13.0 MICROCLIMATE- WIND

This chapter addresses the issue of wind at the proposed mixed-use scheme to complete the RB Central development at Rockbrook, Sandyford, Co. Dublin.

13.1 INTRODUCTION

This chapter of the Environmental Impact Assessment Report (EIAR) assesses the potential impacts and associated likely effects of the RB Central Development (hereafter referred to as the 'Proposed Development') on the local wind microclimate at the Site and within the surrounding area. It considers the potential effects of wind upon pedestrian comfort and pedestrian safety (of the general public passing the application site, as well as future occupants of the Proposed Development) and strong winds which, if they were to occur, would affect pedestrian safety.

This EIAR chapter sets out the methods used to assess the potential effects; the baseline conditions currently existing at the Site and its immediate surrounds (off-site locations); and likely impacts on the wind microclimate of the completed Proposed Development.

The assessment quantifies the expected wind microclimate in pedestrian areas at ground, and balcony levels. The measured wind speed statistics are benchmarked against the RWDI Criteria to determine the suitability of the proposed development for different pedestrian activities. The existing (baseline) conditions at the application site and its surrounds, as well as those for the proposed development are assessed. Strong winds are also considered. Results for the winter season are presented, as well as results for the summer when amenity spaces are more likely to be used frequently.

13.2 METHODOLOGY

The following section outlines the methodologies applied to identify and assess the potential wind impacts likely to result from the proposed development.

The aims of the wind microclimate assessment are as follows:

- To assess the wind conditions at ground and podium levels and at elevated (terrace and balcony) amenity spaces across the proposed development within the study area;
- To assess the suitability of the elevated bridge and canopy level to achieve suitable conditions throughout the year;
- To assess the suitability of entrances of the proposed development to achieve suitable conditions throughout the year; and
- To assess the wind microclimate along pedestrian thoroughfares within the application site and within the study area.

Study Area

Wind conditions have been considered at the application site, as well as within a 360 m radius (from the centre of the application site). This radius (hereafter referred to as the 'study area') is sufficient to capture the localised building-specific wind effects on the local wind microclimate. Buildings and terrain located further away from the application site are modelled as a 'generalised roughness', which modifies the behaviour of wind approaching the application site in the wind tunnel to reflect real conditions at the application site.

Baseline Characterisation

The baseline conditions at the application site were characterised by:

- Review of meteorological data for Dublin to establish the prevailing wind directions and adjustment of that data for site specific application; and
- construction of a 1:300 scale model of the terrain and existing buildings at the application site within a 360 m radius of the study area, and subsequent wind tunnel testing of the existing application site conditions (Configuration 1). Baseline characterisation was completed using the same testing and analysis methods for the proposed development as described in the following section.

A total of 189 probes were used in the baseline test. Measurements were taken covering the various receptor locations identified in the study area. The layout and total number of measurement locations on-site for the Existing Configuration were informed by the ground floor plan of the proposed development to ensure a consistent comparison of measurement locations for the different assessment configurations. This means that some of the measurement locations present on the Proposed Development configuration are not present for the Existing Configuration because there is no comparable location for a measurement location to be placed.

The analysis of the Existing Configuration was completed using the same testing and analysis methods used for the Proposed Development configuration (described later in this Chapter).

METHOD OF ASSESSMENT

Wind tunnel testing is the most well-established and robust means of assessing the pedestrian wind microclimate. It enables the wind conditions at the site to be quantified and classified in accordance with the widely accepted RWDI Criteria.

Wind tunnel tests deliver a detailed assessment of the mean and gust wind conditions around the application site and the proposed development for all wind directions in terms of pedestrian comfort and safety, and provide a basis to assess the potential impacts and likely effects of the proposed development with regards to its intended use. Strong winds, if they occur, are also identified.

As noted in the Assumptions and Limitations section below, the wind environment during the demolition and construction stage has not been tested in the wind tunnel, as this is a temporary condition and would be highly variable as new buildings are constructed in a phased manner. However, potential demolition and construction effects on pedestrian comfort have been assessed through application of prudent professional judgement.

Wind Tunnel Testing and Model Details

A 1:300 scale model of the existing buildings at the application site and within the study area (defined as a 360m radius from the centre of the application site) was constructed (to represent on-site and off-site receptors respectively). Wind measurements were taken at 189 locations for the Proposed Development without landscaping (Configuration 2) and the Proposed Development with landscaping (Configuration 3).

