

# **Appendix: Wind Microclimate**





# **Annex 1: Legislative and Planning Policy Context**



## KEY LEGISLATION, POLICY AND GUIDANCE CONSIDERATIONS

- 1.1 The wind microclimate assessment has been undertaken within the context of relevant planning policies, guidance documents and legislative instruments. These are summarised below.

### Legislation, Regulation and Planning Policy

#### National Legislation and Policy

##### National Planning Policy Framework (2019)<sup>1</sup>

- 1.2 In February 2019, the Government published an updated version of the NPPF. There are no policies pertaining to wind microclimate in the NPPF.

##### National Planning Practice Guidance (2015)<sup>2</sup>

- 1.3 The NPPG was revised on July 2018 and provides a web-based resource in support of the NPPF.
- 1.4 The NPPG identifies the potential for a building's size and shape (particularly in the case of tall and large buildings) to affect the wind microclimate. Under the section addressing 'Design: How should buildings and the spaces between them be considered?', the PPG states that:
- *"Consider form [...] Some forms pose specific design challenges, for example how taller buildings meet the ground and how they affect local wind [...] patterns should be carefully considered".*
  - *"Consider scale [...] Account should be taken of local climatic condition, including [...] wind".*

##### UK Climate Projections (UKCP18) (2018)

- 1.5 The UK Climate Projections (UKCP18) published by the Met Office presents a number of different predicted scenarios. The 'Climate Projects Report' published by UKCP18 presents the probable changes in wind speed for 2070 - 2099 in both the summer and winter seasons. With these predictions, the current trends in the climate change are not likely to have any significant effects on the predicted wind microclimate conditions in and around the Proposed Development. It is therefore not necessary to provide a quantitative analysis of the increase in storm frequency and its implication on the effect on the Wind Microclimate for the Proposed Development.

#### Local Policy

##### Woking Design Supplementary Planning Document (2015)

- 1.6 The Woking Design Supplementary Planning Document (SPD) states in section 4.4 Tall Building Strategy, that:
- *"The criteria against which proposals for tall buildings will be considered include... not adversely affect the site's surrounds in terms of micro-climate, wind..."*
- 1.7 Furthermore, design guidelines have also been stated for balconies in Section 7b, Tall buildings:
- *Balconies in tall buildings should be recessed or semi-recessed to achieve a calm expression, give wind-protection..."*
- 1.8 The section also specifies that:
- *"Proposals for tall buildings must produce wind, shadowing and reflection analysis."*
- 1.9 Further design guidelines are also discussed in the document, for example suggesting to check if the design may make an "environmental impact in terms of wind tunnels".

##### Climate Change Supplementary Planning Document (2013)

- 1.10 There are no policies or guidance pertaining to wind microclimate in Climate Change Supplementary Planning Document.

#### Local Planning Policy

##### Woking Core Strategy Local Development Document (2012)

- 1.11 There are no policies or guidance pertaining to wind microclimate within the Woking Core Strategy Local Development Document.

##### Development Management Policies Development Plan Document (DPD) (2016)

- 1.12 There are no policies or guidance pertaining to wind microclimate within the Development Management Policies DPD for Woking.

#### Other Relevant Standards and Guidance

##### Guidance on tall buildings (2007)<sup>3</sup>

- 1.13 English Heritage and the Commission for Architecture and the Built Environment (CABE) produced a revised and updated version of their joint guidance on tall buildings. The final version was released in July 2007 and in section Criteria for evaluation, state that:

- *"... planning permission for tall buildings should ensure therefore that the following criteria are fully addressed: [...] The effect on the local environment, including microclimate".*

##### A Green Future: Our 25 Year Plan to Improve the Environment (2018)<sup>4</sup>

- 1.14 There are no policies pertaining to wind microclimate in this document published by DEFRA in January 2018.

##### Creating space for beauty (2019)<sup>5</sup>

- 1.15 There are no policies pertaining to wind microclimate in this document published by MHCLG in July 2019.

<sup>1</sup> Department for Communities and Local Government, 2019. Revised National Planning Policy Framework. London. HMSO

<sup>2</sup> Department for Communities and Local Government, 2018. Planning Practice Guidance.

<sup>3</sup> Commission for Architecture and the Built Environment and English Heritage, 2007. Guidance on tall buildings. London. CABE and English Heritage

<sup>4</sup> Department for Environment, Food & Rural Affairs, 2018. A Green Future: Our 25 Year Plan to Improve the Environment. London. DEFRA

<sup>5</sup> Ministry of Housing, Communities & Local Government, 2019. Creating space for beauty: interim report. London MHCLG



# **Annex 2: Pedestrian Level Wind Microclimate Assessment**





# WOKING FOOTBALL CLUB

WOKING, UK

## PEDESTRIAN LEVEL WIND MICROCLIMATE ASSESSMENT

RWDI #1900950 PLW - REV E

21<sup>ST</sup> NOVEMBER 2019

### SUBMITTED TO

Woking Football Club

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## APPENDICES

### APPENDIX A: WIND TUNNEL PHOTOS

### APPENDIX B: METEOROLOGICAL DATA

## 1 EXECUTIVE SUMMARY

The objective of this study was to provide a ground level, podium level and balcony level wind microclimate assessment, based on a series of wind tunnel tests, for the proposed Woking Football Club development in Woking, UK.

The document presents a description of the methodology used and summary of results for four configurations tested in the wind tunnel, namely:

- Configuration 1: Existing Site with existing surrounding buildings;
- Configuration 2: Block 1 of Proposed Development built, with existing site buildings (e.g. the existing stadium, leisure centre, gymnastics club etc.) demolished and existing surrounding buildings;
- Configuration 3: Proposed Development with existing surrounding buildings; and
- Configuration 4: Proposed Development with existing surrounding buildings and proposed landscaping scheme.

Local wind conditions derived from the combined meteorological data collected at two London airports (Heathrow and City) indicate prevailing winds from the south-west throughout the year. There is a secondary peak from the north-east during the spring season.

In the baseline scenario (Configuration 1), wind conditions around the site are suitable for intended use with conditions ranging from sitting use to strolling use in the windiest season and there are no strong winds exceeding the safety threshold at any location on or off-Site.

With Block 1 built and the rest of the Site demolished (Configuration 2), wind conditions would remain calm with wind conditions ranging from sitting use to strolling use in the windiest and all locations on and off-Site would be suitable for their intended use. There would be no instances of strong winds exceeding the 15m/s safety threshold anywhere around the Site.

With the Proposed Development in place (Configuration 3), wind conditions on-Site would become windier whilst wind conditions off-Site would be similar to those in the baseline. There would be four thoroughfare locations that would have wind conditions unsuitable for the intended use between Blocks 1, 2, 3 and the Stadium and would require mitigation measures. Additionally, there would be entrances located at Blocks 1, 2, 4, and 5 of the Proposed Development as well as the Stadium which would have unsuitable wind conditions in the windiest season and would therefore require mitigation. All ground, podium and balcony amenity locations around the Site would have suitable wind conditions and require no mitigation.

There would also be two locations, one at the north-west corner of the stadium and one at a thoroughfare location between the Stadium and Block 3, that would have strong winds exceeding the safety threshold. These locations would require mitigation to ensure they are safe for pedestrian use.

Mitigation measures, in addition to the proposed landscaping, were developed to ensure a safe and comfortable wind environment around the Proposed Development (Configuration 4). The following mitigation measures were added to the Proposed Development:

- A 3m tall, 1.5m wide, solid side screen to canopies above entrances at probe locations 21, 67, and 95;
- Two, 2m tall, 2m wide 50% porous screens located either side of entrances at probe location 35;





- Three, 3m tall, 2m wide, 50% porous baffles with a 3m ground clearance placed at the north west corner of the stadium and spaced 4m apart running south along the stadium façade;
- Recessing of entrance locations 19, 91, and 128 by 1.5m;
- Two, 5m tall deciduous trees in the amenity space to the south of Building 3 and to the west of building 4 (north of probe 40);
- Three, 5m tall deciduous trees at ground level to the south-east of Building 4;
- A 3m tall, 50% porous screen separating entrances at the south façade of the eastern most block of Building 4;
- A 3m tall, 5m wide, 50% porous screen extending eastward from the eastern façade at the south-east of Building 4 spanning the entire width of the podium level;
- A single 3m tall deciduous tree at the south-east corner of Building 1; and
- A 3m tall, 4m wide, 50% porous screen at the eastern end of the podium level at the south façade of Building 1.

It should be noted that the existing landscaping (trees) located off-site, to the south of the site, was included as part of the wind tunnel model during the testing of the mitigation measures. Should the condition of these trees materially change at any point in the future, the wind microclimate around the south of the Blocks 4 and 5 of the Proposed Development would likely change. It is RWDI's professional opinion that if these trees are materially affected, further wind tunnel testing should be conducted to understand the potential impact and resultant effect that this would have on the wind microclimate around the Proposed Development, and to ensure that the Proposed Development has wind conditions suitable for the intended uses.

With the Proposed Development, proposed landscaping and mitigation measures in place (Configuration 4), the wind conditions around the Proposed Development would be much calmer with every location both on and off-Site being suitable for the intended use and there would be no instances of exceedance of the safety threshold therefore no further mitigation measures would be required.

**Overall the wind conditions around the Proposed Development are generally suitable for the intended use; however locally windy conditions are expected at thoroughfares and entrances throughout the Proposed Development and would require mitigation. With the above mitigation measures implemented, in addition to the proposed landscaping scheme, the wind conditions would be suitable for the intended uses and safe for pedestrians.**



## 2 INTRODUCTION

RWDI was retained by Woking Football Club to conduct a pedestrian level wind microclimate assessment of the proposed Woking Football Club development (referred to hereafter as the Proposed Development) in Woking, UK. This document presents the background, objectives and a summary of results and recommendations from RWDI's assessment.

### 3 BACKGROUND AND APPROACH

Wind tunnel tests were conducted on a 1:300 scale model of the Proposed Development in Woking, UK. The investigation quantifies the wind conditions within and around the Site, by comparing the measured wind speed and frequency of occurrence with the well-established Lawson Comfort Criteria. Meteorological data combined from the meteorological stations at two London airports (Heathrow and City) has been analysed and adjusted to the local site conditions by modelling the effect of terrain roughness on the wind speeds approaching the Site.

Measurements were taken at up to 242 locations for 36 directions at 10° intervals. The measurements covered ground, podium, and balcony level locations along the building façades and at corners, thoroughfares, within open amenity spaces and on pedestrian routes within and around the Site.

Analysis was conducted on a seasonal basis, but the report focuses on the windiest season results (generally winter in the UK) and those for the summer season, when pedestrian activity generally requires 'calmer' wind conditions.

Four configurations of the wind tunnel model were assessed as follows:

- Configuration 1: Existing Site with existing surrounding buildings;
- Configuration 2: Block 1 of Proposed Development built, with existing site buildings (e.g. the existing stadium, leisure centre, gymnastics club etc.) demolished and existing surrounding buildings;
- Configuration 3: Proposed Development with existing surrounding buildings; and
- Configuration 4: Proposed Development with existing surrounding buildings and Proposed Landscaping Scheme and Mitigation Measures.

#### 3.1 Site Description and Surroundings

The site is currently occupied by a football stadium (Woking Football Club); a collection of large-footprint, low-rise buildings, including the Woking Snooker Centre; David Lloyd Leisure Centre (including tennis courts), Woking Gymnastics Club; car parking; and a small number of residential properties situated in the north of the site.

Beyond the immediate bounds of the Site, the surroundings are predominantly low rise. The surrounding area is characterised by 'suburban' terrain which results in a relatively turbulent wind environment with a lower mean wind speed (compared to an equivalent site in open terrain).

It should be noted that there are no cumulative developments in the surrounding area which have been considered in this assessment.

#### 3.2 The Proposed Development

The Proposed Development comprises redevelopment of the site, following the demolition of all existing buildings and structures, to provide a replacement stadium with ancillary facilities, including flexible retail, hospitality and community spaces, independent retail floorspace (Classes A1/A2/A3), a medical centre (Class D1) and vehicle parking, plus residential accommodation comprising of 1,048 dwellings (Class C3) within 5 buildings of varying heights of between 3 and 10 storeys (and undercroft and part basement levels) on the south and west sides of the site, together with provision of new accesses from Westfield Avenue to car parking, associated landscaping and the provision of a detached residential concierge building..



Figure 1: Aerial view of the Site with approximate site location highlighted.

The wind tunnel model is shown in Figure 2. Further photographs of the various test configurations are included in Appendix A.



Figure 2: Image of the Proposed Development (red) with existing surrounding buildings (view from south).





## 4 METHODOLOGY AND ASSESSMENT CRITERIA

Wind tunnel testing is a well-established and robust means of assessing the pedestrian wind microclimate of the Proposed Development, allowing wind conditions at the Site to be quantified and classified in accordance with the established Lawson Comfort Criteria. Testing is undertaken using a 1:300 scale model of the Proposed Development with existing and consented surrounding buildings and terrain covering a 360 metre (m) radius centred on the Site.

The basic methodology for quantifying the pedestrian level wind environment is outlined below:

- Measure the wind speeds at pedestrian level in the wind tunnel relative to a reference wind speed;
- Adjust standard meteorological data to account for conditions at the Site;
- Combine these to obtain the expected frequency and magnitude of wind speeds at pedestrian level; and
- Compare the results with the Lawson Comfort Criteria to 'grade' conditions around the Site.

### 4.1 Simulation of Atmospheric Winds

The wind is gusty, which is to say it is a turbulent flow. As this turbulence varies depending upon the site, it is necessary to reflect site specific conditions in the wind tunnel test. Additionally, as the fluid in the atmospheric boundary layer is viscous, mean wind speed will increase with height as the layers within the atmospheric boundary layer shear against each other. Modelling these effects is achieved by a combination of spires and floor roughness elements to create a naturally-grown boundary layer that is representative of urban or open country conditions, as appropriate. The detailed proximity model around the Site is used to fine-tune the flow and create conditions similar to those expected at full scale.

### 4.2 Measurement Technique

Wind speed measurements were made using Irwin probes. For pedestrian comfort studies, both the mean wind speed and the peak wind speed are measured at each location at a scaled height of 1.5m above ground level. The typical equivalent full-scale time period for measuring the mean wind speed is around 90 minutes, whereas the peak wind speed is taken as the wind speed exceeded for 1% of the time.

Wind speeds at each location were measured for 36 wind directions in 10° intervals, with 0° representing a wind blowing from the north and 90° a wind blowing from the east.

### 4.3 Scaling

The length scale of the model was 1:300 and the velocity scale was approximately 1:2 for strong winds. Consequently, the time scale for the tests was 1:150, or in other words 1 second in the wind tunnel is equivalent to 150 seconds at full scale. The sampling frequency for the data acquisition equipment is therefore adjusted for the time scale.



### 4.4 Meteorological Data

Approximately 30 years of meteorological data derived from the meteorological stations at two London airports (Heathrow and City) is presented in Appendix B as wind roses by season (Figure 40). The radial axis indicates the percentage hours per season that the wind speed exceeds the particular velocity range. The seasons are defined as spring (March, April and May), summer (June, July and August), autumn (September, October and November) and winter (December, January and February). The data has been corrected to standard conditions of 10m above open flat level country terrain, over which pedestrian level wind speeds are greatest. The meteorological station data is then adjusted to the Site conditions using the methodology implemented in the ESDU software package. Low to medium rise inner city environments increase the turbulence within the atmospheric boundary layer which reduces the mean wind speed, requiring terrain roughness factors to be specified and applied to the meteorological data to account for the variations in terrain surrounding the Site.

The meteorological data indicate that the prevailing wind direction is from the south-west throughout the year, which is consistent with many areas of the south-east of England. During the spring season, there is a secondary peak of winds from the north-east.

The combination of meteorological data, site altitude and velocity ratios permit the percentage of time that wind speeds are exceeded at ground level on the site to be evaluated. The locations can then be assessed using the Lawson Comfort Criteria, as described below.

### 4.5 Pedestrian Comfort

The assessment of the wind conditions requires a standard against which the measurements can be compared. This report uses the Lawson Comfort Criteria, which have been established for over thirty years. The comfort criteria, which seek to define the reaction of an average pedestrian to the wind, are described in Table 1. If the measured wind conditions exceed the threshold, then they are unacceptable for the stated pedestrian activity and the expectation is that there may be complaints of nuisance or people will not use the area for its intended purpose.

The criteria set out four pedestrian activities and reflect the fact that less active pursuits require more benign wind conditions. The categories are sitting, standing, strolling and walking, in ascending order of activity level, with a further category uncomfortable for all pedestrian uses. For example, the wind conditions in an area for sitting need to be calmer than a location that people merely walk past.

The criteria are derived for open air conditions and assume that pedestrians will be suitably dressed for the season. Thermal comfort is not part of the assessment.

The coloured key in Table 1 corresponds to the presentation of wind tunnel test results described in the Section 5 of this report.



Table 1: LDDC Criteria (based on the Lawson Comfort Criteria)

Key	Comfort Category	Threshold	Description
●	Sitting	0 – 4 m/s	Light breezes desired for outdoor restaurants and seating areas where one can read a paper or comfortably sit for long periods
●	Standing	4 – 6 m/s	Gentle breezes acceptable for main building entrances, pick-up/drop-off points and bus stops
●	Strolling	6 – 8 m/s	Moderate breezes that would be appropriate for strolling along a city/town centre street, plaza or park
●	Walking	8-10 m/s	Relatively high speeds that can be tolerated if one's objective is to walk, run or cycle without lingering.
●	Uncomfortable	>10 m/s	Winds of this magnitude are considered a nuisance for most activities, and wind mitigation is typically recommended

#### 4.6 Strong Winds

The criteria also specify a strong wind threshold when winds exceed 15m/s for more than 0.025% of the time. Exceedance of this threshold indicates a need for remedial measures and careful assessment of the expected use of that location.

In the UK, strong winds are associated with areas which would be classified as uncomfortable for pedestrian use. In a mixed-use, urban development scheme, uncomfortable conditions would not usually form part of the 'target' wind environment and would usually require mitigation due to pedestrian comfort considerations. Mitigation applied to improve pedestrian comfort would also reduce the frequency of, or even eliminate, any strong winds.



## 5 RESULTS

### 5.1 Details of Analysis

To account for the difference in height and terrain roughness between meteorological conditions at the meteorological station and the Site, it is necessary to apply adjustment factors to the wind tunnel velocity ratios. Adjustment factors (mean factors) were computed for wind directions from 0° through to 360°. The reference height in the wind tunnel was at the equivalent full-scale height of 120 meters. Table 2 presents the mean factors for the Site.

