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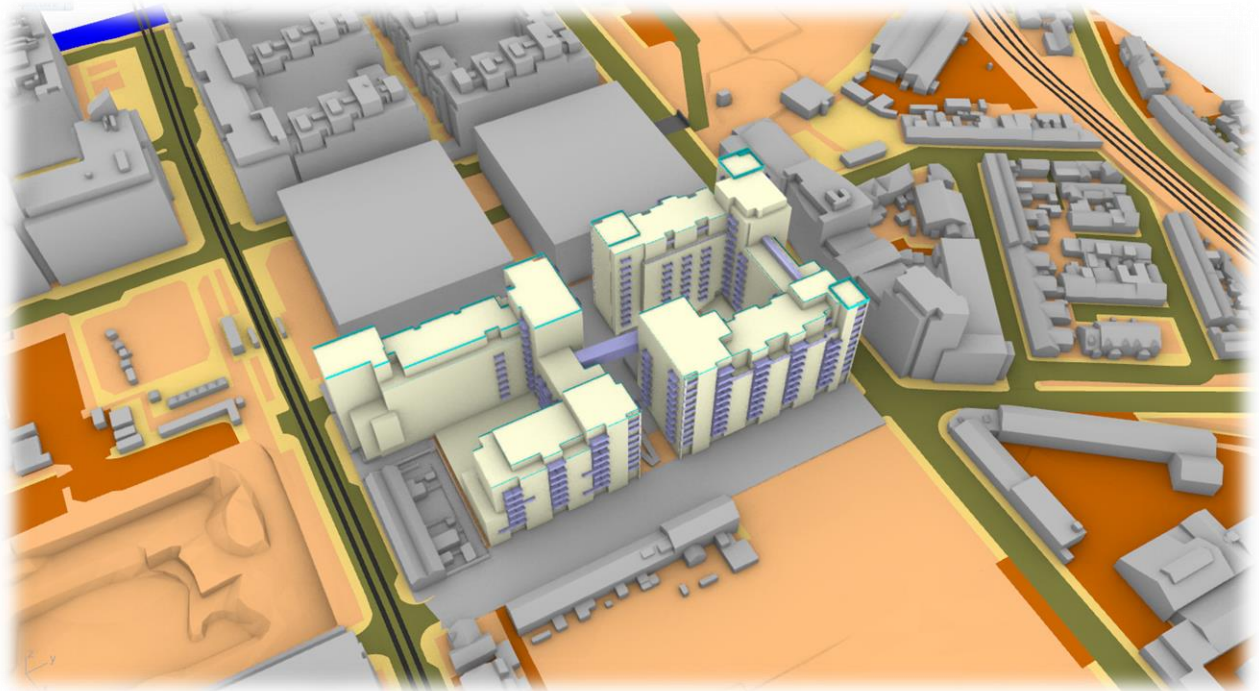
# Spencer Place North Wind CFD

## Pedestrian Comfort CFD Analysis

Report\_P3

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## 1 Executive Summary

The proposed development seeks revisions to the permitted Block 1 and 2 to provide for an increase in the number of residential units from 349 no. to 464 no. apartment units and the change of use of the permitted aparthotel development to Co-Living to provide for 84 no. co-living units (200 bed spaces). The proposed development will increase the height of the permitted development increasing the maximum height of Block 1 from 7 no. storeys to a maximum height of 13 no. storeys and increasing the maximum height of Block 2 to 11 no. storeys.

The proposed development will also include the provision of a link bridge between Block 1 and Block 2 at 6<sup>th</sup> floor level, revised landscaping, the provision of communal open space, revised undercroft level, provision of roof terraces and all other associated site development works to facilitate the development.

The following report explains the methodology to be used for performing the wind related comfort and safety assessment. The assessment will be used to identify if any locations in the development are unlikely to be subjected to adverse effects from wind.

For the analysis, 8 steady state CFD simulations were performed, one each for 8 wind directions – N, NE, E, SE, S, SW, W and NW. The wind speed was set to the annual average. The wind was assumed to have characteristics associated with wind flowing through a large city center. The results obtained from these 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 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 provides 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 <sup>2</sup> (m/s)
S1	Typical Pedestrian	20
S2	Sensitive Pedestrian	15

***Overall, we observe the site is compliant with the requirements of the Lawson's Wind Comfort and Safety criteria as noted before.***

## 1.1 Sitting Criterion

The podium levels of both blocks show excellent compliance with the sitting comfort criterion. This can be seen circled in blue in [Figure 29](#) and [Figure 30](#). These locations are shielded from the wind due to being surrounded on three sides by the buildings. ***These courtyards would provide a good environment for sitting and recreational activities.***

The balconies show good compliance with the sitting criteria as well. Some balconies on the north-west and south-west corner of block 1 show limited compliance. This is most likely due to their high location of the building, where the wind naturally will be faster than near the ground. ***For block 2, most than two thirds of the balconies demonstrate good to excellent compliance with the sitting criterion.***

For the roof spaces, the highest roof spaces show limited compliance with the sitting criterion requirements. Lower roof spaces show better compliance as they are shielded better than the highest spaces. The highest spaces are less shielded from the wind resulting in limited compliance.

The streets surrounding the blocks show only marginal compliance with sitting criterion in places but these locations are not intended for seating anyway.

## 1.2 Standing Criterion

The standing criterion results for Block 1 are seen in [Figure 31](#). Most locations in this block show good to excellent compliance for standing criterion requirements. There is limited compliance observed only on the highest roof of the buildings. This is likely due to exposure to the highest wind speeds due to height of the location. This can be easily remedied with 1.2 to 2m high glass screens.

Similarly, standing criterion results can be observed for Block 2 in [Figure 32](#). This block also shows good to excellent compliance with standing criterion results at all locations: roof, balconies and the podium at lower level.

The streets around the site also show good compliance with the standing criterion. So the pedestrian coming in and out of the buildings will not be too inconvenienced while accessing the buildings.

***Overall, the site demonstrates good compliance with the standing criteria requirements everywhere.***

## 1.3 Walking Criteria

The leisure walking criteria results are observed in [section 7.3](#) and business walking results in [section 7.4](#).

***Both sections demonstrate the site shows generally good compliance with the walking criteria. Pedestrians traversing the site to access the buildings or passing through will not be affected by the development.***

## 1.4 Safety Criteria

As observed in [section 7.5](#) and [section 7.6](#), ***the site shows excellent compliance with the safety criteria.***



## 2 Introduction

IES Consulting have been commissioned to investigate the potential impact of wind movement on pedestrian comfort around the proposed development near Spencer Place North, City Block 2, Spencer Dock, Dublin 1.

The analysis is to be performed to study the effect from building layout on pedestrian comfort for people using public amenity spaces around the site.

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

### 3 Weather Data

The analysis is based on the 'Dublin\_TMY5.epw' weather file. The variation of wind speed recorded in the weather file is shown in Figure 1 below. Figure 2 shows the wind direction variation and Figure 3 shows the wind rose.

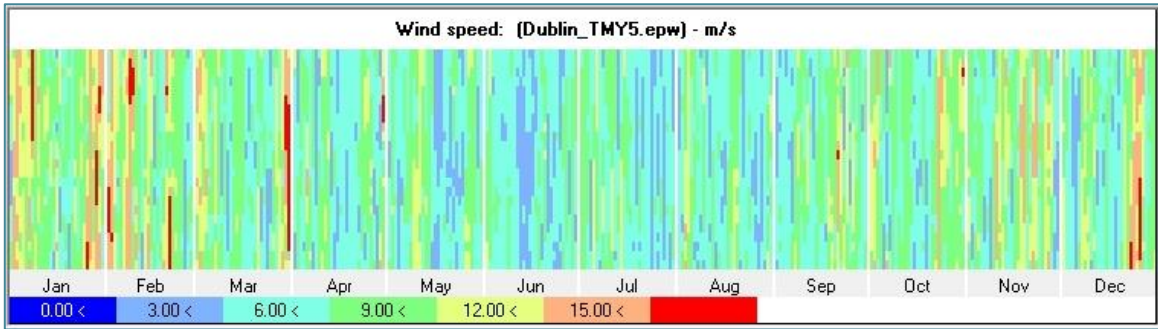


Figure 1: Wind speed variation as per Dublin\_TMY5.epw

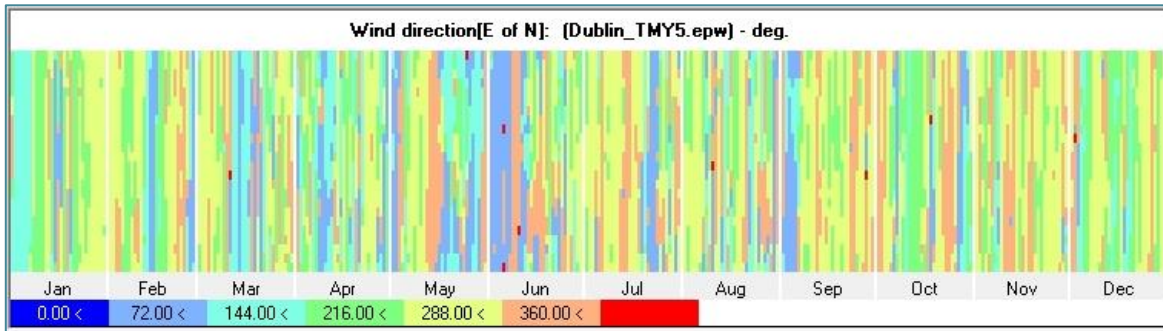


Figure 2: Wind direction variation as per Dublin\_TMY5.epw

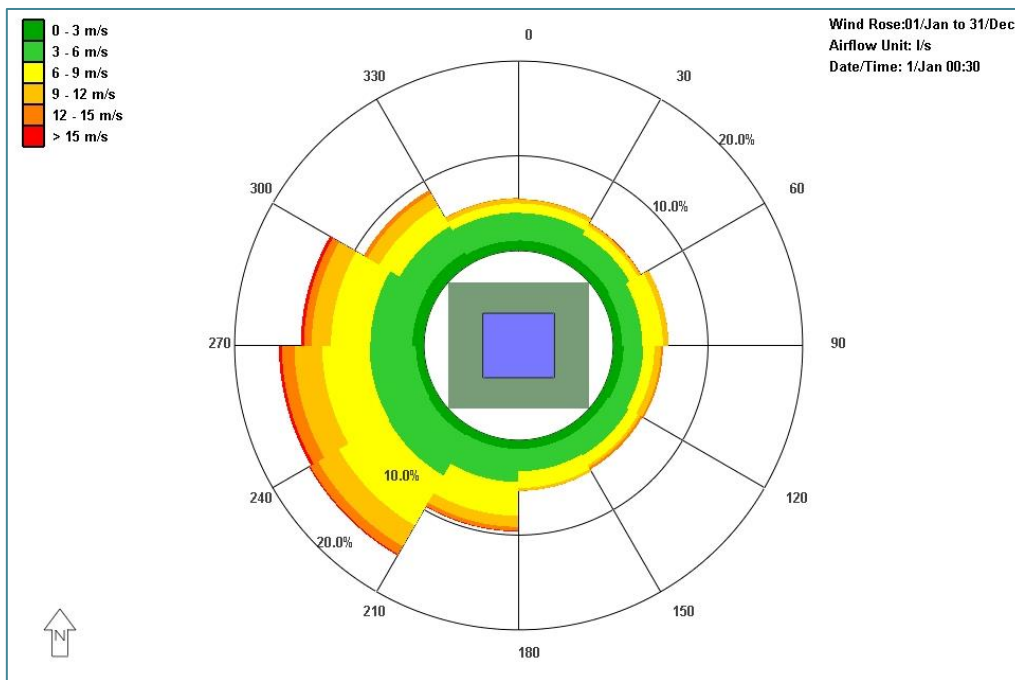


Figure 3: Wind rose as per Dublin\_TMY5.epw

Based on this, the mean wind speed recorded was **6.4m/s** with a westerly prevailing direction.

## 4 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 4.

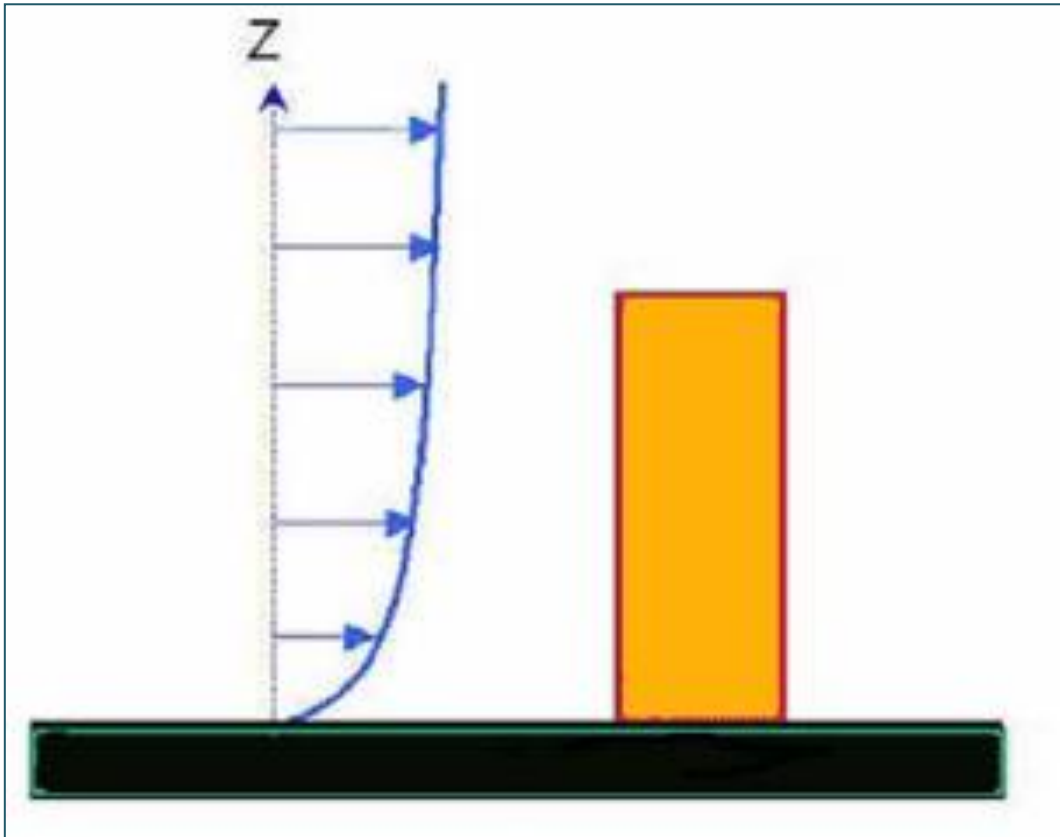


Figure 4: Typical velocity profile of an atmospheric boundary layer

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  $U_H$  at height  $H$  above the ground is given by:

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

Where,

- $a$  = Exponent in power law wind speed profile for local building terrain
- $\delta$  = fully developed strong wind atmospheric boundary layer thickness (m)
- $a_{met}$  = Exponent for the meteorological station
- $\delta_{met}$  = 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)