To summarise, the following configurations were assessed in the wind tunnel:

- Configuration 1: Existing application site (baseline) with existing surrounding buildings;
- Configuration 2: Proposed development with existing surrounding buildings;
- Configuration 3: Proposed development with cumulative surrounding buildings;
- Configuration 4: Proposed Development with landscaping and existing surrounding buildings; and
- Configuration 5: Proposed Development with landscaping and cumulative surrounding buildings.

A photograph of the wind tunnel model (Configuration 3) is shown in Figure 13.1.

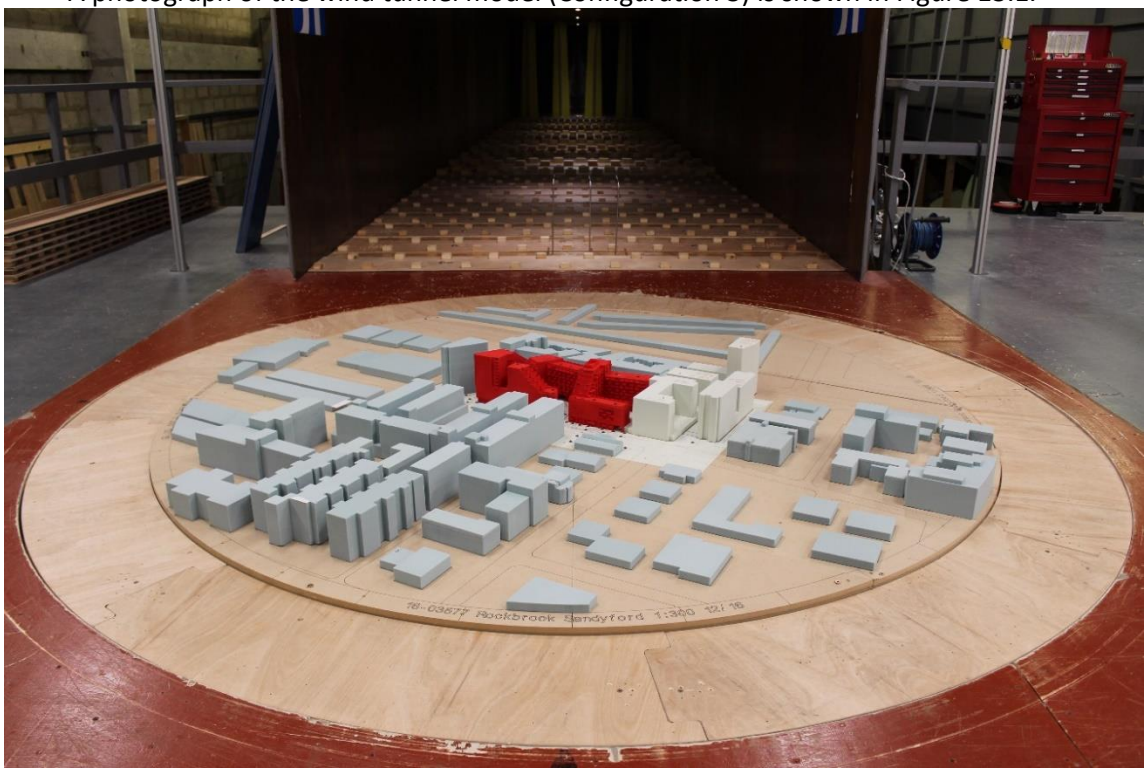

Figure 13.1: Photo of the wind tunnel model (Configuration 3) from the south

The methodology for quantifying the pedestrian level wind environment of the existing application site and the proposed development is outlined below:

- Step 1: Measure the building-induced wind speeds at pedestrian level in the wind tunnel;
- Step 2: Adjust standard meteorological data to account for conditions at the application site;
- Step 3: Combine these to obtain the expected frequency and magnitude of wind speeds at pedestrian level (on an annual and seasonal basis for comfort, and annual and monthly basis for strong winds); and
- Step 4: Compare the results with the RWDI criteria to 'grade' conditions around the application site.

Wind comfort results are presented for the winter season (November through to April), and summer (May through to October).