Table 2: ESDU mean factors at 120m above ground level

Wind Direction	0°	30°	60°	90°	120°	150°	180°	210°	240°	270°	300°	330°
Mean Factor at 120 m	1.25	1.25	1.25	1.29	1.30	1.30	1.30	1.28	1.26	1.26	1.26	1.25

### 5.2 'Target' Wind Conditions

Generally, for a mixed-use development, the target conditions are:

- Strolling during the windiest season on pedestrian thoroughfares;
- Standing/entrance conditions at main entrances, drop off areas or taxi ranks, and bus stops throughout the year (although it should be noted that back of house entrances and fire escapes, which are used less frequently, would tolerate windier conditions suitable for strolling use);
- Standing use conditions during the summer season at private balcony/terrace spaces where there is no designated seating; and
- Sitting conditions at outdoor seating and amenity areas during the summer season when these areas are more likely to be frequently used by pedestrians. Larger amenity spaces would tolerate a mixture of sitting and standing use wind conditions during the summer season, should all seating areas be suitable for sitting use.

The walking and uncomfortable classifications are usually avoided because of their association with occasional strong winds, unless they are on a minor pedestrian route or a route where pedestrian access could be controlled in the event of strong winds.

Achieving a sitting classification in the summer usually means that the same measurement location would be suitable for standing in the windiest season because winds are stronger during this period. This is considered an acceptable occurrence for the majority of external amenity spaces because other factors such as air temperature and precipitation influence people's perceptions about the 'need' to use seating in the middle of winter.



### 5.3 Performance against the Lawson Comfort Criteria

The wind microclimate within and around the Proposed Development has been assessed and classified using the Lawson Comfort Criteria defined in Table 1. Expected usage of each location is shown in Table 2, below.

**Table 3: Expected Receptor Usage**

Receptor	Location	Receptor Reference (Probe Measurement Number)
<b>On-site</b>		
Thoroughfares	8, 14-16, 18, 20, 26-28, 30, 32-34, 36-40, 43, 44, 46, 47, 54-60, 62-66, 70, 73, 85, 89, 92-94, 96, 98, 110, 115, 117, 118, 121, 122, 124, 126, 127, 129, 132, 136, 137, 139, 142, 145, 149, 150, 152-155, 157-161, 164-166, 170	
Entrances	7, 17, 19, 21-25, 29, 35, 42, 48-50, 52, 53, 61, 67-69, 74-76, 78, 80, 90, 91, 95, 97, 99, 106-109, 123, 125, 128, 130, 131, 133-135, 138, 140, 141, 143, 144, 151, 156, 167-169	
Ground Level Amenity	9-13, 31, 51, 77, 79, 81, 146-148, 171-175	
Podium Level Amenity	186-188, 192-194, 206-211, 215, 216, 218, 219, 229, 230, 233-235, 237, 242, 243	
Balconies	176-185, 189-191, 195-199, 201-205, 212-214, 217, 220-228, 231, 232, 236, 238-241	
Bus Stop	120	
<b>Off-site</b>		
Thoroughfares	71, 72, 82-84, 86-88, 100-105, 111-114, 116, 119	
Ground Level Amenity	1-6, 41, 45, 162, 163	



### 5.4 Occurrence of Strong Winds

Strong winds exceeding 15m/s and 20m/s for more than 0.025% (2.2 hours) of the year are listed below.

**Table 4: Annual exceedance of strong winds**

Location	Threshold Exceedance	Wind Direction	Hours per Annum
<b>Configuration 1: Existing site and surrounding buildings</b>			
<b>There were no instances of exceedance of the safety criteria in Configuration 1</b>			
<b>Configuration 2: Block 1 of Proposed Development built, with existing site buildings (e.g. the existing stadium, leisure centre, gymnastics club etc.) demolished and existing surrounding buildings</b>			
<b>There would be no instances of exceedance of the safety criteria in Configuration 2</b>			
<b>Configuration 3: Proposed development with existing surrounding buildings without landscaping</b>			
126	S15	250	6.4
136	S15	289	3.3
<b>Configuration 4: Proposed development and existing surrounding buildings with Proposed Landscaping Scheme and Mitigation Measures</b>			
<b>There would be no instances of exceedance of the safety criteria in Configuration 4</b>			



## 6 CONCLUSION

In conclusion:

1. The meteorological data for the Site indicates prevailing winds from the south-west quadrant throughout the year with secondary winds from the north-east directions which are more prevalent during the spring months.
2. All locations in and around the Site in the baseline scenario (Configuration 1) would be suitable for their intended use with sitting to strolling wind conditions. During the summer season, wind conditions would be generally one category calmer.
3. There would not be any exceedances of the strong wind threshold (15m/s) in Configuration 1 at any on or off-Site location.
4. With Block 1 of the Proposed Development built and the rest of the Site demolished (Configuration 2), wind conditions in and around the Site would remain calm with wind conditions ranging from sitting use to strolling use and all locations on and off-Site being suitable for their intended use.
5. There would be no instances of strong winds exceeding the strong wind threshold (15m/s) in Configuration 2 at any on or off-Site location.
6. With the Proposed Development in situ (Configuration 3), wind conditions in and around the Site would be slightly windier than the baseline scenario due to the increased massing on the Site and the channelling effects between the Blocks of the Proposed Development.
7. Wind conditions would range from suitable for sitting to walking use. At ground level, four thoroughfare locations between Blocks 1, 2, 3 and the Stadium as well as nine entrance locations spread between all buildings of the Proposed Development would be unsuitable for the intended use during the windiest season and therefore would require mitigation measures. All other thoroughfares, entrances, amenity areas and bus stops would be suitable for their intended use.
8. Wind conditions at the podium levels and balconies around the Proposed Development would range from suitable for sitting use to standing use during the summer season. These conditions are suitable for the intended usage of these locations and therefore no mitigation is required at the podium level or balconies.
9. There would be two exceedances of the strong wind threshold (15m/s) throughout the year in Configuration 3. One exceedance occurs at the north-west corner of the Stadium, and one exceedance occurs at a thoroughfare location in between the Stadium and Block 3. Both of these locations would require mitigation measures to ensure they are safe for pedestrian use.
10. Configuration 4 consisted of the Proposed Development in situ with the existing surrounding buildings modelled as well as the proposed landscaping scheme and a number of mitigation measures. In addition to the landscaping scheme the wind mitigation measures required would be:
  - A 3m tall, 1.5m wide, solid side screen to canopies above entrances at probe locations 21, 67, and 95;
  - Two, 2m tall, 2m wide 50% porous screens located either side of entrances at probe location 35;
  - Three, 3m tall, 2m wide, 50% porous baffles with a 3m ground clearance placed at the north west corner of the stadium and spaced 4m apart running south along the stadium façade;
  - Recessing of entrance locations 19, 91, and 128 by 1.5m;

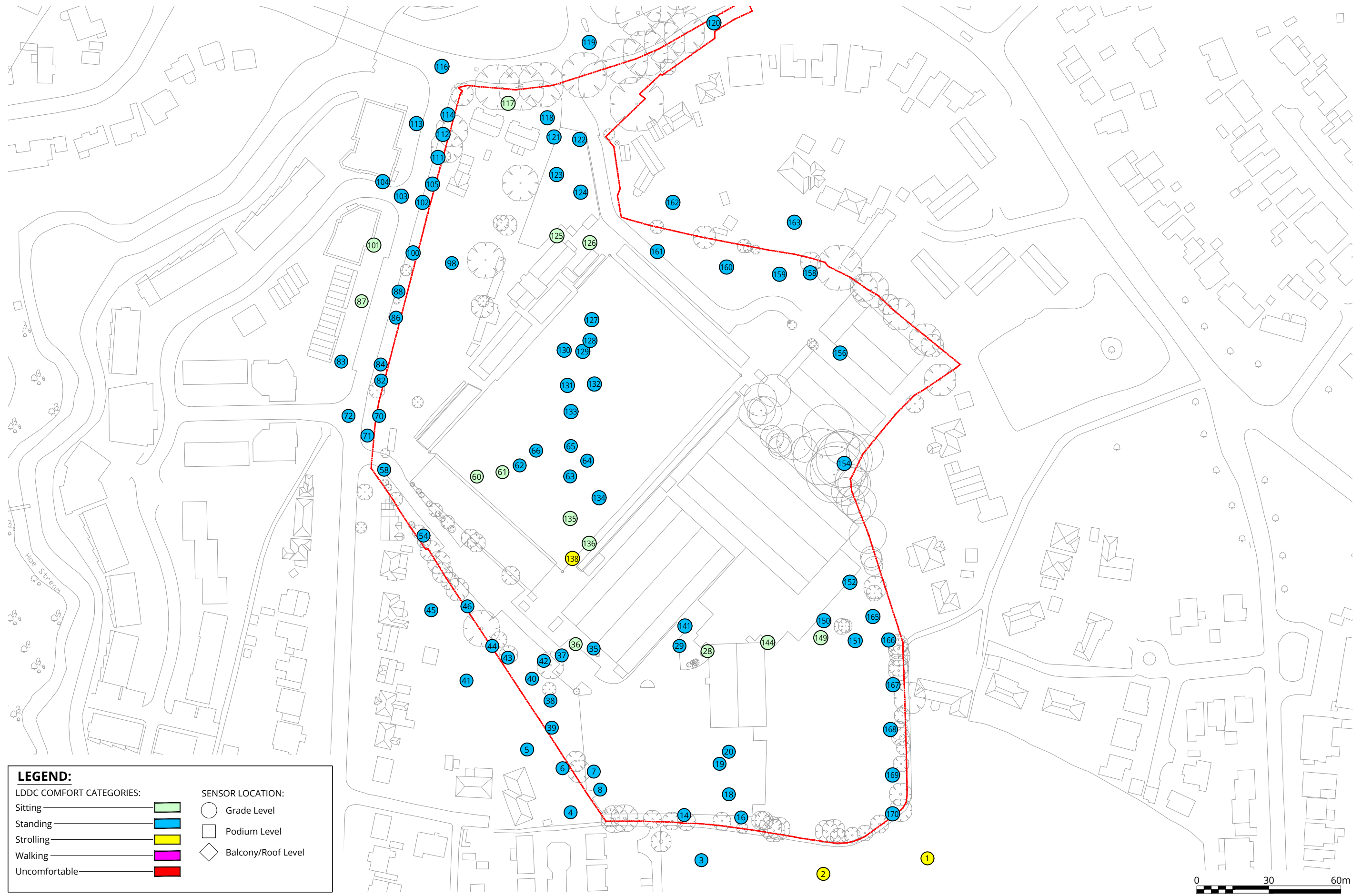


- Two, 5m tall deciduous trees in the amenity space to the south of Building 3 and to the west of building 4 (north of probe 40);
  - Three, 5m tall deciduous trees at ground level to the south-east of Building 4;
  - A 3m tall, 50% porous screen separating entrances at the south façade of the eastern most block of Building 4;
  - A 3m tall, 5m wide, 50% porous screen extending eastward from the eastern façade at the south-east of Building 4 spanning the entire width of the podium level;
  - A single 3m tall deciduous tree at the south-east corner of Building 1; and
  - A 3m tall, 4m wide, 50% porous screen at the eastern end of the podium level at the south façade of Building 1.
11. With the Proposed Development in situ and the proposed landscaping scheme and mitigation measures modelled (Configuration 4), all locations at ground and podium levels, as well as all balconies, on-Site would be suitable for intended use. No further mitigation measures would be required.
  12. There would be no instances of exceedance of the strong wind threshold (15m/s) at any location on or off-Site with the Proposed Development, proposed landscaping and mitigation measures in place (Configuration 4). No further mitigation measures would be required.

## FIGURES







**LEGEND:**

**LDDC COMFORT CATEGORIES:**

- Sitting
- Standing
- Strolling
- Walking
- Uncomfortable

**SENSOR LOCATION:**

- Grade Level
- Podium Level
- Balcony/Roof Level

**Pedestrian Wind Comfort Conditions - Ground Floor and Podium Level**  
 Configuration 1: Existing Site with Existing Surrounding Buildings  
 Windiest Season

Woking Football Club - Woking, UK

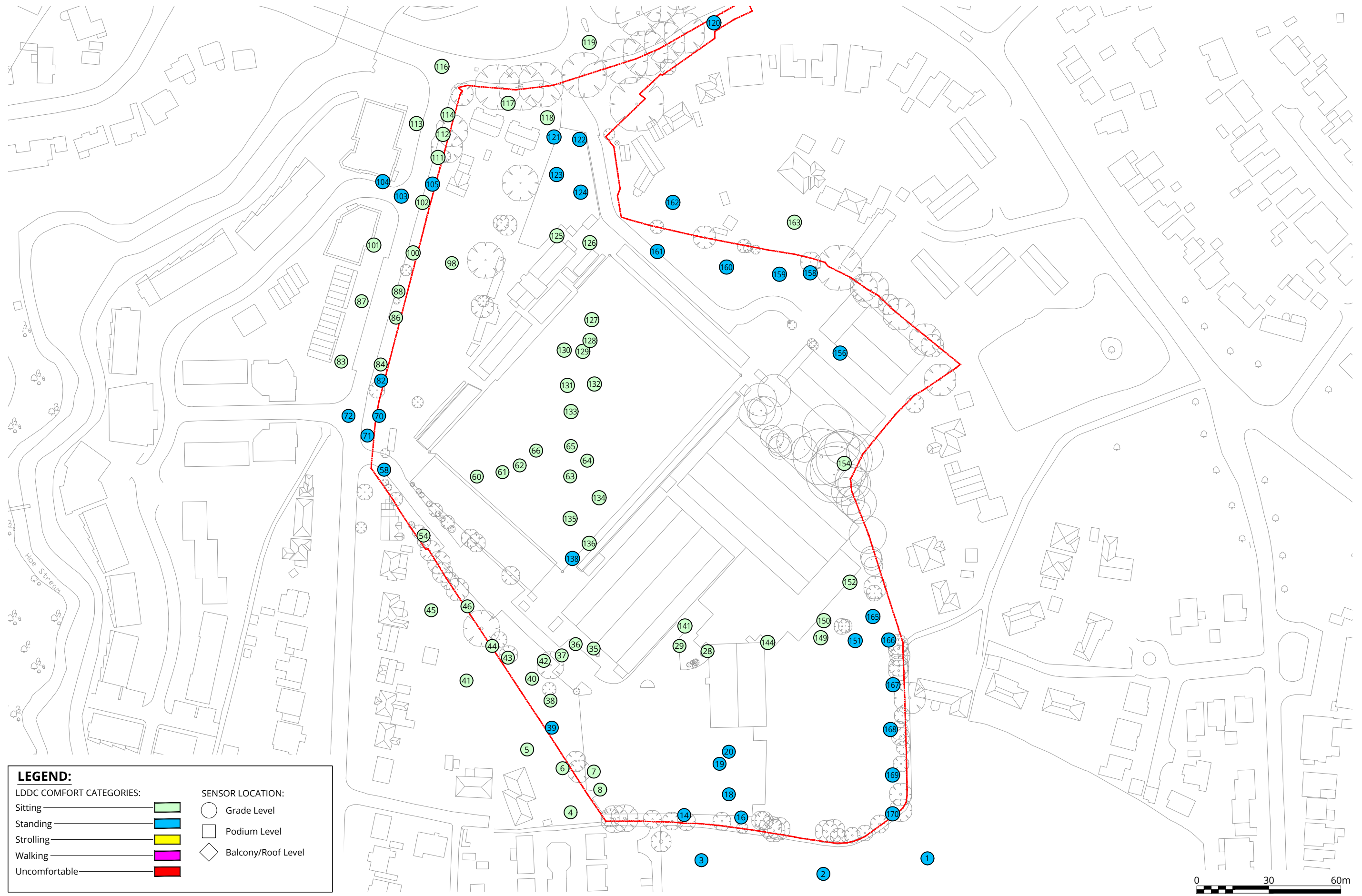


Drawn by: JLF	Figure: 3
Approx. Scale @A3: 1:1500	
Date Revised: Nov. 21, 2019	



Project #1900950





**LEGEND:**

<b>LDDC COMFORT CATEGORIES:</b>	<b>SENSOR LOCATION:</b>
Sitting — <span style="display:inline-block; width:15px; height:10px; background-color:#90EE90; border:1px solid black;"></span>	○ Grade Level
Standing — <span style="display:inline-block; width:15px; height:10px; background-color:#00BFFF; border:1px solid black;"></span>	□ Podium Level
Strolling — <span style="display:inline-block; width:15px; height:10px; background-color:#FFFF00; border:1px solid black;"></span>	◇ Balcony/Roof Level
Walking — <span style="display:inline-block; width:15px; height:10px; background-color:#FF00FF; border:1px solid black;"></span>	
Uncomfortable — <span style="display:inline-block; width:15px; height:10px; background-color:#FF0000; border:1px solid black;"></span>	

**Pedestrian Wind Comfort Conditions - Ground Floor and Podium Level**  
 Configuration 1: Existing Site with Existing Surrounding Buildings  
 Summer Season

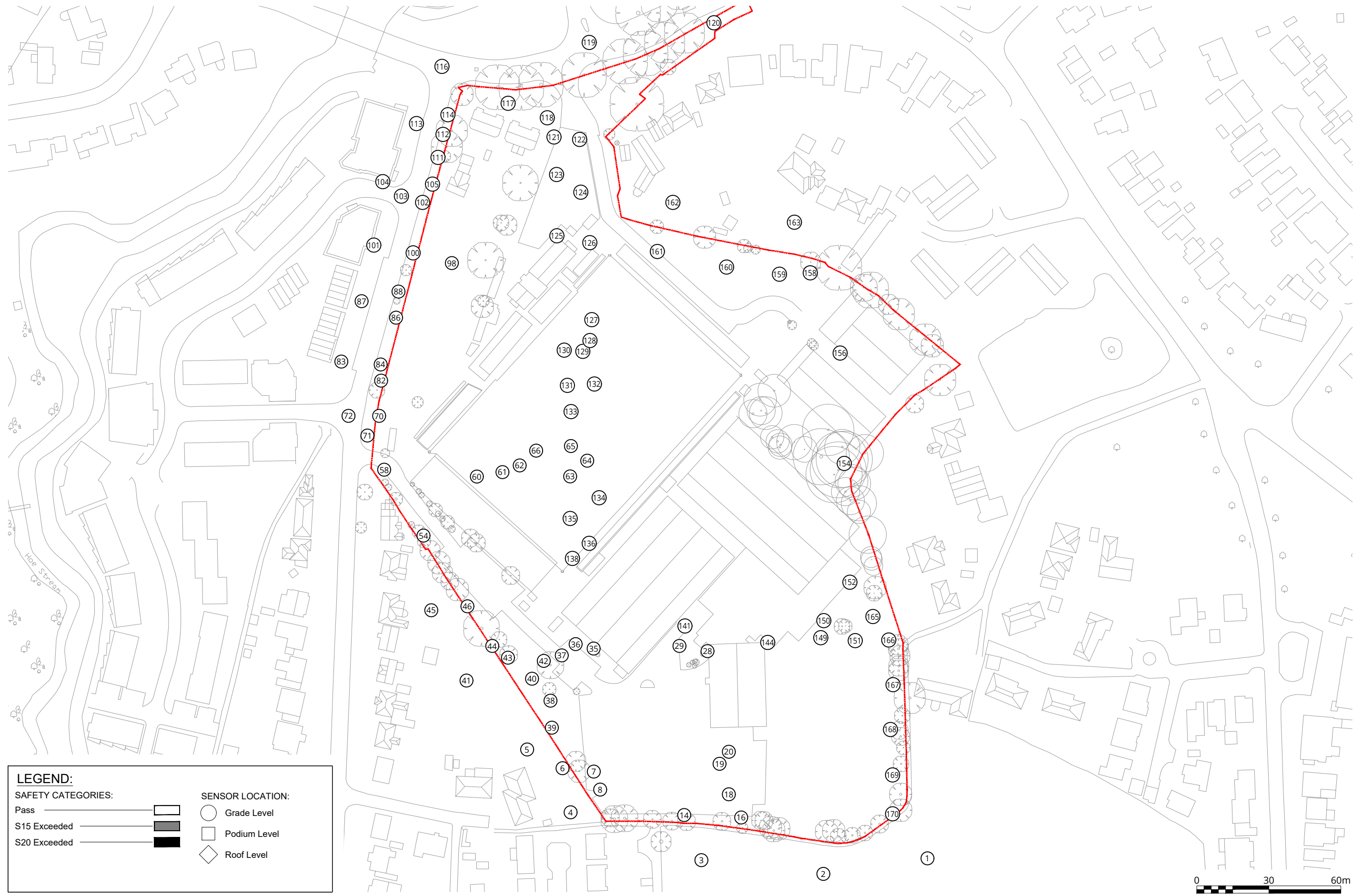
Woking Football Club - Woking, UK



Drawn by: JLF	Figure: 4
Approx. Scale @A3: 1:1500	
Date Revised: Nov. 21, 2019	



Project #1900950



**LEGEND:**

**SAFETY CATEGORIES:**


- Pass ————
- S15 Exceeded - - - - -
- S20 Exceeded . . . . .