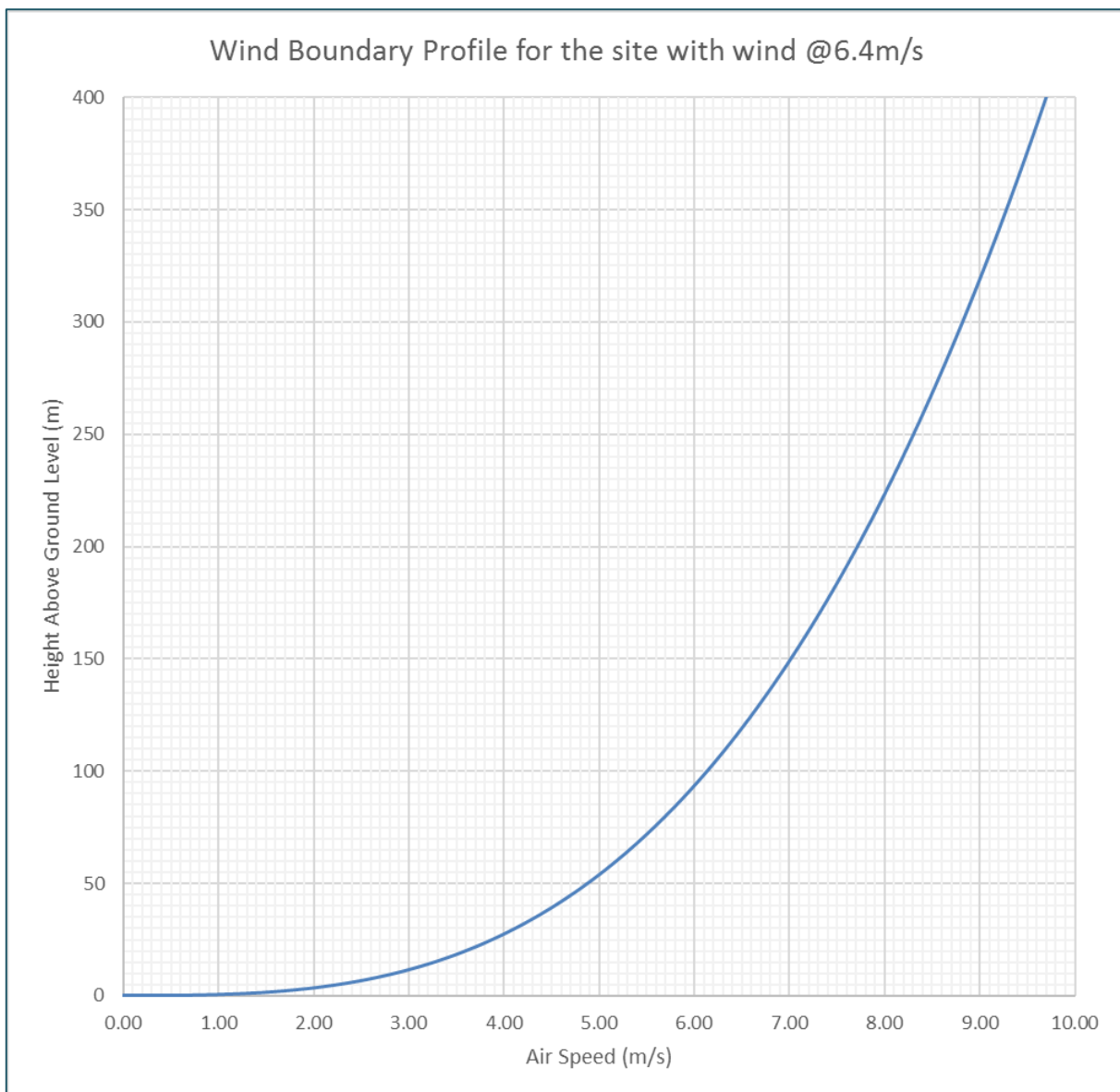
The parameters for different types of terrain are given as in table 1.



**Table 1: Atmospheric boundary layer parameters**

Terrain Category	Description	a	$\delta$
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 1 i.e. large city centres type of site. The met data was taken on category 3 terrain at a height of 10m. Figure 5 below shows the shape of the wind boundary profile.

**Figure 5: Wind boundary profile for the CFD simulations using annual average wind speed**

## 5 Analysis Methodology

The methodology for the analysis was as follows:

- 1) The annual mean wind speed was determined from the weather file described earlier in [section 2](#).
- 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.

### 5.1 Lawson Pedestrian Comfort/Safety Criteria

The Lawson Criteria<sup>1</sup> 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 assesses 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.

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

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 <sup>2</sup> (m/s)
S1	Typical Pedestrian	20
S2	Sensitive Pedestrian	15

<sup>1</sup>T. V. Lawson (2001) *Building Aerodynamics*, Imperial College Press, London.

<sup>2</sup>Once per annum means the safety threshold is not be exceeded 0.01% of the year.

## 6 CFD Model

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

### 6.1 Model Geometry

Figures 6 to 20 show the geometry as modelled.