The wind tunnel tests for Configurations 1 to 3 were conducted on a model devoid of trees or landscape detail in order to obtain conservative results (i.e. generate a relatively windy microclimate). However, the results for Configurations 4 and include the final landscape scheme and mitigation measures.

Simulation of Atmospheric Winds

Wind is unsteady or gusty, and this 'gustiness' or turbulence varies depending upon the application site. Modelling these effects is achieved by a series of spire, barrier and floor roughness elements to create a boundary layer that is representative of urban or open country conditions, as is appropriate.

Measurement Technique

Wind speed measurements were made using Irwin probes, which measure the wind speed at a scaled 1.5 m height above the level instrumented, for example ground, podium, terrace and balcony levels. Irwin probes are a reliable standard instrumentation type which have been used in wind microclimate assessments for 30 years. For pedestrian comfort studies, both the mean wind speed and peak wind speed were determined at each measurement location.

The wind speed was measured at locations on ground and balcony levels for all wind directions in equal increments, with 0° representing wind blowing from the north and 90° representing wind from the east. The locations included entrances, amenity areas and thoroughfares within the application site, as well as off-site locations in the immediate surrounds. The identification of sensitive receptors and the number of probes required was based on professional judgement and probes were situated in close proximity to sensitive locations such as building entrances, along thoroughfares and within amenity areas.

13.3 ASSUMPTIONS AND LIMITATIONS

Results are presented for the winter season. This is because some pedestrian activities defined by the RWDI Comfort Criteria need to be met during the windiest (typically winter) season whereas others, primarily seating and amenity areas, are dependent upon the summer time conditions because they are reasonably expected to be more frequently used during this period.

The 1:300 model was constructed based on the design information supplied by the Applicants' Architect Design Team, and is considered to provide an accurate basis for assessment of wind impacts.

It should be noted that the open walkways between the blocks to the south-west of the Site were too small to instrument with receptors on the wind tunnel model at 1:300 scale. However, the area is expected to be well sheltered by the solid balustrades which are taller than the majority of the pedestrian population's height (2m tall). The assessment of these walkways has been made qualitatively, informed by wind conditions at nearby receptors at roof level.

13.4 RWDI CRITERIA

The RWDI criteria have been developed by RWDI through research and consulting practice since 1974. They have also been widely accepted by municipal authorities as well as by the building design and city planning community throughout the world.

The criteria (set out in Table 13.1 below) define a range of pedestrian activities from sitting, through to more transient activities such as crossing the road, and for each activity defines a threshold wind speed and frequency of occurrence beyond which the wind environment would be unsuitable for each activity. The criteria reflect the fact that sedentary activity, such as sitting, requires a low wind speed whereas for more transient activity (such as walking) pedestrians would tolerate stronger winds.

If the wind conditions exceed the threshold, then the conditions are deemed to be unacceptable for the stated activity. If the wind conditions are below the threshold then they are described as tolerable (or suitable) for the stated activity. For example, if the wind speed exceeds 14km/h for more than 20% of the time then the conditions would be unacceptable for standing.

Previous experience has shown that the walking or uncomfortable classifications are associated with relatively strong winds during the winter season. Wind conditions in excess of 90 km/h would be expected to require mitigation in an urban Development.

Table 13.1: The RWDI Criteria

Comfort Category	GEM Speed (km/h)	Description
Sitting	≤ 10	Calm or light breezes desired for outdoor restaurants and seating areas where one can read a paper without having it blown away
Standing	≤ 14	Gentle breezes acceptable for main building entrances and bus stops
Strolling	≤ 17	Moderate winds that would be appropriate for window shopping and strolling along a downtown street, plaza or park
Walking	≤ 20	Relatively high speeds that can be tolerated if one's objective is to walk, run or cycle without lingering
Uncomfortable	> 20	Strong winds of this magnitude are considered a nuisance for most activities, and wind mitigation is typically recommended

Notes: (1) Gust Equivalent Mean (GEM) speed = max(mean speed, gust speed/1.85); and
(2) GEM speeds listed above are based on a seasonal exceedance of 20% of the time between 6:00 and 23:00.

Table 13.2: Strong Winds

Safety Criterion	GEM Speed (km/h)	Description
Exceeded	> 90	Excessive gust speeds that can adversely affect a pedestrian's balance and footing. Wind mitigation is typically required.