**SENSOR LOCATION:**

- Grade Level
- ◐ Podium Level
- ◑ Roof Level

**Pedestrian Wind Safety Conditions - Ground and Podium Levels**  
 Configuration 1: Existing Site with Existing Surrounding Buildings  
 Annual


Woking Football Club - Woking, UK

True North 

Drawn by: JLF Figure: 5

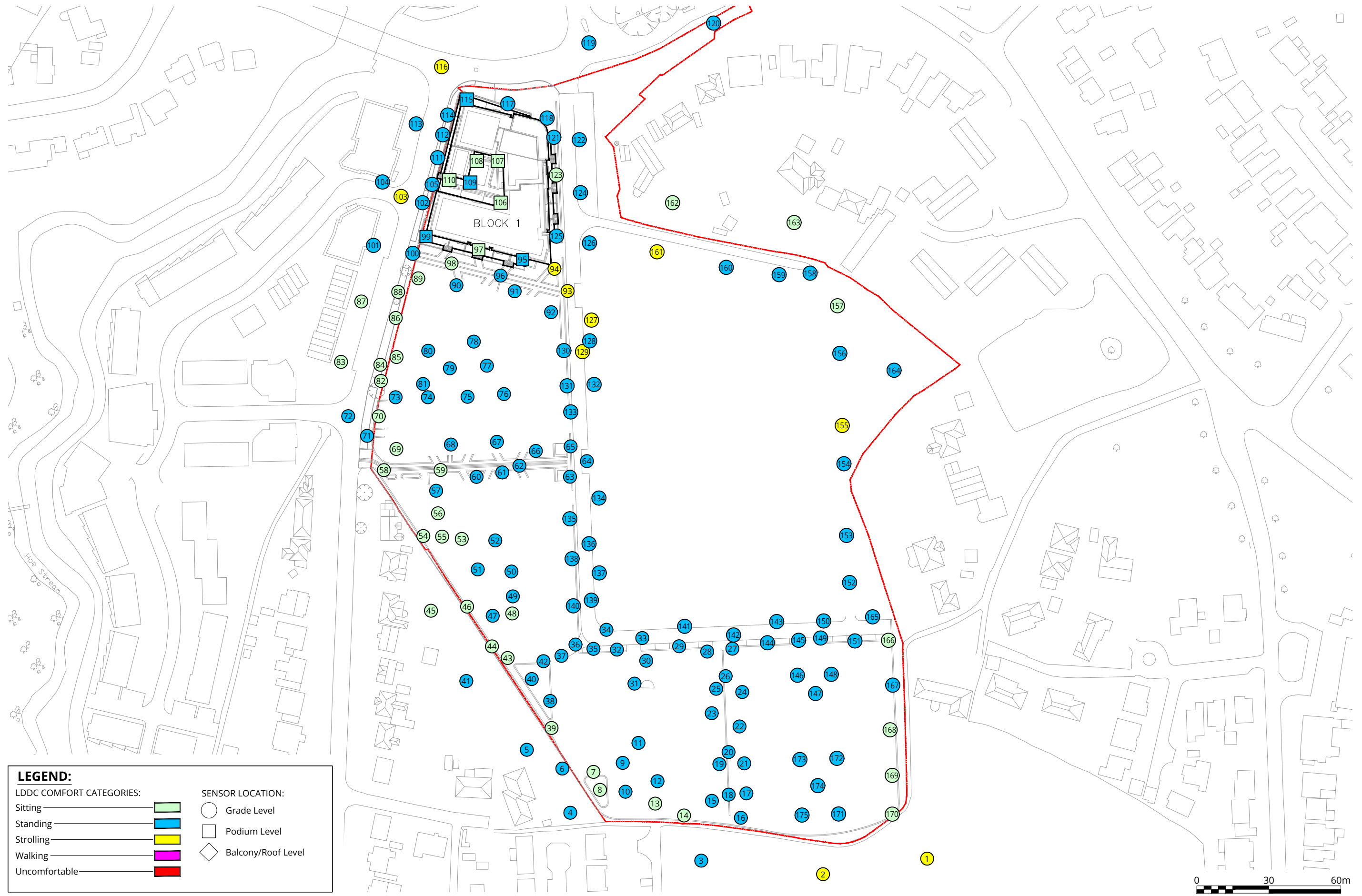
Approx. Scale @A3: 1:1500

Date Revised: Nov. 21, 2019



Project #1900950





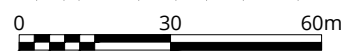
**LEGEND:**

**LDDC COMFORT CATEGORIES:**

- Sitting
- Standing
- Strolling
- Walking
- Uncomfortable

**SENSOR LOCATION:**

- Grade Level
- Podium Level
- Balcony/Roof Level



**Pedestrian Wind Comfort Conditions - Ground Floor and Podium Level**  
 Configuration 2: Block 1 of the Proposed Development with Existing surrounding Buildings  
 Windiest Season

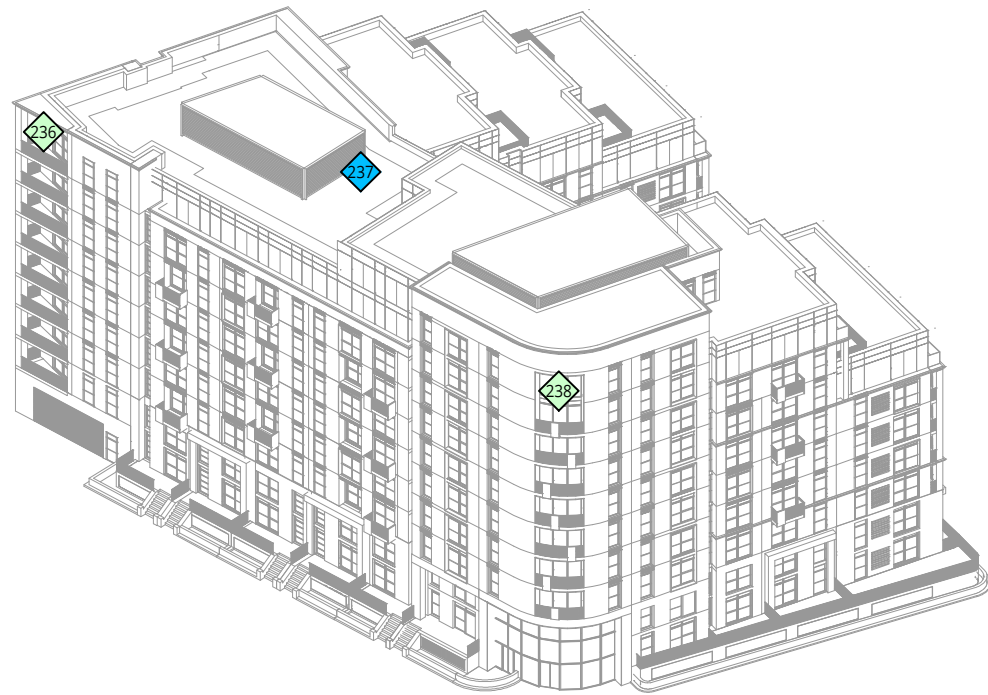
Woking Football Club - Woking, UK



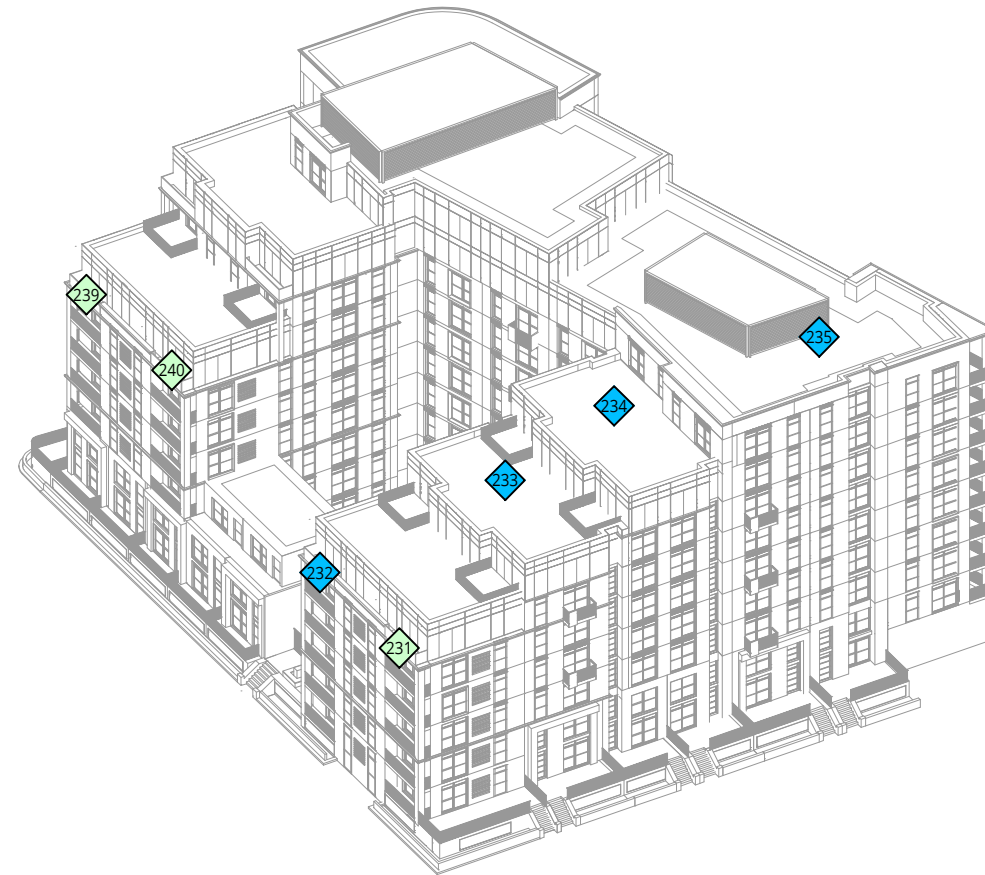
Drawn by: JLF Figure: 6  
 Approx. Scale @A3: 1:1500  
 Date Revised: Nov. 21, 2019



Project #1900950











NORTH / EAST



SOUTH / WEST

**LEGEND:**

LDDC COMFORT CATEGORIES:		SENSOR LOCATION:	
Sitting		 Grade Level	
Standing		 Podium Level	
Strolling		 Balcony/Roof Level	
Walking			
Uncomfortable			



**Pedestrian Wind Comfort Conditions - Isometric Views**  
 Configuration 2: Block 1 of the Proposed Development with Existing surrounding Buildings  
 Windiest Season

Woking Football Club - Woking, UK

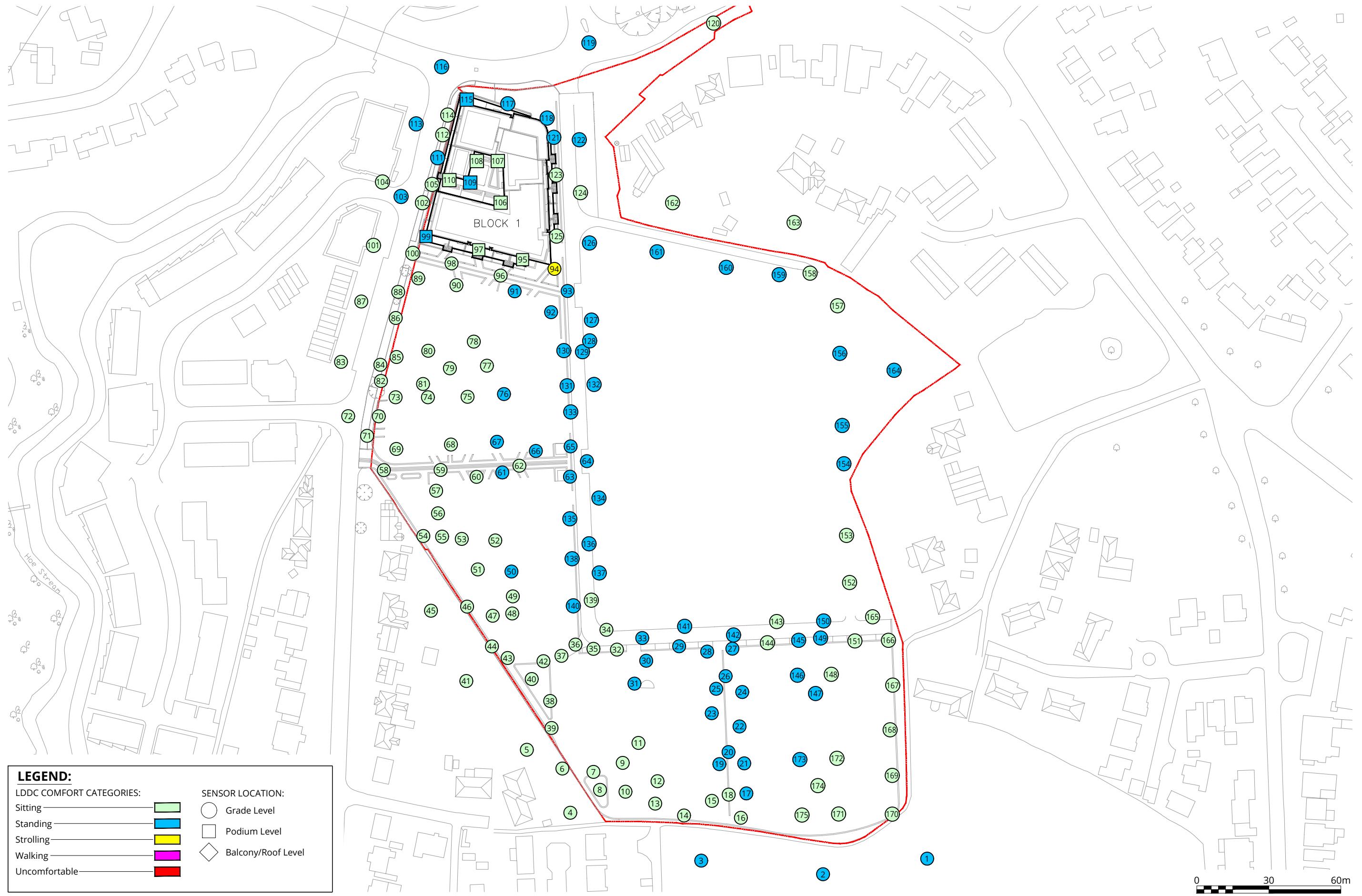
Drawn by: JLF Figure: 7

Approx. Scale @A3: 1:600

Date Revised: Nov. 21, 2019

Project #1900950





**LEGEND:**

**LDDC COMFORT CATEGORIES:**

- Sitting
- Standing
- Strolling
- Walking
- Uncomfortable

**SENSOR LOCATION:**

- Grade Level
- Podium Level
- ◇ Balcony/Roof Level

**Pedestrian Wind Comfort Conditions - Ground Floor and Podium Level**  
 Configuration 2: Block 1 of the Proposed Development with Existing surrounding Buildings  
 Summer Season

Woking Football Club - Woking, UK

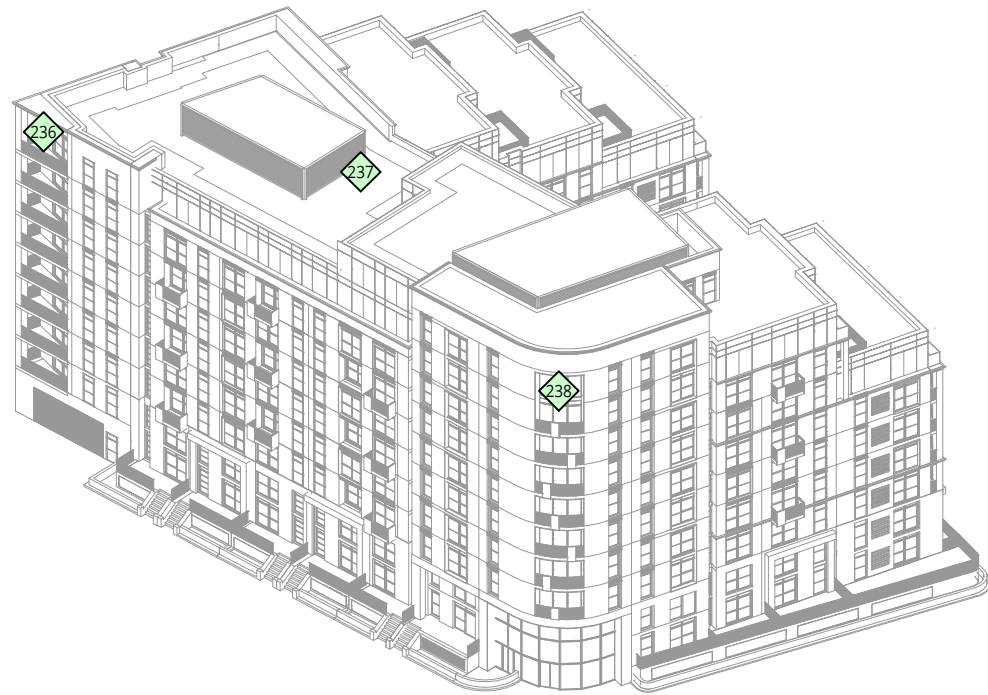


Drawn by: JLF Figure: 8  
 Approx. Scale @A3: 1:1500  
 Date Revised: Nov. 21, 2019