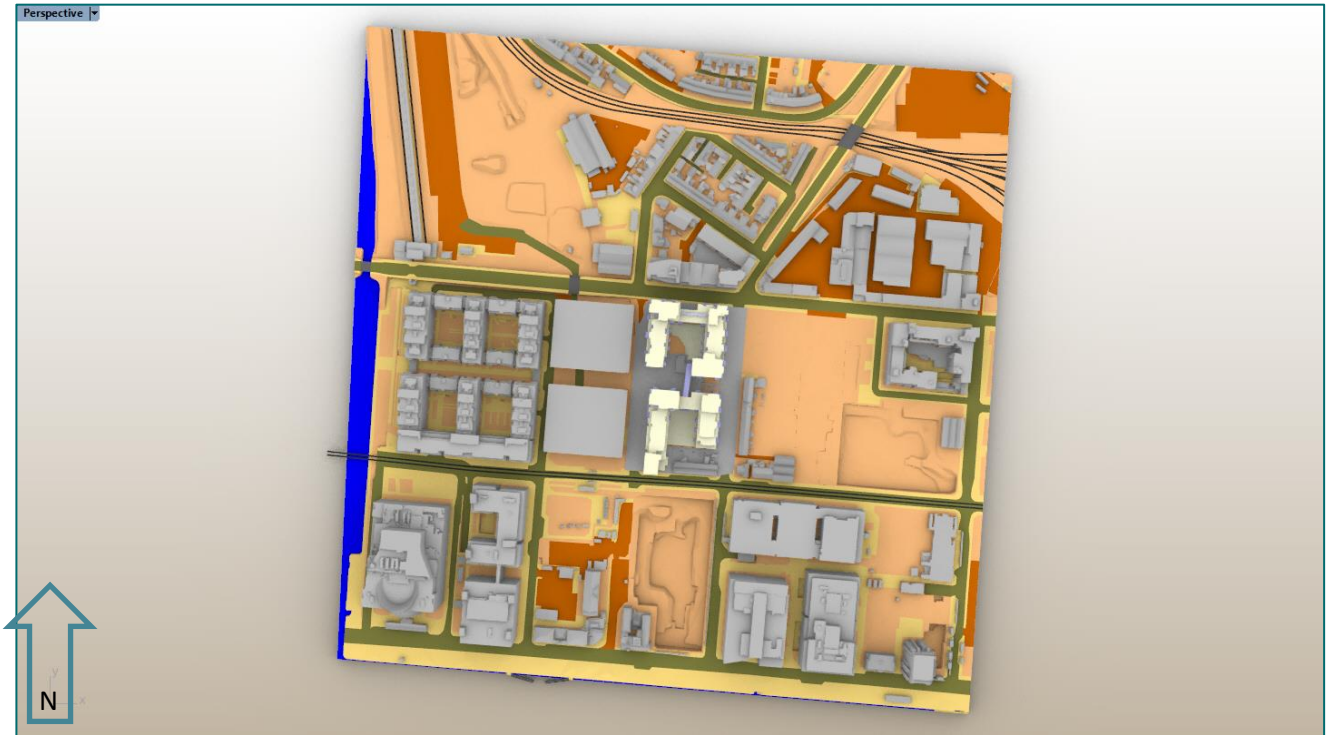


Figure 6: Plan view of the site

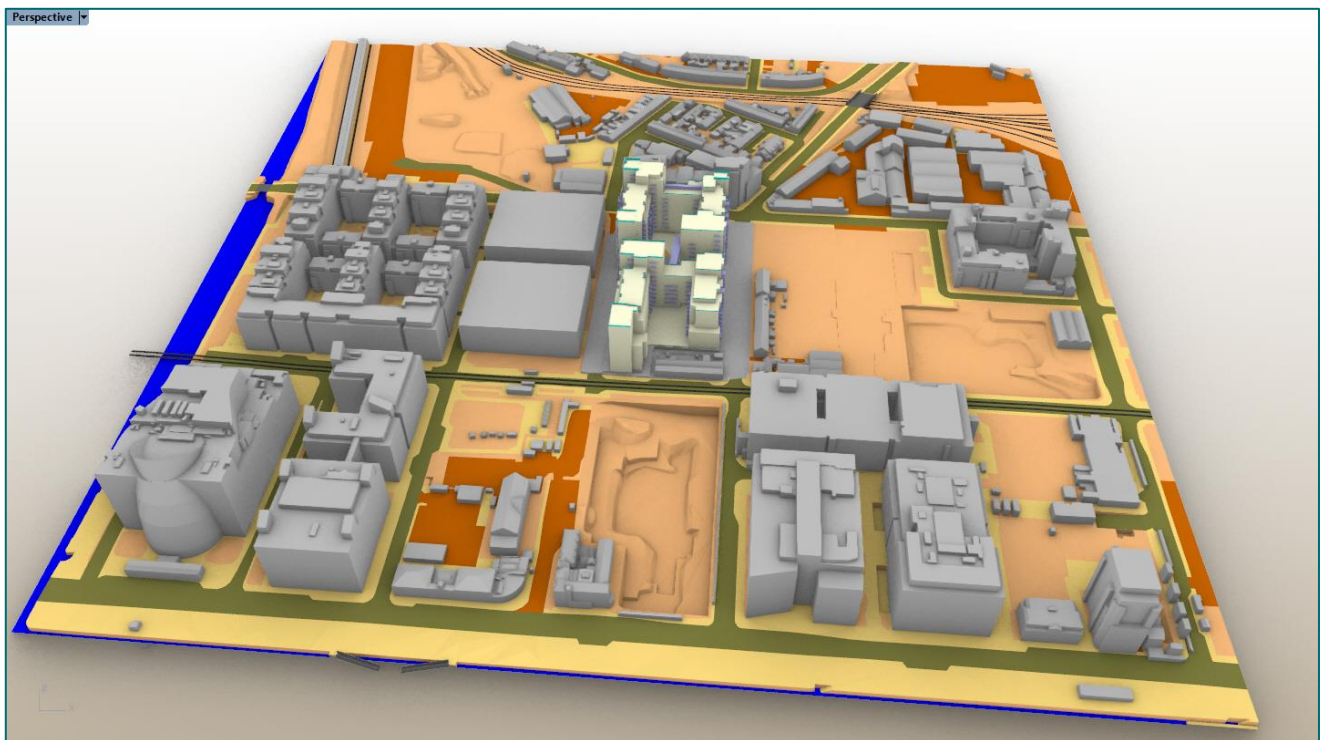


Figure 7: View of the site from the south

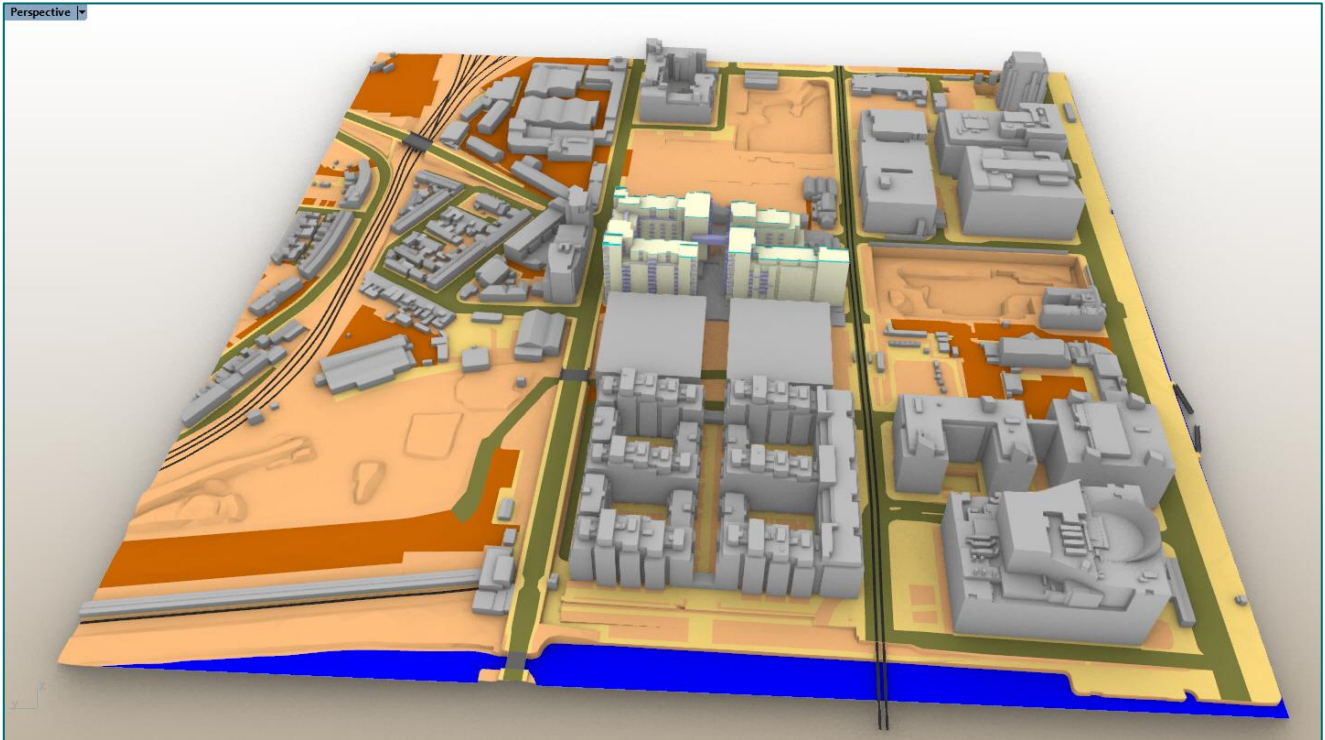


Figure 8: View of the site from the west

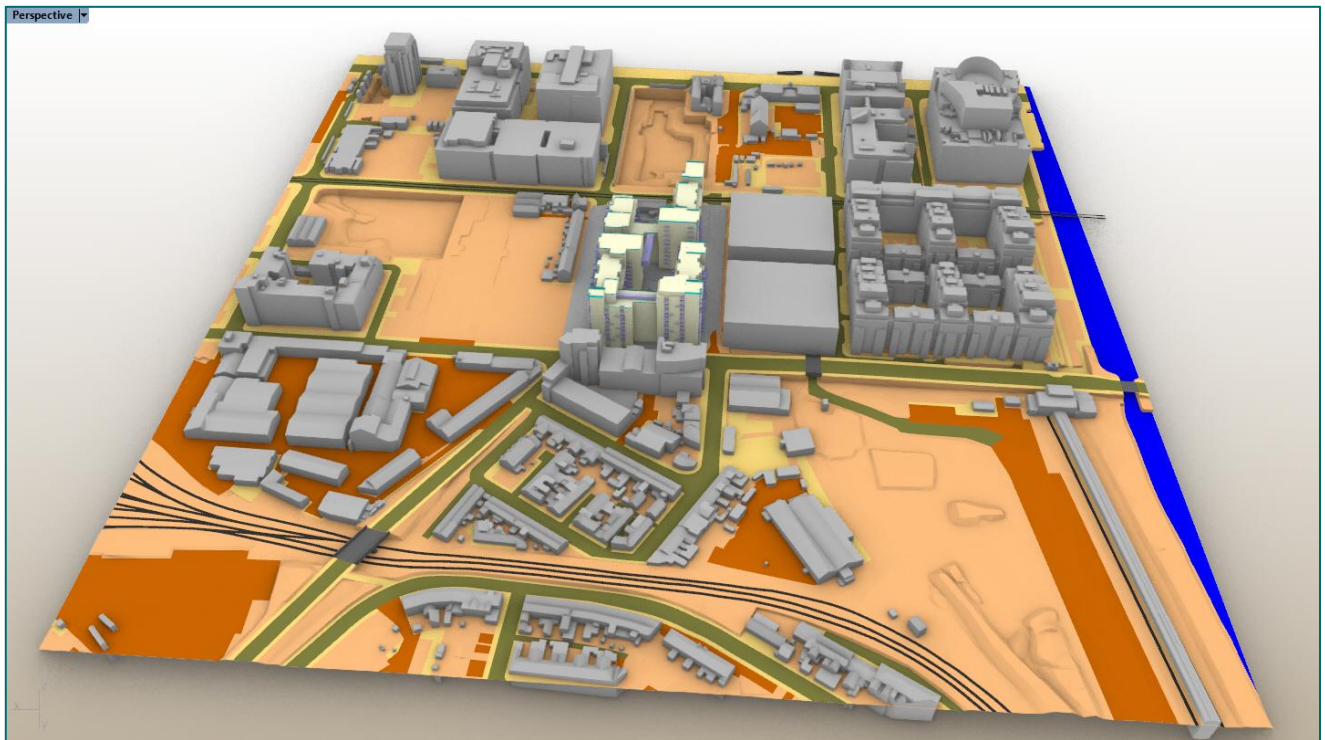


Figure 9: View of the site from the north

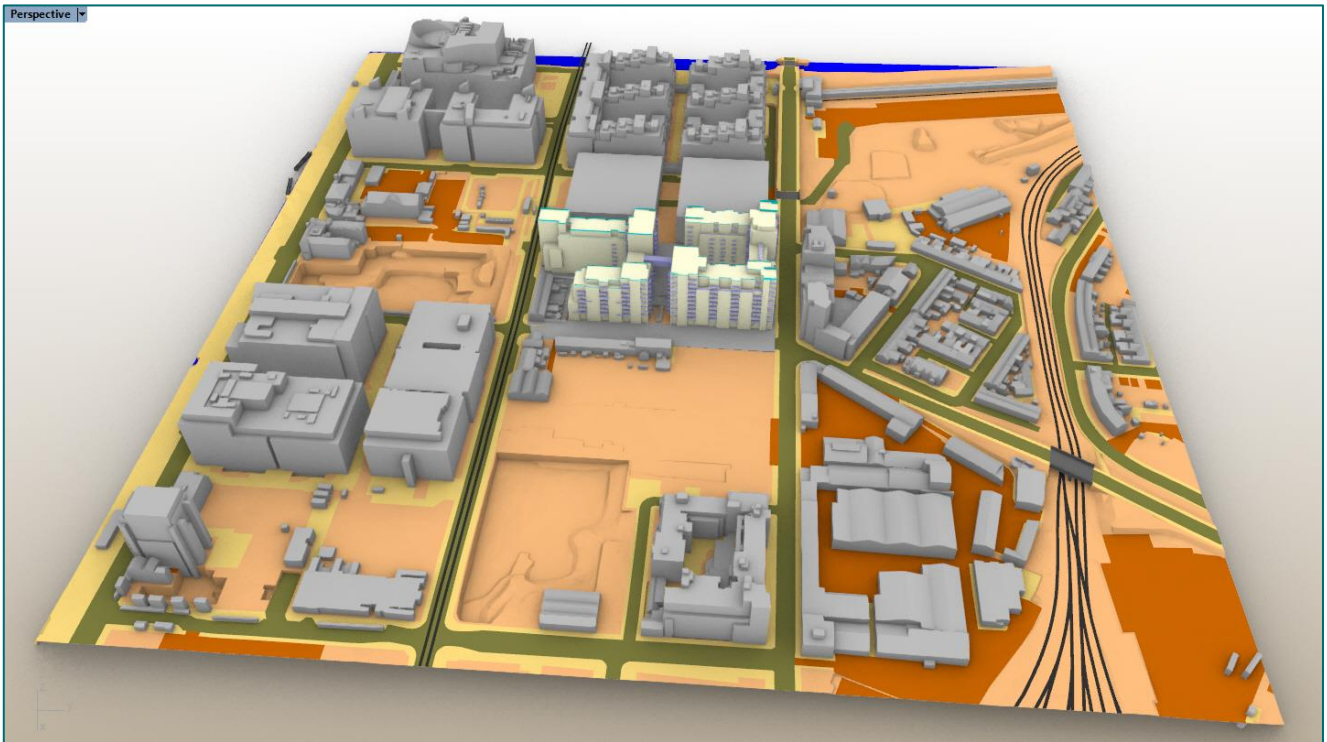


Figure 10: View of the site from the east

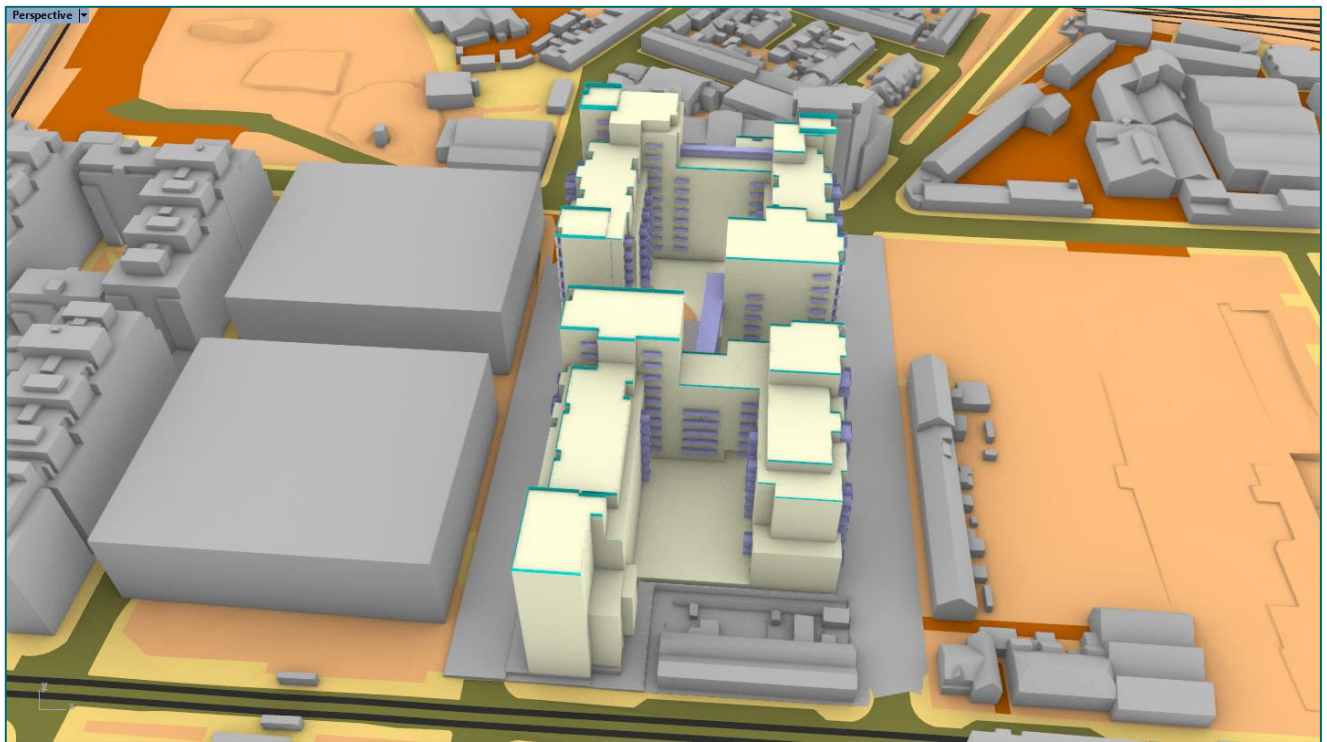


Figure 11: Closer view of buildings from the south

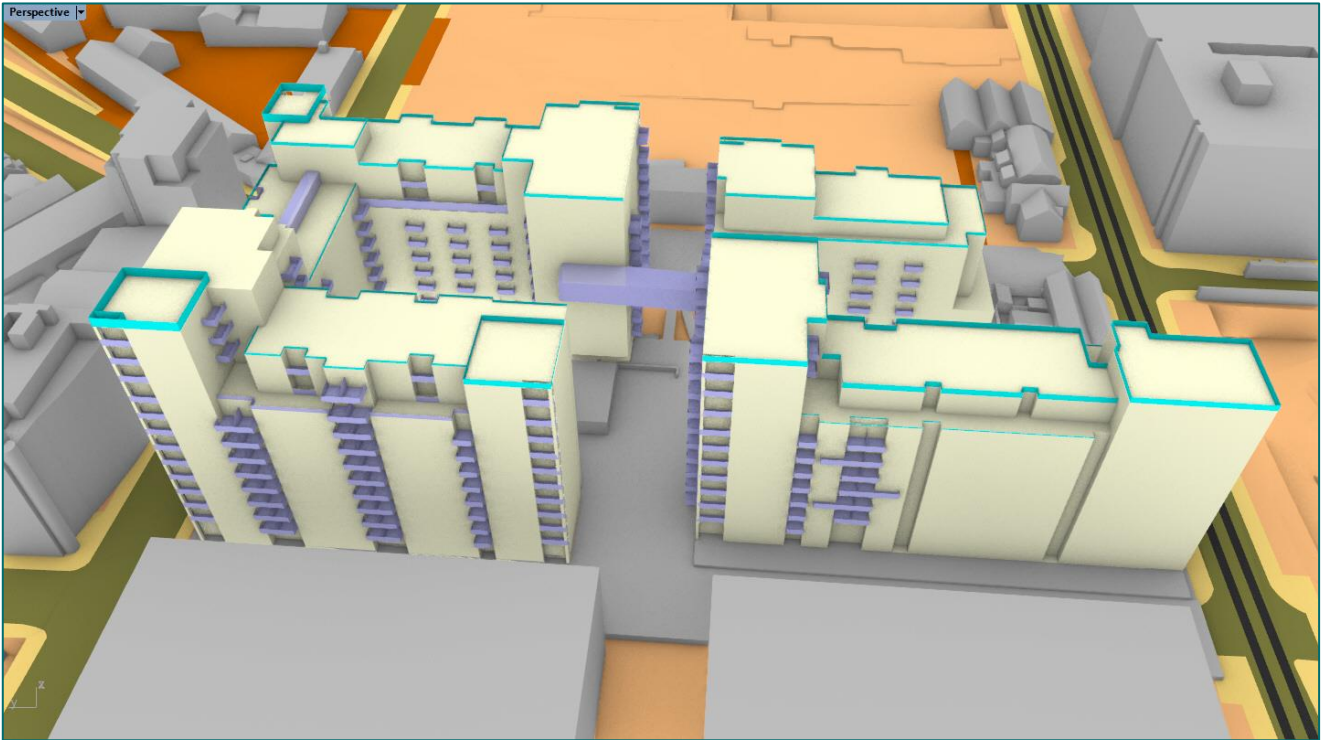


Figure 12: Closer view of buildings from the west

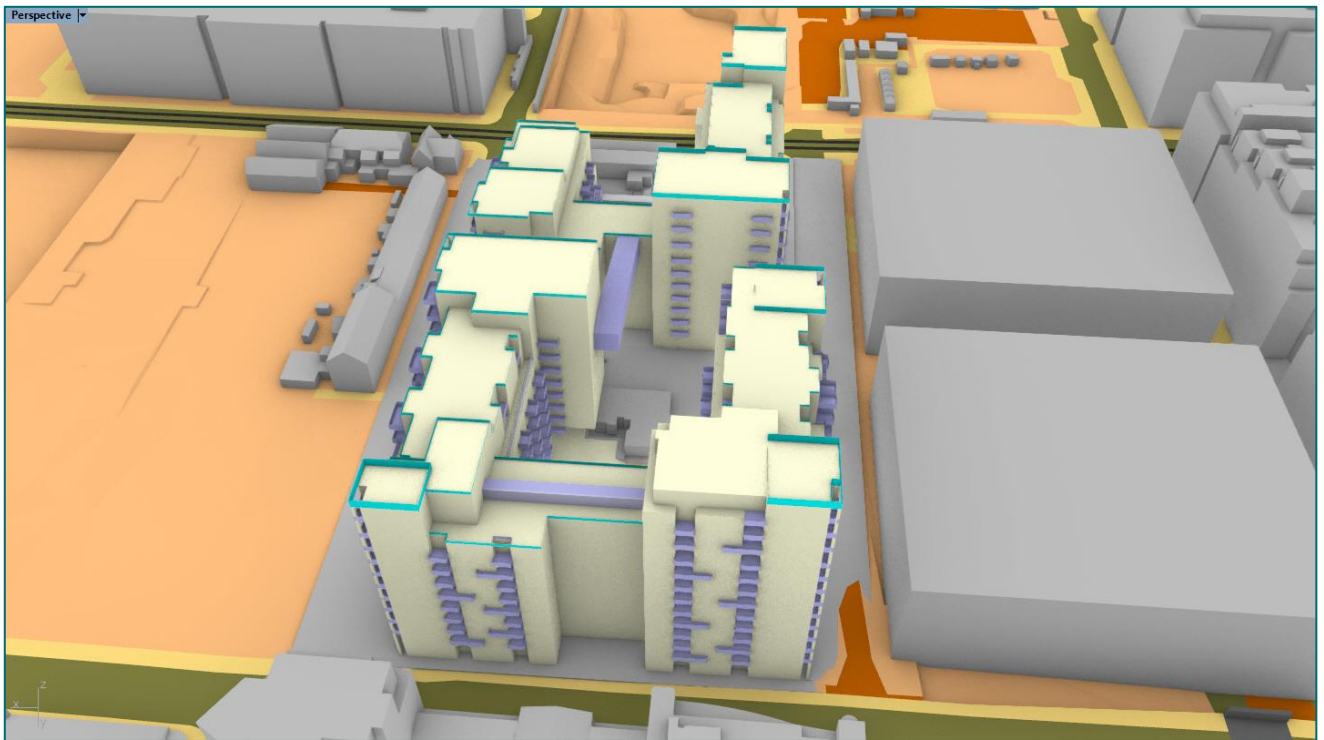


Figure 13: Closer view of buildings from the north

