

TOPIC TITLE E.G. AIR QUALITY	
AUTHOR	RWDI
SUPPORTING APPENDIX	ES Volume 3: Appendix: Wind Microclimate Annex 1: Planning Policy Context; and Annex 2: Wind Tunnel Photos.
KEY CONSIDERATIONS	This chapter will assess the effects of the Proposed Development on the site and if the resulting changes in wind speeds would be suitable, in regard to comfort and safety, for the intended usage of sensitive locations in and around the site.
CONSULTATION	An EIA Scoping Report was prepared and submitted to the RBC in September 2018 requesting a formal Scoping Opinion from the RBC on the scope of the EIA. A copy of the EIA Scoping Report is provided in ES Volume 3: Appendix- EIA Scoping. A Scoping Opinion has not been received at the time of preparing this ES. The EIA has proceeded in the absence of a formal opinion received.

ASSESSMENT METHODOLOGY

Defining the Baseline

Current Baseline Conditions

- 10.1** The baseline conditions across the existing site and the wider surroundings have been defined using wind tunnel testing. Mean and peak wind speeds have been measured for both the winter (worst case being the windiest season) and summer seasons, at locations across the existing site and at other surrounding buildings, paths, roads and areas of open spaces for all wind directions within an appropriate proximity to the site.
- 10.2** The baseline conditions are reflected within wind tunnel model – ‘*Configuration 1: Existing Site with Existing Surrounding Buildings*’ (also referred as the ‘Baseline Scenario’). Details of the tunnel test methodology is presented in the section ‘*Wind Tunnel Testing Methodology*’ of this ES Chapter. The Baseline Scenario was assessed with existing trees to the south of Dusseldorf Way, and at the North of the site on Oxford Road in order to assess a realistic worst-case (i.e. windy) condition.
- 10.3** The results have been combined with long-term meteorological climate data for the local Reading area (Heathrow Airport). The meteorological data used in this assessment is deemed to provide the best representation of the local wind microclimate for the Reading area. The meteorological data used is presented within ‘*Baseline Condition – Meteorological Data*’ section and shown in Figure 10.1.

Evolution of the Baseline

- 10.4** The evolution of the baseline condition (in the event that the Proposed Development does not come forward) has been considered using professional judgement informed by the results of the Baseline Scenario (test Configuration 1) and the wind tunnel results undertaken as part of the cumulative effects assessment (see section ‘*Assessment of Future Environment – Cumulative Effects Assessment*’ of this ES Chapter).
- 10.5** The cumulative scenario provides information on the general changes, if any, in wind conditions around the site as a result of the Committed Developments. This cumulative effect assessment takes account of the other Committed Developments within the area surrounding the site (presented within **ES Volume 1: Chapter 2 – EIA Methodology**).

Impact Assessment Methodology

Demolition and Construction

- 10.6** The potential microclimate effects during demolition and construction are assessed using the professional judgement of an experienced wind engineer, based on an assessment of the background wind climate at the site (the results of the tested configurations for the baseline and completed development scenarios) and an understanding of the likely effects based on RWDI’s experience of assessing wind in the built environment.
- 10.7** This approach is taken assuming that the activity on-site during this time (i.e. construction activity) is less sensitive to wind conditions (due to protection from site hoarding, and site access being restricted to site workers) than when the Proposed Development is completed and occupied (which would include new building entrances and outdoor seating within amenity spaces, for example). Windier conditions (in terms of pedestrian comfort) will be tolerable across the active demolition and construction site as this area is not for typical pedestrian use.

Assumptions

- 10.8** It is assumed that there will be restricted access across the site during the demolition and construction works, and therefore windier conditions will be tolerable as the area is not for typical pedestrian use where the tolerable wind speed threshold would be lower.
- 10.9** It is expected that the worst-case scenario (in term of wind impacts across the site and surrounding area) would be represented with all the buildings of the completed Proposed Development in place.

Completed Development

- 10.10** To predict the local wind environment associated with the completed development, and the resulting pedestrian comfort within and in the area surrounding the site, wind tunnel testing of the Proposed Development has been undertaken within the wind tunnel.
- 10.11** Wind tunnel testing allows the pedestrian level wind microclimate at and surrounding the site to be quantified and classified in accordance with the accepted criteria (refer to ‘*Assessment Criteria*’ section of this ES Chapter).
- 10.12** Wind tunnel testing delivers a detailed assessment of the mean and gust wind conditions in and around the site for the tested wind directions in terms of pedestrian comfort and safety and, provide a basis to assess the potential wind microclimate impacts and likely effects of the Proposed Development with regards to its intended use.
- 10.13** It is acknowledged that a direct comparison with the baseline conditions would be useful to understand changes from the existing (baseline) wind conditions across the site due to the Proposed Development. However, a comparison of the measured wind environment for the Proposed Development with the existing conditions does not take into account any change in pedestrian activity that would usually accompany development.
- 10.14** Comparisons between the baseline scenario and ‘completed development’ scenario have therefore been made where possible.

Wind Tunnel Testing Methodology

- 10.15** The methodology for quantifying the pedestrian level wind environment is outlined below within four steps:
- Step 1: The subject site’s induced wind speeds are measured for the appropriate configuration(s) at the appropriate pedestrian level(s) in the wind tunnel;
 - Step 2: Standard meteorological data is adjusted to account for conditions at a subject site (for this assessment, meteorological data has been derived from London meteorological stations (Heathrow, Stansted and Gatwick airports combined));
 - Step 3: Data from Step 1 and Step 2 is combined to obtain the expected frequency and magnitude of wind speed for the appropriate configuration(s) and at the appropriate pedestrian level(s); and
 - Step 4: The results of Step 3 are compared with the Lawson Comfort Criteria (and where relevant, the change in the wind microclimate conditions between appropriate test configuration(s)) to ‘grade / score’ the conditions within and around a subject site.
- 10.16** To produce the results within the wind tunnel, a 1:300 scale model comprising the site and the surrounding area (including relevant existing buildings and other topographical features) was constructed on a 2.4m diameter disc allowing for the surrounding area within a 360 metre (m) radius of the centre of the Proposed Development to be modelled (the radius is determined based on the scale model and due to the physical constraints of the modelling in the wind tunnel). This radius is considered a large enough scale to ensure all likely wind effects are captured.
- 10.17** Wind is unsteady, or gusty, and this ‘gustiness’ or turbulence, varies depending upon the site. In order to model the likely effects of gustiness or turbulence (which depends on the geographical location), a series of grid, barrier and floor roughness elements have been employed in the wind tunnel in order to create a ‘boundary layer’ that is representative of the urban location of the site. The detailed wind tunnel model around the Proposed Development is used to fine-tune the flow and create conditions similar to those expected at full scale.
- 10.18** Other developments outside the 360m radius of the site would not individually be expected to modify the wind approaching the site and as such have been included within the analysis of the surrounding terrain.
- 10.19** To test the Proposed Development, a scale model of the buildings comprising the completed Proposed Development has been constructed (*Configuration 2: The Proposed Development with Existing Surrounding Buildings*).

10.20 Wind conditions are assessed with existing trees to the south of Dusseldorf Way, and at the North of the site on Oxford Road in order to assess a realistic worst-case (i.e. windy) scenario at the Proposed Development.

10.21 Wind speed measurements within and around the site for the tested configurations were established using 'Irwin probes'. These sensors are able to measure the mean and gust wind speeds at a full-scale height of approximately 1.5 m above the surface upon which the probe is located.

10.22 The wind speed was measured at up to 122 locations under the existing conditions; the Proposed Development and the cumulative configurations for all wind directions in equal increments, with 0° representing wind blowing from the north and 90° wind from the east and so on.

Configurations Assessed

10.23 The assessment of the wind microclimate is based on the results from a series of tests of physical models within the wind tunnel to provide a detailed, quantitative assessment. Each configuration was assessed with minimal landscaping in order to consider a realistic worst-case scenario.

10.24 Configurations tested within the wind tunnel include:

- Configuration 1: Existing Site and Surrounding Buildings;
- Configuration 2: Proposed Development with Existing Surrounding Buildings;
- Configuration 3: Proposed Development with Mitigation and Existing Surrounding Buildings; and
- Configuration 4: Proposed Development with Mitigation and Cumulative Surrounding Buildings'.

10.25 Committed Developments identified within the 360m radius of the site assessed in the wind tunnel model are:

- Land between Weldale Street and Chatham Street;
- Hotel application;
- 52 – 55 Friar Street and 12 Greyfriars Road; and
- Plot E & Telecom House Land Friar Street/ Garrard Street Station Hill.

Assessment Criteria

Lawson Comfort Criteria

10.26 The assessment of the wind conditions requires a standard against which the measurements can be compared. This assessment of the wind tunnel results presented in this ES Chapter adopts the Lawson Comfort Criteria ('the Lawson Criteria') (Lawson T, 2001, *Building Aerodynamics*) (LDDC version)¹, which have been established for over 30 years.

10.27 The Lawson Criteria is presented to define the reaction of an average pedestrian to the wind - these are described in Table 10.1. If the measured wind conditions exceed the threshold wind speed for more than 5 % of the time, 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.

10.28 The Lawson Criteria set out four pedestrian activities (comfort categories) and reflect the fact that less active pursuits require more benign wind conditions. The four categories are: sitting, standing, strolling and walking, in ascending order of activity level, with a fifth category for conditions that are uncomfortable for all uses. In other words, the wind conditions in an area for sitting need to be calmer than a location that people merely walk past. The distinction between strolling and walking is that in the strolling scenario pedestrian are more likely to take on a leisurely pace, with the intention of taking time to move through the area, whereas in the walking scenario pedestrians are intending to move through the area quickly and are therefore expected to be more tolerant of stronger winds.

10.29 The Lawson Criteria are derived for open air conditions and assume that pedestrians would be suitably dressed for the season. Thermal comfort is discussed with reference to acceptable wind environments but not evaluated as part of the assessment.

10.30 The coloured key in Table 10.1 corresponds to the presentation of wind tunnel test results described later in this chapter.

Table 10.1 Lawson Comfort Criteria

Key	Comfort Category	Threshold	Description
●	Uncomfortable	>10 m/s	Winds of this magnitude are considered a nuisance for most activities, and wind mitigation is typically recommended.
●	Walking	8-10 m/s	Relatively high speeds that can be tolerated if the objective is to walk, run or cycle without lingering.
●	Strolling	6-8 m/s	Moderate breezes that would be appropriate for strolling along a city/town centre street, plaza or park.
●	Standing	4-6 m/s	Gentle breezes suitable for main building entrances, pick-up/drop-off points and bus stops.
●	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.

Target Wind Conditions

10.31 For a mixed-use urban environment, such as the Proposed Development and surrounding area, the desired wind microclimate would typically need to have areas suitable for sitting, standing/entrance use and strolling (Table 10.1).

10.32 The walking and uncomfortable classifications may be acceptable in isolated areas, but these classifications are also associated with occasional strong winds (which are described below) and so the aim has been to avoid conditions in these categories.