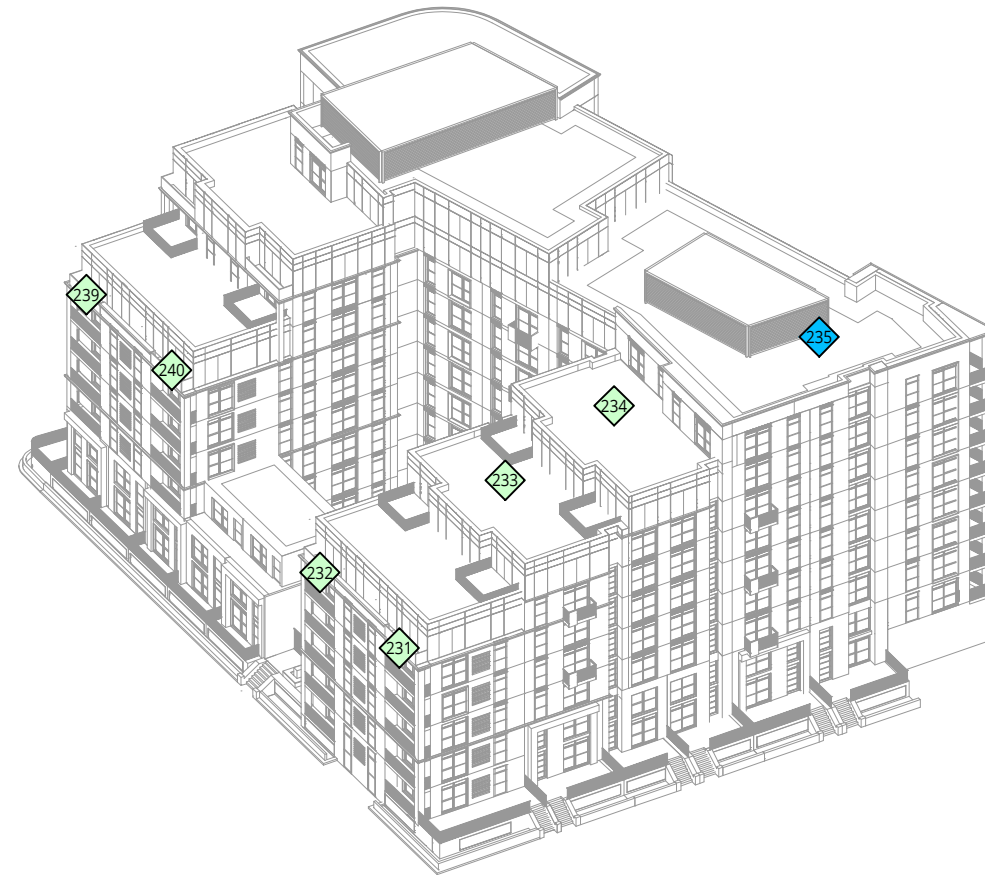


Project #1900950













NORTH / EAST



SOUTH / WEST

**LEGEND:**

LDDC COMFORT CATEGORIES:		SENSOR LOCATION:	
Sitting		 Grade Level	
Standing		 Podium Level	
Strolling		 Balcony/Roof Level	
Walking			
Uncomfortable			



**Pedestrian Wind Comfort Conditions - Isometric Views**  
 Configuration 2: Block 1 of the Proposed Development with Existing surrounding Buildings  
 Summer Season

Woking Football Club - Woking, UK

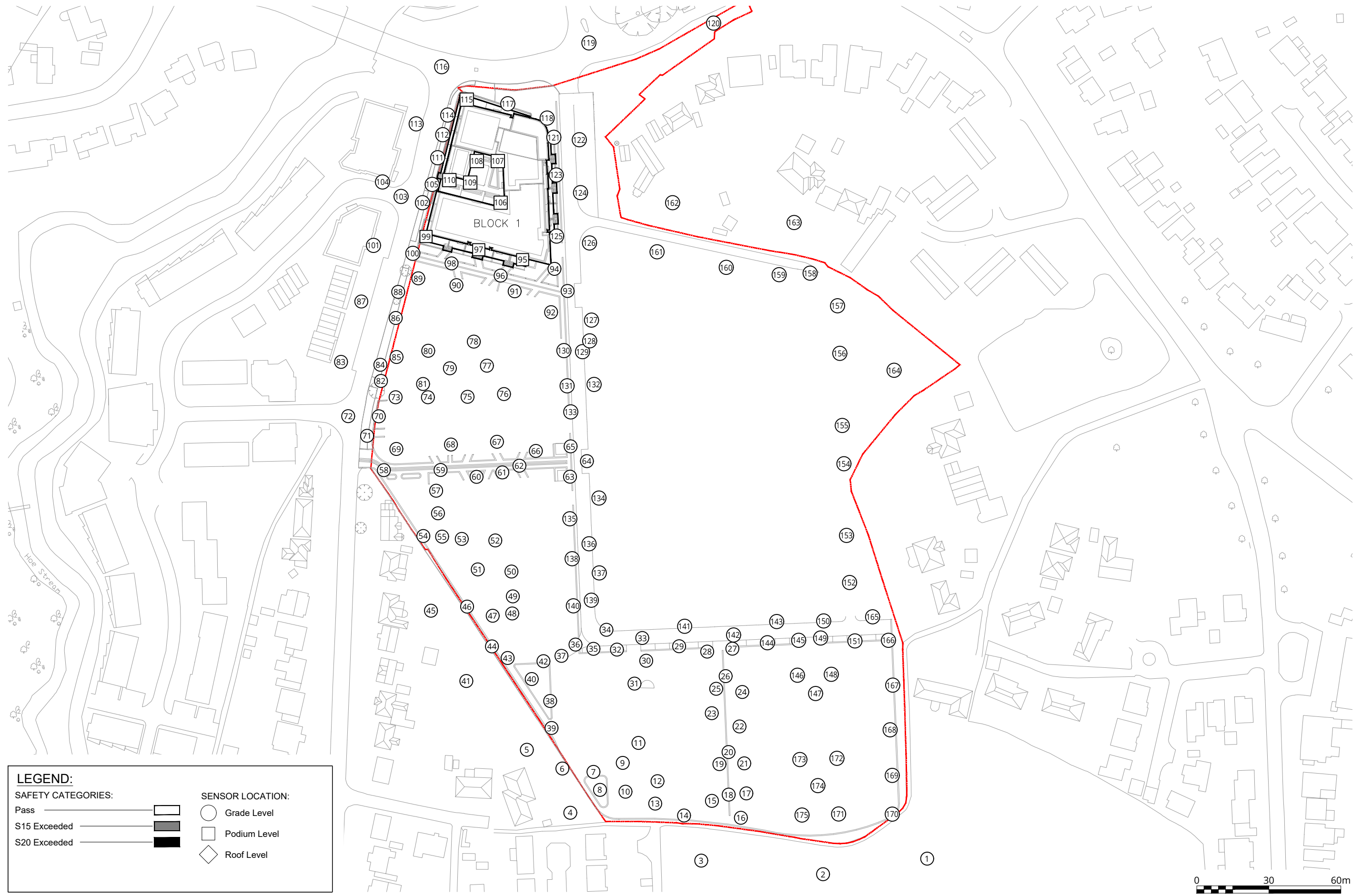
Drawn by: JLF | Figure: 9

Approx. Scale @A3: 1:600

Date Revised: Nov. 21, 2019

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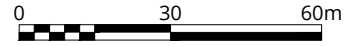
**LEGEND:**

**SAFETY CATEGORIES:**

- Pass
- S15 Exceeded
- S20 Exceeded

**SENSOR LOCATION:**

- Grade Level
- Podium Level
- ◇ Roof Level



**Pedestrian Wind Safety Conditions - Ground Floor and Podium Level**  
 Configuration 2: Block 1 of the Proposed Development with Existing surrounding Buildings  
 Annual

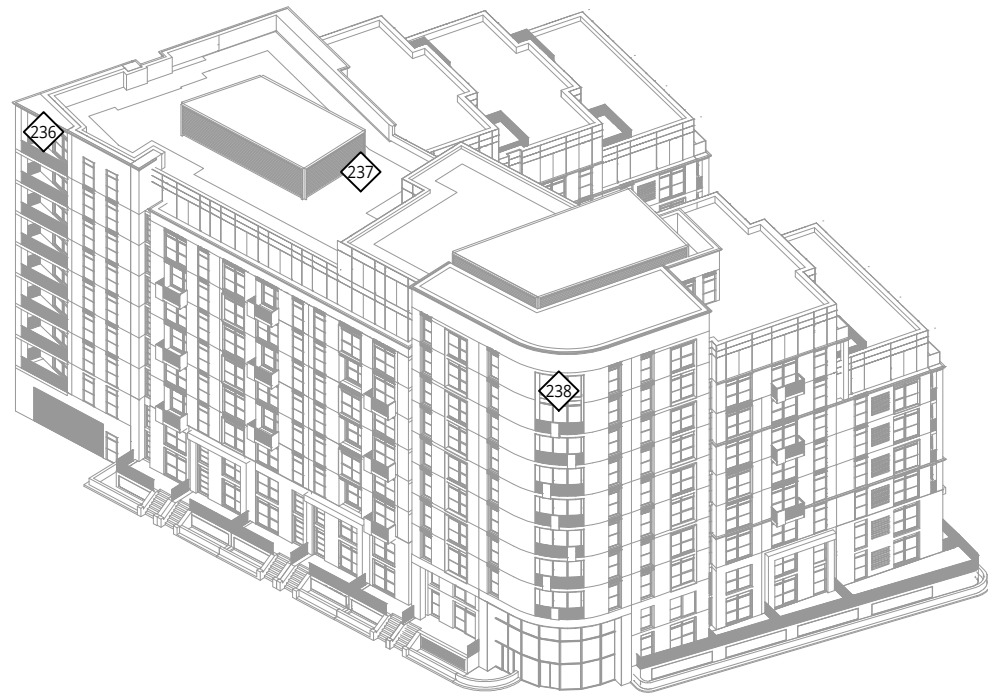
Woking Football Club - Woking, UK



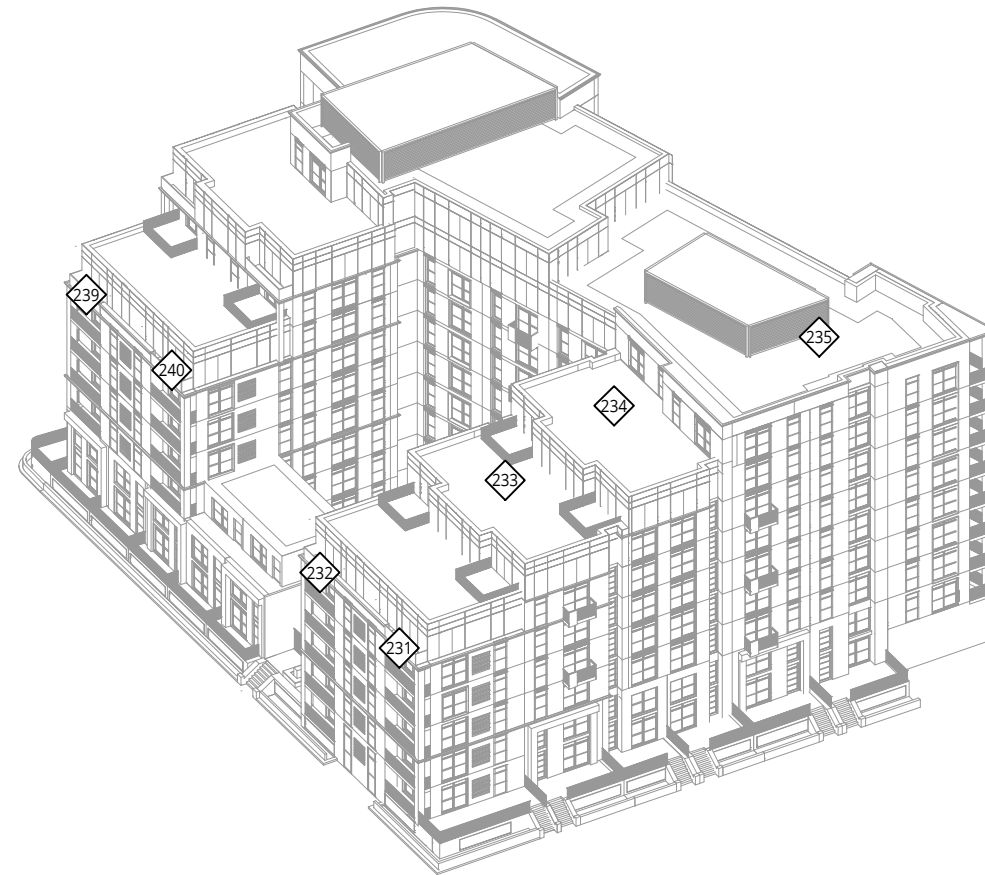
Drawn by: JLF Figure: 10  
 Approx. Scale @A3: 1:1500  
 Date Revised: Nov. 21, 2019

Project #1900950






NORTH / EAST





SOUTH / WEST

**LEGEND:**


**SAFETY CATEGORIES:**


Pass ———— 


S15 Exceeded ———— 

S20 Exceeded ———— 

**SENSOR LOCATION:**

 Grade Level

 Podium Level

 Roof Level



**Pedestrian Wind Safety Conditions - Isometric Views**  
 Configuration 2: Block 1 of the Proposed Development with Existing surrounding Buildings  
 Annual

Woking Football Club - Woking, UK

Drawn by: JLF Figure: 11

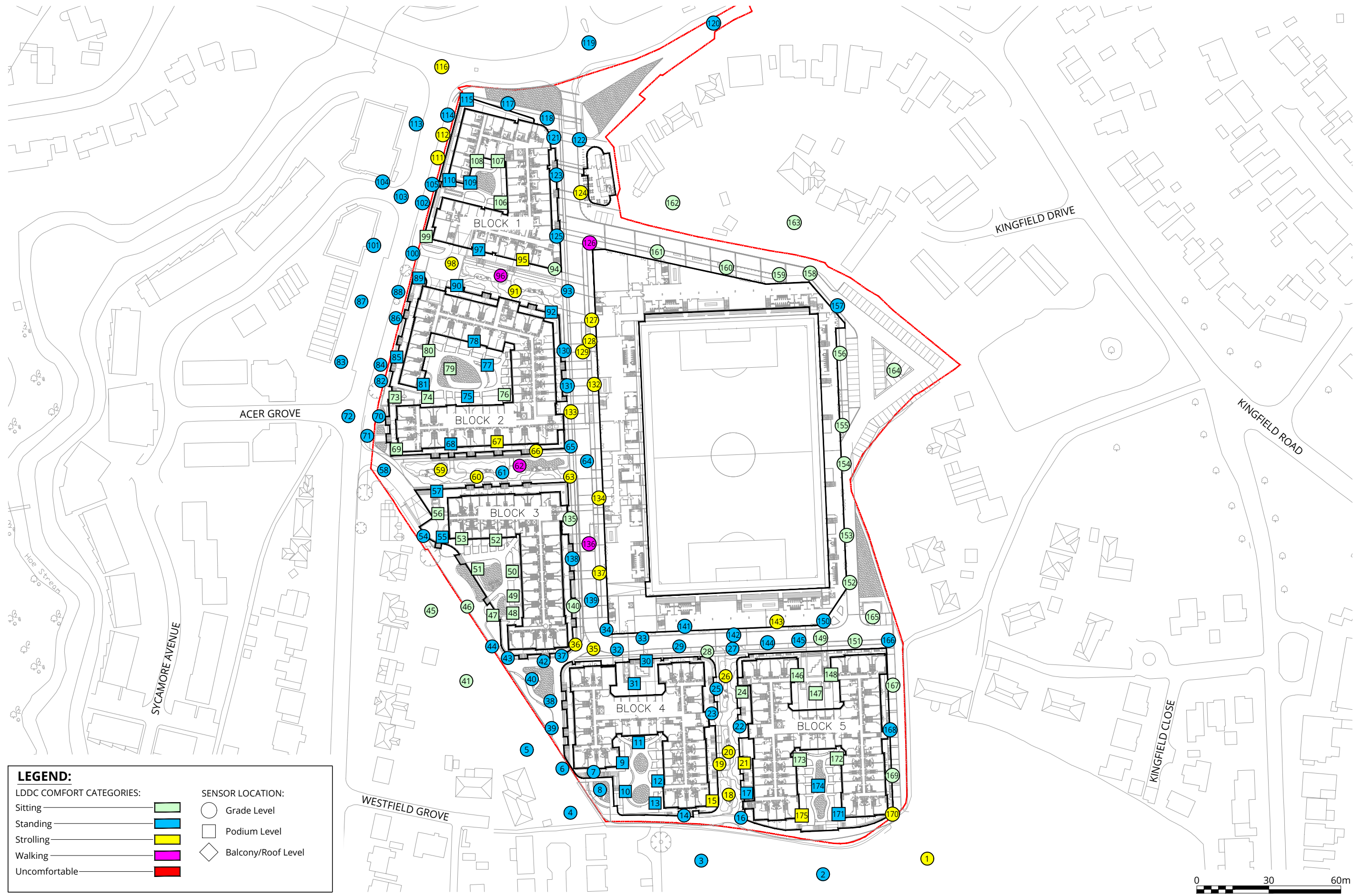
Approx. Scale @A3: 1:600

Date Revised: Nov. 21, 2019



Project #1900950





**LEGEND:**

**LDDC COMFORT CATEGORIES:**

- Sitting
- Standing
- Strolling
- Walking
- Uncomfortable

**SENSOR LOCATION:**

- Grade Level
- Podium Level
- Balcony/Roof Level

**Pedestrian Wind Comfort Conditions - Ground Floor and Podium Level**  
 Configuration 3: Proposed Development with Existing Surrounding Buildings  
 Windiest Season

Woking Football Club - Woking, UK



Drawn by: JLF Figure: 12  
 Approx. Scale @A3: 1:1500  
 Date Revised: Nov. 21, 2019