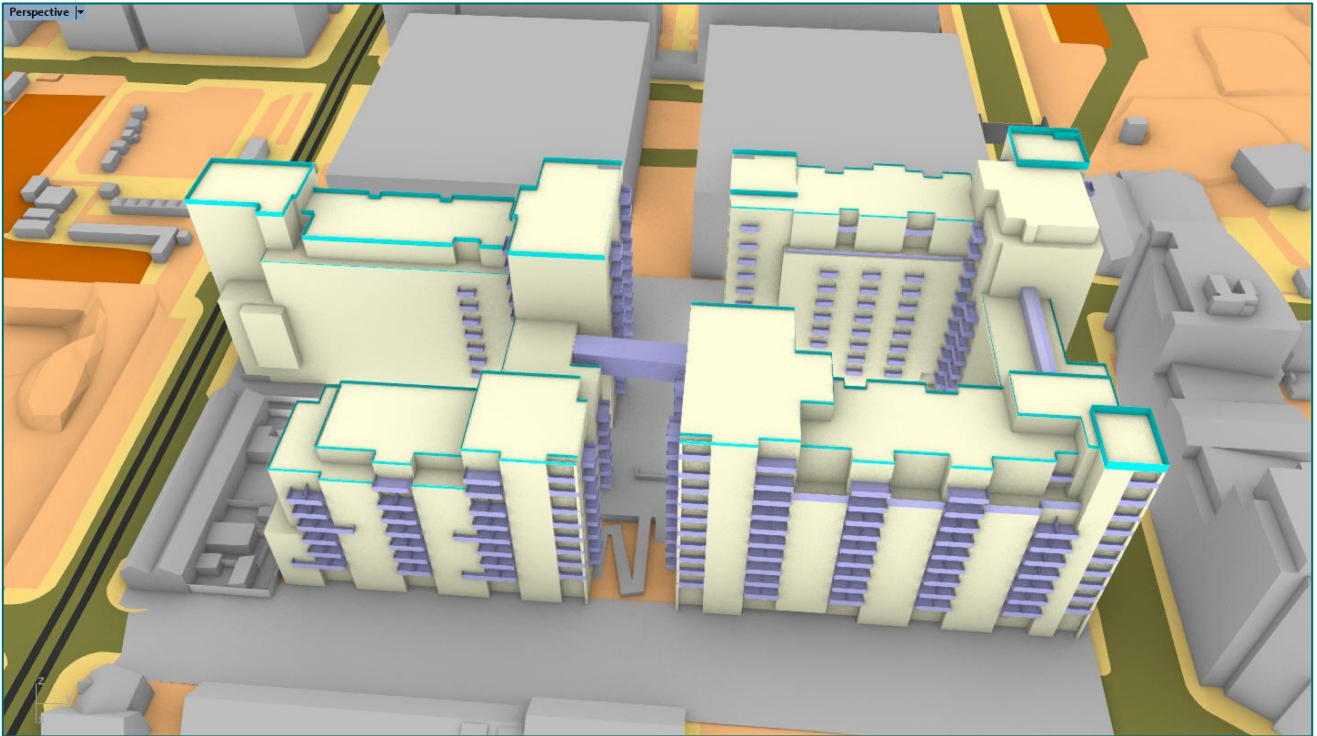


Figure 14: Closer view of buildings from the east

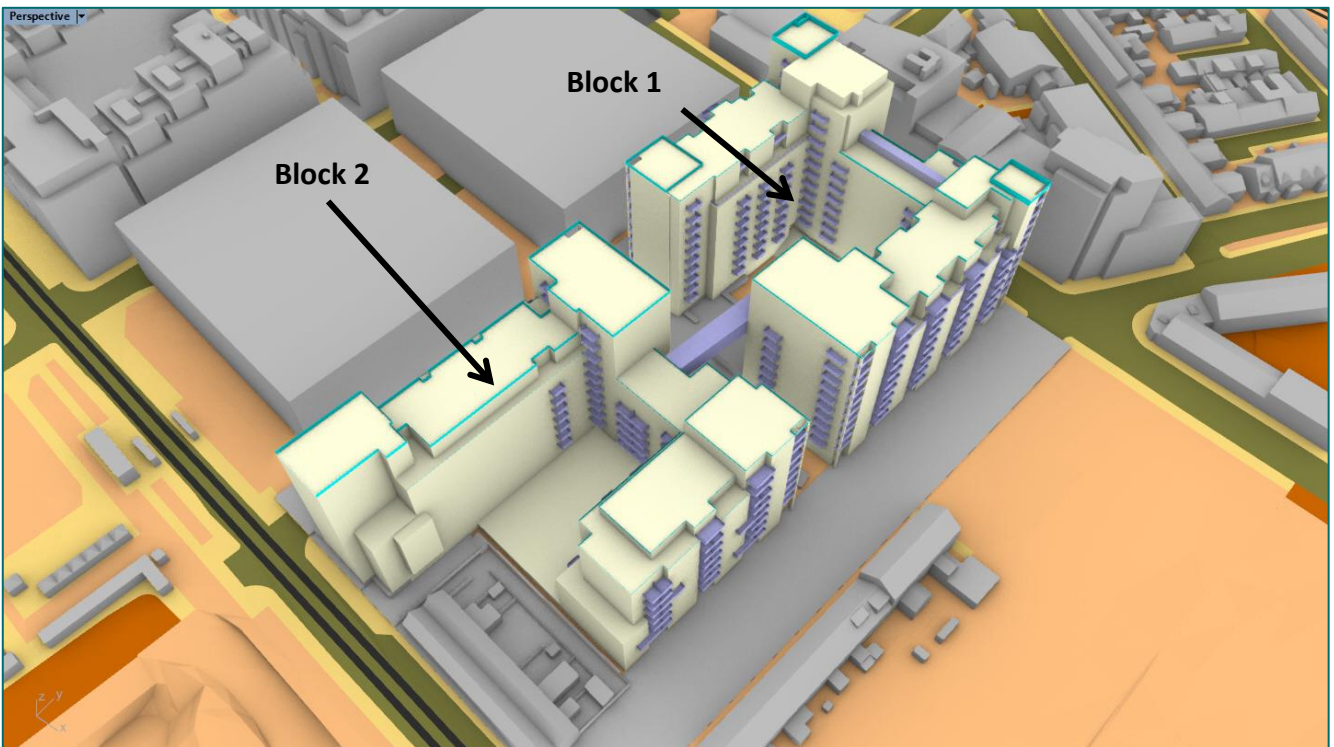


Figure 15: View of the building blocks

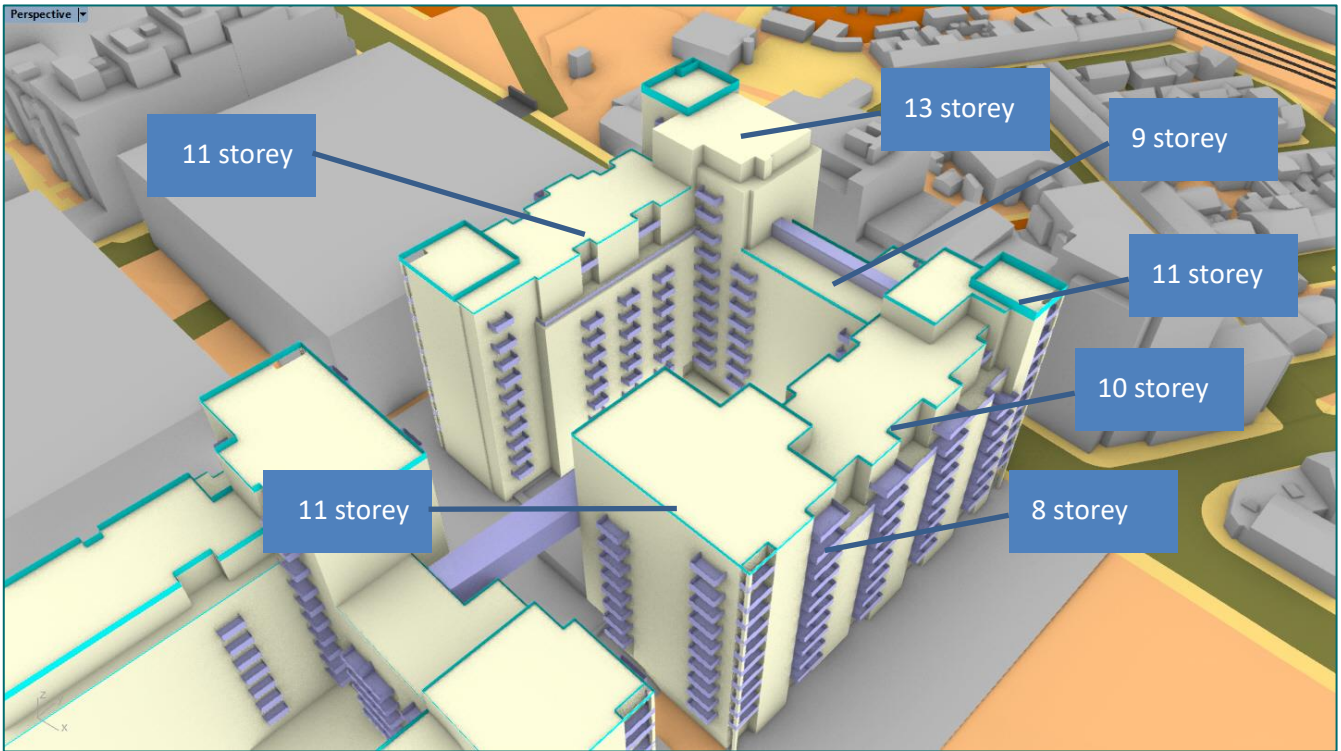


Figure 16: View of the building block 1



Figure 17: Another view of the building block 1



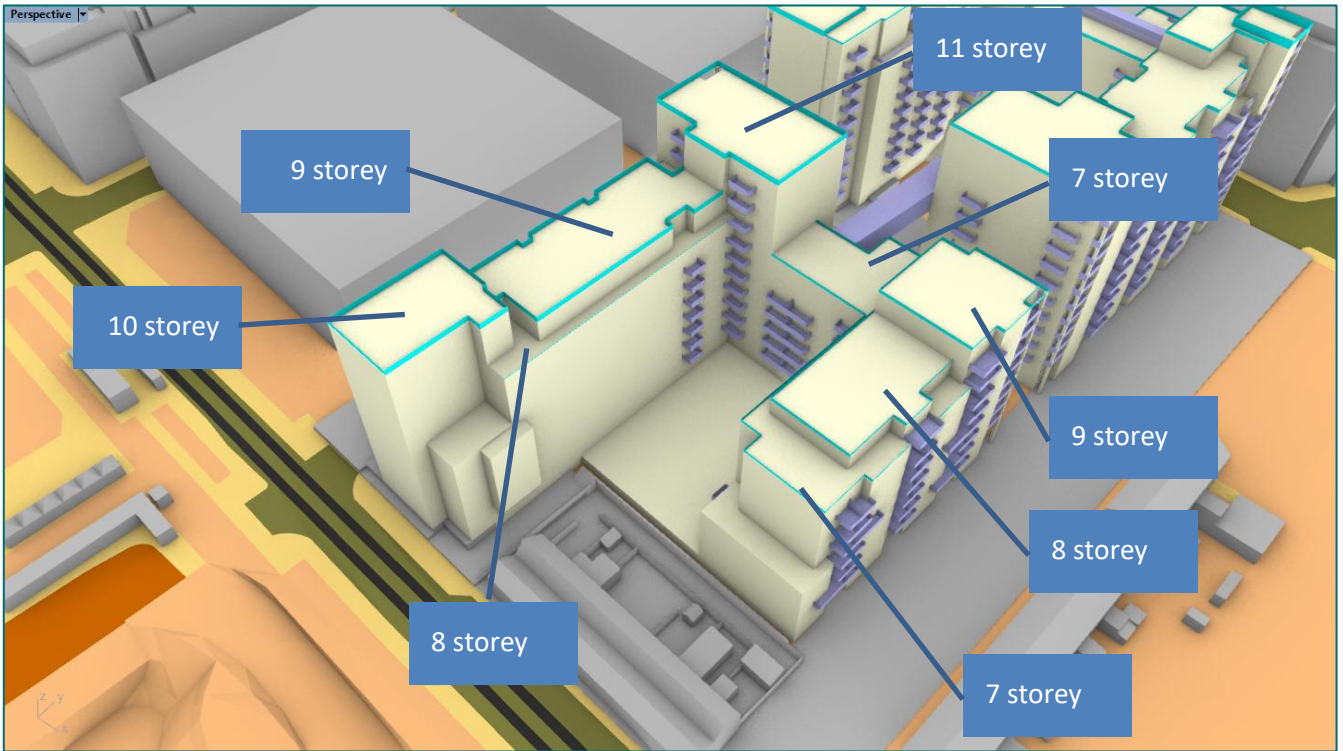


Figure 18: View of the building block 2

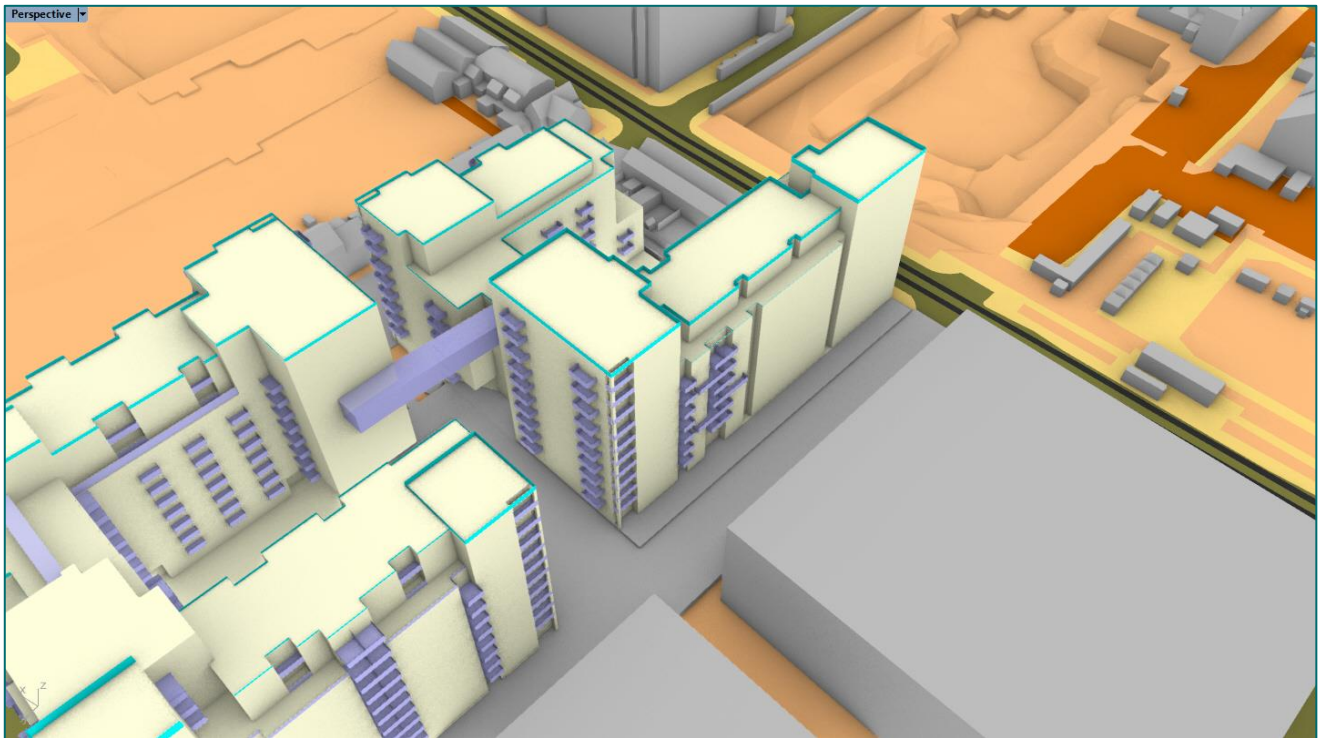


Figure 19: Another view of the building block 2

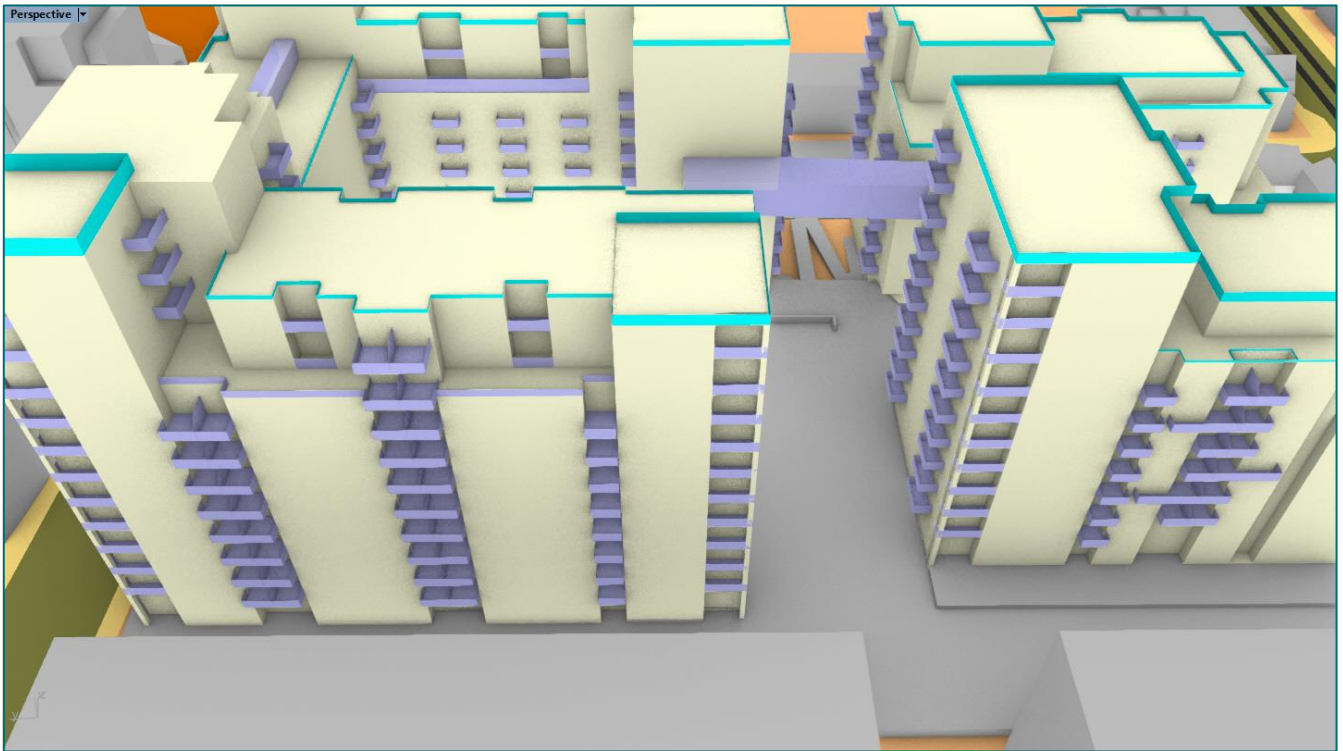


Figure 20: View of the balconies

## 6.2 Reportage Locations

Figures 21 to 28 below show the different locations where pedestrian comfort parameters will be reported coloured in blue.