Notes: Based on an annual exceedance of 9 hours or 0.1% of the time for 24 hours a day.

13.5 Target Wind Conditions

For residential led urban site, such as the Proposed Development (and surrounding area), the desired wind microclimate would typically need to have areas suitable for sitting to walking 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.

It should be noted that the general windy environment in Dublin will lead to a certain amount of acclimatisation for pedestrians and residents, who will therefore expect slightly windier conditions. Therefore, in certain cases, slightly windier conditions (by one comfort category) may be tolerable provided that the wind conditions are not associated with strong winds or made windier by the inclusion of the Proposed Development.

Amenity Areas

The target condition in seating areas is a wind microclimate that is suitable for sitting in the summer months. This is because these areas are more likely to be frequently used by pedestrians who would expect to be able to sit comfortably in the summer. Nevertheless, both summer and winter conditions are recorded for the Proposed Development.

Larger amenity spaces can have wind conditions suitable for a mixture of sitting and standing use during the summer season, however seating areas should be restricted to locations which have sitting conditions.

If an area is classified as suitable for sitting in the summer, in RWDI's experience, the stronger winds that occur during the winter season usually mean that the area would be classified as suitable for standing at this time of year, unless additional shelter was provided.

At private balcony locations, although sitting use wind conditions are desired, standing use wind conditions during the summer season are considered tolerable.

Entrances

Near building entrances, a wind environment suitable for standing or calmer is desired throughout the year because these are used throughout the year.

Thoroughfares

A pedestrian thoroughfare should be suitable for walking or calmer.

Walking use wind conditions are suitable at thoroughfares where pedestrians are not intended to linger (i.e. they are at the location to get from A-to-B). Calmer conditions suitable for strolling use are required at thoroughfares where pedestrians are expected to take their time, such as near retail units where pedestrians may window shop, or through garden areas.

Strong Winds

The assessments undertaken also provide a notification of stronger winds, which are defined as wind speeds in excess of 90km/h for more than 9 hours per year or 0.1% of time. It is noted that these stronger winds are associated with the walking and uncomfortable classifications.

13.6 SIGNIFICANCE CRITERIA

The criteria used in the assessment of the potential effects are based on the relationship between the desired pedestrian uses (as defined by the RWDI Criteria) in relation to the wind conditions at a particular location with the Proposed Development in place. This allows for the assessment to take into account any change in pedestrian activity that might accompany the Proposed Development.

The assessment criteria are an increasing scale to reflect the increasing magnitude of impact, as shown in Table 13.1.

Table 13.3 Significance Classification

Wind Microclimate Criteria	Effect Classification and Significance
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

In line with RWDI's overall methodology, strong winds are reported separately from the Comfort Criteria assessment and do not form part of the significance criteria.

The criteria used in the assessment of both potential and residual effects is based upon the relationship between the desired pedestrian use of an area of the Proposed Development (based on the categories defined by the RWDI Criteria) and, the predicted wind conditions at that area. This also allows for the assessment to account for any change in pedestrian activity that might arise because of the Proposed Development.

In terms of the nature of the effect, effects can either be Beneficial (calmer conditions than required) or Adverse (windier conditions than required). An adverse effect implies that a location has a wind environment that is unsuitable for its intended use and mitigation would therefore be required.

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, a corresponding entry has been included in the 'Mitigation Measures' section of this chapter to describe the remedial measures expected to mitigate the effect.

Potential adverse effects that are assessed as minor, moderate or major effects are considered to be significant, i.e. they would require mitigation in order for local conditions to become suitable for the intended use of the area. As an example, if the design wind conditions at a particular location are required to be suitable for standing, but the modelled wind conditions are identified as being suitable for strolling, the difference between the desired and modelled wind conditions is described as being one-step windier than desired. In this case, the potential effect would be identified as being of minor significance and adverse (i.e. windier than desired).

Any adverse effect is a 'significant effect' because it implies that a location, or area, has a wind microclimate that is unsuitable for the desired use of that area. On this basis, effects that are adverse need mitigating.

It should be noted that off-site locations can only be deemed to have a beneficial effect if the wind conditions have been made better because of the Proposed Development. This means, if the wind conditions are calmer than required in both the baseline and the completed development scenarios this would represent a negligible effect.