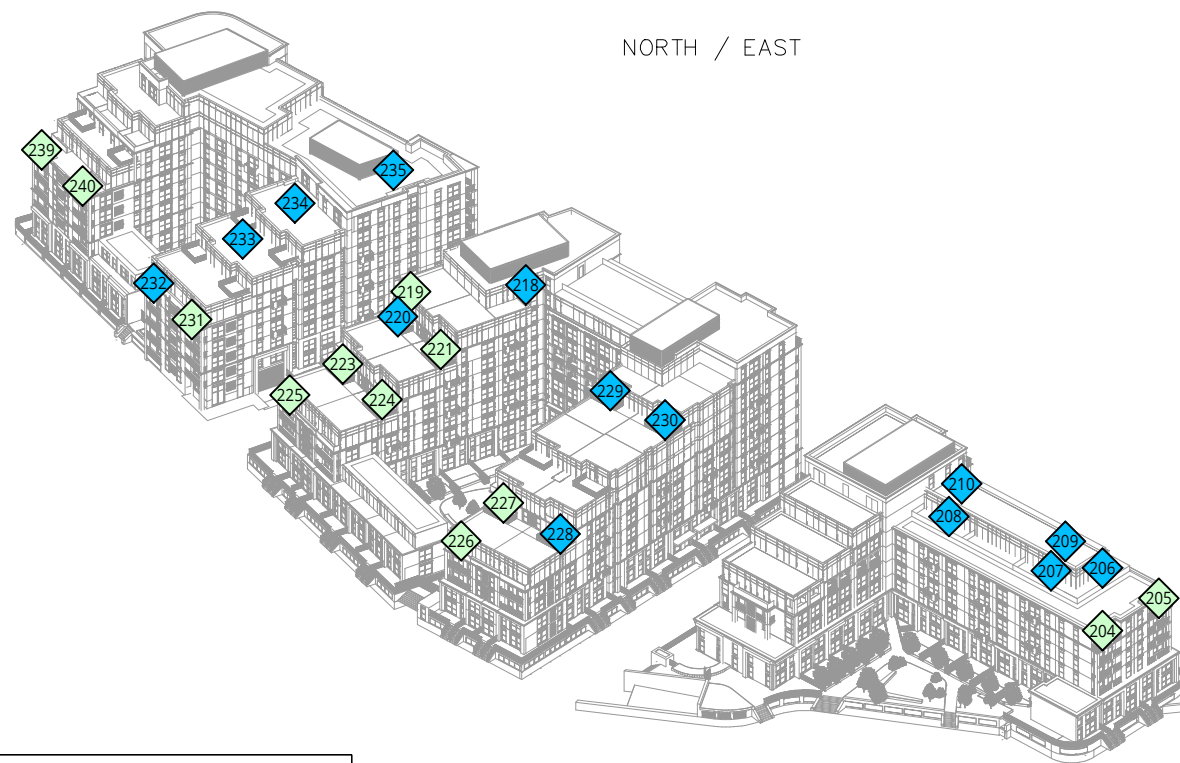


Project #1900950

BUILDING 1, 2 and 3



NORTH / EAST



SOUTH / WEST

**LEGEND:**

LDDC COMFORT CATEGORIES:

- Sitting —
- Standing —
- Strolling —
- Walking —
- Uncomfortable —

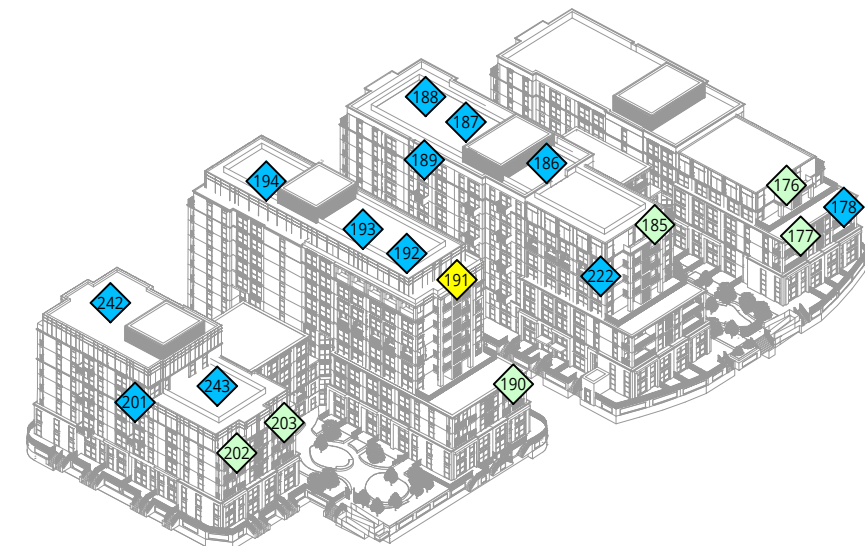
SENSOR LOCATION:

- Grade Level
- Podium Level
- Balcony/Roof Level

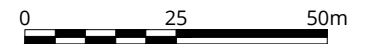
BUILDING 4 and 5



NORTH / EAST



SOUTH / WEST



**Pedestrian Wind Comfort Conditions - Isometric Views**  
 Configuration 3: Proposed Development with Existing Surrounding Buildings  
 Windiest Season

Woking Football Club - Woking, UK

Project #1900950

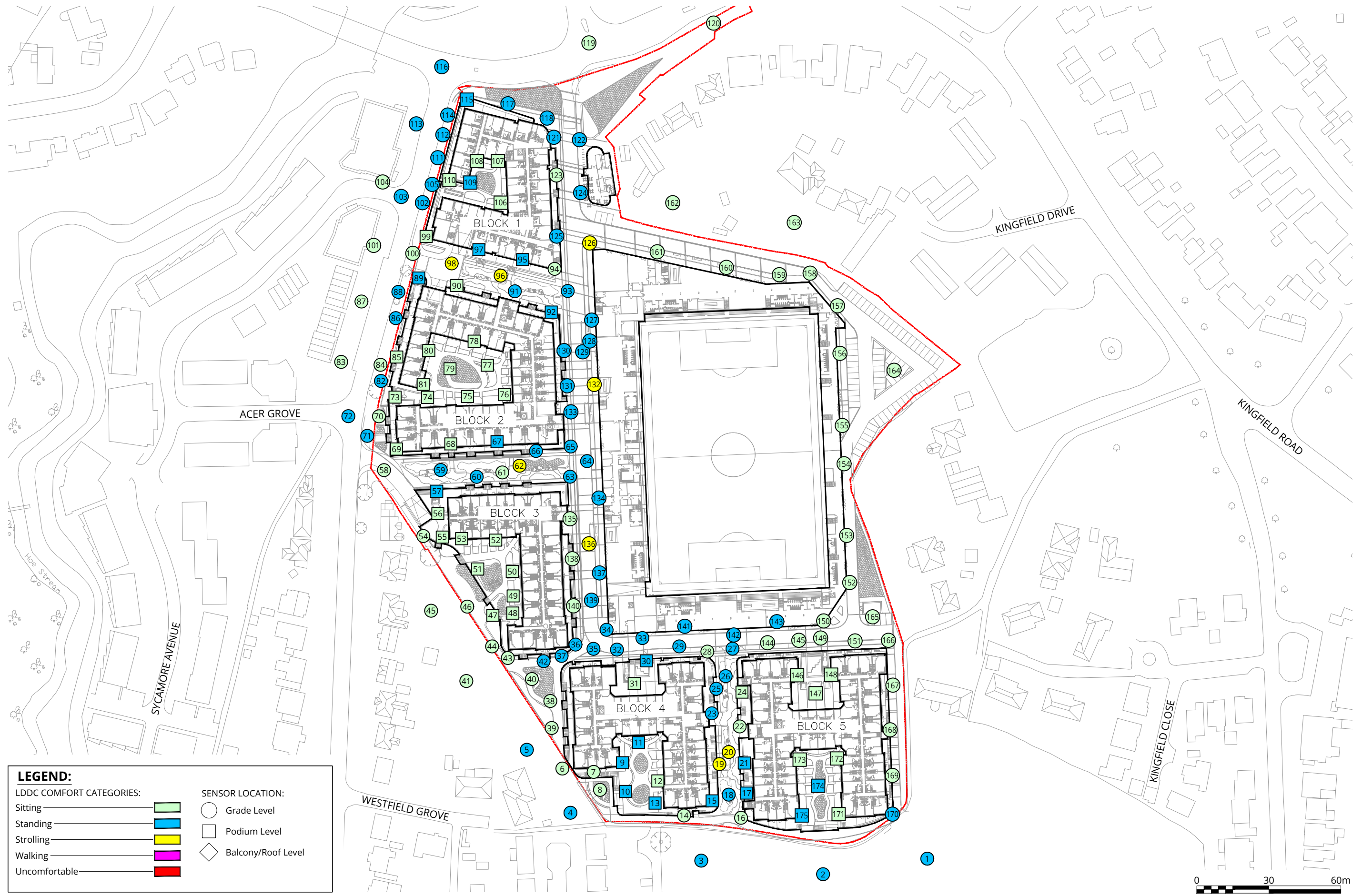
Drawn by: JLF Figure: 13

Approx. Scale @A3: 1:1250

Date Revised: Nov. 21, 2019







**LEGEND:**

**LDDC COMFORT CATEGORIES:**

- Sitting
- Standing
- Strolling
- Walking
- Uncomfortable

**SENSOR LOCATION:**

- Grade Level
- Podium Level
- Balcony/Roof Level

**Pedestrian Wind Comfort Conditions - Ground Floor and Podium Level**  
 Configuration 3: Proposed Development with Existing Surrounding Buildings  
 Summer Season

Woking Football Club - Woking, UK



Drawn by: JLF Figure: 14  
 Approx. Scale @A3: 1:1500  
 Date Revised: Nov. 21, 2019

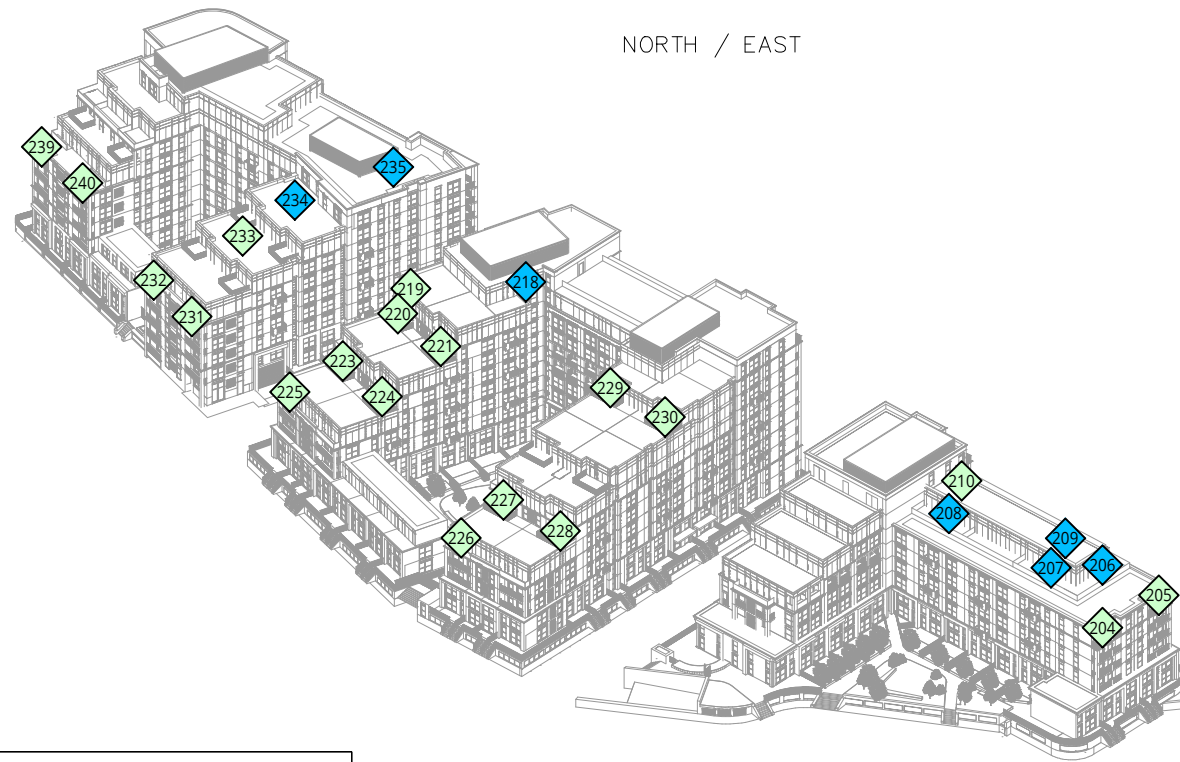


Project #1900950

BUILDING 1, 2 and 3



NORTH / EAST



SOUTH / WEST

**LEGEND:**

LDDC COMFORT CATEGORIES:

- Sitting —
- Standing —
- Strolling —
- Walking —
- Uncomfortable —

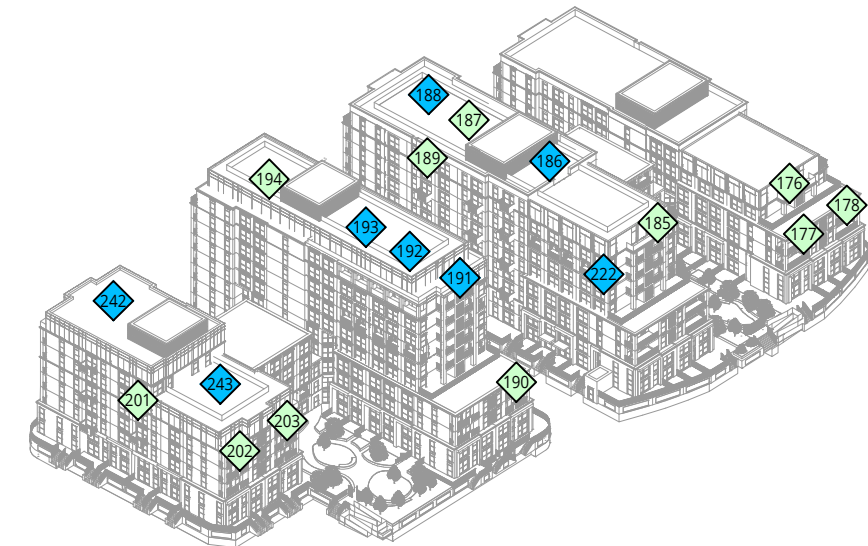
SENSOR LOCATION:

- Grade Level
- Podium Level
- Balcony/Roof Level

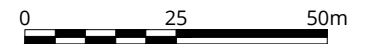
BUILDING 4 and 5



NORTH / EAST



SOUTH / WEST



**Pedestrian Wind Comfort Conditions - Isometric Views**  
 Configuration 3: Proposed Development with Existing Surrounding Buildings  
 Summer Season

Woking Football Club - Woking, UK

Project #1900950

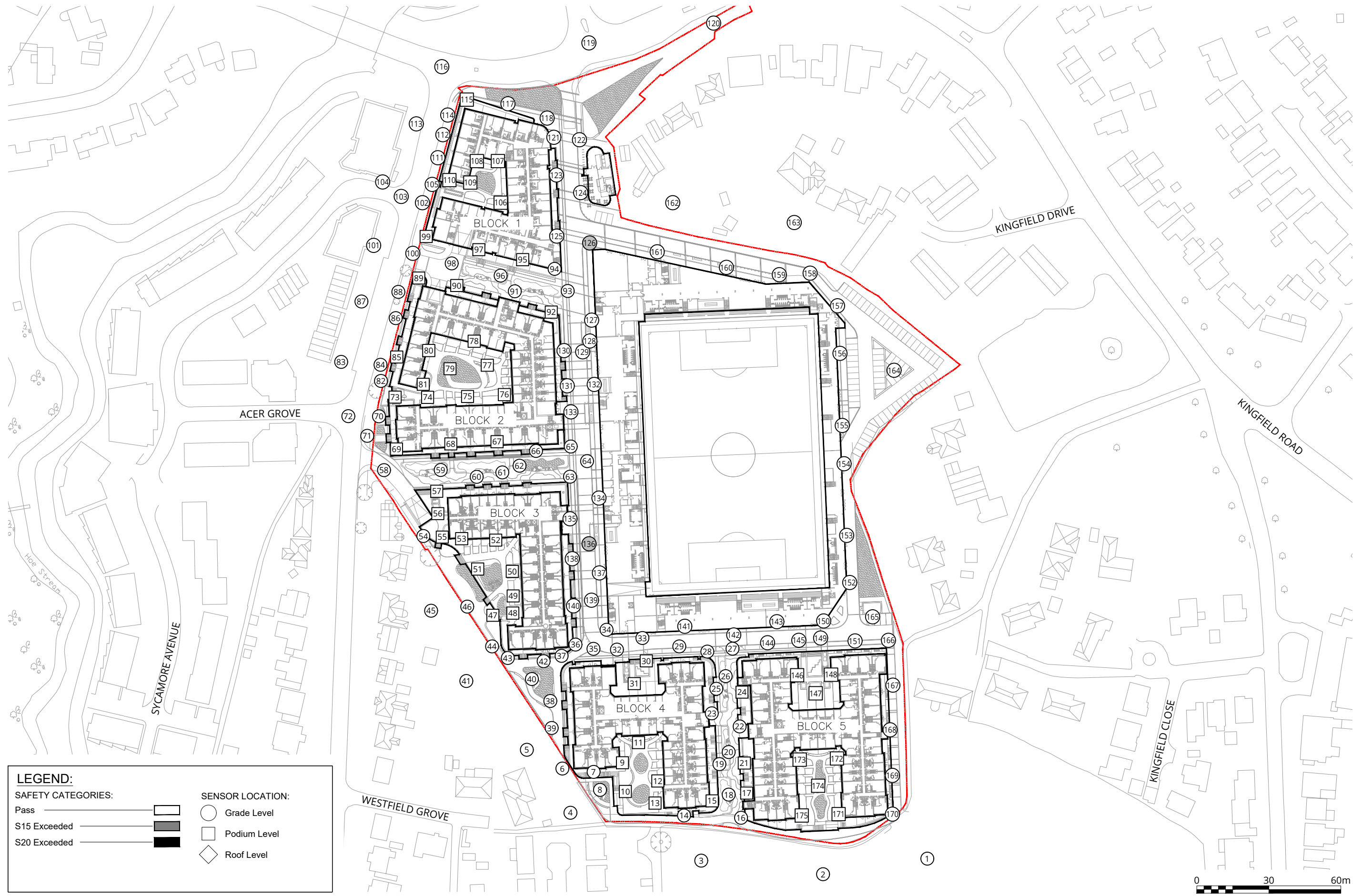
Drawn by: JLF Figure: 15

Approx. Scale @A3: 1:1250

Date Revised: Nov. 21, 2019







**LEGEND:**

**SAFETY CATEGORIES:**

- Pass
- S15 Exceeded
- S20 Exceeded

**SENSOR LOCATION:**

- Grade Level
- Podium Level
- ◇ Roof Level

**Pedestrian Wind Safety Conditions - Ground Floor and Podium Level**  
 Configuration 3: Proposed Development with Existing Surrounding Buildings  
 Annual

Woking Football Club - Woking, UK



Drawn by: JLF Figure: 16  
 Approx. Scale @A3: 1:1500  
 Date Revised: Nov. 21, 2019