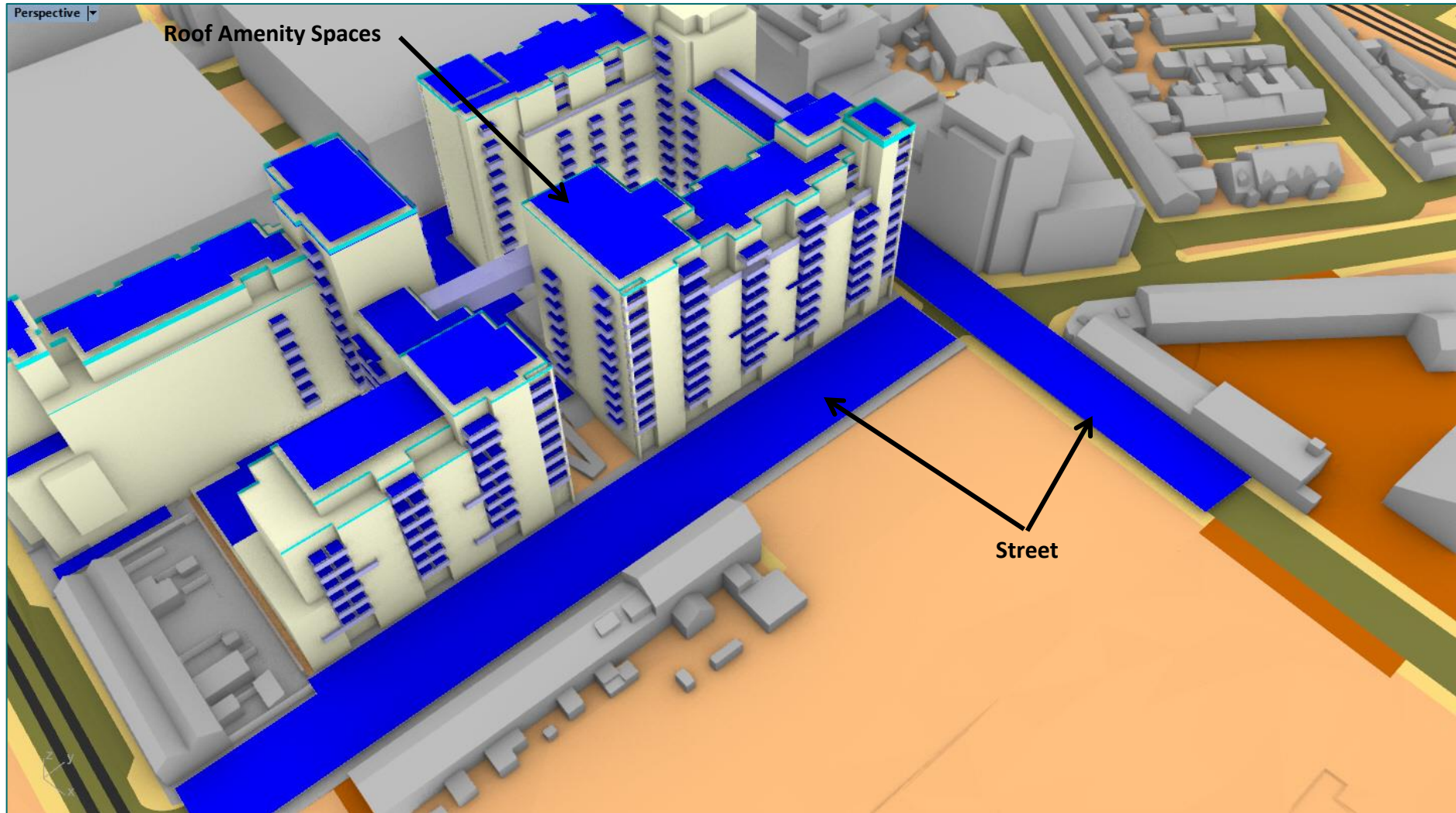


Figure 21: Reportage Locations: Seen from south-east

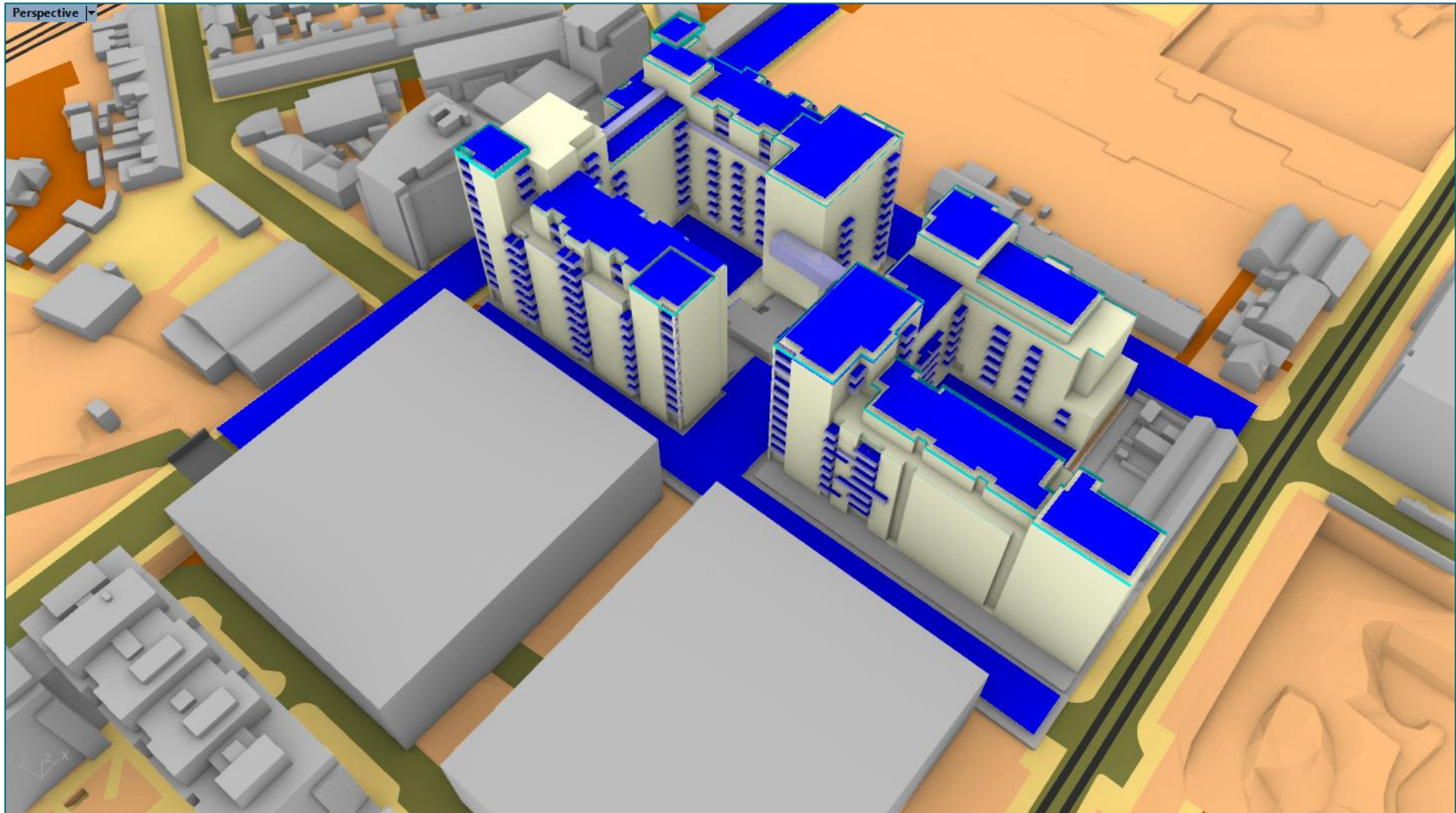


Figure 22: Reporting Locations: Seen from south-west

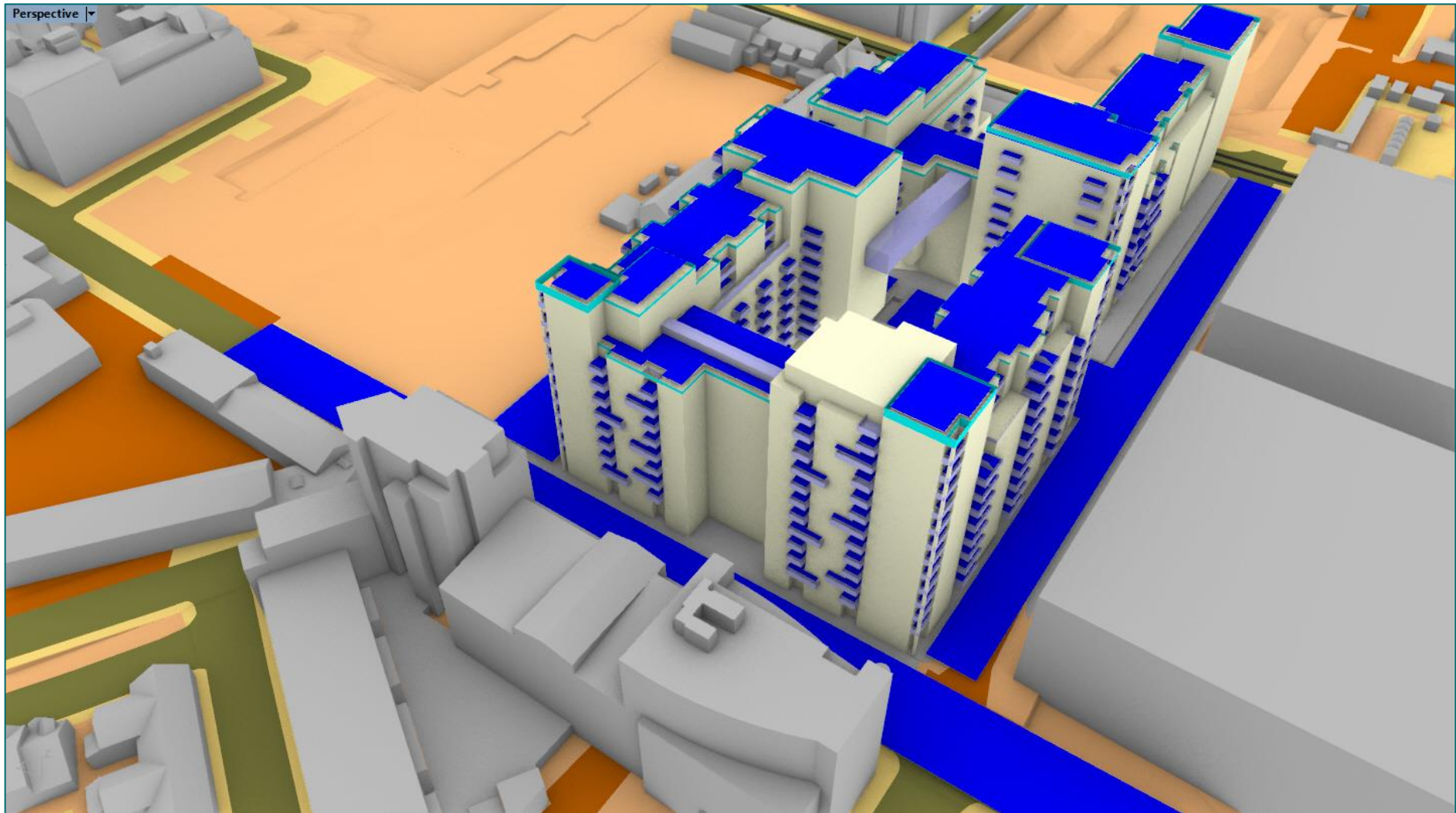


Figure 23: Reporting Locations: Seen from north-west

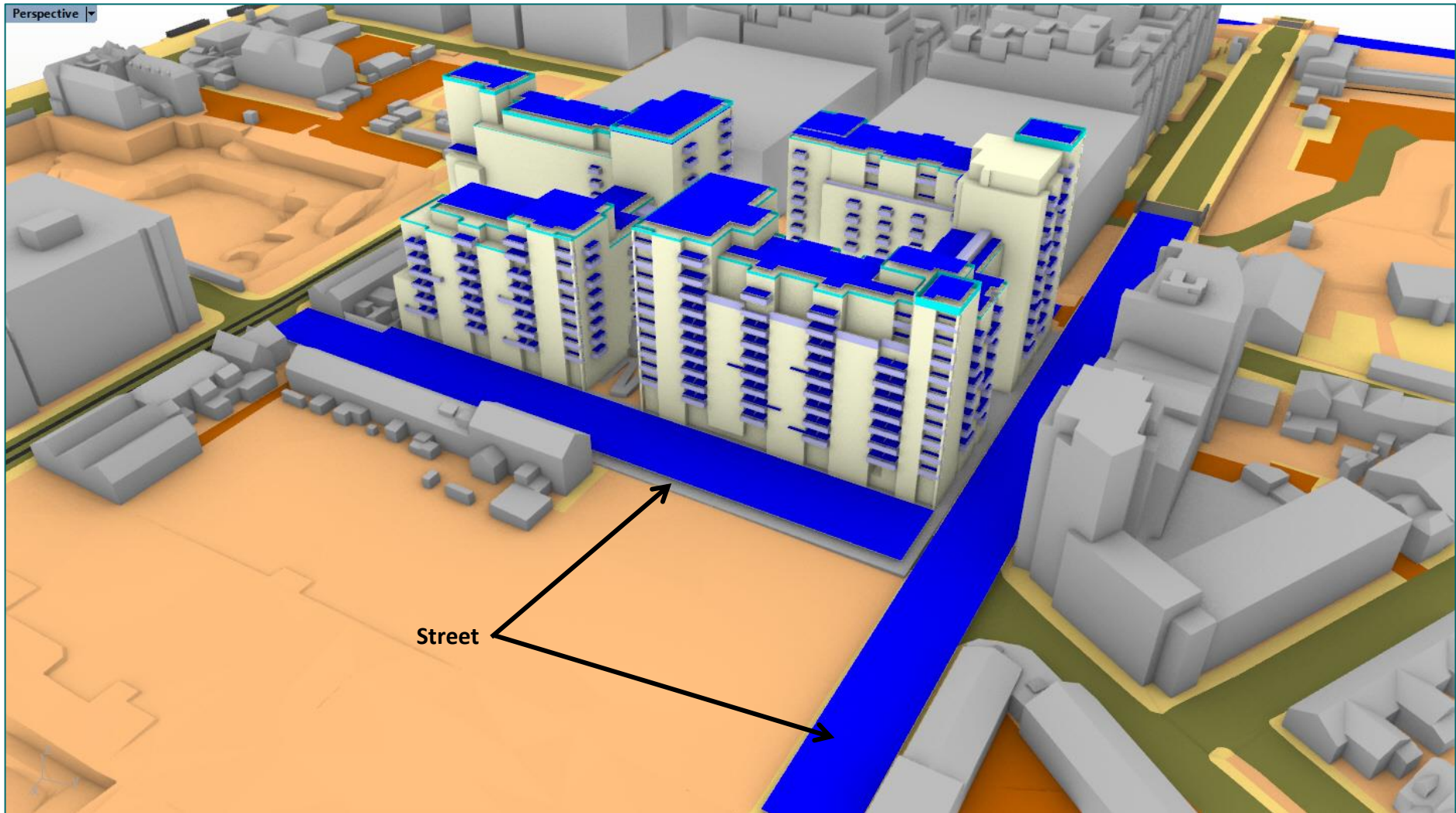


Figure 24: Reporting Locations: Seen from north-east

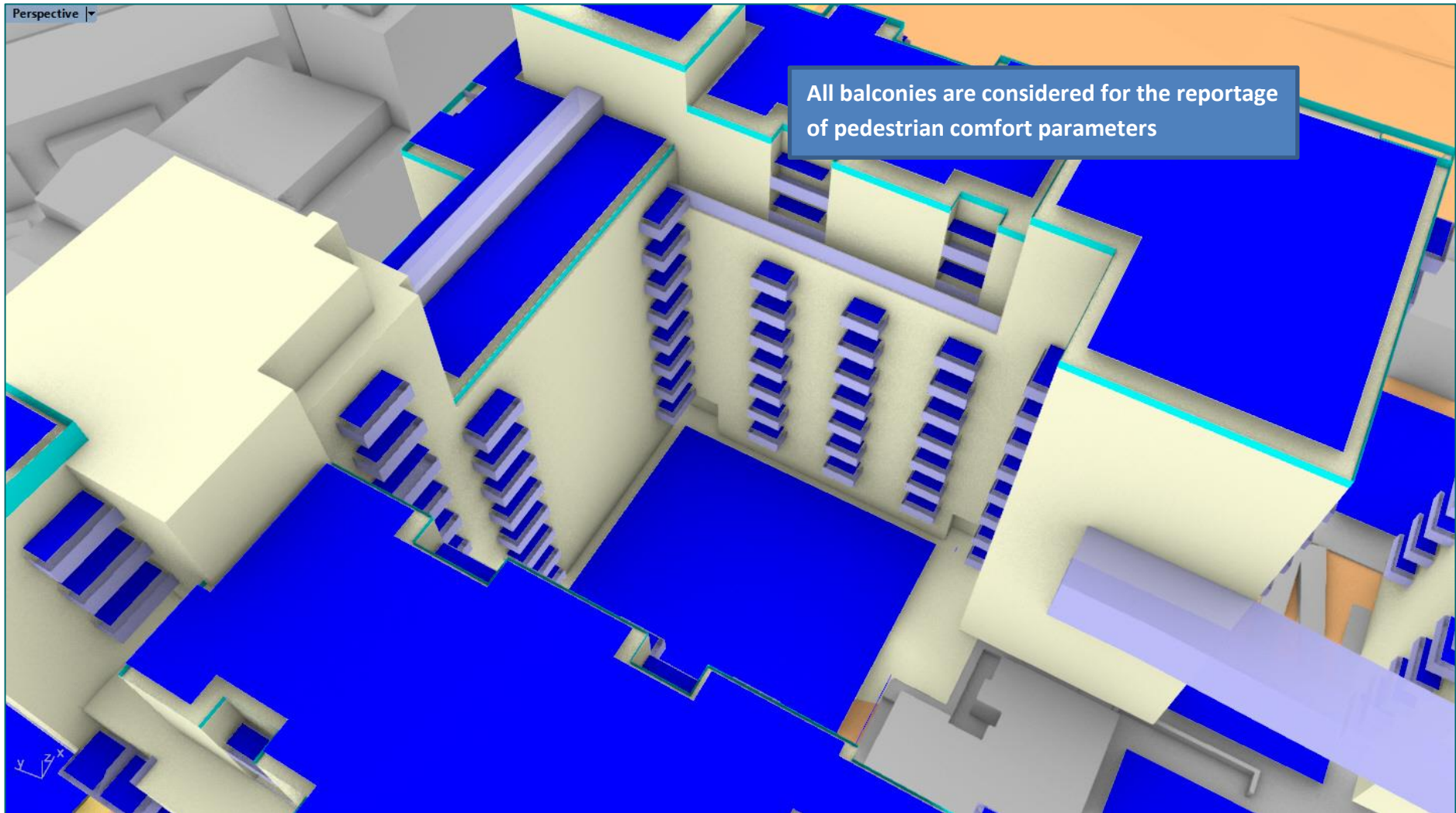


