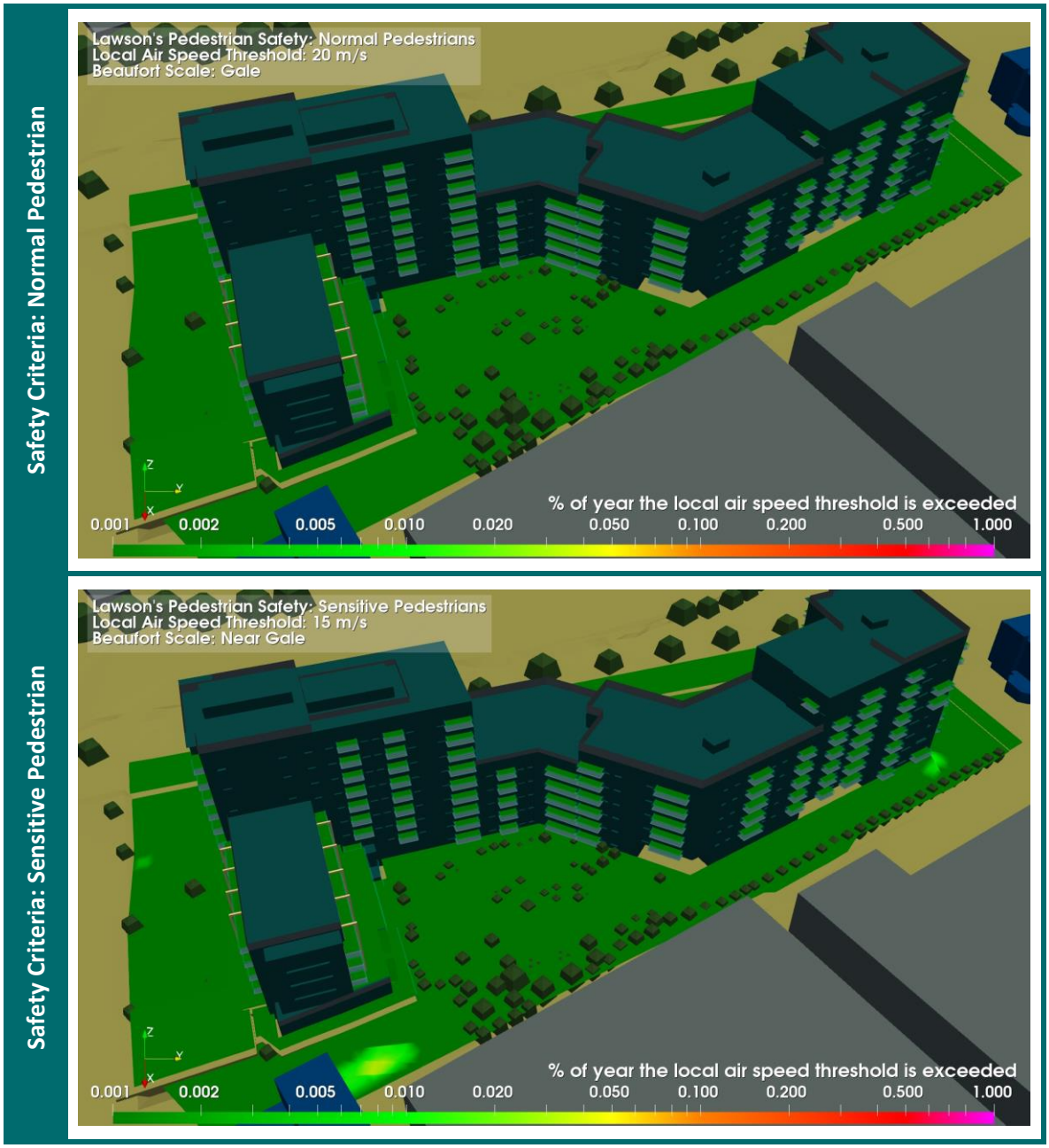

Figure 123: Safety Criteria: All Season: Phase 1: View from the east