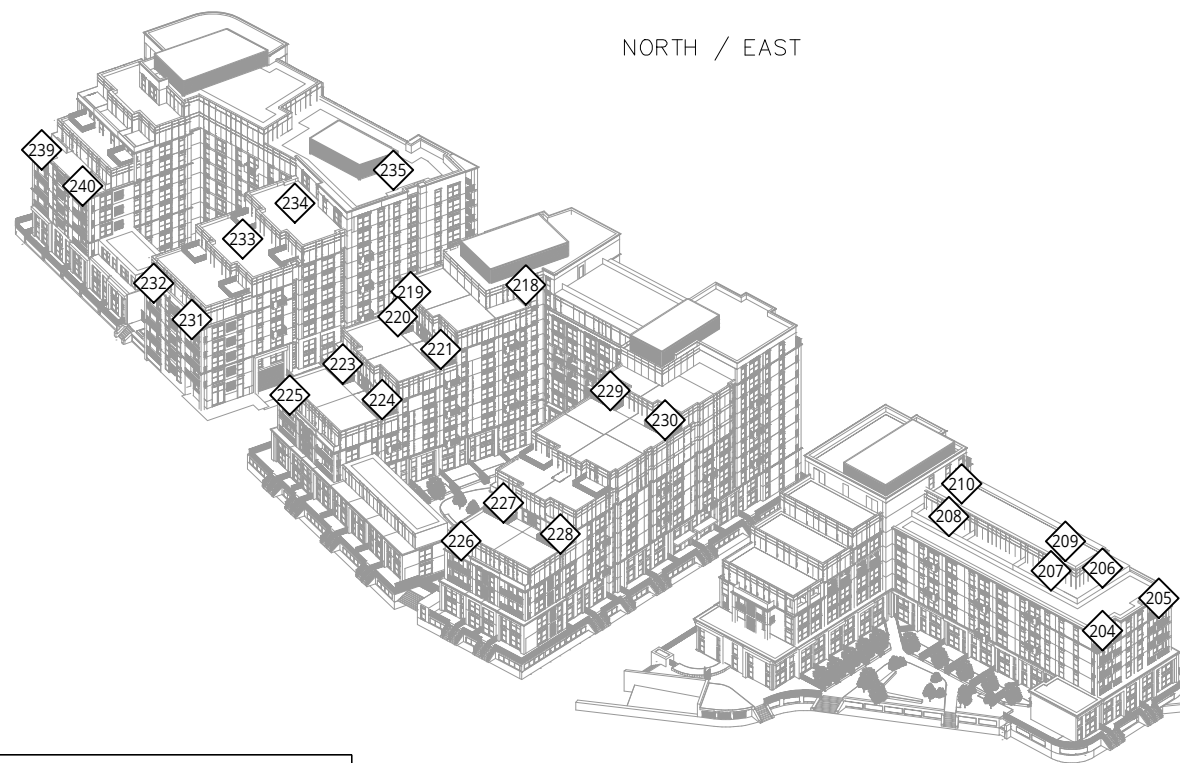


Project #1900950

BUILDING 1, 2 and 3



NORTH / EAST



SOUTH / WEST

**LEGEND:**

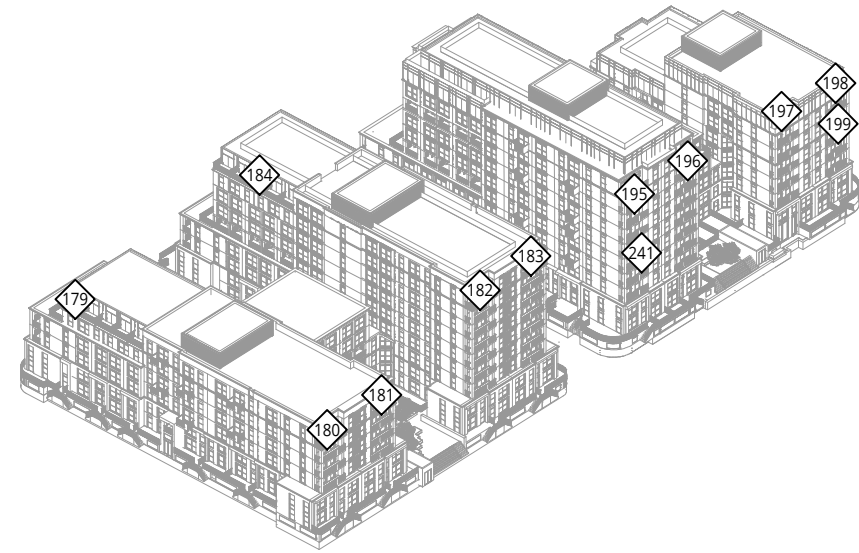
**SAFETY CATEGORIES:**

- Pass
- S15 Exceeded
- S20 Exceeded

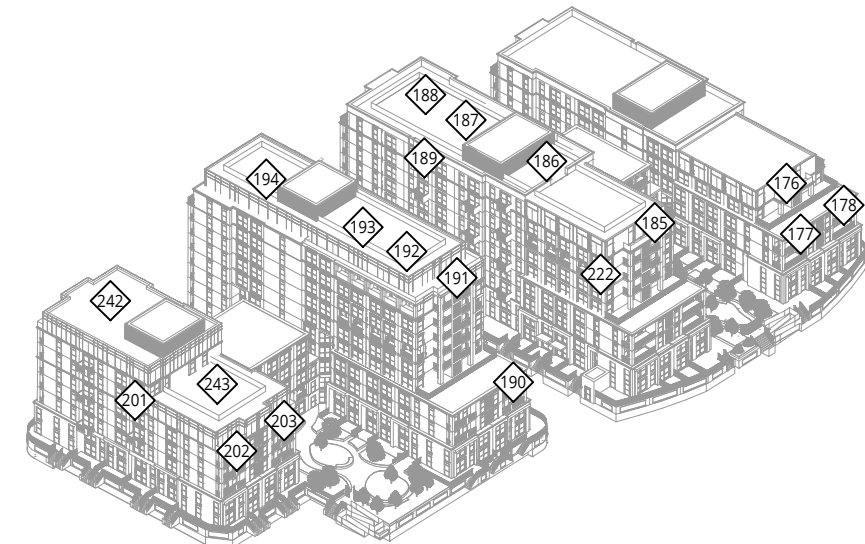
**SENSOR LOCATION:**

- Grade Level
- Podium Level
- Roof Level

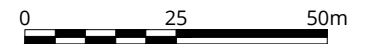
BUILDING 4 and 5



NORTH / EAST



SOUTH / WEST



**Pedestrian Wind Safety Conditions - Isometric Views**  
 Configuration 3: Proposed Development with Existing Surrounding Buildings  
 Annual

Woking Football Club - Woking, UK

Drawn by: JLF Figure: 17

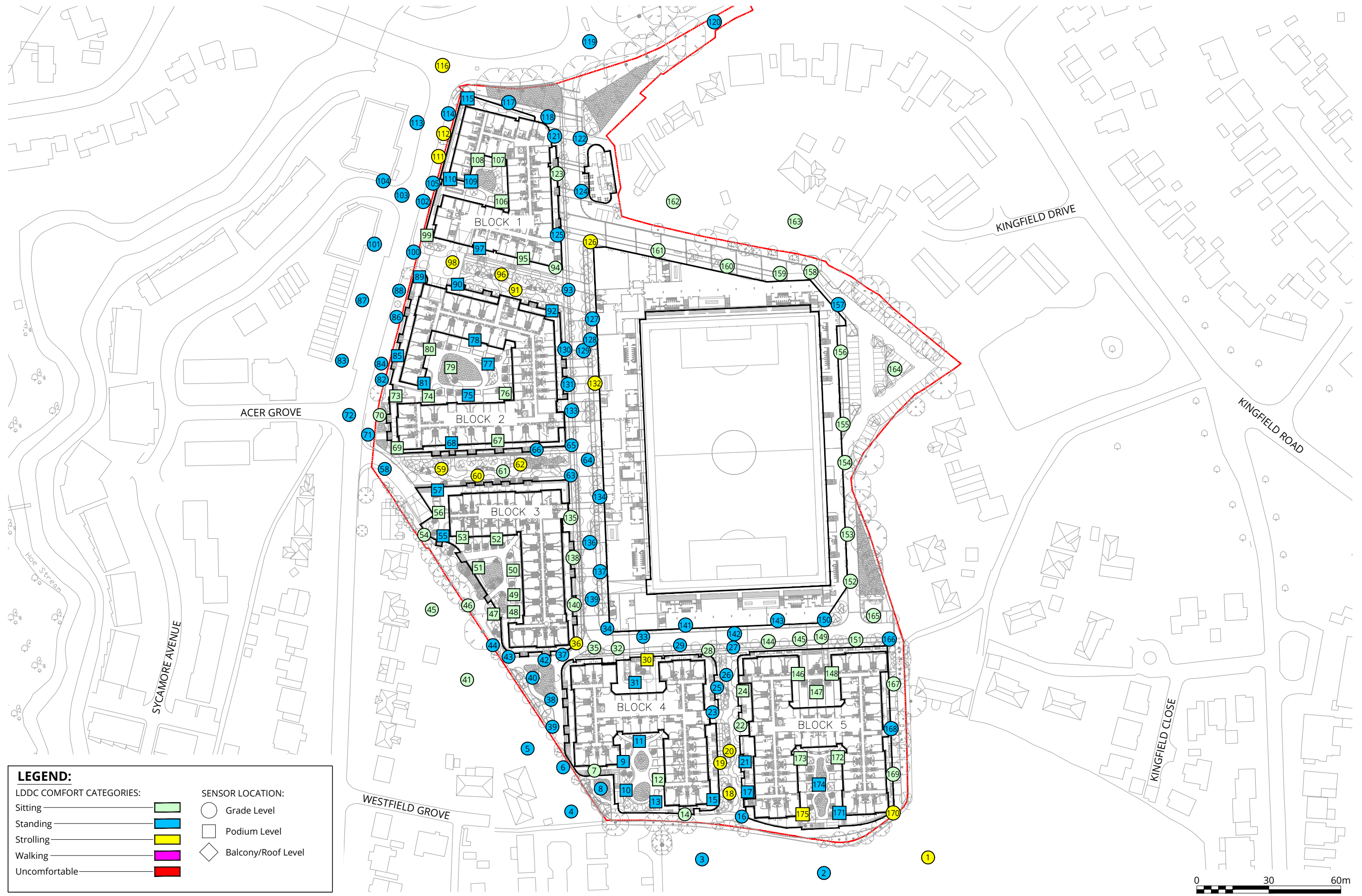
Approx. Scale @A3: 1:1250

Date Revised: Nov. 21, 2019

Project #1900950







**LEGEND:**

**LDDC COMFORT CATEGORIES:**

- Sitting
- Standing
- Strolling
- Walking
- Uncomfortable

**SENSOR LOCATION:**

- Grade Level
- Podium Level
- Balcony/Roof Level

**Pedestrian Wind Comfort Conditions - Ground Floor and Podium Level**  
 Configuration 4: Proposed Development with Existing Surrounding Buildings and Proposed Landscaping Scheme and Mitigation Measures  
 Windiest Season

Woking Football Club - Woking, UK

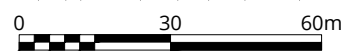
True North

Drawn by: JLF Figure: 18

Approx. Scale @A3: 1:1500

Date Revised: Nov. 21, 2019

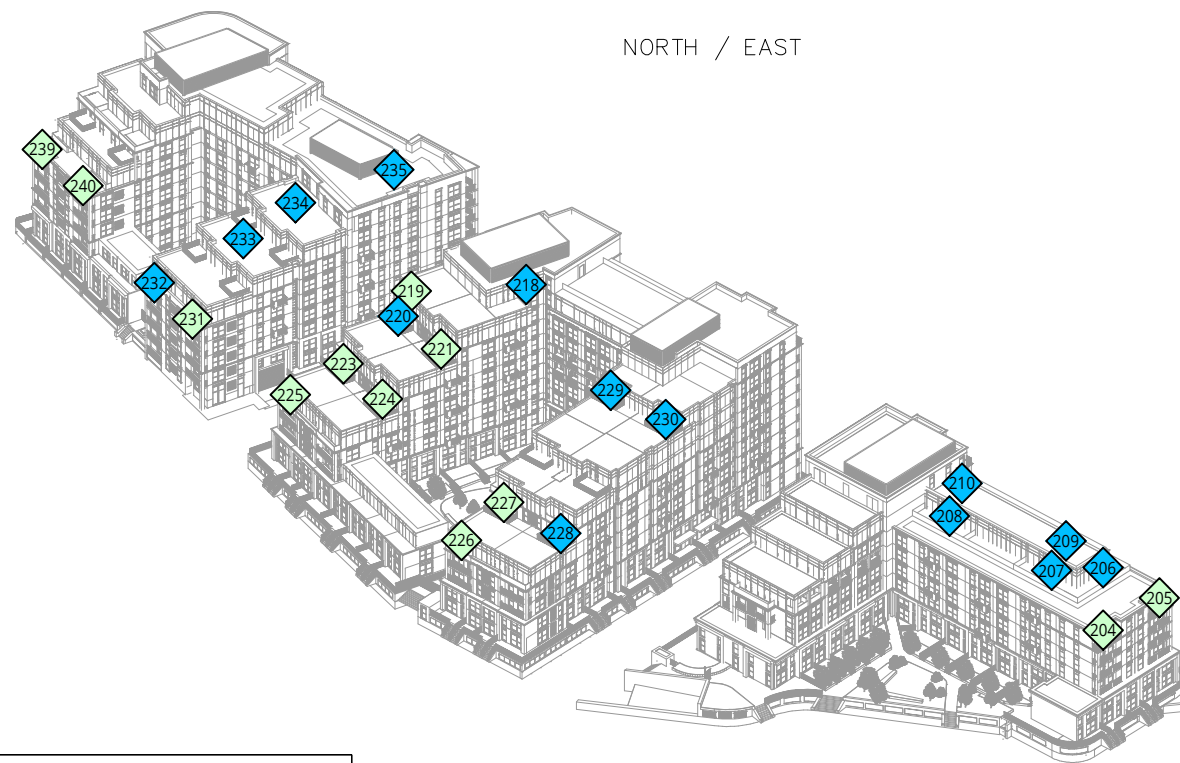
Project #1900950



BUILDING 1, 2 and 3



NORTH / EAST



SOUTH / WEST

**LEGEND:**

LDDC COMFORT CATEGORIES:

- Sitting —
- Standing —
- Strolling —
- Walking —
- Uncomfortable —

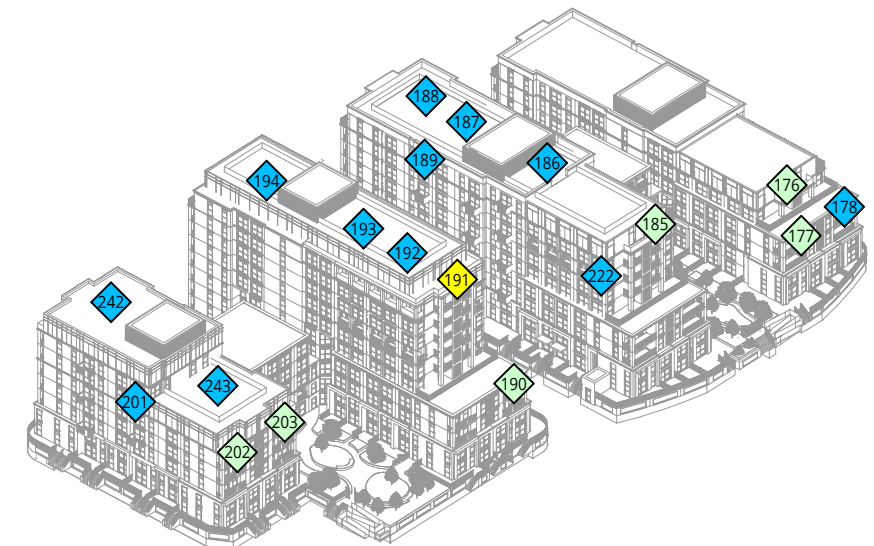
SENSOR LOCATION:

- Grade Level
- Podium Level
- Balcony/Roof Level

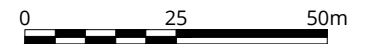
BUILDING 4 and 5



NORTH / EAST



SOUTH / WEST



**Pedestrian Wind Comfort Conditions - Isometric Views**  
 Configuration 4: Proposed Development with Existing Surrounding Buildings and Proposed Landscaping Scheme and Mitigation Measures  
 Windiest Season

Woking Football Club - Woking, UK

Project #1900950

Drawn by: JLF Figure: 19

Approx. Scale @A3: 1:1250

Date Revised: Nov. 21, 2019







**LEGEND:**

**LDDC COMFORT CATEGORIES:**

- Sitting
- Standing
- Strolling
- Walking
- Uncomfortable

**SENSOR LOCATION:**

- Grade Level
- Podium Level
- Balcony/Roof Level

**Pedestrian Wind Comfort Conditions - Ground Floor and Podium Level**  
 Configuration 4: Proposed Development with Existing Surrounding Buildings and Proposed Landscaping Scheme and Mitigation Measures  
 Summer Season

Woking Football Club - Woking, UK



Drawn by: JLF Figure: 20  
 Approx. Scale @A3: 1:1500  
 Date Revised: Nov. 21, 2019

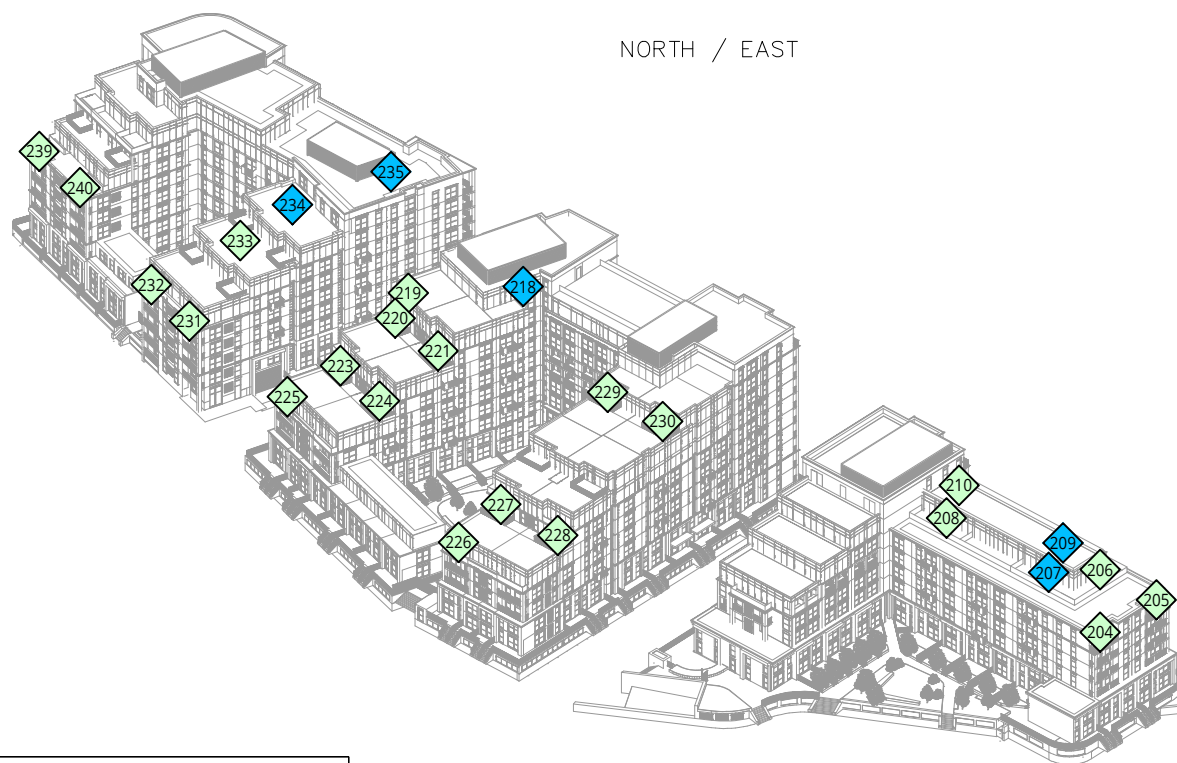


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BUILDING 1, 2 and 3



NORTH / EAST



SOUTH / WEST

**LEGEND:**

LDDC COMFORT CATEGORIES:

- Sitting —
- Standing —
- Strolling —
- Walking —
- Uncomfortable —

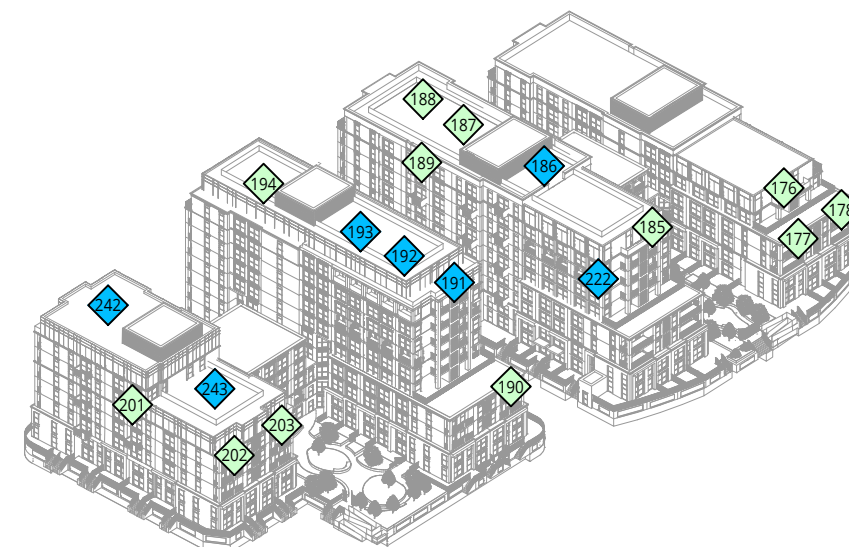
SENSOR LOCATION:

- Grade Level
- Podium Level
- Balcony/Roof Level

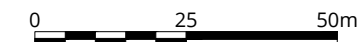
BUILDING 4 and 5



NORTH / EAST



SOUTH / WEST



**Pedestrian Wind Comfort Conditions - Isometric Views**  
 Configuration 4: Proposed Development with Existing Surrounding Buildings and Proposed Landscaping Scheme and Mitigation Measures  
 Summer Season

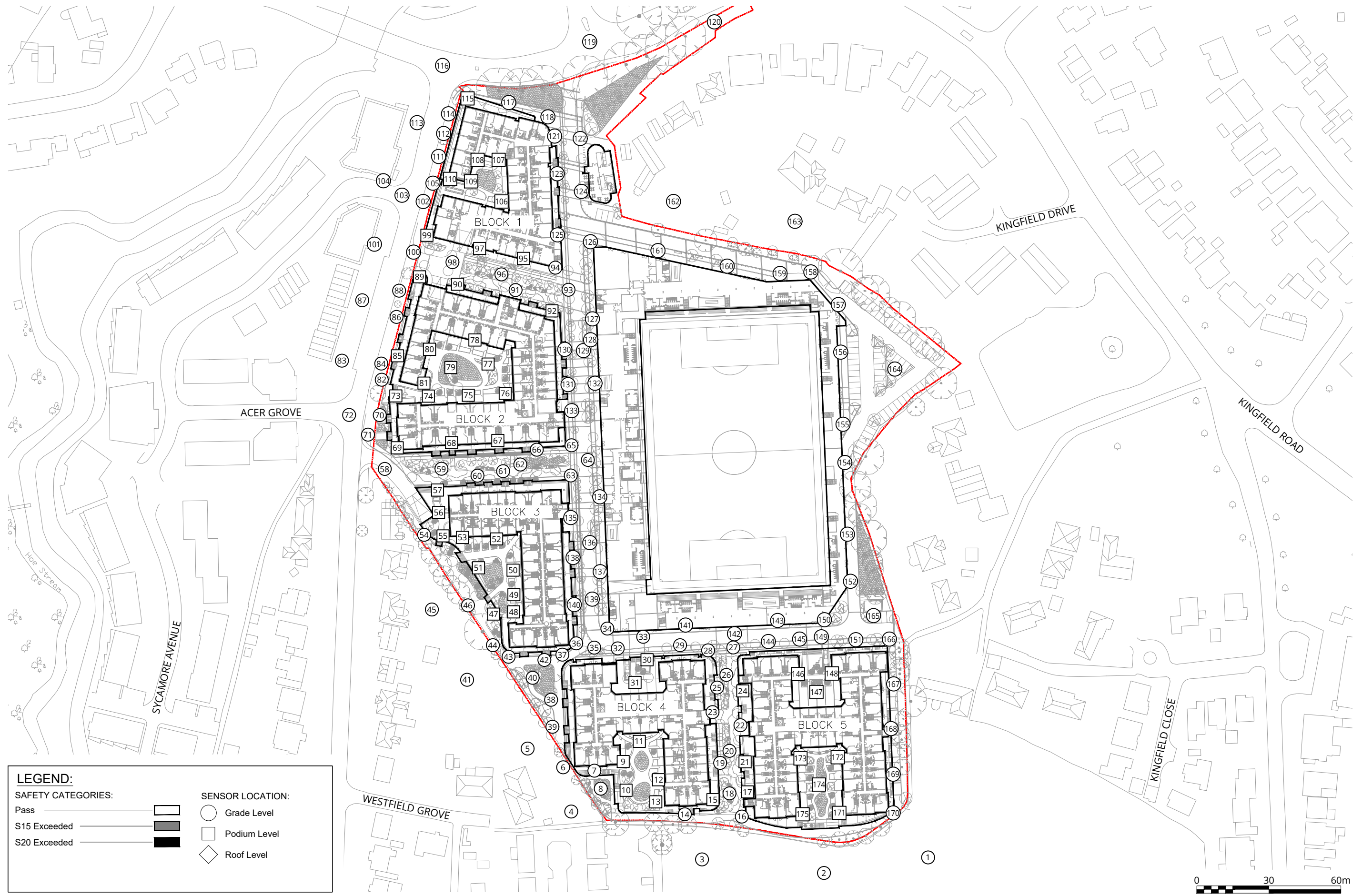
Woking Football Club - Woking, UK

Project #1900950

Drawn by: JLF	Figure: 21
Approx. Scale @A3: 1:1250	
Date Revised: Nov. 21, 2019	







**LEGEND:**

**SAFETY CATEGORIES:**

- Pass
- S15 Exceeded
- S20 Exceeded

**SENSOR LOCATION:**

- Grade Level
- Podium Level
- Roof Level

**Pedestrian Wind Safety Conditions - Ground Floor and Podium Level**  
 Configuration 4: Proposed Development with Existing Surrounding Buildings and Proposed Landscaping Scheme and Mitigation Measures  
 Annual

Woking Football Club - Woking, UK

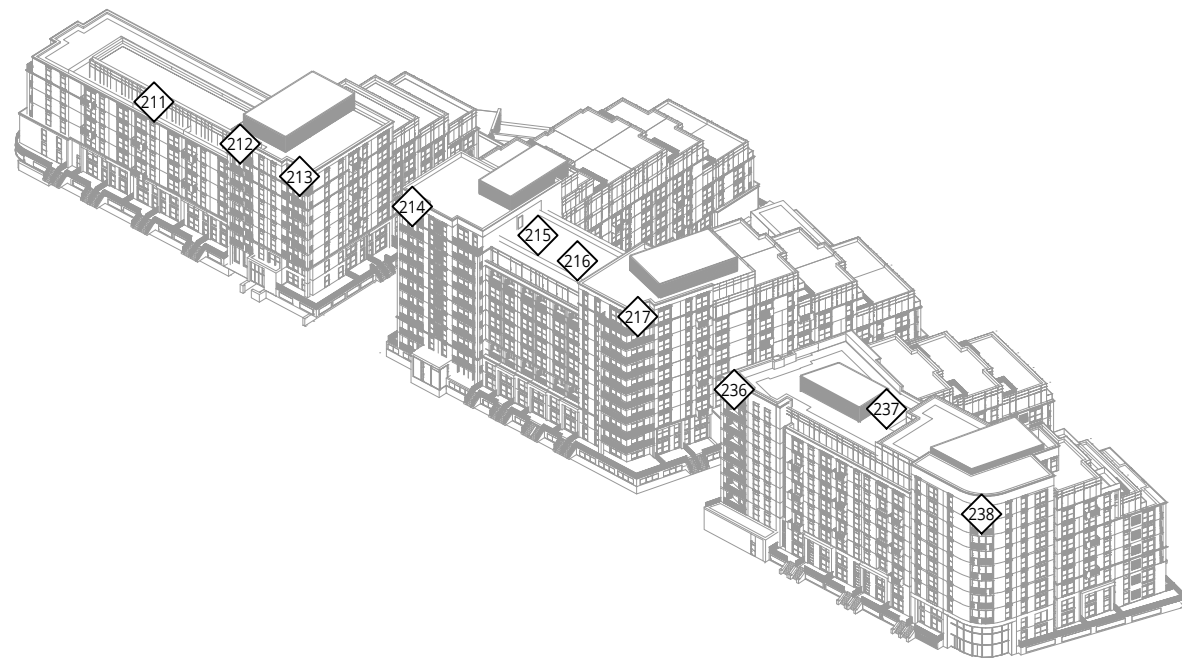
True North

Drawn by: JLF Figure: 22

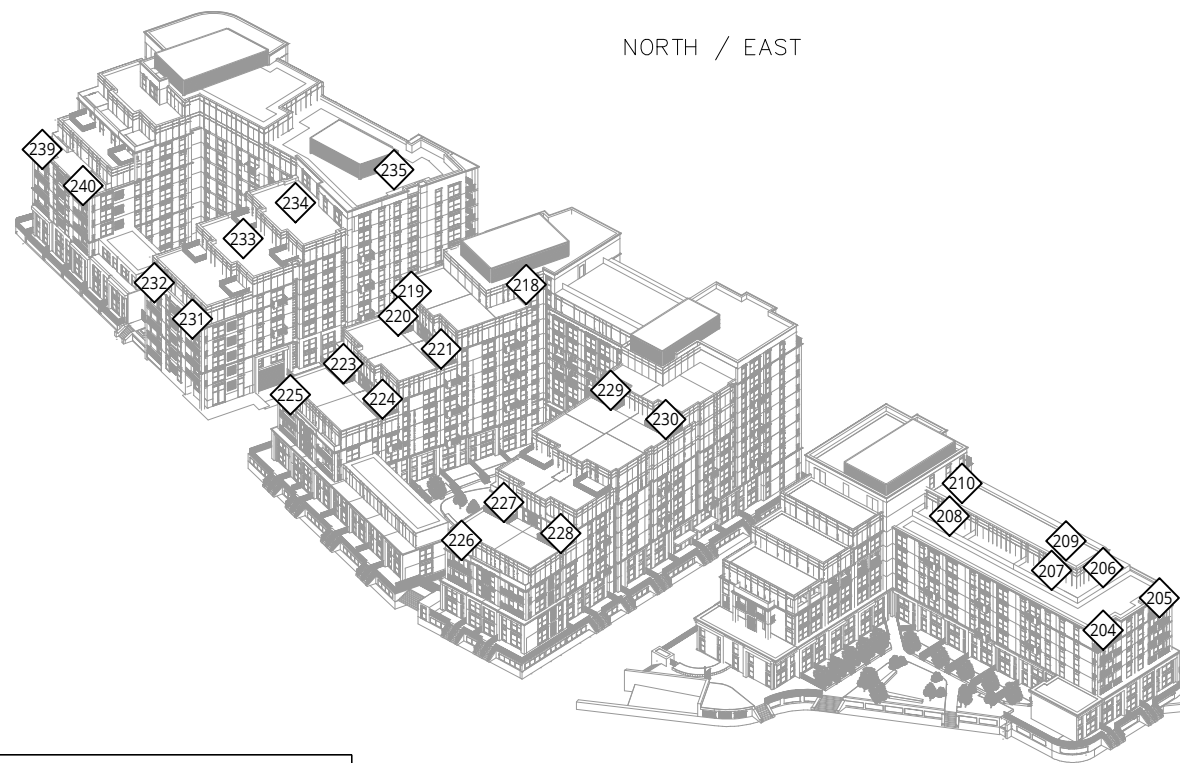
Approx. Scale @A3: 1:1500

Date Revised: Nov. 21, 2019

BUILDING 1, 2 and 3



NORTH / EAST



SOUTH / WEST

**LEGEND:**

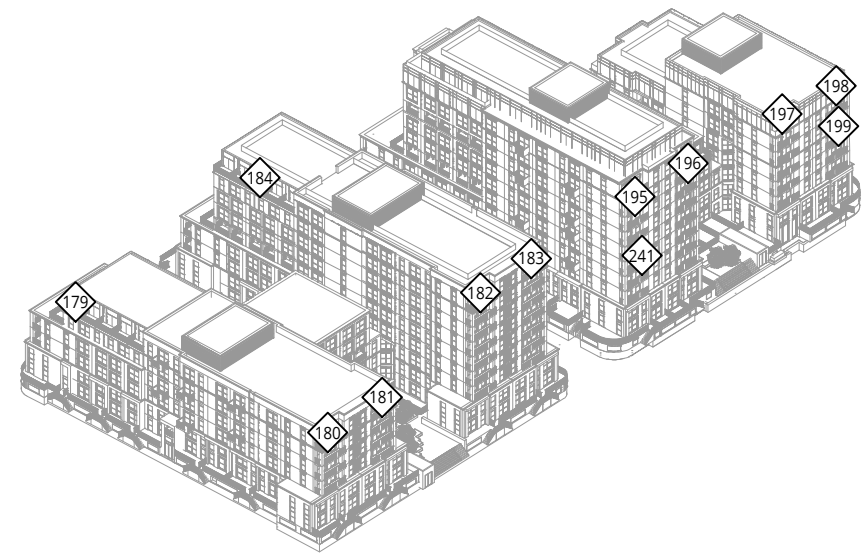
**SAFETY CATEGORIES:**

- Pass
- S15 Exceeded
- S20 Exceeded

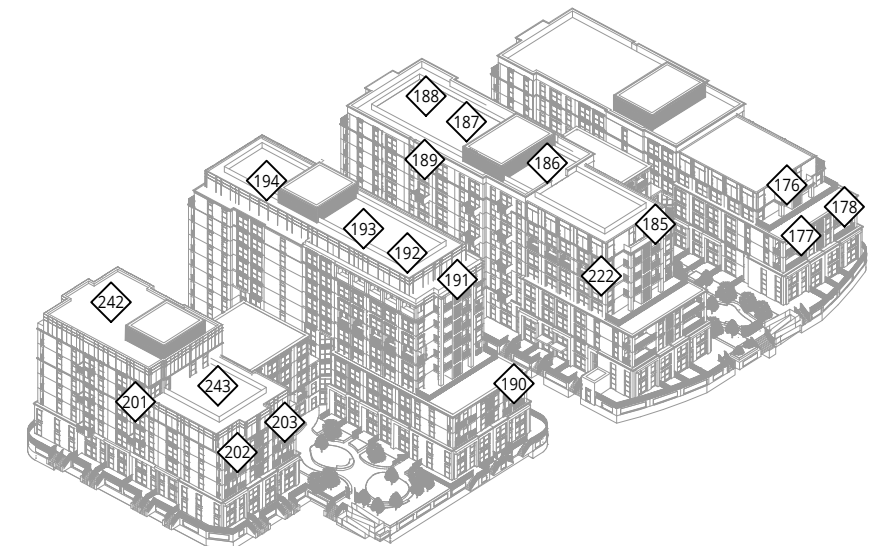
**SENSOR LOCATION:**

- Grade Level
- Podium Level
- Roof Level

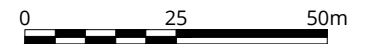
BUILDING 4 and 5



NORTH / EAST



SOUTH / WEST



**Pedestrian Wind Safety Conditions - Isometric Views**

Configuration 4: Proposed Development with Existing Surrounding Buildings and Proposed Landscaping Scheme and Mitigation Measures Annual

Woking Football Club - Woking, UK

Drawn by: JLF Figure: 23

Approx. Scale @A3: 1:1250

Date Revised: Nov. 21, 2019

Project #1900950





## APPENDIX A



## APPENDIX A: WIND TUNNEL PHOTOS



Figure 24: Existing Site and Surrounding Buildings (Configuration 1) - View in the Wind Tunnel (from the South)



Figure 25: Existing Site and Surrounding Buildings (Configuration 1) - View in the Wind Tunnel (from the South)





Figure 26: Proposed Development and Existing Surrounding Buildings (Configuration 2) - View in the Wind Tunnel (from the East)

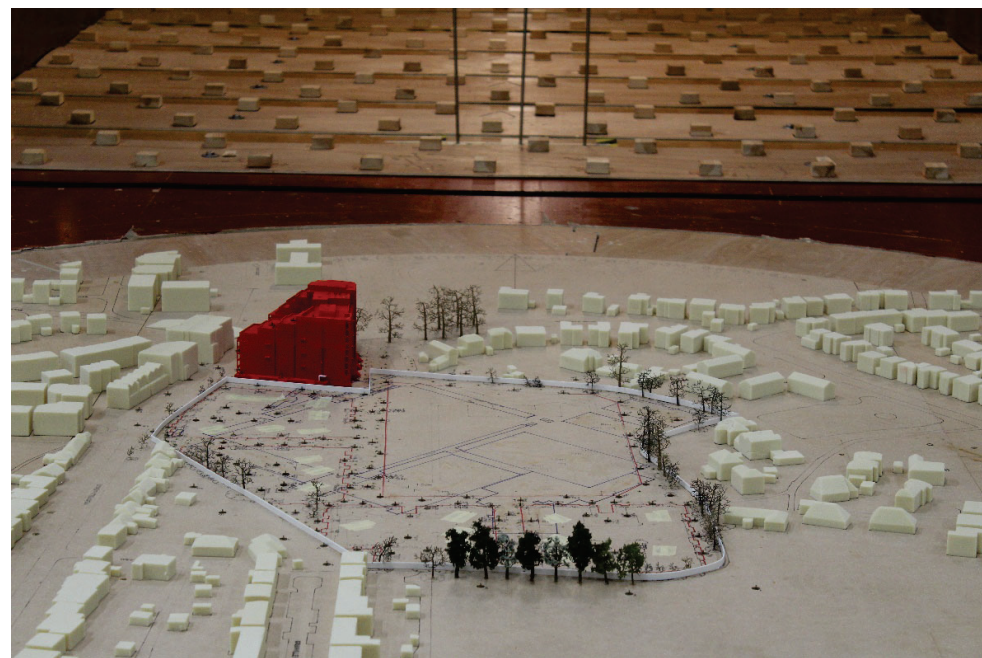


Figure 27: Proposed Development and Existing Surrounding Buildings (Configuration 2) - View in the Wind Tunnel (from the South)