Figure 25: Reporting Locations: View of the balconies

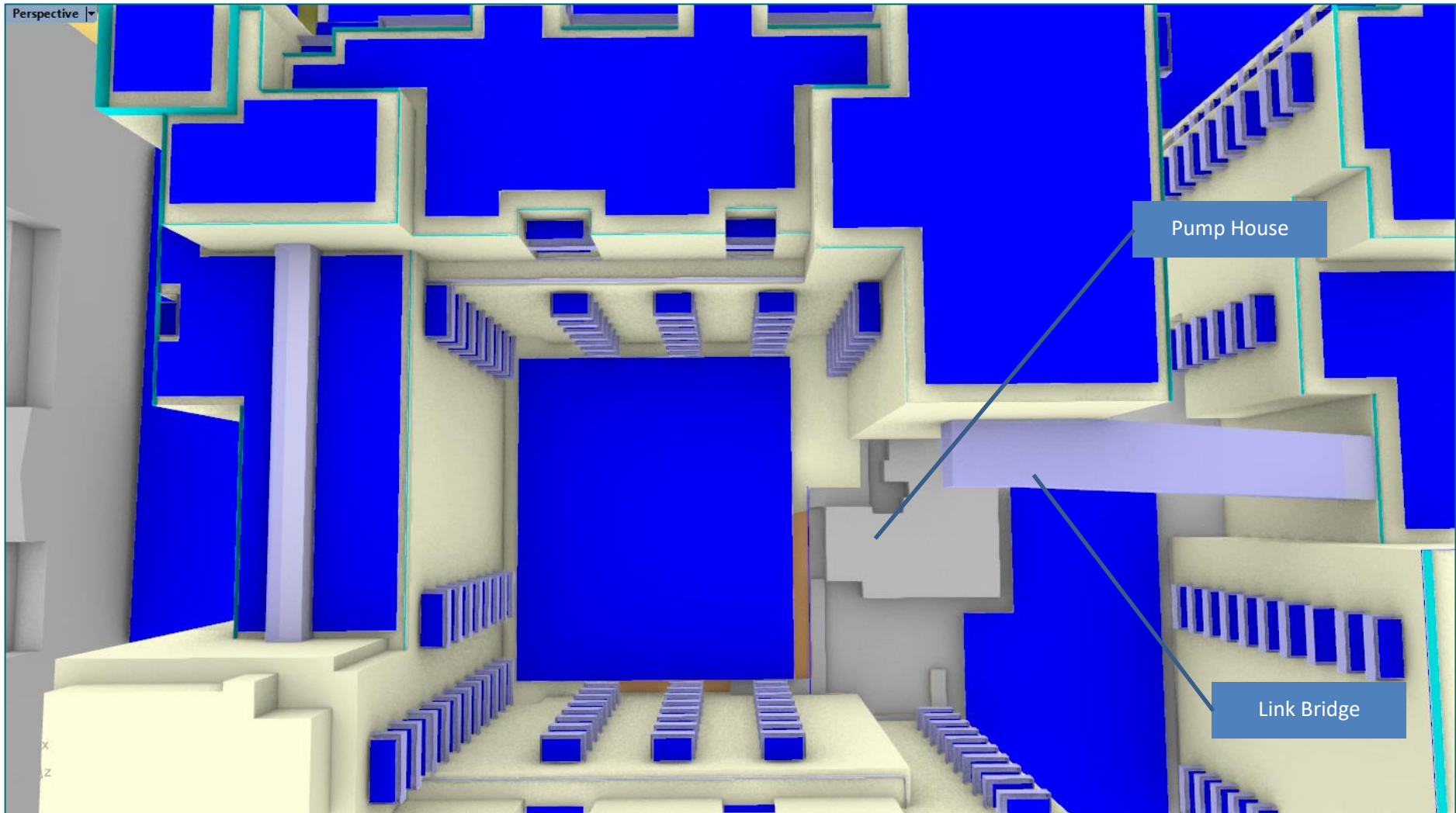


Figure 26: Reporting Locations: Common space and street



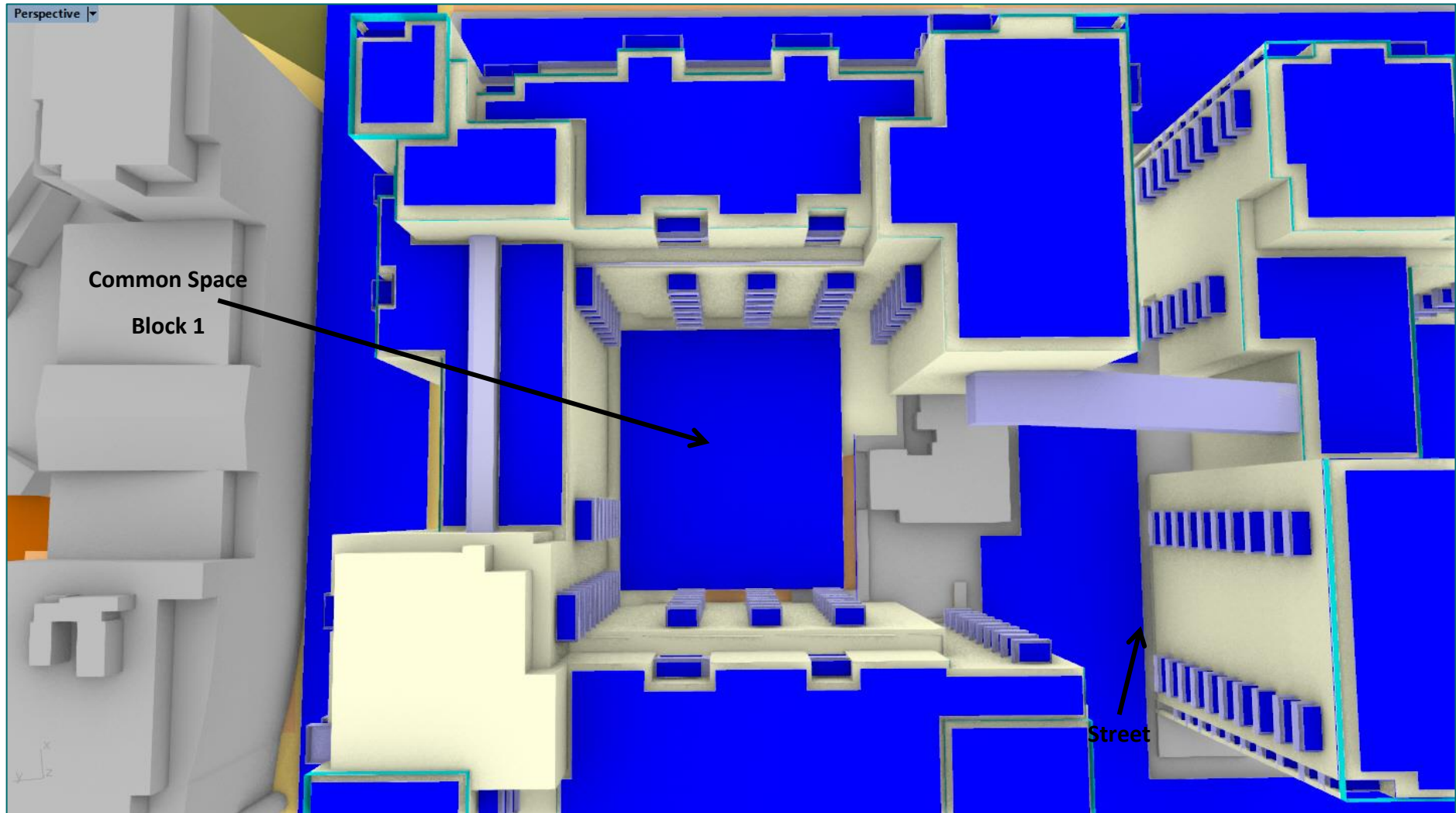


Figure 27: Reporting Locations: Podium

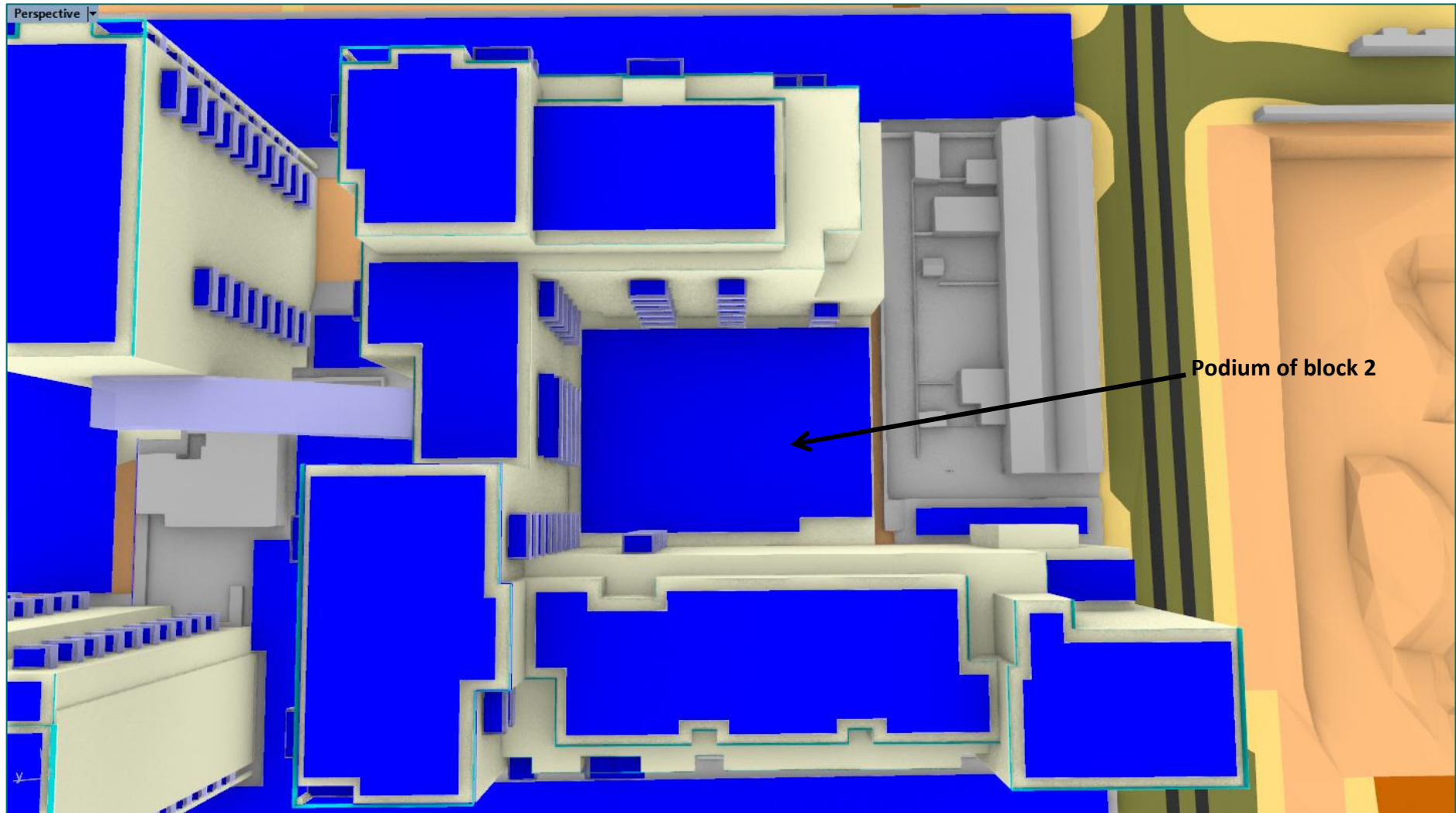


Figure 28: Reporting Locations: Podium

### 6.3 Comfort Activities

The following table lists the various activities, according to the amenity type, to be focused on in the simulation.