Amenity Areas

10.33 The target condition for seating in amenity areas is a wind microclimate that is suitable for sitting during the summer season. This is because these areas are more likely to be frequently used during the summer when pedestrians would expect to be able to sit comfortably. If an area is classified as suitable for sitting in the summer, the windier conditions that occur during the winter season usually mean that the area would be classified as suitable for standing in the windiest season, unless additional shelter was provided.

10.34 Upper level podium / terraces are assessed on the basis that these are amenity spaces intended for good-weather use only. Sitting or standing conditions during the summer would be acceptable in these areas.

Entrances

10.35 Near building entrances, a wind environment suitable for standing or calmer is desired, as pedestrians will transition from the calm indoors to the windier outdoors throughout the year. The assessment for building entrances therefore focuses on the windiest season result.

10.36 An entrance which is recessed, then the recessed zone provides a transition area for pedestrians existing the building. If strolling conditions are observed on the pavement outside a recessed entrance, acceptable standing conditions would be expected at the recessed entrance.

Thoroughfares

10.37 A pedestrian thoroughfare should be suitable for strolling during the windiest season. The assessment for pedestrian thoroughfares therefore focuses on the windiest season result.

10.38 Localised occurrence of walking conditions may be acceptable in areas with limited footfall, or service areas, as long as the strong wind criteria (see '*Strong Winds*' described below) is not exceeded. For this application, the area comprising the on-site car park on the upper levels is included within this category.

¹ Building Aerodynamics, Lawson T.

Roadways

- 10.39** The Lawson Comfort Criteria does not specify criteria for acceptable wind conditions for cyclists; however, the occurrence of winds exceeding the strong winds threshold (as described below) would be considered unsuitable for cyclists. The assessment for roadways focusses on the annual result.

Strong Winds

- 10.40** The Lawson Criteria also specifies a strong wind threshold when winds exceed 15m/s for more than 2.2 hours of the year. Exceedance of this threshold may indicate a need for remedial measures or a careful assessment of the expected use of that location; e.g. is it reasonable to expect older adults or young children to be present at the location on the windiest day of the year? Wind Speeds that exceed 20m/s for more than 2.2 hours of the year represent safety issue for all members of the population, which would require mitigation to provide an appropriate wind environment.
- 10.41** Strong winds are generally associated with areas which would be classified as acceptable for walking or as uncomfortable. In a mixed-use urban development scheme, walking and uncomfortable conditions would not usually form part of the 'target' wind environment and would usually require mitigation due to pedestrian comfort considerations. This mitigation would also reduce the frequency of, or even eliminate, any strong winds.

Assumptions

- 10.42** This assessment is based on worst-case wind speeds, expected to be encountered during the winter season (December, January and February) in the UK.
- 10.43** Additional consideration has been made for summer wind conditions due to the presence of outdoor amenity spaces and rooftop terraces. This complies with the standard methodology set out by Lawson for wind microclimate assessments.
- 10.44** It is expected that use of outdoor amenity spaces and rooftop terraces for sitting will be limited to the summer season. During the winter, it would be expected that these spaces would increase a criteria level to standing use.

Methodology for Defining Effects

Receptors and Receptor Sensitivity

- 10.45** The sensitivity of receptors is related to the intended pedestrian usage at each location; there are no definitions for sensitivity, as the important consideration is whether the wind conditions experienced at a particular receptor location are suitable for the intended use (in terms of comfort and strong winds) at that particular location. All receptors are considered to be highly sensitive to the local wind microclimate conditions and are given an equal weighting.

Defining Significance

- 10.46** The assessment of the potential effects is based on the desired pedestrian uses (as defined by the Lawson Criteria) in relation to the wind conditions measured at a particular probe location with the Proposed Development in place. This allows for the assessment to take into account any changes in pedestrian activity that might accompany the Proposed Development.
- 10.47** The assessment criteria for the modelled wind microclimate, as shown in Table 10.2, comprise a stepped scale to reflect the change in magnitude of impact.
- 10.48** In line with Lawson's overall methodology, any strong winds (i.e. affecting pedestrian safety) would be unsuitable, and therefore as any strong wind exceedance is inherently significant. The occurrence of strong winds is reported as a separate category from the Lawson Criteria assessment. Where strong winds are identified, mitigation is required (as per adverse effects related to pedestrian comfort).

Table 10.2 Effect Classification Criteria

Modelled Wind Microclimate Criteria	Effect Classification
Wind Conditions are 3-steps calmer / windier than desired.	Major
Wind Conditions are 2-steps calmer / windier than desired	Moderate
Wind Conditions are 1-step calmer / windier than desired	Minor
Wind Conditions are similar to those desired.	Negligible

- 10.49** The minor, moderate and major categories indicate the severity of the change in wind condition between the desired wind microclimate and the wind microclimate presented in the modelled results. As an example, if the desired wind conditions at a location are required to be suitable for 'Standing', but the predicted wind conditions are suitable for 'Strolling', the difference between the desired and predicted wind condition is one category windier than desired. In this case, the scale of the effect would be identified as 'minor adverse'.
- 10.50** The effect classification criteria must also account for comparison against the Baseline conditions and the predicted (modelled) wind conditions for the Proposed Development. Where predicted wind conditions are windier than the Baseline conditions, yet remain calmer than required, these would be identified as negligible rather than minor beneficial.
- 10.51** An adverse effect implies that a location has a wind environment that is windier than the desired conditions and mitigation should therefore be considered. Where potential adverse effects are identified, consideration is provided in the 'Mitigation and Monitoring Measures' section of this ES Chapter to discuss the remedial measures required to mitigate the potential impact.
- 10.52** Any adverse effect is 'significant' because it implies that a location, or area, has a wind microclimate that is unsuitable for the desired use of that area. It is therefore also assessed that beneficial effects classified as minor, moderate or major in scale are also considered to be significant as they are calmer than the desired condition.
- 10.53** Effects once the Proposed Development is completed are direct, local and long-term (permanent) and irreversible unless there is a change in the Proposed Development's massing on-site or the local wind microclimate.

BASELINE CONDITIONS

Current Baseline Conditions

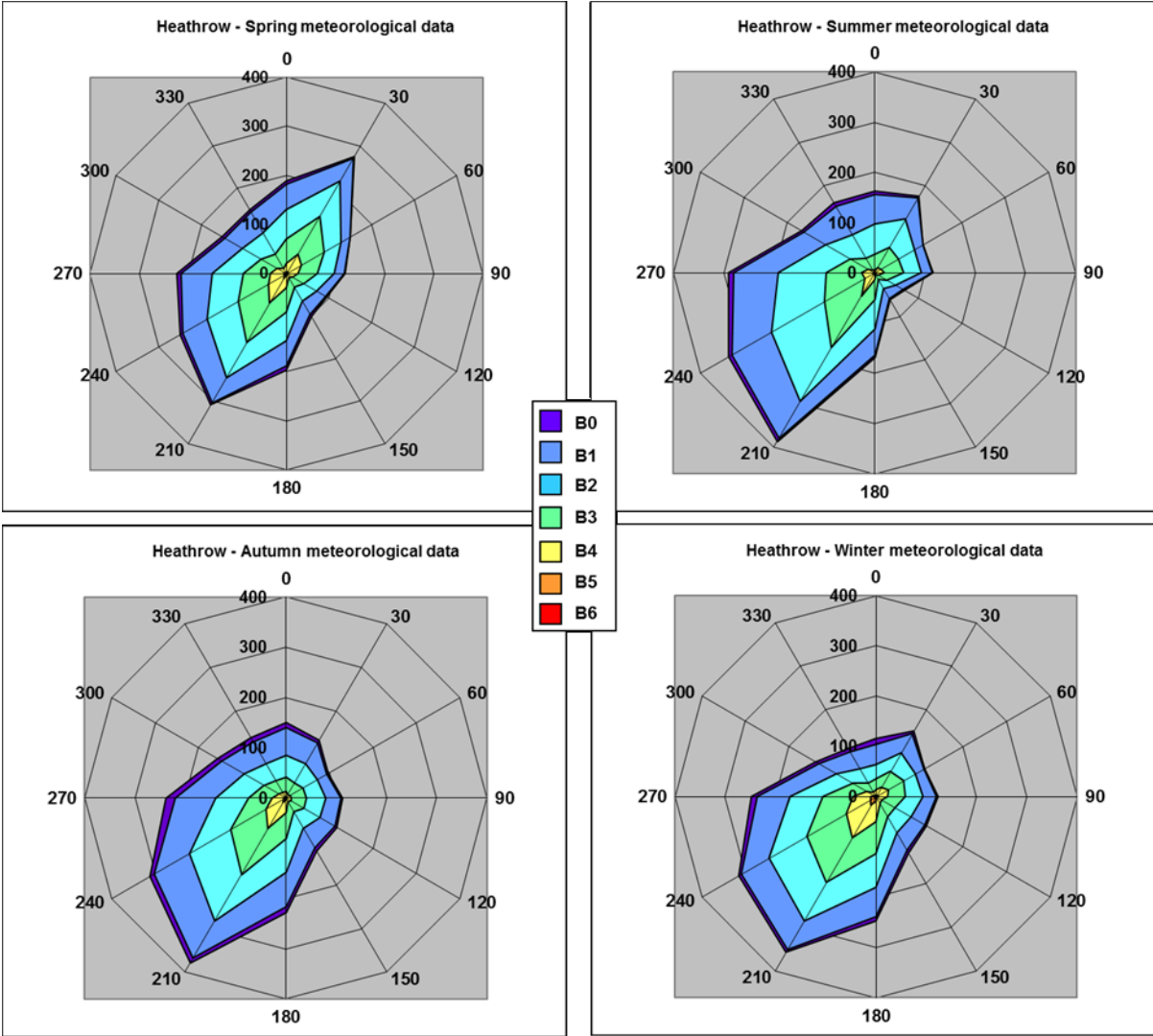
Meteorological Data

- 10.54** The UK Meteorological Office supplies records of the number of hours that wind occurs for ranges of wind speed (using the Beaufort Scale) and by direction. Meteorological data for Heathrow Airport is shown in Figure 10.1 and provides a representation of the local wind microclimate for the area.
- 10.55** The meteorological data indicates that the prevailing wind throughout the year is from the south-west (i.e. 210 to 240 degrees on the compass). This is typical for many areas of southern England. There is a secondary peak from the north-east during the late spring and early summer. The winds from the north-east are not as strong as the prevailing winds from the south-west, although the winds are colder.
- 10.56** The meteorological data were corrected to standard conditions of 10m above open flat level country terrain. The meteorological model was then adjusted to the site conditions taking account of the terrain roughness using the BREVe3 software package which models the wind characteristics caused by changes in the terrain roughness at the stated reference height of 120 m above the surface. The results are shown in Table 10.3

Table 10.3 Site Meteorological Data Adjustment

Direction (°N)												
Mean Factor	1.41	1.42	1.44	1.43	1.39	1.45	1.46	1.51	1.46	1.41	1.41	1.40

Figure 10.1 Seasonal Wind Roses for Heathrow Airport



Configuration 1: Existing Site and Surrounding Buildings

Pedestrian comfort

- 10.57 As shown in the figures in Annex 1 of this ES Chapter, the baseline for the site and surrounding area has a wind microclimate that is mainly suitable for strolling, standing, and sitting use, with location 6 (along Queen’s Walk) being classified as suitable for walking use during the windiest season (one category windier than desired). The windier conditions are located off-site along Queen’s Walk and at the west end of Oxford Road.
- 10.58 Conditions within the car park (roof level) (see Annex 1 of this ES Chapter) range between strolling and sitting use (desired target condition is for thoroughfares – walking, strolling).
- 10.59 During the summer season (see Annex 1 of this ES Chapter) wind conditions in and around the site generally become one category calmer due to lower wind speeds experienced at this time of year. As such the wind microclimate around the site is primarily suited to sitting and standing conditions, with one strolling condition located on Queen’s Walk and Oxford Road (consistent with the target condition for thoroughfares).