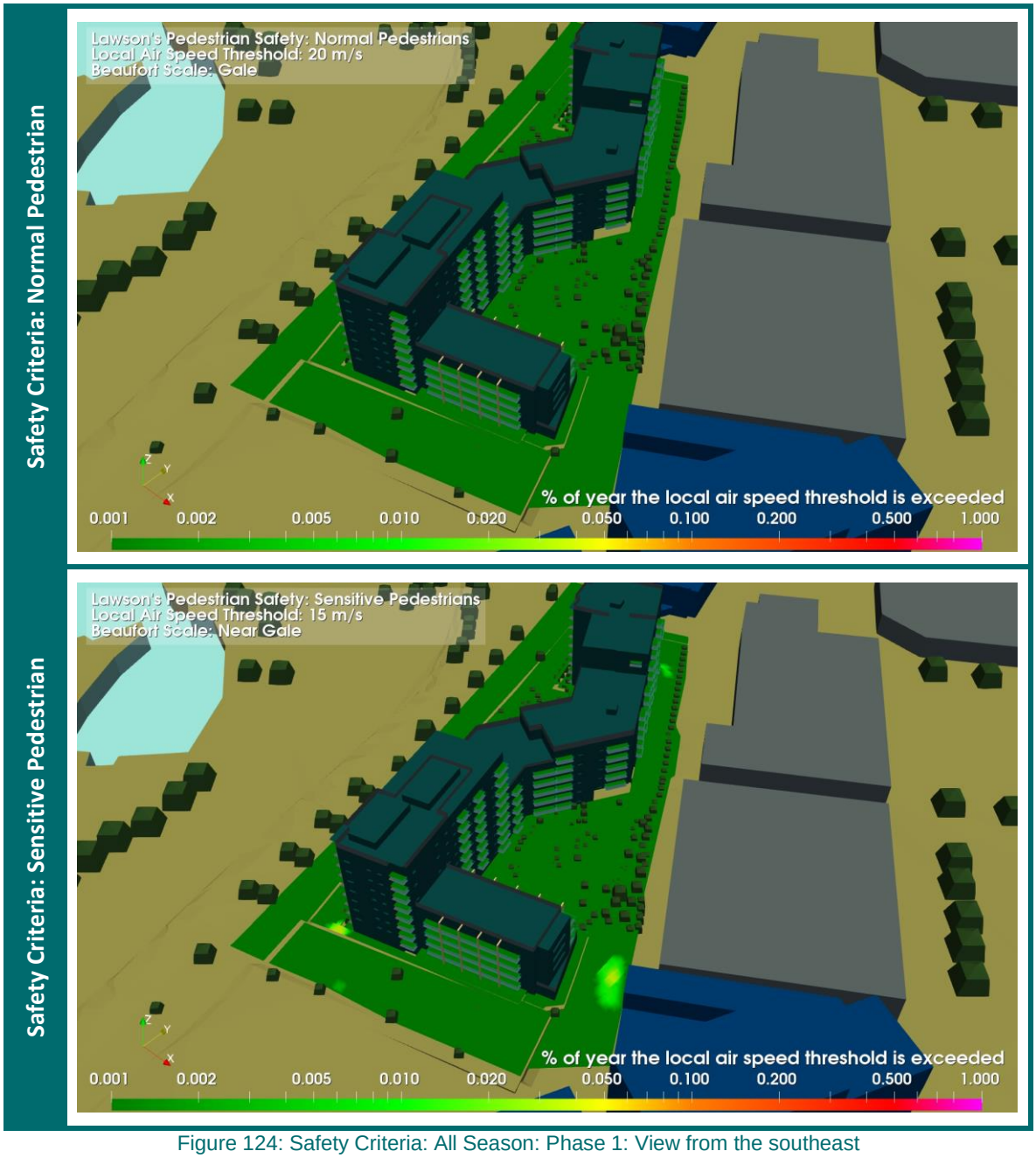

Figure 124: Safety Criteria: All Season: Phase 1: View from the southeast