Amenity Area	Business Walking Activity	Leisurely Walking Activity	Standing Activity	Sitting Activity
Common Space between the blocks	✓	✓	✓	✓
Podium	✓	✓	✓	✓
Roof level amenities	✓	✓	✓	✓
Balconies			✓	✓
Streets	✓	✓		

## 7 Simulation Results

### 7.1 Sitting Criterion

Figure below shows the results for the full year sitting criterion analysis for Block 1.

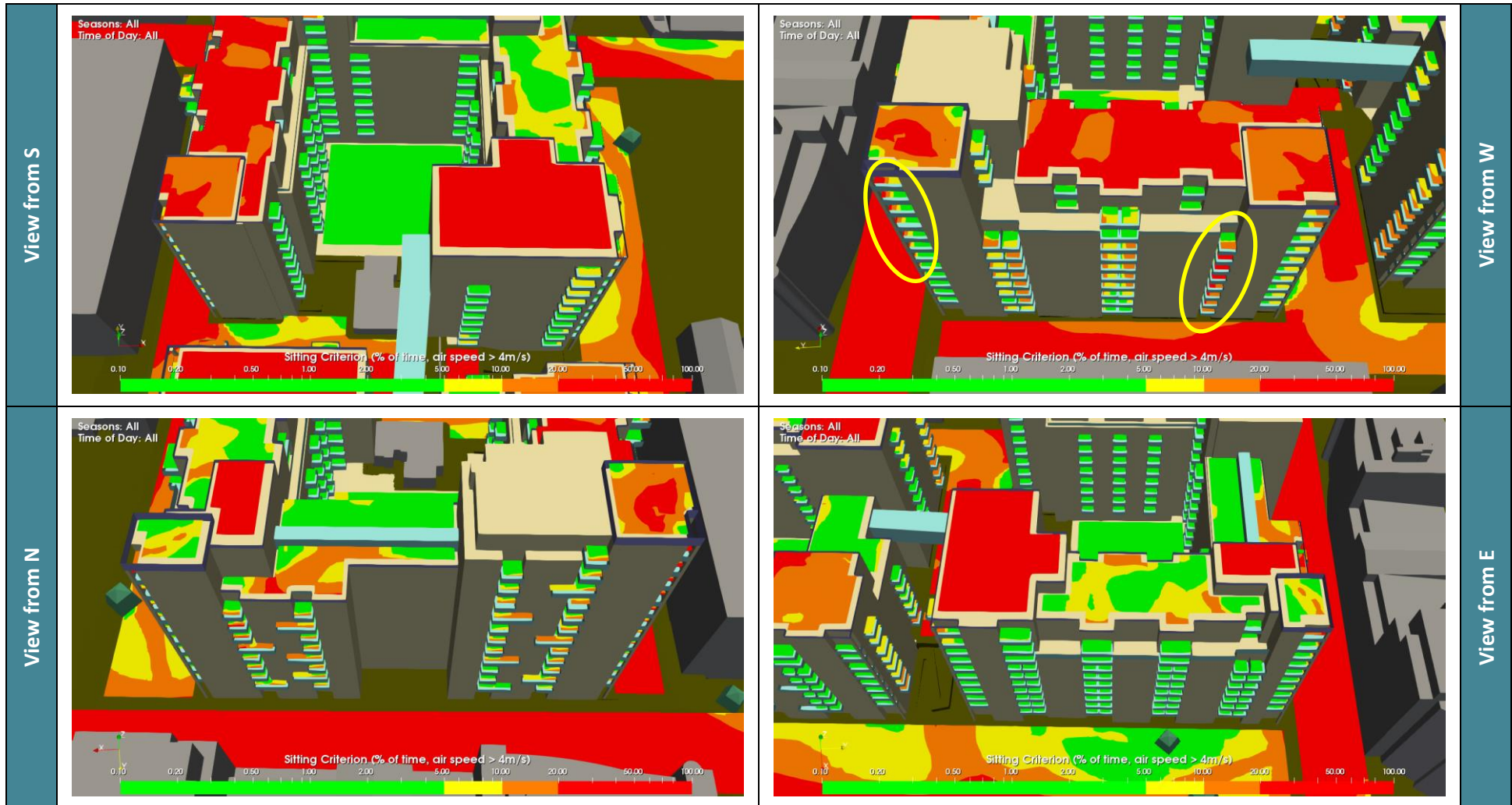


Figure 29: Sitting Criterion: Block 1

Figure below shows the results for the full year sitting criterion analysis for Block 2.

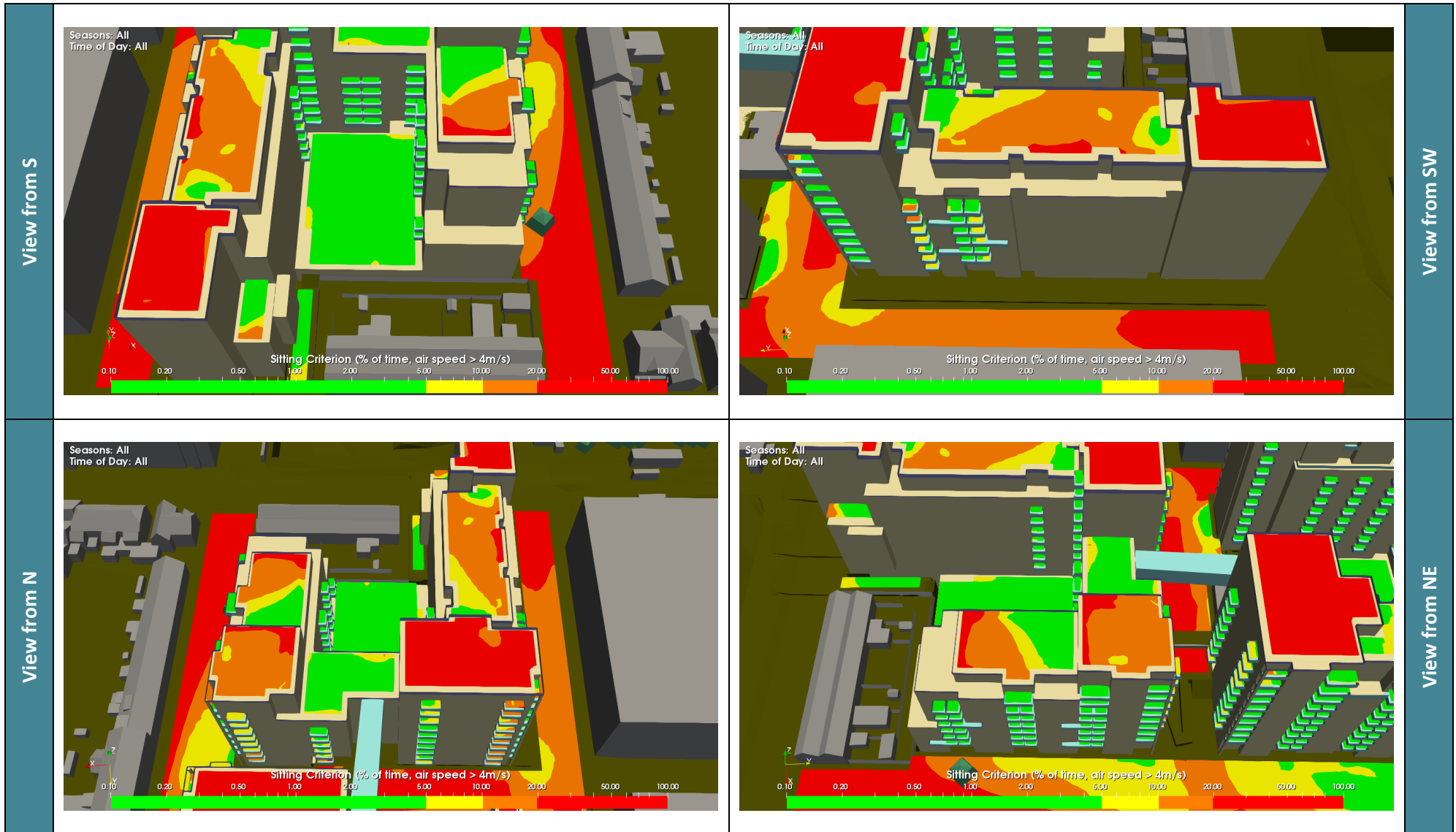


Figure 30: Sitting Criterion: Block 2

## 7.2 Standing Criterion

Figure below shows the results for the full year standing criterion analysis for Block 1.

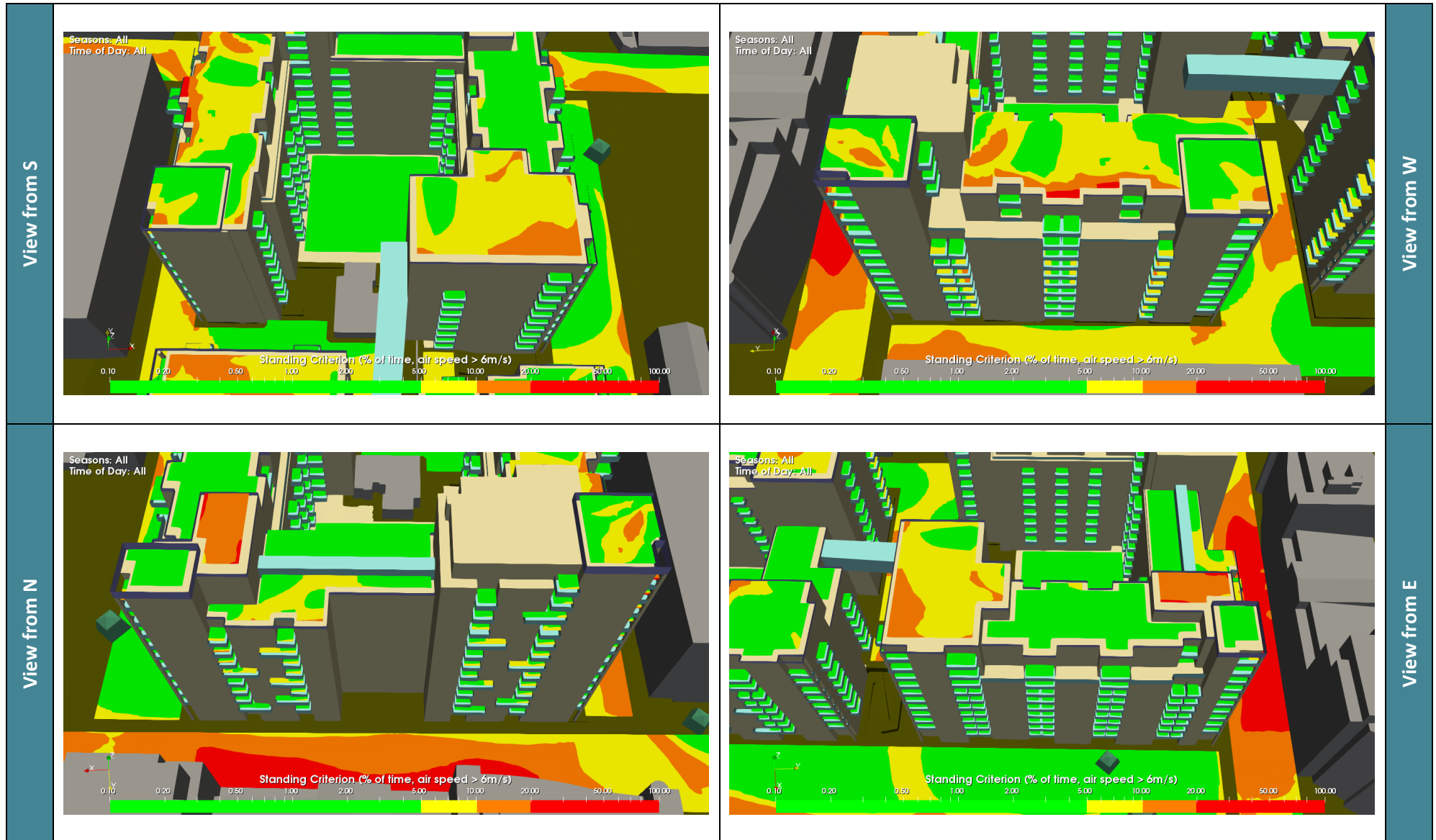


Figure 31: Standing Criterion: Block 1

Figure below shows the results for the full year standing criterion analysis for Block 2.

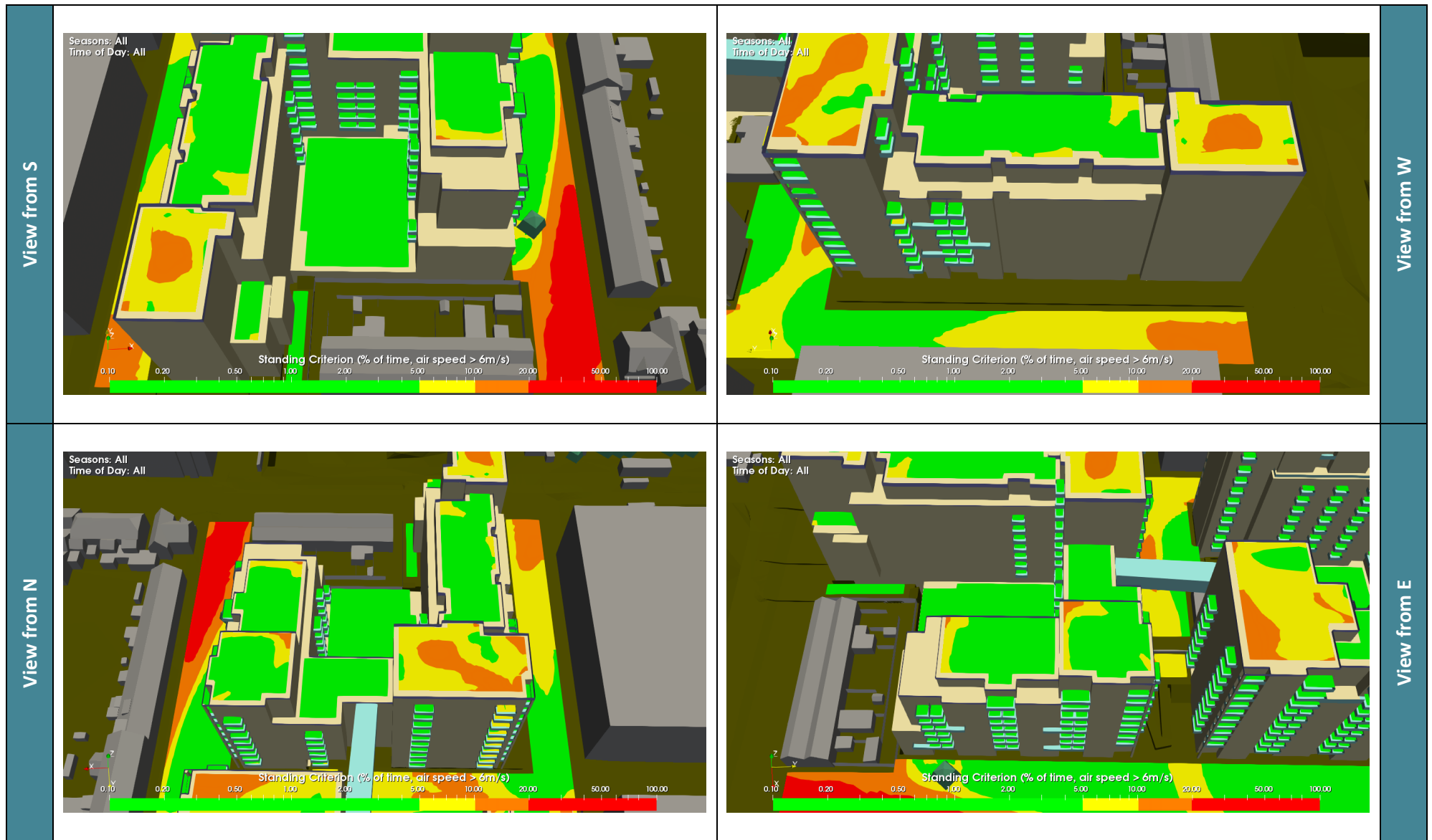


Figure 32: Standing Criterion: Block 2

### 7.3 Leisure Walking Criterion

Figure below shows the results for the full year leisure walking criterion analysis for the site.