Occurrence of Strong Winds

- 10.60 For Configuration 1, location 6 (along Queen’s Walk) is the only area where wind speeds exceed 15 m/s for more than 2.2 hours annually.

RECEPTORS AND RECEPTOR SENSITIVITY

Existing Receptors

- 10.61 Receptors likely to be affected by the Proposed Development include all pedestrians using/visiting the Proposed Development and the surrounding areas, as well as pedestrians and cyclists on surrounding thoroughfares, retained entrances to the Proposed Development and those of surrounding buildings and surrounding amenity spaces, including café spill out space and outdoor seating.
- 10.62 There is an overall total of 122 measurement locations (refer to Table 10.4) across the Proposed Development and surrounding area, which have been assessed. The locations of the probes are fixed and have been subjectively determined based on examination of architectural drawings, reflecting the use of the Proposed Development.
- 10.63 The following description of receptor categories for the Site and the approach taken to the allocation of the probe locations to the categories is as follows:
- On-Site
 - Thoroughfare: Relating to the car park on the upper levels;
 - Entrances: includes entrances at ground level; and
 - Amenity Areas: such as the podium and terraces on the residential towers (located on the upper levels of the buildings);
 - Off-Site locations: includes all receptors falling outside the definition of the boundary of the site, including:
 - Pedestrian Thoroughfares: includes areas that are immediately adjacent to the site (i.e. within 5m of the building line) – along routes such as Queen’s Walk, Hosier Street, Dusseldorf Way);
 - Roadways (locations which are either adjacent to a road, or within the road itself, such as along St Mary’s Butts, Oxford Road)).

Table 10.4 Likely Resource / Receptor

Receptor	Development Plot / Off-Site Location	Receptor Reference (Probe Measurement Number)
On-site		
Thoroughfares	Car Park	93, 94, 95, 96, 97, 98, 99, 100, 101
Amenity Areas	Podium	102, 103, 104, 106, 107, 108,109, 110, 111, 112, 113, 114, 115, 116
	Site A Terrace	118
	Site B Terrace	120
	Site C Terrace	122
	St Mary’s Butts	74, 64
Entrances	Queen’s Walk	7, 15, 18
	Oxford Road	29, 31, 34, 38, 39
	St Mary’s Butts	57
Off-site		
Thoroughfare	Queen’s Walk	3, 4, 5, 6, 8, 9, 11, 14, 16, 17, 19
	Dusseldorf Way (South)	1, 2, 81, 83, 86, 87, 91, 91,
	Oxford Road	22, 23, 24, 25, 26, 35, 36, 37, 46, 47
	Broad Street	43, 44, 45
	St Mary’s Butts	49, 51, 52, 53, 55, 56, 58, 59, 68, 69, 60, 61, 62, 63, 70,72,73, 66
	Hosier Street	73, 75, 76, 77, 78, 79, 80, 81, 82
Entrances	Queen’s Court	10, 12
	Oxford Road	20, 21, 27
	St Mary’s Church	67

Receptor	Development Plot / Off-Site Location	Receptor Reference (Probe Measurement Number)
Road	Oxford Road	24, 28, 30, 33
	St Mary's Butts	50, 54, 71
Roadways	Oxford Road	40, 41, 32
	St Mary's Butts	42, 48, 65

POTENTIAL EFFECTS (Pre-Mitigation)

Demolition and Construction

- 10.64** Wind conditions during the demolition and construction works would be expected to gradually adjust from those of the Baseline Scenario (Configuration 1) (see Annex 1 of this ES Chapter), to the likely wind conditions identified for the Completed Development (Configuration 2) (see Annex 1 of this ES Chapter).
- 10.65** The development consists of the construction of residential towers to the existing Broad Street Mall. The proposed demolition works are minimal and are not considered to make material changes to the existing massing of the building. The demolition phase is not expected to alter wind conditions from the Baseline Scenario presented in Configuration 1.
- 10.66** It is expected that the wind conditions during the period of construction works will gradually transition from the Baseline Scenario (existing site wind microclimate - Configuration 1) to the completed Proposed Development wind microclimate (Configuration 2) (as described on 'Potential Effects – Completed Development').

Completed Development

- 10.67** The following section includes results from the wind tunnel test of Configuration 2 (*Proposed Development with existing surrounding buildings*).
- 10.68** The figures in Annex 1 of this ES Chapter are presented in support of the assessment of the Proposed Development:

Pedestrian Thoroughfares

On-site

- 10.69** All locations in the car park area remain suitable for the intended use.

Off-Site

- 10.70** All thoroughfares have sitting to strolling conditions with the exception of location 6 (on Queen's Walk) which has a 'walking' condition (one category windier than desired - strolling) during the windiest season. Location 6 represents a **minor adverse** condition due to its use as a thoroughfare with high footfall. It is noted that this exceedance (walking condition) is also present within the existing baseline condition Configuration 1.
- 10.71** All off-site thoroughfares have suitable wind conditions representing a **negligible** effect.

Entrances

On-Site

- 10.72** On-site entrances mostly have sitting to standing conditions representing a **minor beneficial** (one category calmer than required - standing) to **negligible** effect (target condition) during the windiest season.
- 10.73** Location 7 is an exception, which has recorded a **minor adverse** effect due to being one category windier than required (i.e. suitable for strolling rather than standing).

Off-Site

- 10.74** Off-site entrances have desired standing or calmer wind conditions during the windiest season, with the exception of location 67 at the entrance to St Mary's Church which has a **minor adverse** effect (one category windier than desired condition – standing).

Amenity Areas

Ground Level (off-site)

- 10.75** Conditions at on-site ground level amenity areas along St Mary's Butts during the summer season at locations 64 and 74 represent a **negligible** and **minor adverse** effects respectively.

Podium

- 10.76** At the terrace level, wind conditions range from standing to strolling use during the summer season as shown in the figures in Annex 1 of this ES Chapter.
- 10.77** Locations which are intended for sitting use but are assessed as being suitable for standing use (one category windier than desired), if fixed seating is placed in these locations, represent a **minor adverse** effect.
- 10.78** Seven locations (between Buildings A and B - 110, 112, 114; between Buildings B and C - 102, 104, 106) situated on the terrace (which are intended for sitting use) have strolling conditions (two categories windier than desired) during the summer season, representing a **moderate adverse** effect.

Terraces

- 10.79** Locations (118, 120, and 122) are terraces (amenity space) for the residential buildings Building A to C. The results show standing conditions (one category windier than desired - sitting), representing a **minor adverse** effect. The rooftop area of the towers are for maintenance access only and will not be accessible by residents or pedestrians.

Roadways

Off-Site

- 10.80** Crossing locations adjacent to roads are suitable for their intended use during the windiest season (**Negligible** effect), where the microclimate effects are considerably calmer than the maximum tolerable walking condition.
- 10.81** In particular, locations 40 and 48 (corner of Oxford Road and St Mary's Butts) represent a **major** (three steps calmer than desired) and **negligible** effects (two steps calmer) compared to their intended use (walking condition).

Occurrence of Strong Winds

- 10.82** For Configuration 2 (*Proposed Development with existing surrounding buildings*), there are the following occurrences of strong winds at the following locations:
- Ground level locations 6, 74, and 77 exceed 15 m/s for more than 2.2 hours per year. Location 6 is located on Queen's Walk, locations 74 and 77 are located at the east end of Hosier Street.
 - At Podium level 102, 104, 106, 110, 112, 114, 116 all exceed 15 m/s for more than 2.2 hours a year.
 - At Terrace level, location 120 (on Building B) exceeds 15 m/s for more than 2.2 hours a year.
- 10.83** These locations pose a safety concern and a comprehensive landscaping and mitigation plan for these various locations would be required to address all strong wind exceedances.

MITIGATION AND MONITORING MEASURES

Demolition and Construction

- 10.84** The existing massing of the Broad Street Mall is to largely remain in place, and the Proposed Development is to comprise new built elements at the upper levels. The proposed demolition works are largely internal. During the works, where external alterations are being made, hoarding will be erected where required to prevent public access.
- 10.85** It is therefore expected that wind conditions would remain as per the existing condition and evolve as construction progresses to the final massing for the completed Proposed Development (see section 'Completed Development').

Completed Development

- 10.86** The following section includes results from the wind tunnel test of Configuration 3 (*Proposed Development with Mitigation and existing surrounding buildings*)
- 10.87** The completed Proposed Development will require wind mitigation for several locations. The following mitigation strategy; discussed in this section and summarised in **Error! Reference source not found.**, has been developed and wind tunnel tested to achieve a suitable wind microclimate in and around the Proposed Development.
- 10.88** The figures in Annex 1 of this ES Chapter show the result of wind tunnel testing Configuration 3 of the Proposed Development.

Pedestrian Thoroughfares

- 10.89** The off-site thoroughfares around the development all have wind conditions suitable for their intended use or equivalent to the baseline scenario representing a **negligible** effect. See 10.96 Occurrence of Strong Winds.

Entrances

On-Site

- 10.90** The entrance location along Queen's Walk (location 7) has strolling wind conditions; however, this entrance will be recessed into the building by at least 1.5 meters making it suitable for its intended use, representing a **negligible** effect.

Off-Site

- 10.91** The inclusion of existing trees and landscaping to south of St Mary's Butts reduced wind speeds around the entrance to St Mary's Church (location 67), which is now suitable for its intended use (standing conditions) and represents a **negligible** effect.