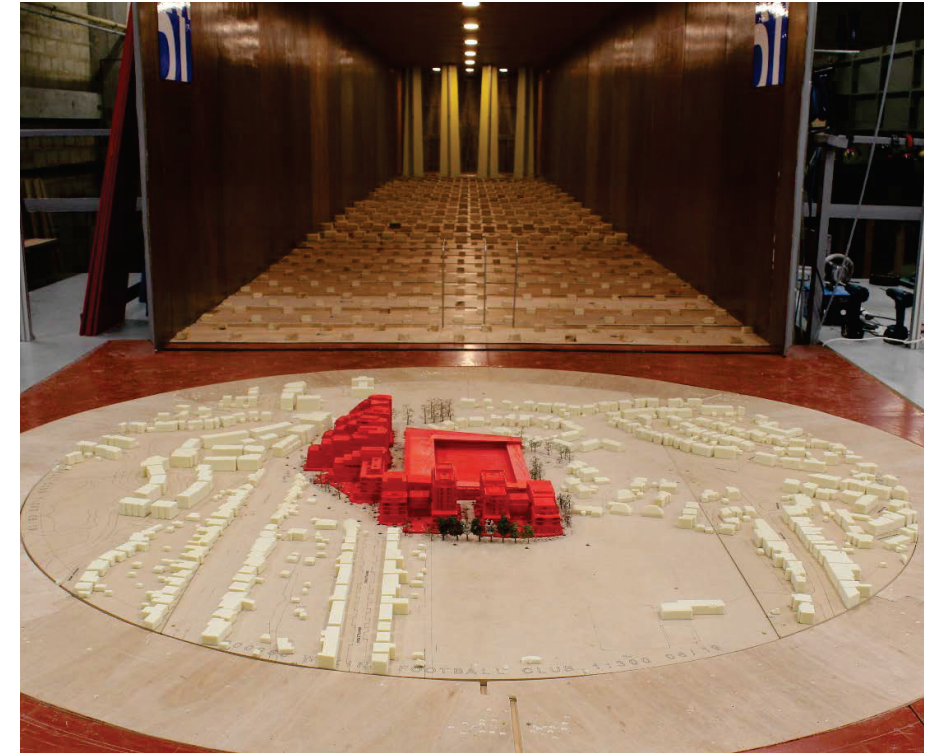


Figure 28: Proposed Development with Existing Surrounding Buildings (Configuration 3) - View in the Wind Tunnel (from the South)

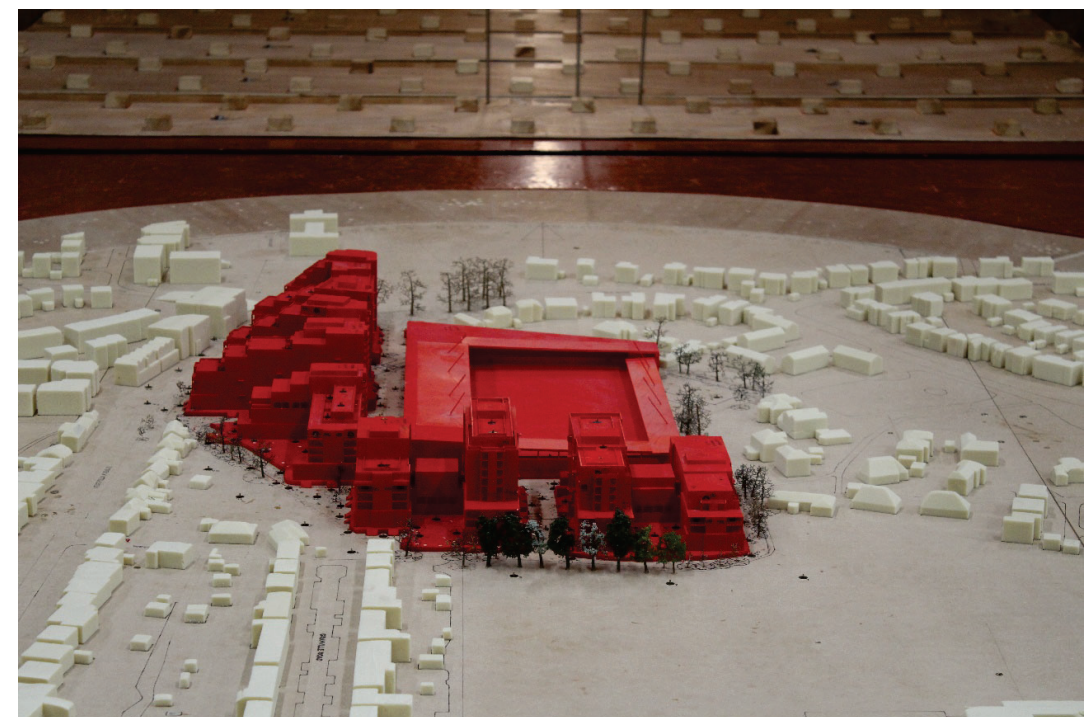


Figure 29: Proposed Development with Existing Surrounding Buildings (Configuration 3) - View in the Wind Tunnel (from the South)



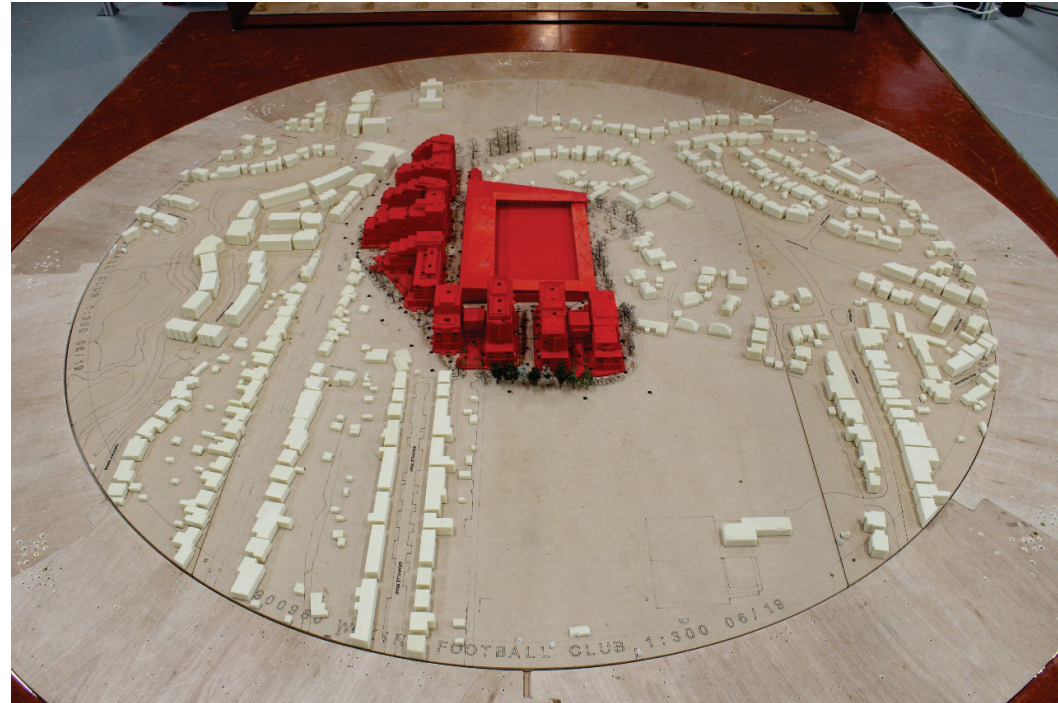


Figure 30: Proposed Development with Existing Surrounding Buildings and proposed landscaping scheme and mitigation measures (Configuration 4) - View in the Wind Tunnel (from the South)

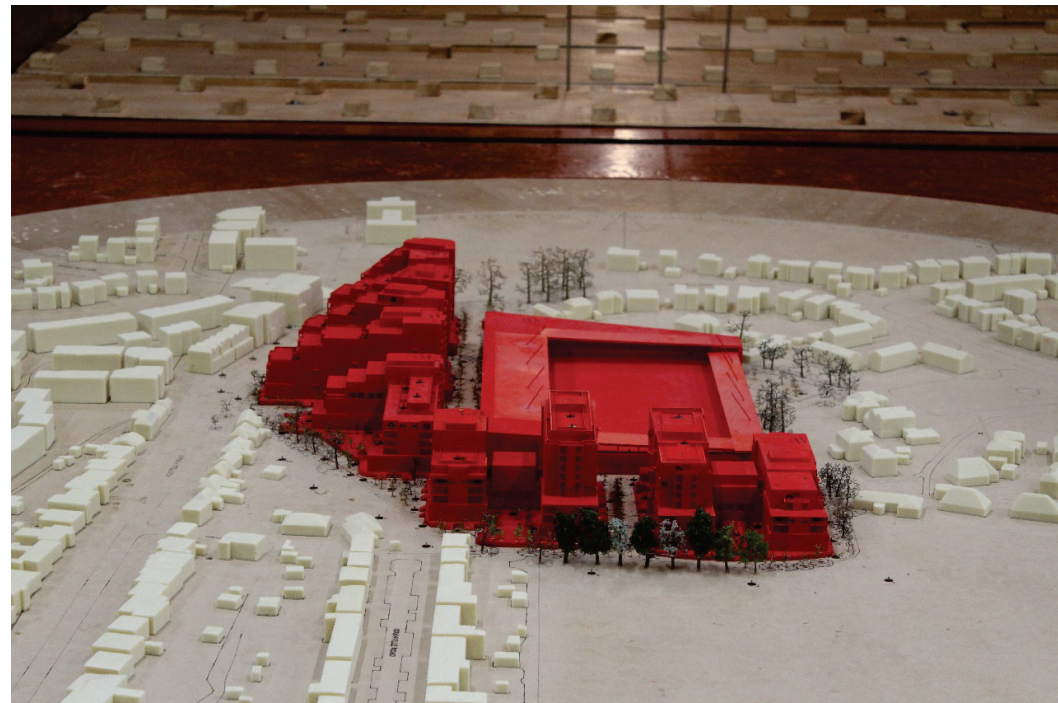


Figure 31: Proposed Development with Existing Surrounding Buildings and proposed landscaping scheme and mitigation measures (Configuration 4) - View in the Wind Tunnel (from the South)



Figure 32: Image of 3m tall, 1.5m wide, solid side screen added to canopy above entrance location at southern façade of Block 1



Figure 33: Image of 3m tall, 1.5m wide, solid side screen added to canopy above entrance location at western façade of Block 5





Figure 34: Image of 3m tall, 1.5m wide, solid side screen added to canopy above entrance location at southern façade of Block 2

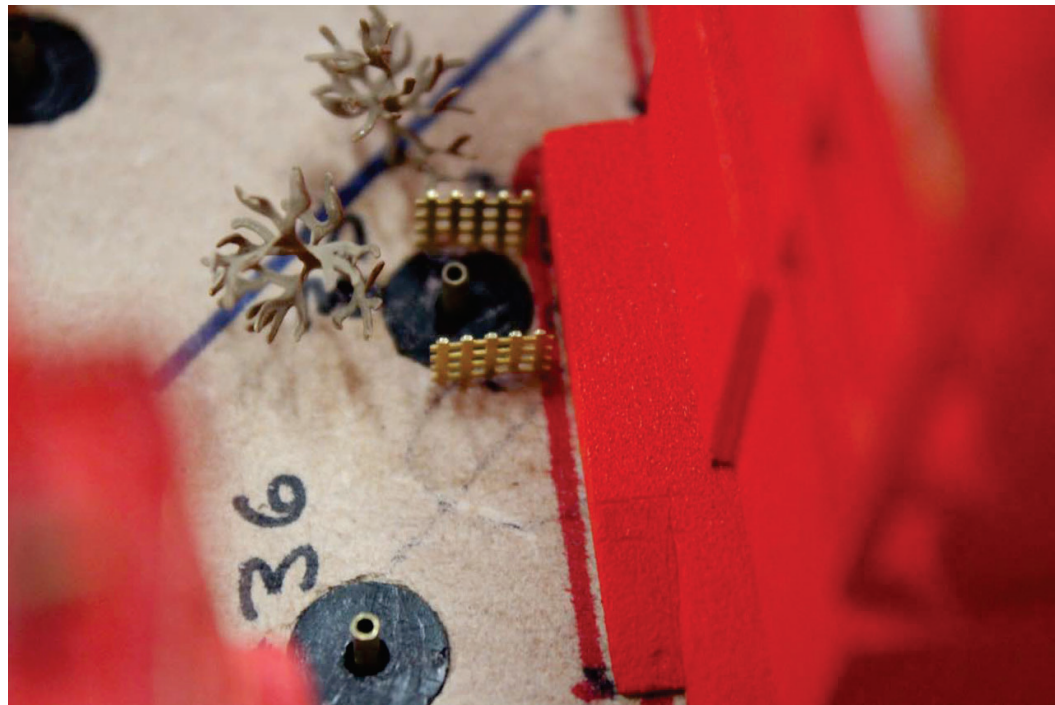


Figure 35: Image of two, 2m tall, 2m wide, 50% porous side screens added to either side of entrance location at north-west of Block 4



Figure 36: Image of 3m tall, 2m wide, 50% porous baffles with a 3m ground clearance hung from the north-west corner of the Stadium spaced 4m apart, running south



Figure 37: Image of two additional 5m tall deciduous trees at the south of Block 3 and to the west of Block 4





Figure 38: Image showing three, 5m tall, deciduous trees at the south-east corner of Block 4, a 3m tall 50% porous screen separating entrances at the south façade of Block 4, and a 3m tall, 5m wide 50% porous screen extending eastward from the eastern façade at the south-east of Block 4

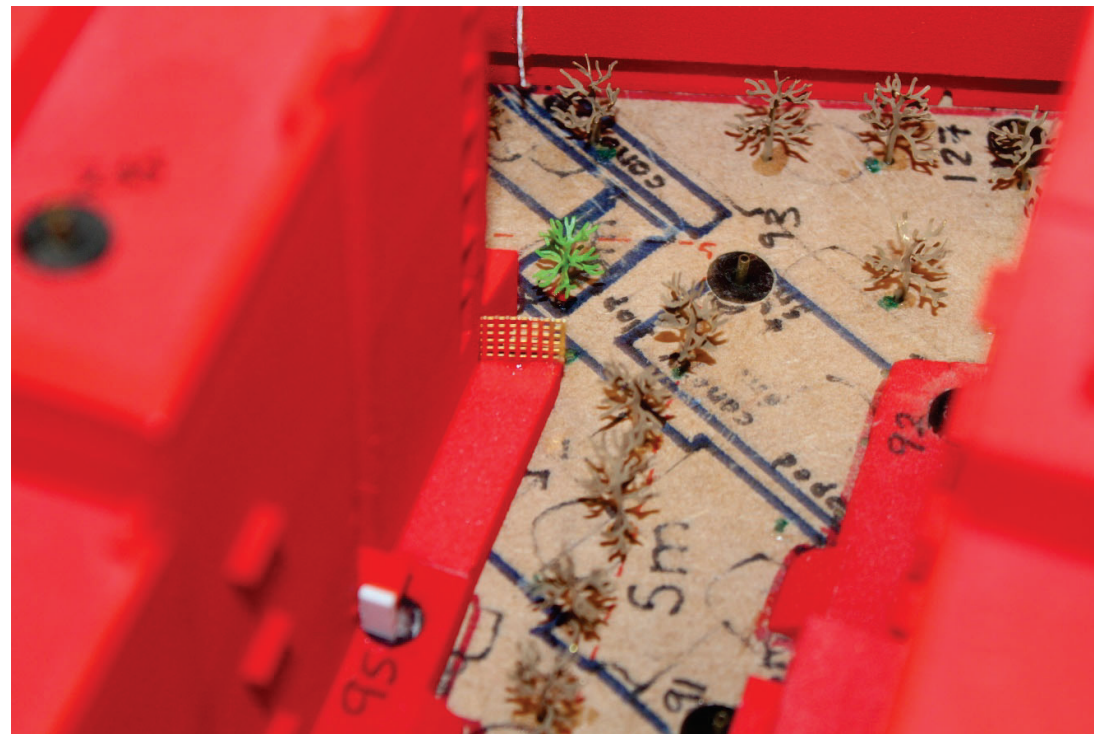


Figure 39: Image of 3m tall, deciduous tree added at the south-east corner of Block 1 and a 3m tall, 4m wide, 50% porous screen at the eastern end of the podium level at the south façade of Block 1

## APPENDIX B





## APPENDIX B: METEOROLOGICAL DATA

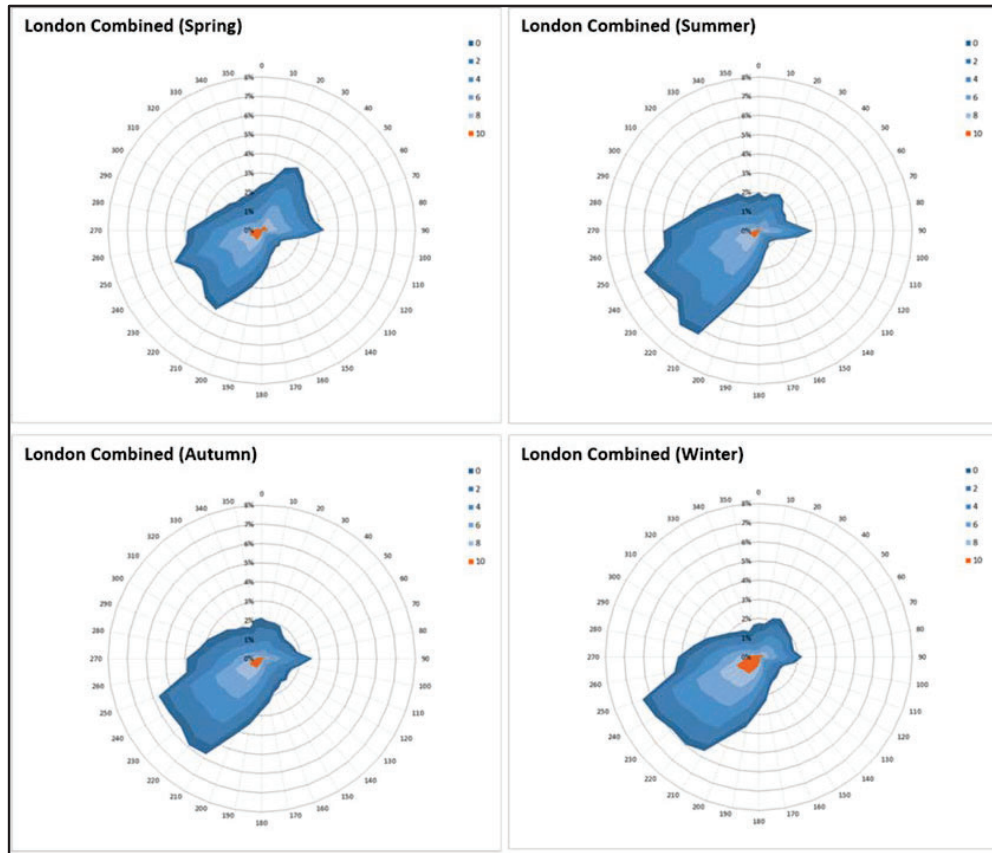


Figure 40: Seasonal wind roses from London Combined (in m/s) - (Radial axis indicates the percentage of time for which the stated threshold is exceeded)