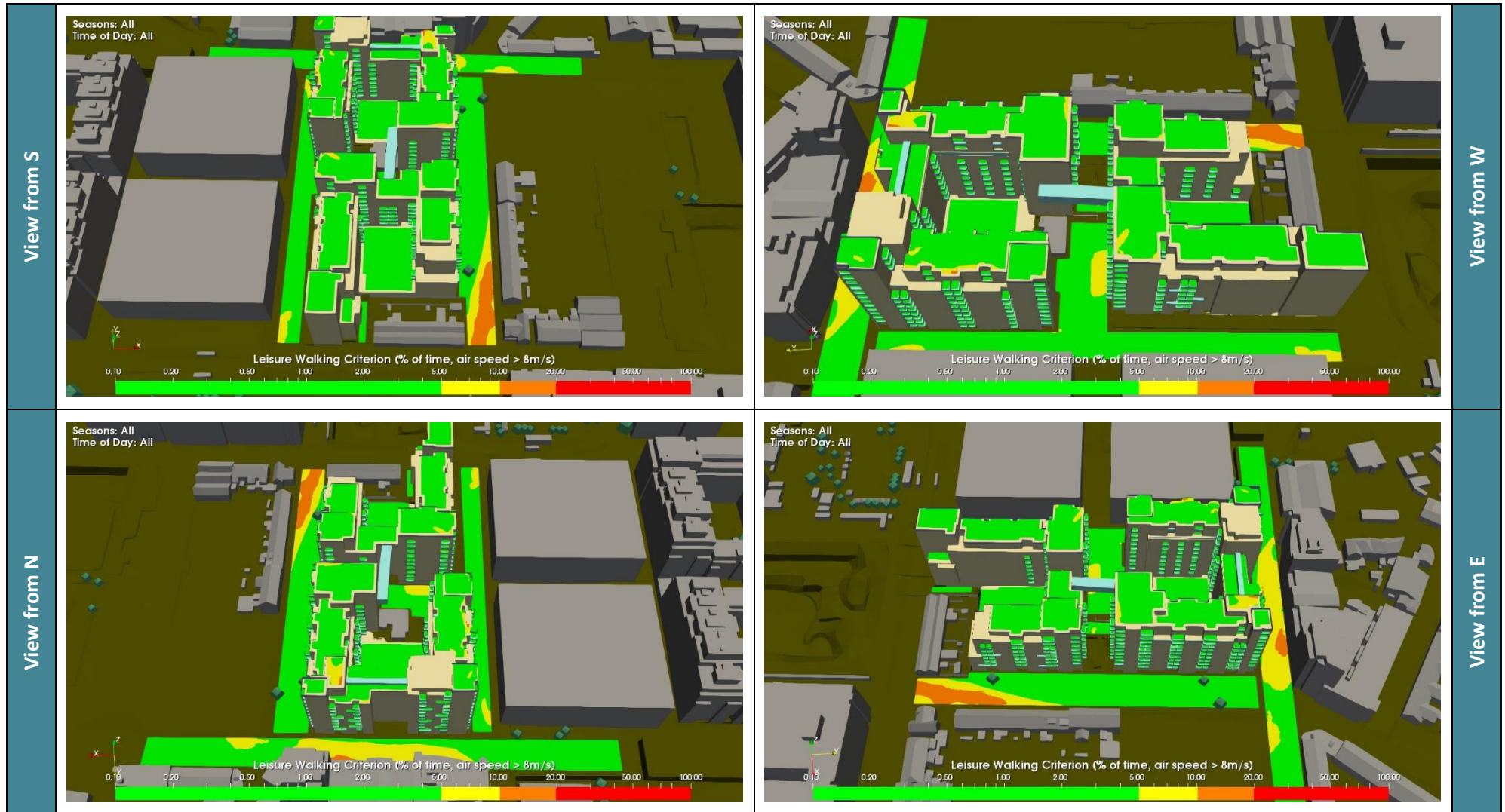


Figure 33: Leisure Walking Criterion: Full Site



### 7.4 Business Walking Criterion

Figure below shows the results for the full year’s business walking criterion analysis for the site.

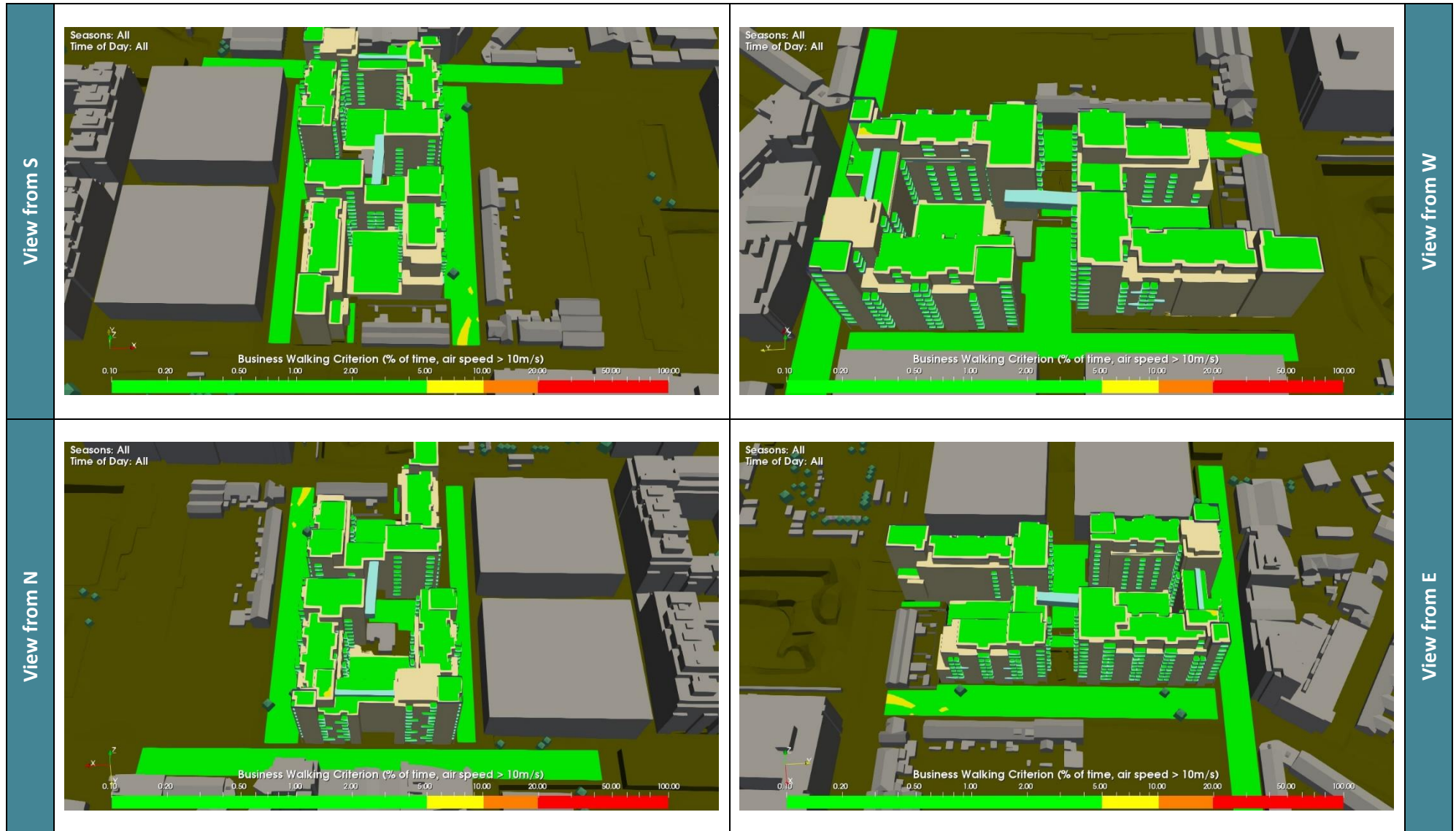


Figure 34: Business Walking Criterion: Full Site

### 7.5 Normal Pedestrian Safety Criterion

Figure below shows the results for the full year normal pedestrian safety criterion analysis for Phase 1.

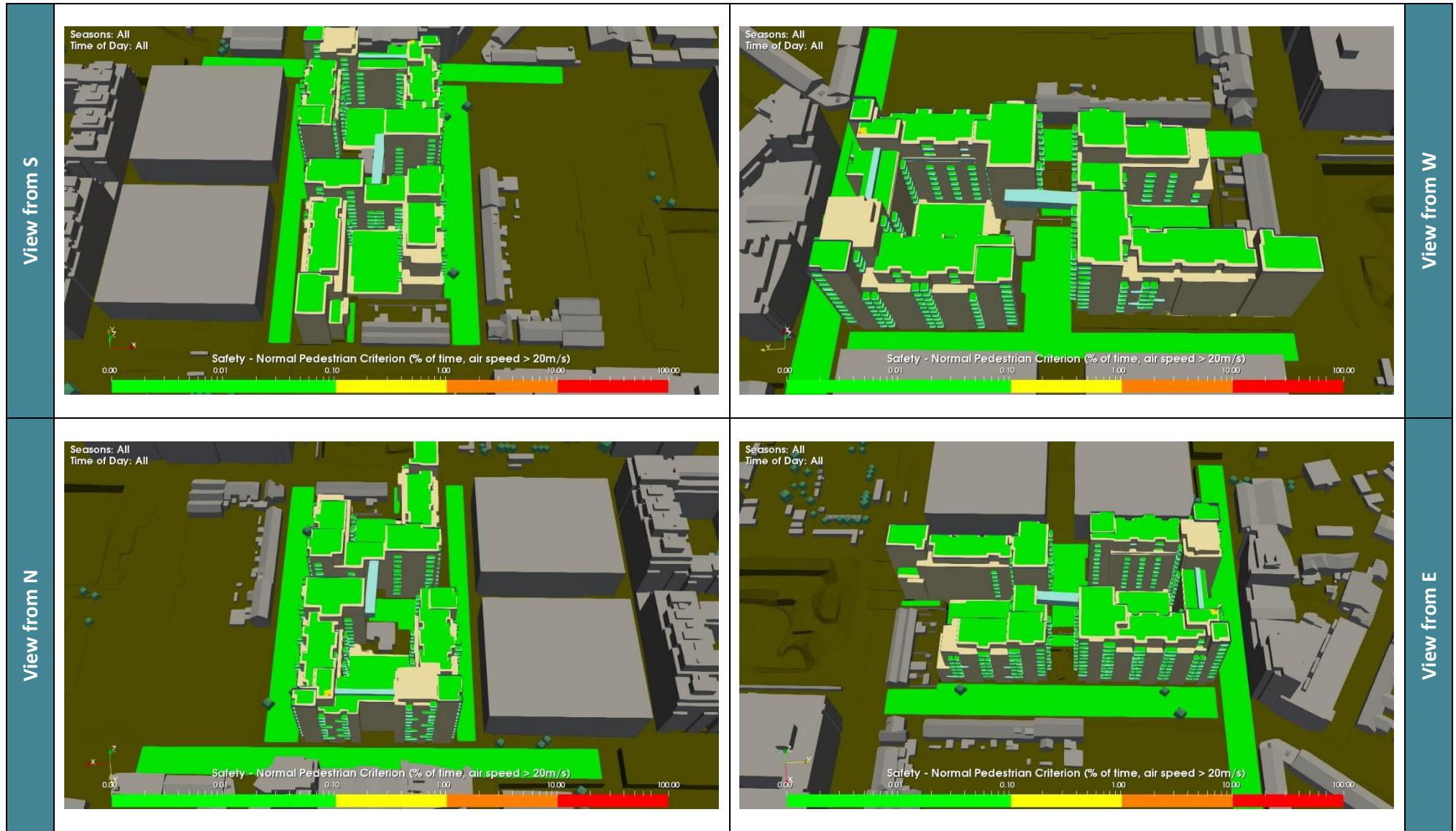


Figure 35: Normal Pedestrian Safety Criterion: Full Site

### 7.6 Sensitive Pedestrian Safety Criterion

Figure below shows the results for the full year sensitive pedestrian safety criterion analysis for Phase 1.

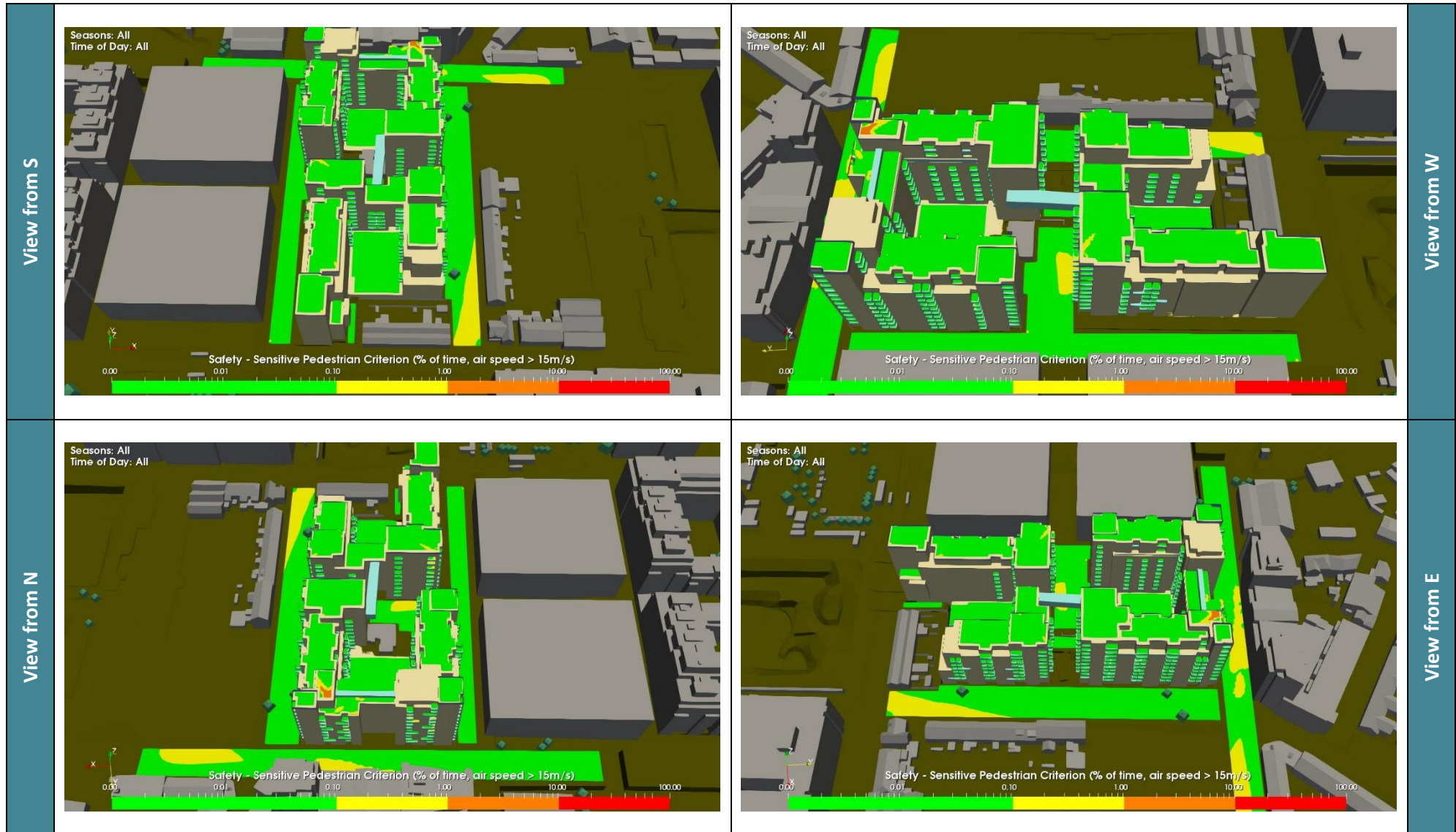


Figure 36: Sensitive Pedestrian Safety Criterion: Full Site



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