Amenity Areas

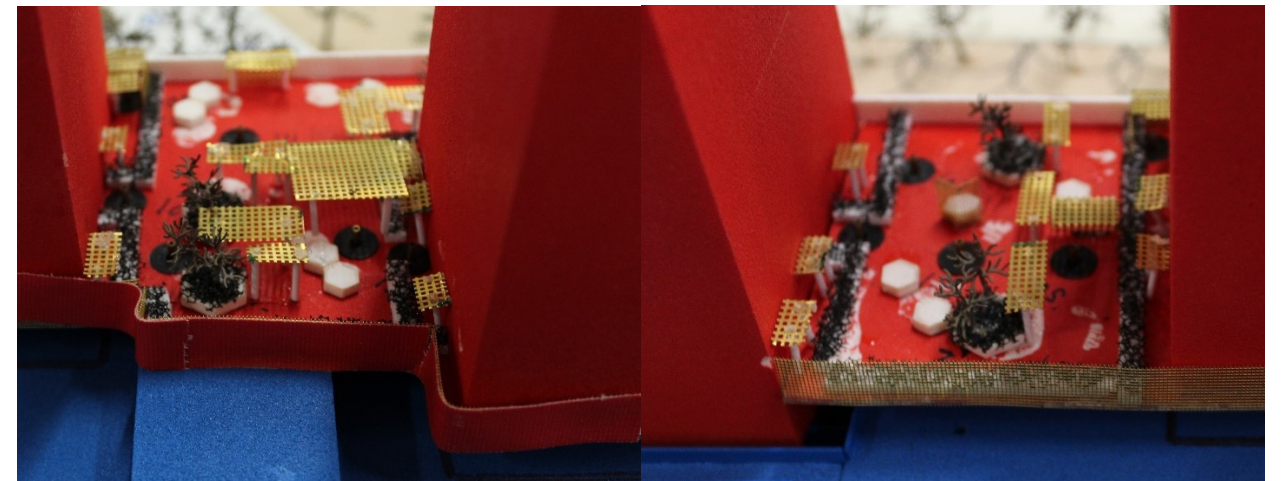
Ground Level

- 10.92** The inclusion of existing trees and landscaping to the south of St Mary's Butts provided sufficient shelter during the summer season to achieve sitting and standing wind conditions at locations 64 and 74 (standing conditions being one category windier than desired) respectively. This represents a **negligible** and **minor adverse** effect, since these conditions are the same as in the baseline scenario they would not require mitigation, There is no impact from the Proposed Development.

Podium

- 10.93** Podium location mitigation incorporated the use of pergolas, trees and shrubs in planters, and porous and solid screens and balustrades. Wind tunnel testing was undertaken to develop these measures and determine the extent to which they are required.
- 10.94** With the mitigation measures in place, podium level wind conditions range from sitting to standing use during the summer season. Fixed seating will be placed at Locations; 102, 103, 107, 108, 109, 115, and 116, which have sitting conditions and represent a **negligible** effect. All other terrace locations have standing conditions and are suitable for their intended use and represent a **negligible** effect.

Figure 10.2 Proposed Landscaping on the Podium Amenity space (Locations 108, 109, 110, 111, 112, 113, 114 Left, Locations 102, 103, 104, 106 Right)



Terraces (Buildings A to C)

- 10.95** The addition of landscaping to the terrace (locations 118, 120, 122) results in sitting wind conditions during the summer season representing a **negligible** effect and therefore suitable for their intended amenity use.

Figure 10.3 Proposed Landscaping for Terrace sections as shown on Tower A (Location 118)



Occurrence of strong winds

- 10.96** For Configuration 3 (post mitigation), there is a strong wind exceedance at ground level location 6, where wind speed exceeds 15 m/s for more than 2.2 hours per year. Location 6 is on Queen's Walk and has an exceedance in the baseline scenario, the presence of the Proposed Development does not increase this exceedance and therefore does not require mitigation.

RESIDUAL EFFECTS (Post Mitigation)

10.97 The residual effects resulting from the Proposed Development are summarised in Table 10.5.

Table 10.5 Summary of Residual Effects

Receptor	Receptor Sensitivity	Residual Effect (Nature and Scale)	Geo	D I	P T	R IR	St Mt Lt
Demolition and Construction							
All receptor locations	Refer 'Assessment Methodology – Demolition and Construction' – It is considered that the completed Proposed Development represents the realistic worst-case assessment in terms of wind microclimate effects. Refer Residual Effects for the Completed Development (see below).						
Completed Development							
Thoroughfares (windiest Season) (on-site)	High	Negligible	L	D	P	IR	Lt
Thoroughfares (windiest season) (off-site)	High	Location 6 (Queen's Walk) - Minor Adverse (Same as baseline) All remaining locations - Negligible	L	D	P	IR	Lt
Entrances (windiest season) (on-site)	High	All locations - Negligible	L	D	P	IR	Lt
Entrances (windiest season) (off-site)	High	All locations - Negligible	L	D	P	IR	Lt
Amenity Areas (summer season) (Ground level - off-site (St Mary's Butts))	High	Location 64 – Negligible Location 74 – Minor Adverse (Same as baseline)	L	D	P	IR	Lt
Amenity Areas (summer season) (Podium - on-site)	High	Between Buildings A and B - 110, 111 112, 113, 114; and between Buildings B and C - 104, 106 – Minor Adverse (If fixed seating placed at location) All remaining locations – Negligible	L	D	P	IR	Lt
Amenity Areas (summer season) (Terraces (Buildings A to C) - on-site)	High	All locations - Negligible	L	D	P	IR	Lt
Roadways (windiest season) (off-site)	High	All locations - Negligible	L	D	P	IR	Lt
Notes: Residual Effect - Scale = Negligible / Minor / Moderate / Major - Nature = Beneficial or Adverse Geo (Geographic Extent) = Local (L), Borough (B), Regional (R), National (N) D = Direct / I = Indirect P = Permanent / T = Temporary R = Reversible / IR= Irreversible St = Short Term / Mt = Medium Term / Lt = Long Term N/A = not applicable / not assessed							

LIKELY SIGNIFICANT EFFECTS

10.98 All thoroughfares, entrances and amenity spaces in and around the Proposed Development would achieve desired or equivalent to baseline wind conditions and would be suitable for their intended use. Therefore, there are no significant effects.

CLIMATE CHANGE

10.99 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. We therefore do not think it 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.

10.100 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.

ASSESSMENT OF FUTURE ENVIRONMENT

Evolution of the Baseline Scenario

10.101 In the absence of the Proposed Development, the wind microclimate conditions across the majority of the site would remain as defined for the current baseline conditions under wind tunnel Configuration 1. This assumes that generally the wind microclimate conditions (as defined by meteorological data) for the south-east of England remain as presented within this assessment.

Cumulative Effects Assessment

10.102 This section identifies the effects of the Proposed Development in combination with the effects of other Committed Developments within the surrounding area (identified in **ES Volume 1: Chapter 2 - EIA Methodology**).

10.103 The following section includes results from the wind tunnel test of Configuration 4 (*Proposed Development with Mitigation and Cumulative Surrounding Buildings*)

10.104 Committed Development Schemes included within the wind tunnel test configuration consist of:

- Land between Weldale Street and Chatham Street;
- Hotel application on Hosier Street;
- 52 – 55 Friar Street and 12 Greyfriars Road; and
- Plot E & Telecom House Land Friar Street/ Garrard Street Station Hill.

Demolition and Construction

10.105 Based upon professional judgement, the demolition and construction works of the existing structure on Site are not anticipated to give rise to any significant change to the existing wind microclimate both on and off-site when compared to those results described in Configuration 2 despite the presence of cumulative buildings.

10.106 The presence of the hotel on Hosier Street creates a strong wind occurrence at location 74 and 75 and therefore additional mitigation will need to be installed prior to the completion of the Hotel.

10.107 As the construction of the Proposed Development proceeds, the wind conditions of the site and its surrounds would gradually adjust to those described below for the completed Proposed Development with cumulative surrounds.

Completed Development (Post Mitigation)

10.108 The figures in Annex 1 of this ES Chapter show the result of wind tunnel testing Configuration 4 of the Proposed Development.

Pedestrian Thoroughfares

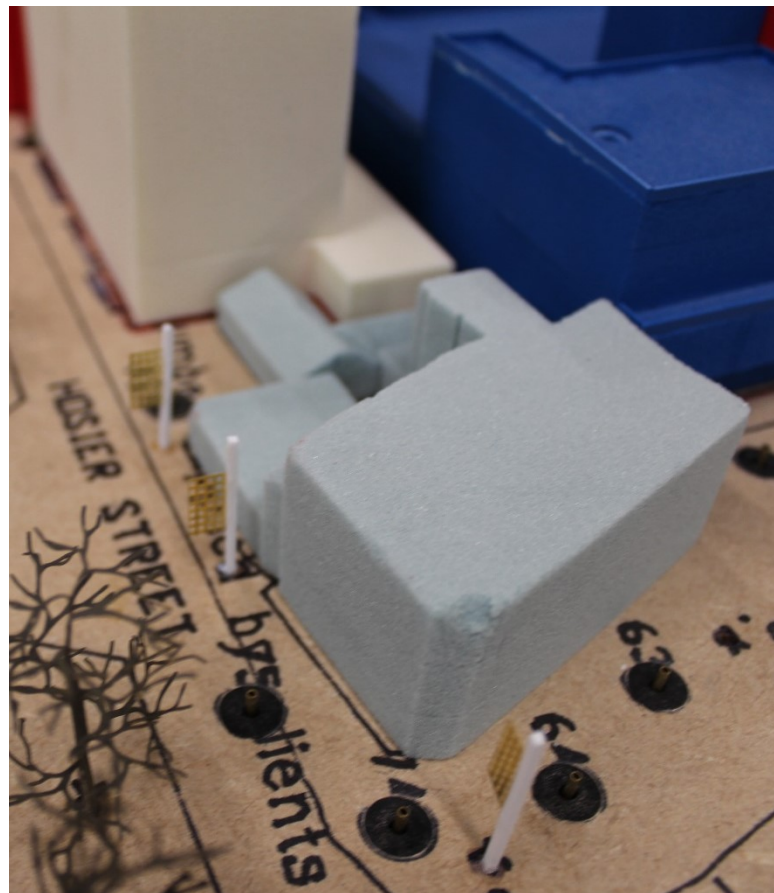
On-site

- 10.109** All locations in the car park area remain suitable for intended use.

Off-Site

- 10.110** Off-site wind conditions range from suitable for sitting to strolling use during the windiest season. This represents a **moderate beneficial** to **minor adverse** effect respectively. Overall, wind conditions at ground level in terms of comfort remain similar to Configuration 3.
- 10.111** In the presence of cumulative surrounding buildings location 75 develops a strong winds exceedance. This is likely a combination of wind interaction between the Hotel on Hosier Street and the Proposed Development as other cumulative schemes are a significant distance away. This location will require mitigation in addition to measures outlined for Configuration 3.
- 10.112** Proposed mitigation consists of the addition of 3 lampposts with porous screens on Hosier Street. These do not fully eliminate the strong winds at location 75, further mitigation will be developed and wind tunnel tested to make this location suitable for its intended use. These would need to be installed as future schemes, in particular the Hotel on Hosier Street, are built.

Figure 10.4 Proposed Landscaping on the corner of Hosier Street (Locations 61, 63, 64, 74, 75, 77)



Entrances

On-Site

- 10.113** Wind conditions at all entrances remain suitable for the intended use consistent with Configuration 3 after the mitigation outlined for Configuration 3 has been included.

Off-site

- 10.114** Off-site entrances remained suitable for use in the presence of cumulative schemes.

Amenity Areas

Ground Level (off-site)

- 10.115** Summer microclimate conditions remained the same as in Configuration 3 with the addition of cumulative schemes, with the exception of Location 74 which develops a strong wind exceedance. This location will require mitigation in addition to measures outlined in Configuration 3. These measures will be developed in conjunction with mitigation for location 75 as discussed in 10.112.

Podium

- 10.116** Podium conditions improved in the presence of cumulative schemes compared to Configuration 2. Conditions ranged from sitting to standing use, representing a **negligible** to **minor adverse** effect. Locations with standing conditions are acceptable so long as no fixed seating is placed in these locations.