The geographical extent of the wind microclimate is expected to be within the Site and its immediate surroundings, i.e. a local impact, for all receptors. All wind effects with the Proposed Development in situ are considered at permanent and irreversible effects. The wind conditions during the construction and demolition stage are temporary, reversible, effects.

The sensitivity of receptors is related to the intended pedestrian usage at each location; there are no separate 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.

13.7 RECEIVING ENVIRONMENT

Meteorological Data

Wind statistics recorded at Dublin Airport between 1973 and 2013 were analysed for two seasons. The assessment presented in this report focusses on winter, representing a 'worst-case' season for windy conditions between November and April and a summer season (representing a time of the year when amenity spaces are expected to be usable between May and October). Figure 13.2 graphically depicts the distribution of wind frequency and directionality for the two seasons.

The meteorological data indicate that the prevailing wind direction throughout the year is from the west-southwest with a secondary peak for south easterly winds. Based upon the background wind climate, Dublin is a relatively windy city (by comparison with London, for example) prior to any further wind-building interactions that might occur. As a result of the generally windy climate it is considered that local residents will be acclimatised to stronger winds and are therefore more likely to tolerate adverse conditions. However, the windier microclimate also means it is more likely that wind safety issues could occur.

The meteorological data of open-countryside terrain obtained for Dublin (Figure 11.2) indicates the expected peak from the south-westerly direction which is prevalent throughout the year and the secondary north-easterly during the spring and summer months

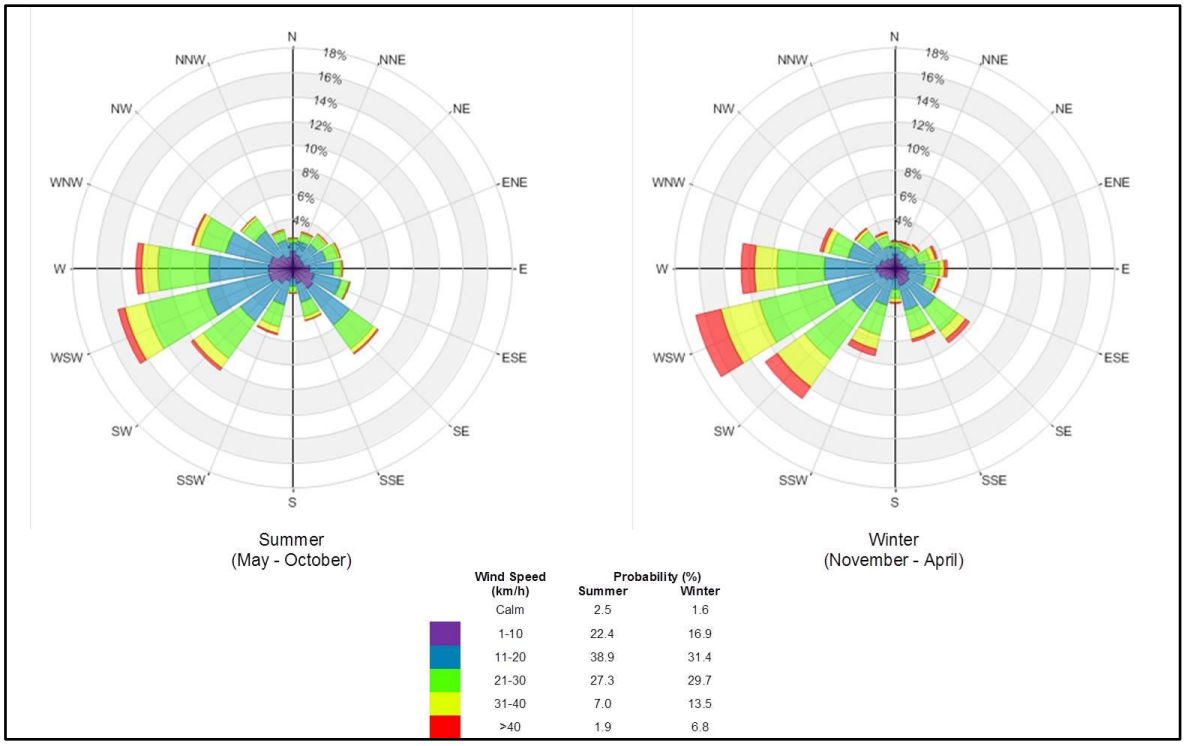

Figure 13.2 Seasonal Wind Roses

A combination of meteorological data, site location and velocity ratios permitted the percentage of time that wind speeds exceed each range of the RWDI Criteria thresholds to be computed for each measurement location.