Terraces

- 10.117** Terrace wind conditions remain the same as compared to Configuration 3

Roadways

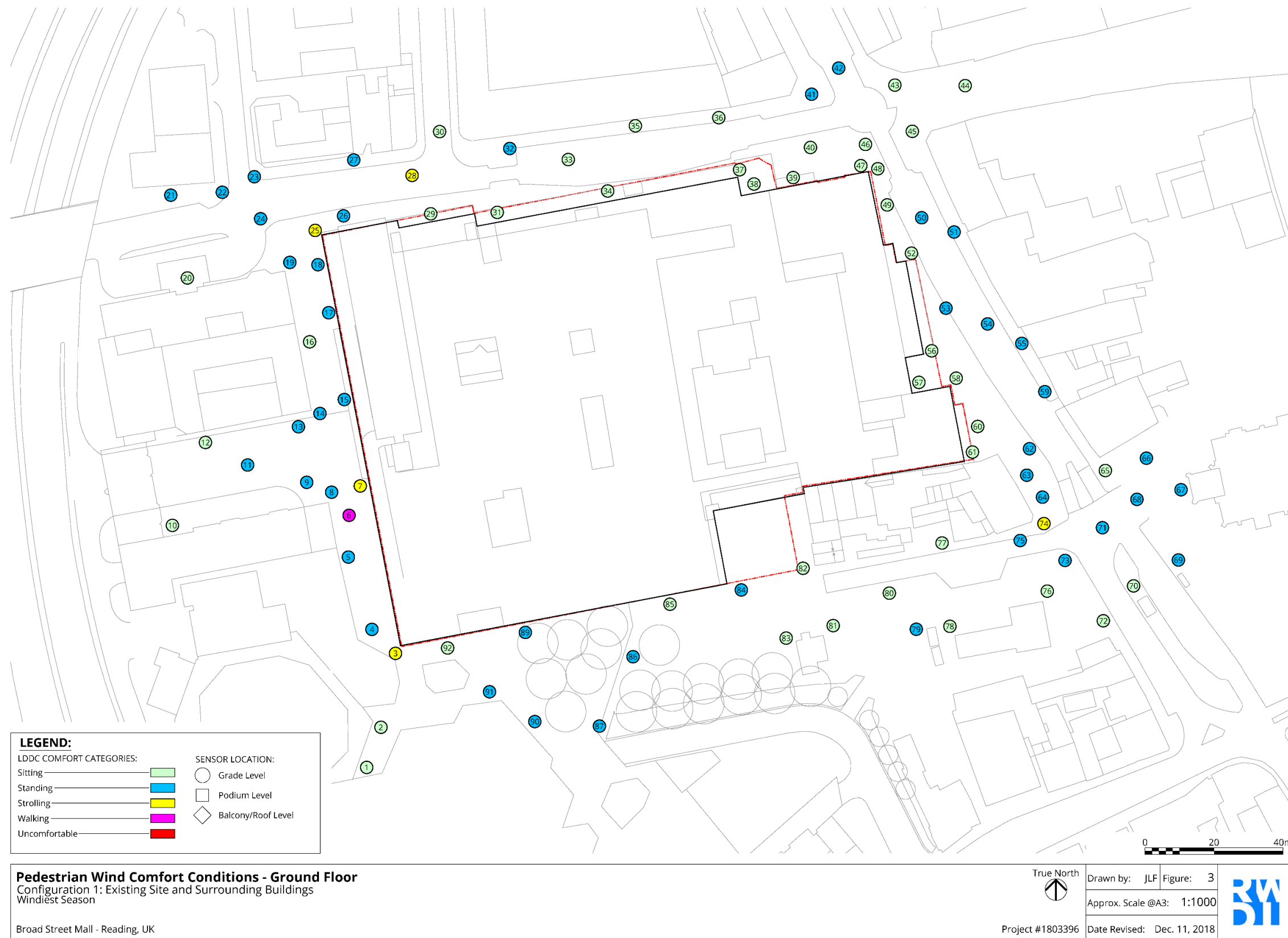
Off-site

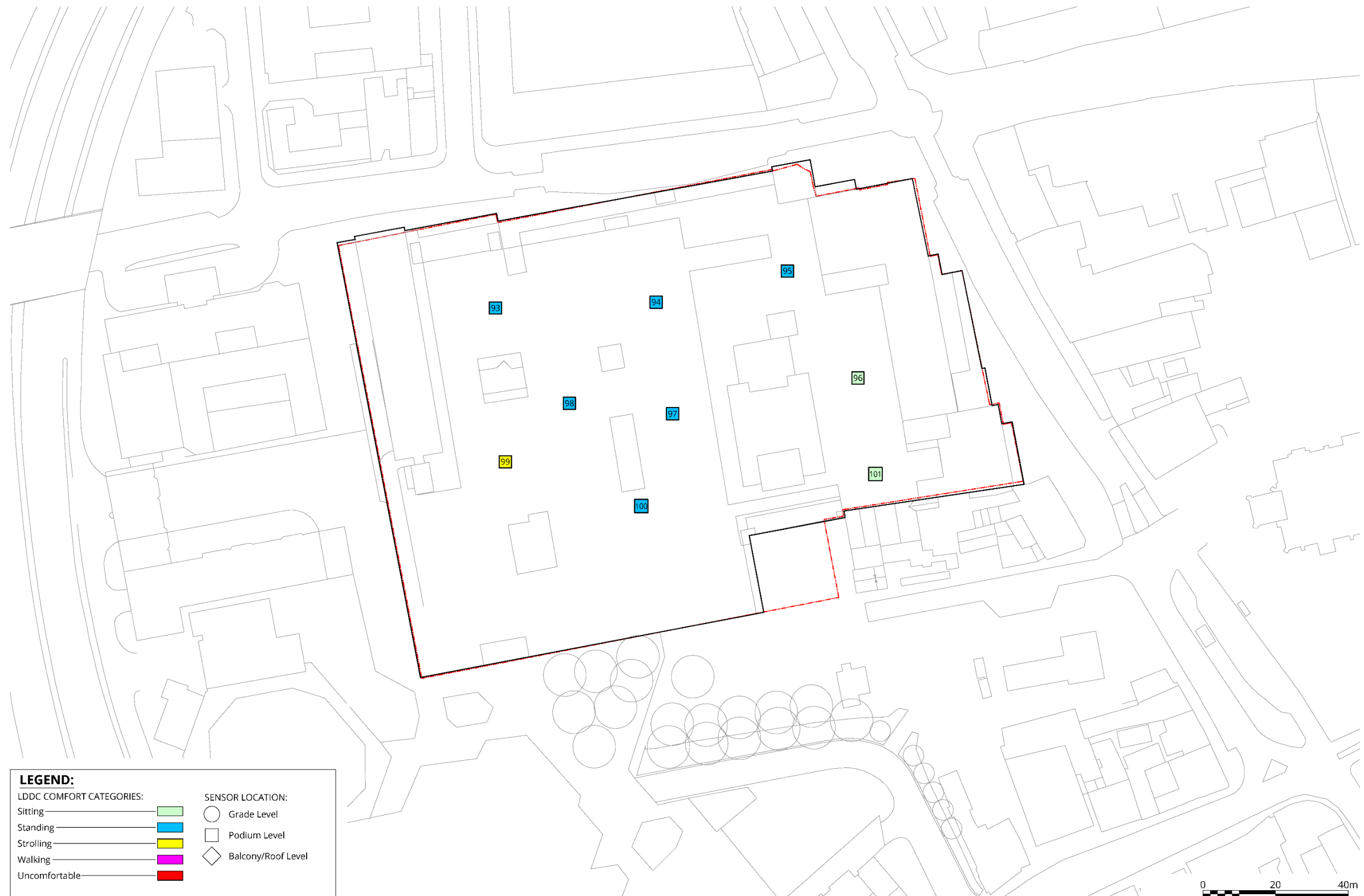
- 10.118** Location 40 has the same conditions as Configuration 3 with the addition of cumulative schemes, however location 48 becomes calmer representing a **negligible** effect with the addition of cumulative schemes. Other roadway wind conditions remain the same as in Configuration 3.

Occurrence of Strong Winds

- 10.119** For Configuration 4, there is a strong wind exceedance at ground level location 6, where wind speed exceeds 15 m/s for more than 2.2 hours per year. Location 6 is on Queen's Walk and has an exceedance in the baseline scenario, and therefore does not require mitigation. The Proposed Development and cumulative surrounding buildings reduce the strong wind exceedance at Location 6 by 0.5 hours per year.
- 10.120** Strong winds will also occur at locations 74, and 75. These locations pose a safety concern and a comprehensive landscaping and mitigation plan will be developed and wind tunnel tested to address these strong wind exceedances post planning as part of the detailed design.

Annex 1





Pedestrian Wind Comfort Conditions - Roof View
Configuration 2: Proposed Development with Existing Surrounding Buildings
Windiest Season

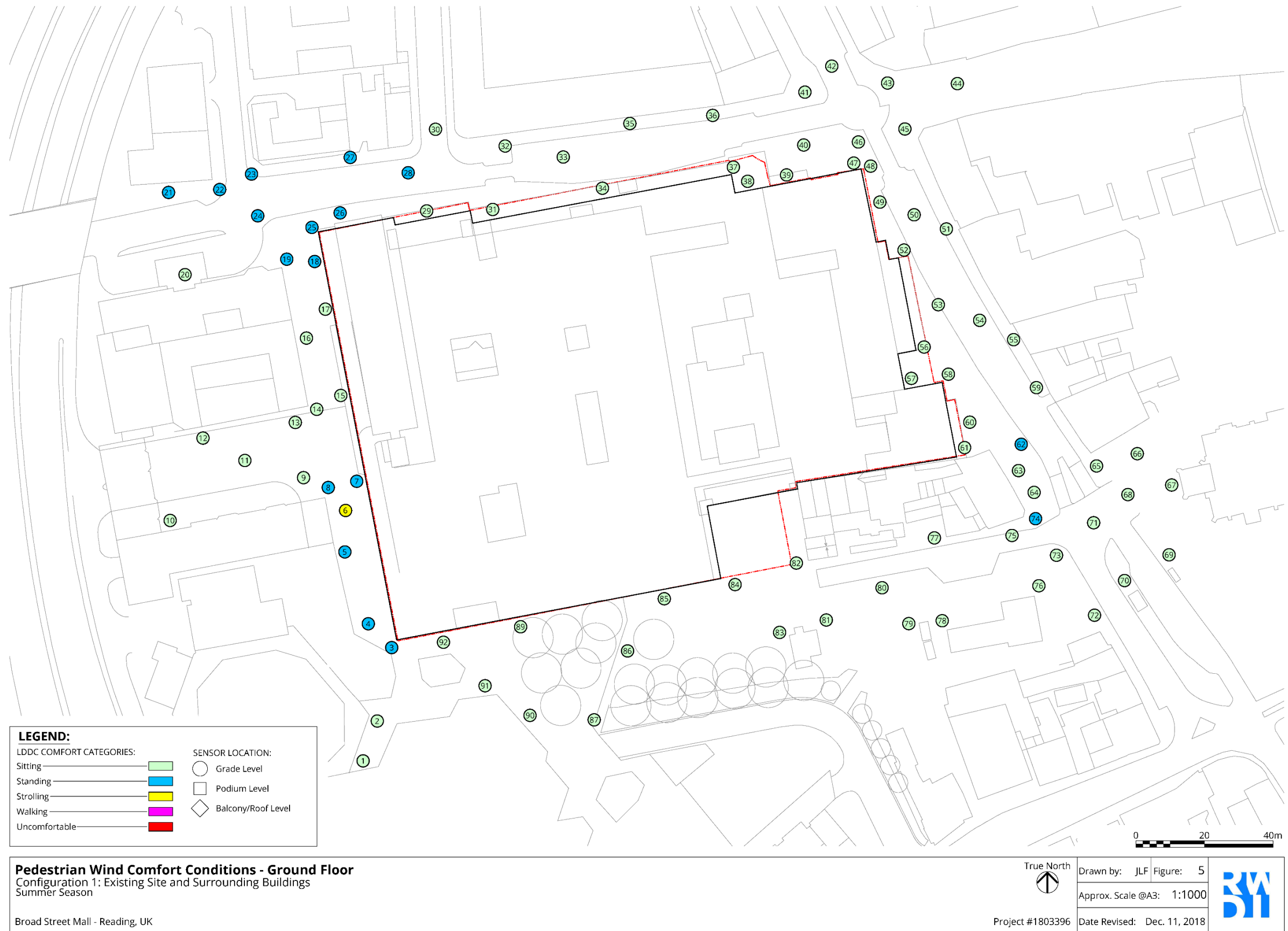
Broad Street Mall - Reading, UK



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Pedestrian Wind Comfort Conditions - Roof View
Configuration 2: Proposed Development with Existing Surrounding Buildings
Summer Season

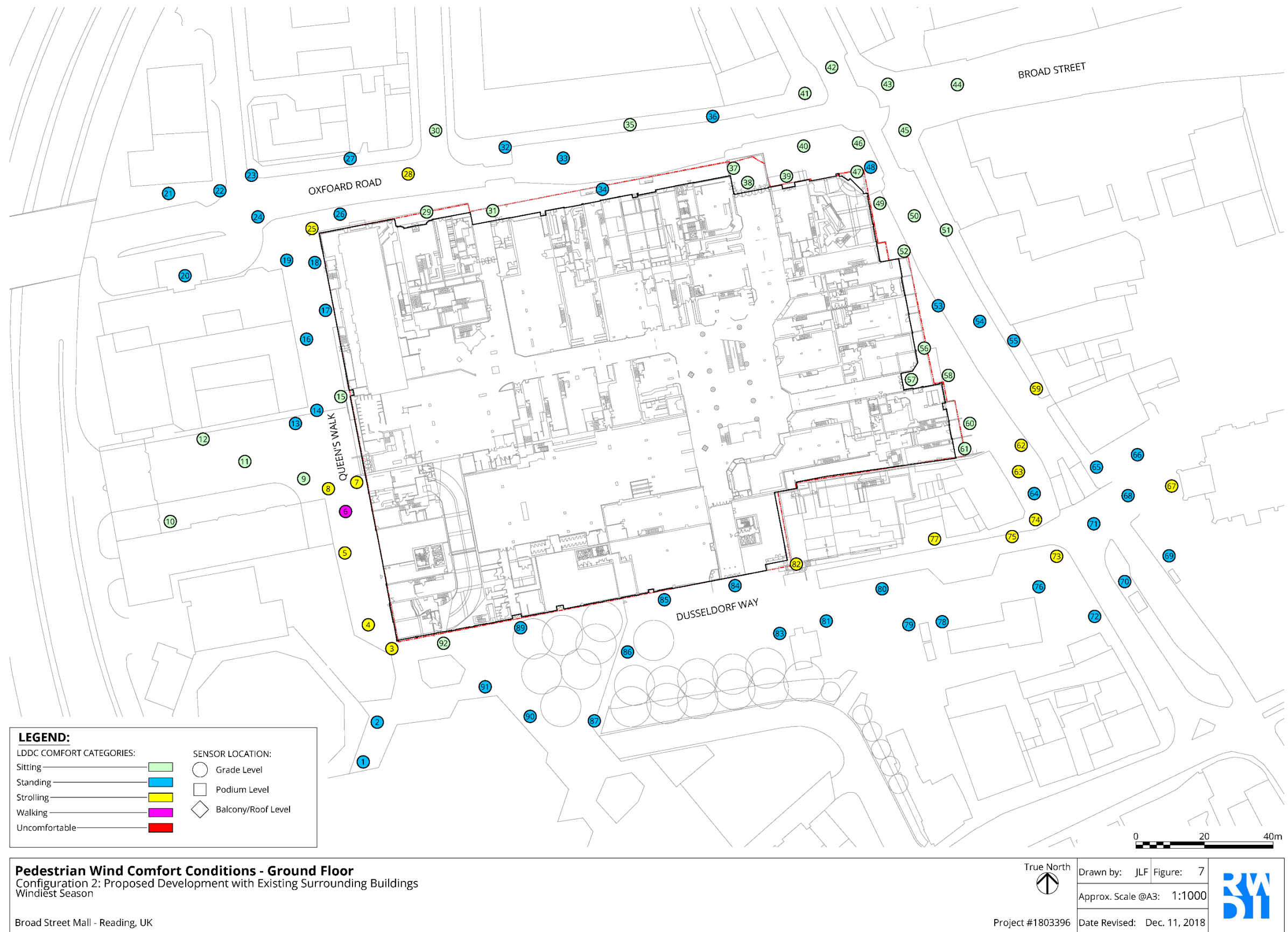
Broad Street Mall - Reading, UK

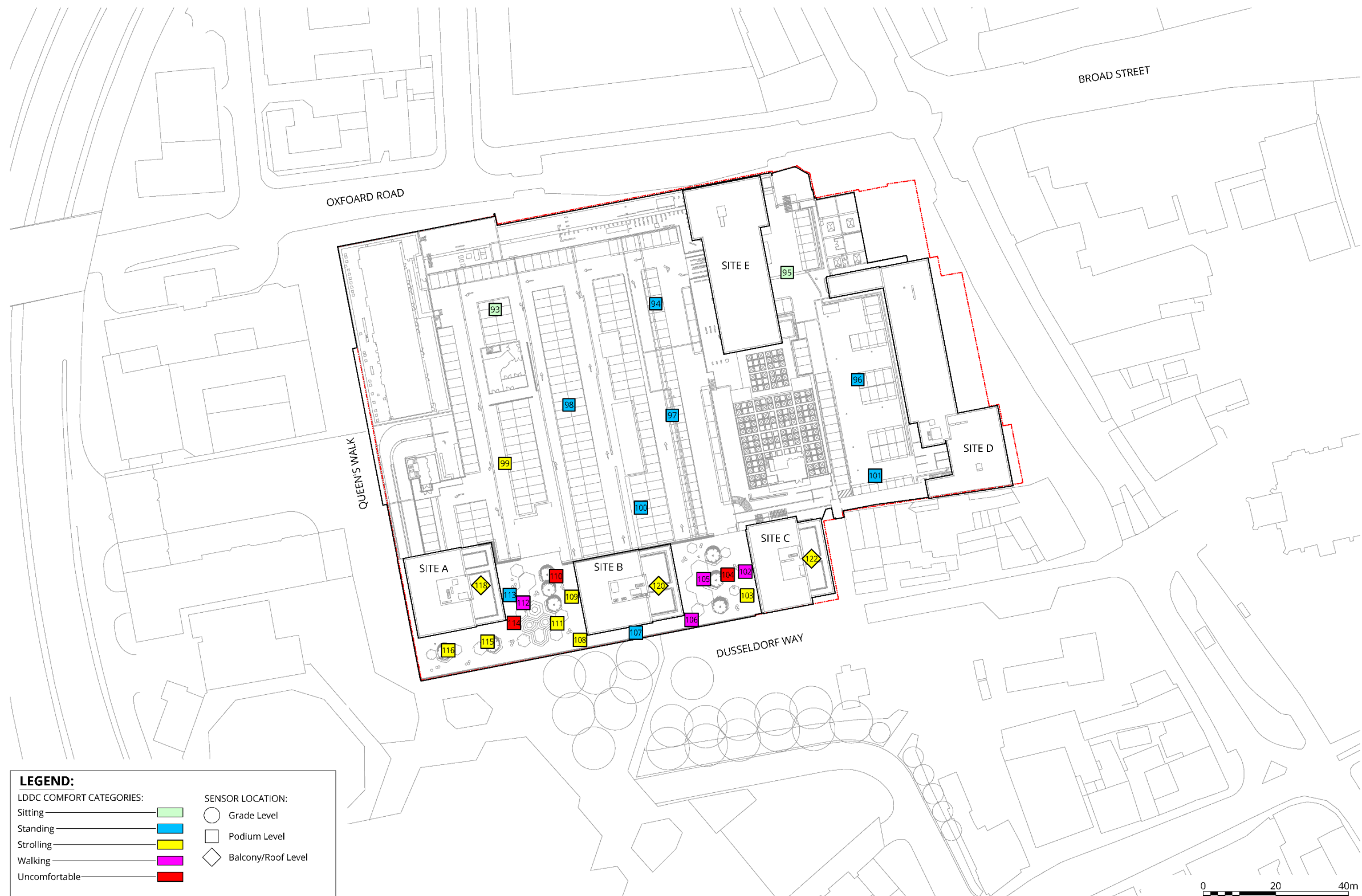


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Date Revised: Dec. 11, 2018



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Pedestrian Wind Comfort Conditions - Roof View
Configuration 2: Proposed Development with Existing Surrounding Buildings
Windiest Season