13.8 EXISTING SITE

Wind conditions for the existing site (Configuration 1) can be seen in Figures 3 and 4 of the Appendix. The existing site is currently empty meaning there is little shelter from the strong south westerly winds leading to a naturally windy environment.

The windiest conditions were found at the south west corner of the site, as well as off-site to the south west.

Thoroughfares

Thoroughfares throughout the Site and surrounding area were suitable for sitting use to uncomfortable during the windiest season.

The windiest conditions were uncomfortable for all uses, and were generally to the south-west on and off-Site (at probes 39, 41 to 44 and 48). Probe location 59 to the north of the Site also had wind conditions uncomfortable for all uses. This is two categories windier than general thoroughfare use.

Wind conditions suitable for walking use generally occur to the south and south-west of the Site, and at the off-Site courtyard (at probe locations 23 to 25, 27 to 34, 40, 45,47, 49, 50, 54, 61, 66, 109, 182 and 184). Walking use is suitable for thoroughfare use where people are not intended to linger.

Entrances

Off-Site entrances are represented by probe locations 11, 21 and 38. Probe locations 21 and 38 are suitable for sitting use and standing use respectively during the winter season, and are suitable for the intended use.

Probe location 11 is suitable for strolling use which is one category windier than required for entrance use.

Crossings

Crossings are located at probe location 27, 31, 39 and 41. Wind conditions at probe locations 39 and 41 are uncomfortable for all uses, which is windier than required for the intended use.

Probe locations 27 and 31 are suitable for walking use. These wind conditions are suitable for the intended use.

Safety

Safety exceedances are shown in Figure 6 of the Appendix. Probe location 44 (located at the south west corner of the Site), had strong gusts exceeding the safety criterion of 90km/h for more than 0.1% of the time annually during Configuration 1.

13.9 CHARACTERISTICS OF THE PROPOSED DEVELOPMENT

The Proposed Development is a residential and retail development of up to 14 floors, where amenity spaces are located at ground, balcony and roof terrace levels.

Entrances are located are probes 16 to 18, 33, 35, 69, 70, 85, 86, 88, 92, 100, 101, 106, 109, 117, 118, 120 to 122, 124 to 126 and 129.

Outdoor amenity areas are situated:

- Ground level play areas: probes 91 and 127;
- Ground level seating (western thoroughfare): probes 45, 48 and 80;
- Ground level seating (central gardens): probe 115;
- Roof terraces: probes 142 to 149, 152 to 159, 163, 164, 170 to 172, 176 to 178 and 181;
- Balconies: 130 to 139, 150, 161, 165, 167 to 169, 173 to 175, 179 and 180.

13.10 POTENTIAL IMPACTS

Construction Phase

The potential effects on wind microclimate at the Site during the construction phase have not been directly assessed. Instead, professional judgement has been used to assess the likely conditions during these stages of development.

As construction of the Proposed Development proceeds from the empty site, the wind conditions at the Site would gradually adjust to those of the completed development. However, during the latter stages of construction, it may be necessary to implement the advised mitigation measures in areas which have been predicted to be windier than desired, if it is the intention for parts of the development to become operational before construction is completed.

As windier conditions are tolerable within a construction area (not accessible to the public), and the on-Site uncomfortable wind conditions are not caused by the proposed development (and are slightly calmer with the Proposed Development in situ), the on-Site predicted impacts are classified at **negligible**.

Off-Site, areas to the west of the Site are expected to have calmer conditions when the Proposed Development is built. However, wind conditions to the south are windier with the Proposed Development in situ (discussed in the Operational Phase section below). Therefore, the predicted impacts are classified as **negligible** to **moderate adverse**. Mitigation measures will be required at these locations, which will need to be implemented during the construction phase. These measures are discussed below.