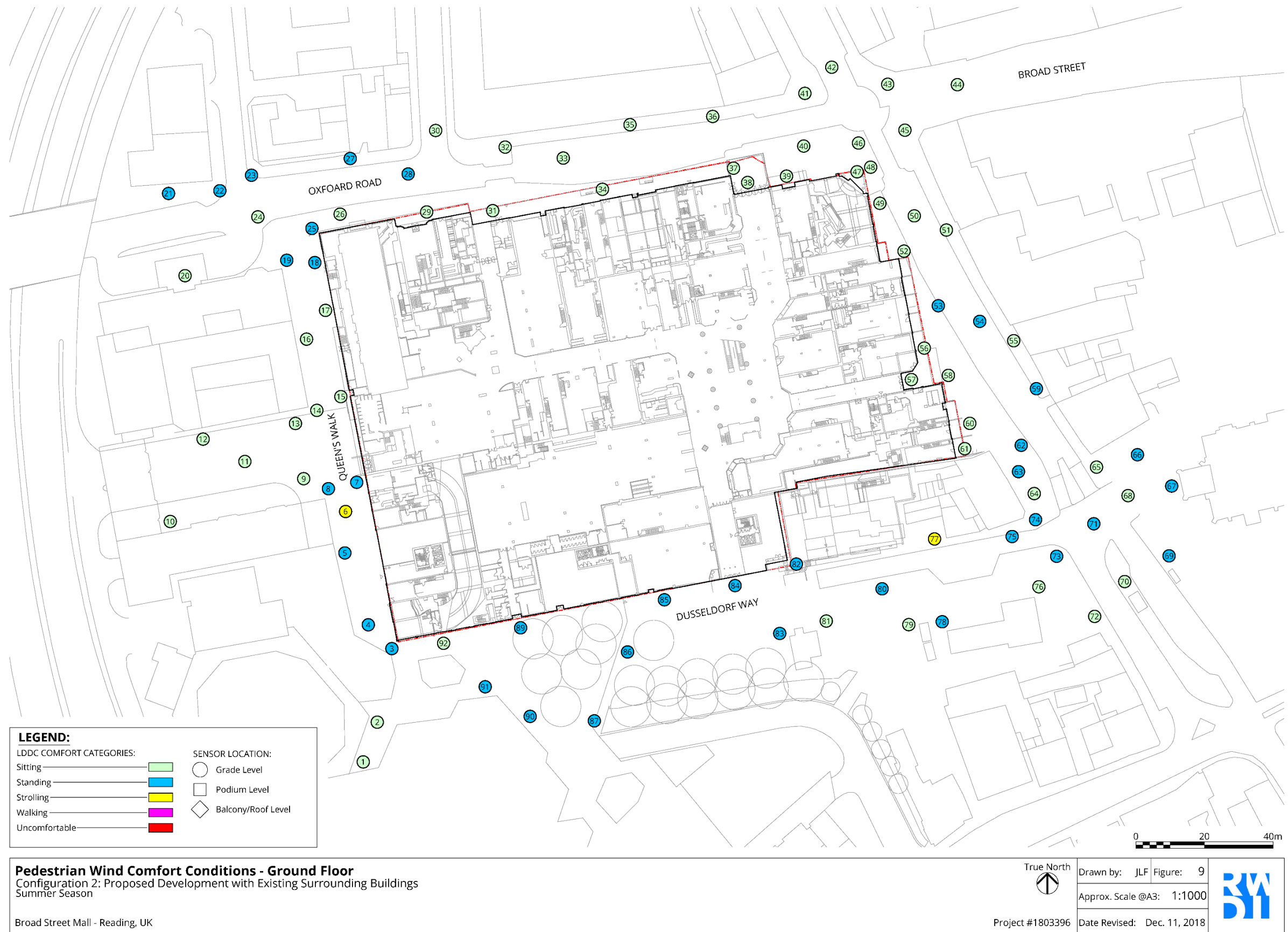
Broad Street Mall - Reading, UK

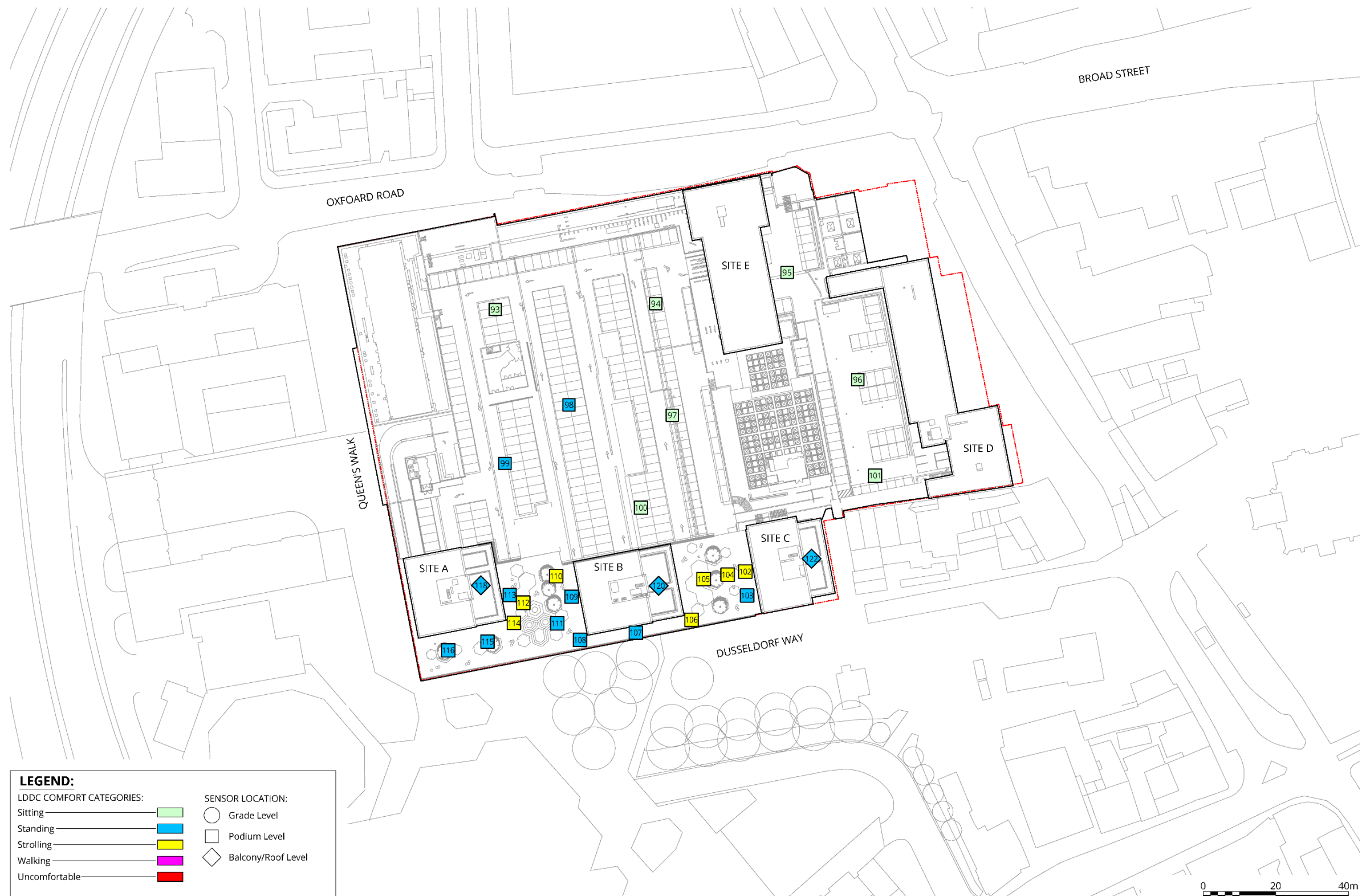


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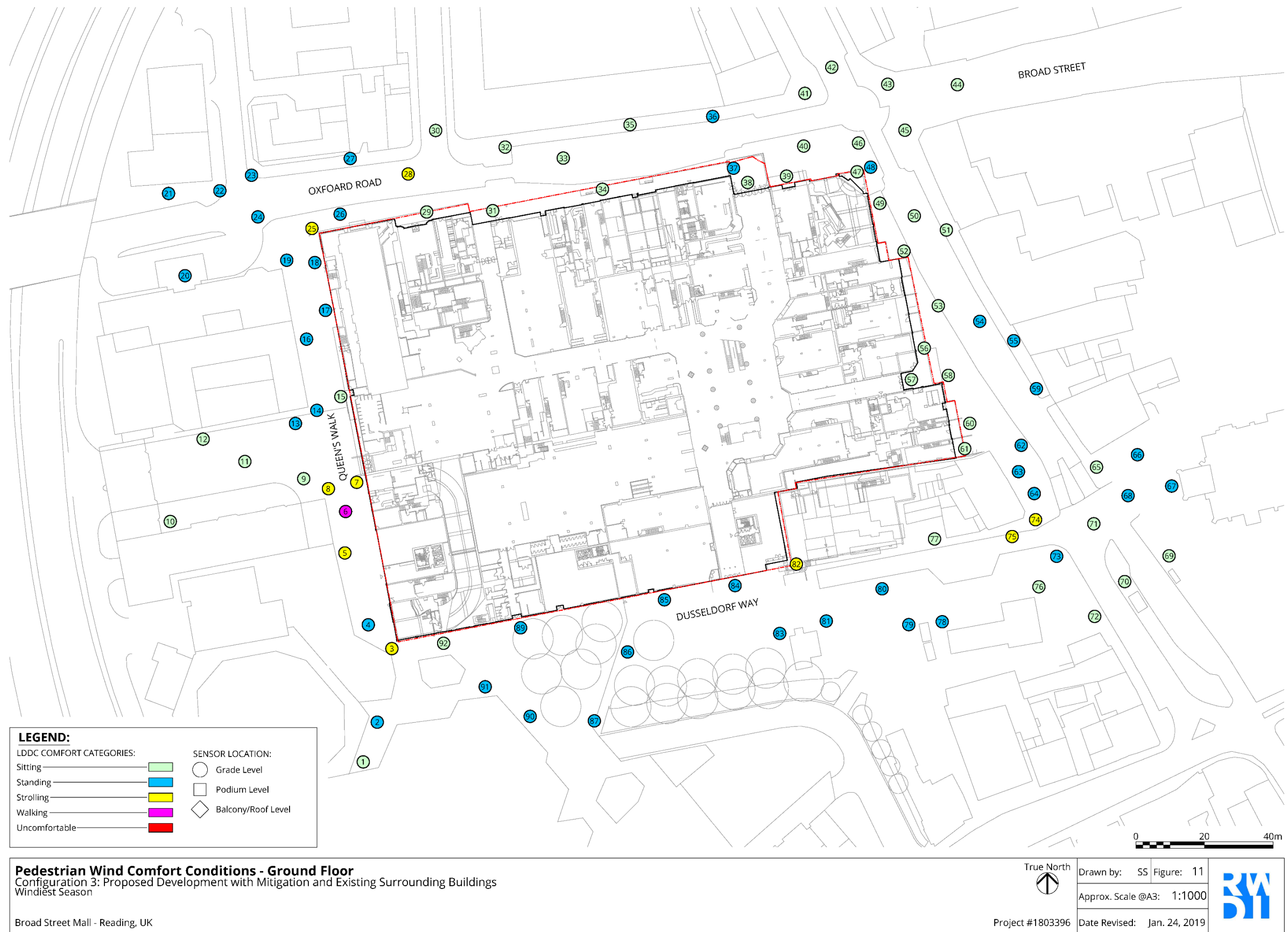


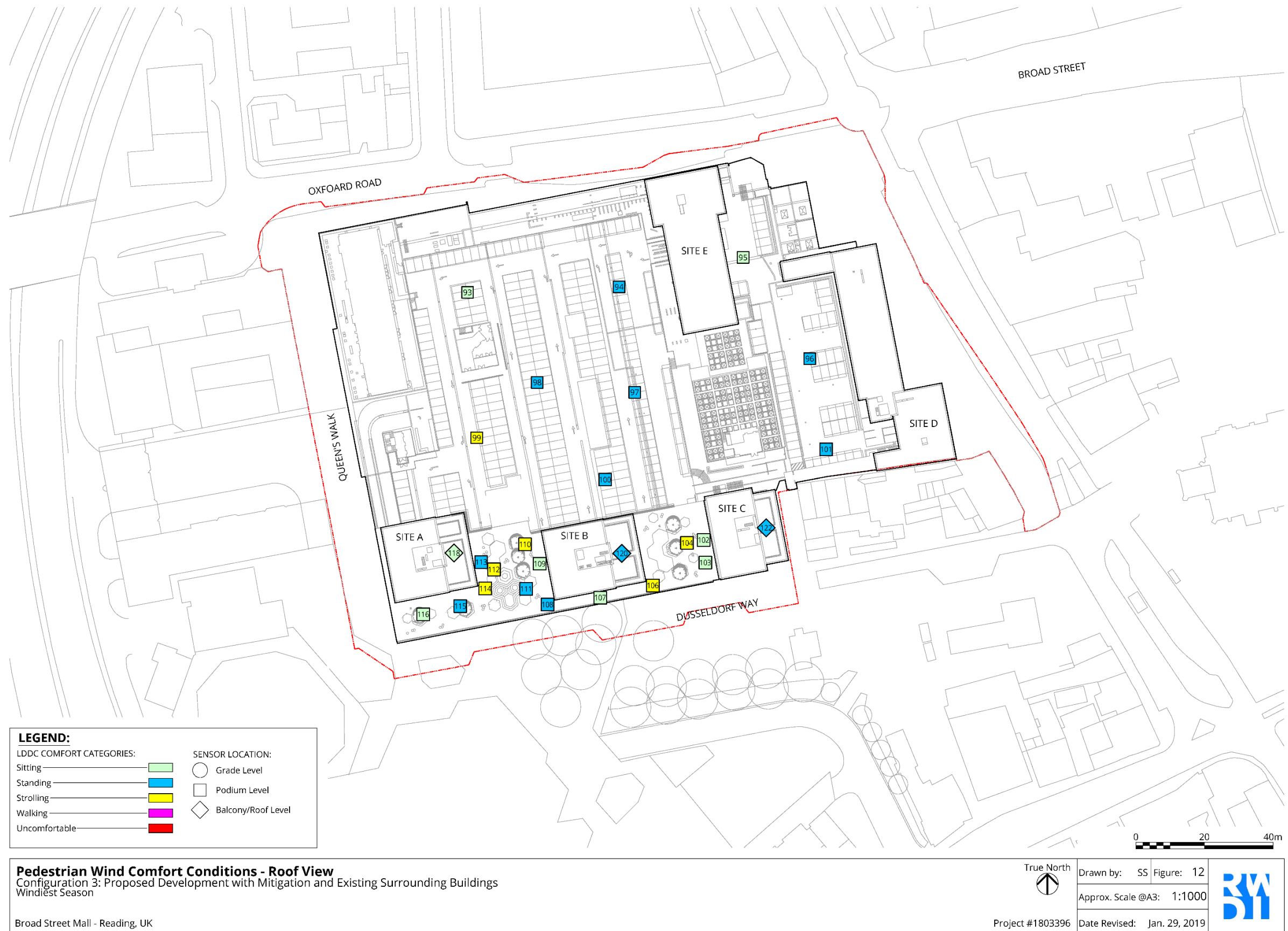
Pedestrian Wind Comfort Conditions - Roof View
 Configuration 2: Proposed Development with Existing Surrounding Buildings
 Summer Season

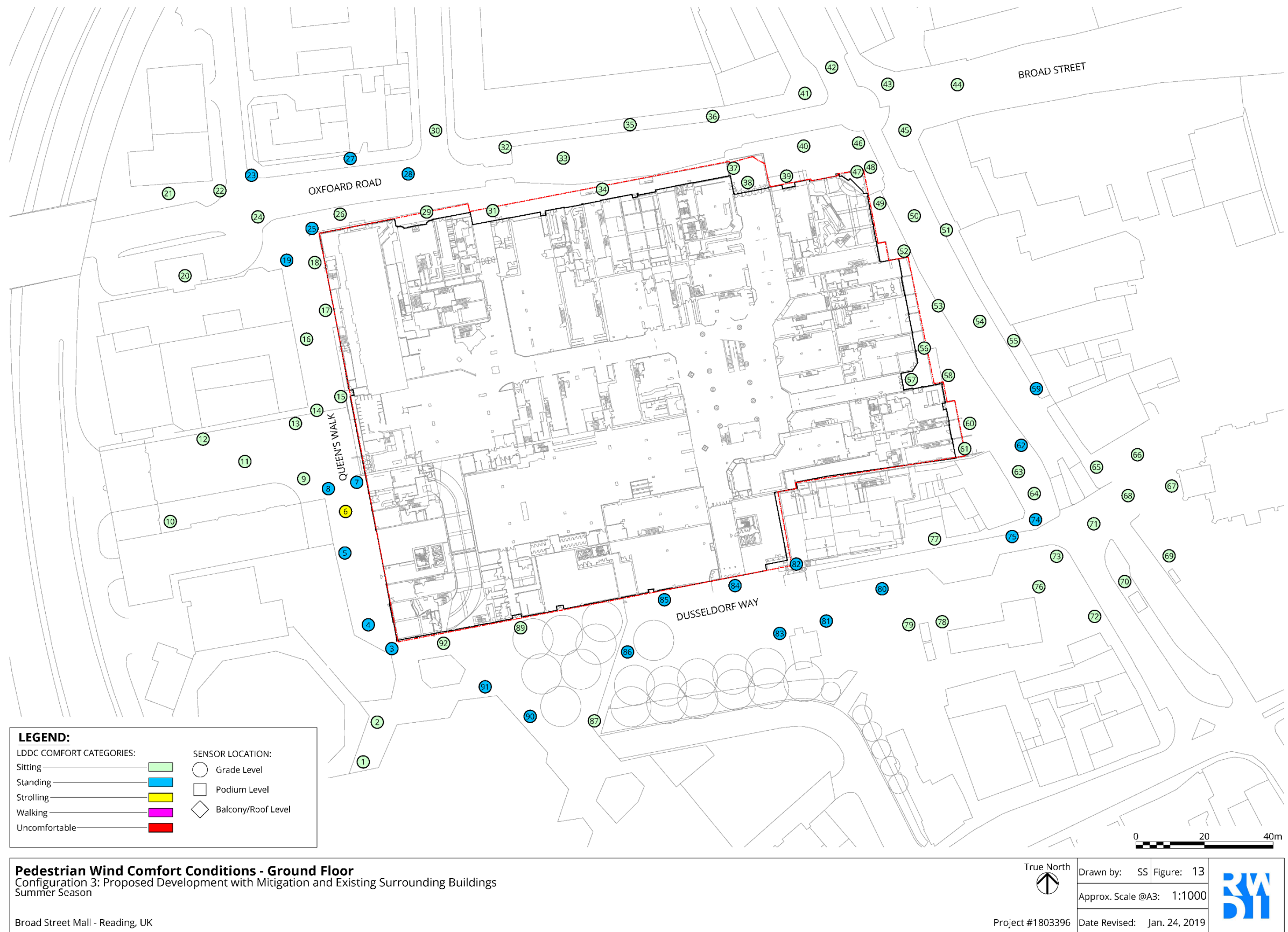
Broad Street Mall - Reading, UK

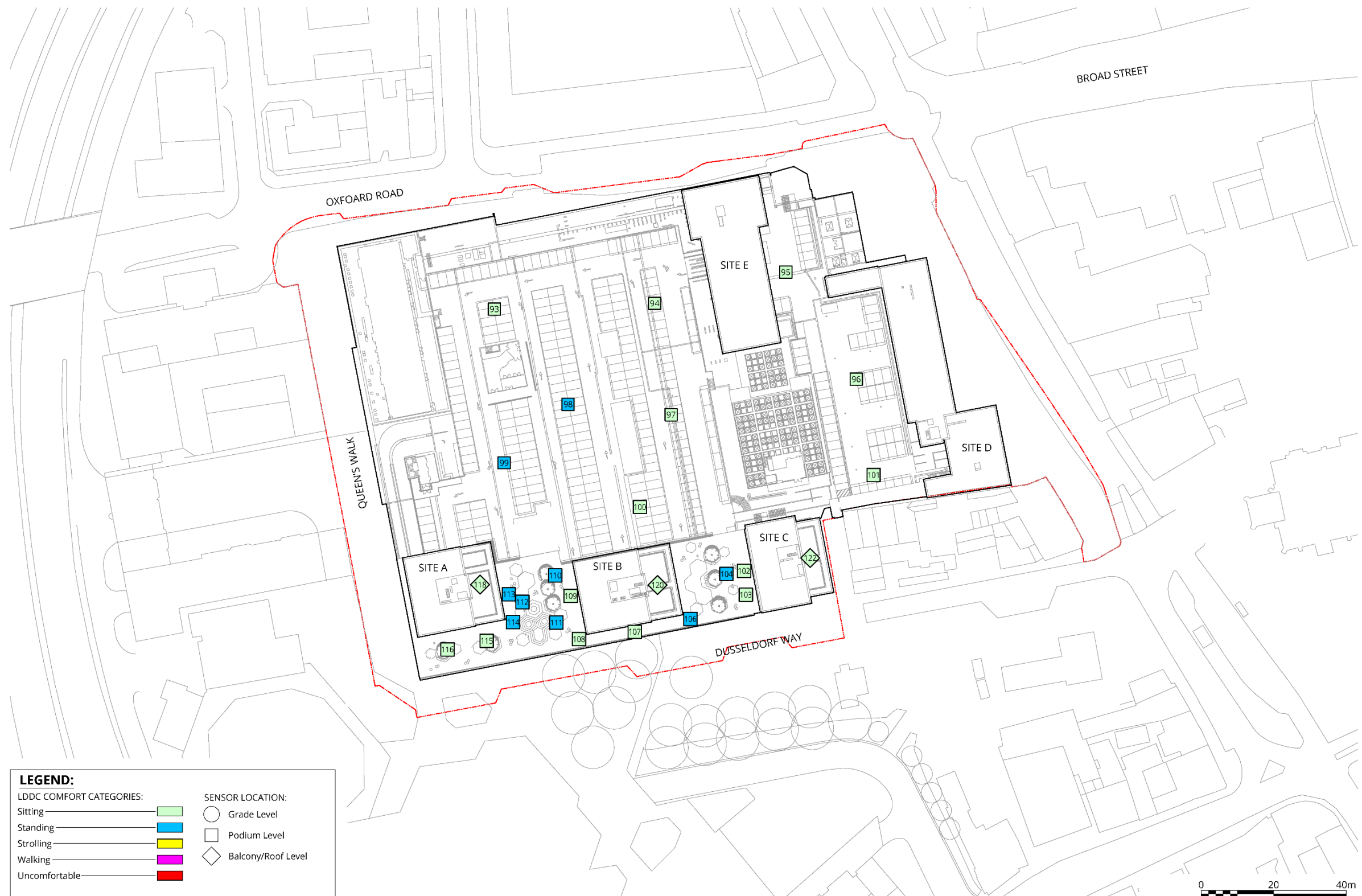
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 Date Revised: Dec. 11, 2018











Pedestrian Wind Comfort Conditions - Roof View
Configuration 3: Proposed Development with Mitigation and Existing Surrounding Buildings
Summer Season

Broad Street Mall - Reading, UK



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Approx. Scale @A3: 1:1000
Date Revised: Jan. 29, 2019