Operational Phase

The inclusion of the Proposed Development without landscaping (Configuration 2) generally provides beneficial shelter to the Site, providing a calmer environment at many locations compared to the baseline scenario. This includes the relatively windy south west corner identified in section 13.9

However, the addition of the Proposed Development also increases the wind speeds in certain areas, particularly to the south of the Proposed Development (off-Site.)

Figures 7 and 8 of the Appendix show the wind conditions at ground/roof level and balcony levels during the winter season, and Figures 9 and 10 show the wind conditions at ground/roof levels and balcony levels during the summer season.

Thoroughfares

Wind conditions on thoroughfares ranged from being suitable for sitting use to uncomfortable for all uses during the winter season.

The majority of wind conditions on-Site and to the south-east and east of the Site are suitable for strolling use to sitting use, which represents a negligible to moderate beneficial effect.

However, conditions predominantly to the south-west of the Site and to the south of the Site are windier than required for the intended use.

It is expected that the wind conditions at the walkways will be well sheltered from uncomfortable winds, due to the tall solid balustrades (2m in height) enclosing the small area providing direct shelter. Therefore, wind conditions at the walkways are expected to have a negligible effect.

Probe locations 15, 19, 23, 24, 26, 36, 39, 40, 41, 43, 45, 46, 48 to 50, 53, 54, 97, 110 and 187 are suitable for walking use. It should be noted that probe locations 39, 41, 43 and 48 are one category calmer than the existing scenario (see 0) where wind conditions at these locations were uncomfortable for all uses. Furthermore, wind conditions at probe locations 45, 49, 50 and 54 are as for the existing scenario (see 0). Therefore, the windier conditions at these locations are existing, and at several locations are improved by the Proposed Development (prior to landscaping or mitigation measures being in situ).

Locations 43, 45, 48, 50, and 54 are within a landscaped area where pedestrians are expected to linger, and therefore walking wind conditions represents a minor adverse effect

Probes 15, 19, 23, 24, 26, 36, 46, 51, 53 97, 110 and 187 are all at thoroughfare locations where pedestrians are not expected to linger, and therefore walking wind conditions represent a negligible effect at these locations.

Probe locations 20, 27, 28, 42 and 44 have wind conditions which are uncomfortable for all uses, representing a minor adverse (at probes 20, 27 and 28 where people are not expected to linger) to moderate adverse (at probes 42 and 44) effect. Wind conditions at probe locations 42 and 44 are existing wind conditions, which are slightly calmer with the Proposed Development in situ. However, the southern locations are windier with the Proposed Development built out. Mitigation measures are required at the locations with minor or moderate adverse effects.

Entrances

Off-Site entrances and the majority of on-Site entrances are suitable for standing use or sitting use during the winter, which represents a negligible to minor beneficial effect. On-Site entrance locations 17, 18, 35, 101, 106 and 117 are suitable for strolling use, which represents a minor adverse effect and requires mitigation measures.

Crossings

Wind conditions at probe locations 39 and 41 are calmer with the Proposed Development in Situ, with wind conditions suitable for walking use and represents a negligible effect.

Probe location 31 is also calmer in comparison to the existing scenario, with wind conditions suitable for strolling use, representing a **negligible** effect.

Probe location 27 is windier with the Proposed Development in situ, with wind conditions uncomfortable for all uses. This is three categories windier than required for the intended use representing a **minor adverse** effect. Mitigation measures are required at this location.

Ground Floor Amenity

The ground level play spaces at probe locations 91 and 127 are both suitable for sitting use during the summer season, and therefore represent a **negligible** effect.

Ground level seating locations on the western thoroughfare have wind conditions suitable for standing use (probe 80) and strolling use ((probes 45 and 48) during the summer season. This represents a **minor adverse** to **moderate adverse** effect and required mitigation.

Seating at the central garden is suitable for standing use during the summer season at probe location 115, which represents a **minor adverse** effect and required mitigation.

Roof Terraces

Wind conditions at roof terraces ranged from suitable for sitting use to walking use during the summer season.

Probe locations 152, 154 to 156, 164, 170, 171 and 181 are suitable for sitting use and represent a **negligible** effect.

Probe locations 142 to 146, 149, 153, 157, 159, 163, 172 and 176 had wind conditions suitable for standing use. At private amenity areas, wind conditions suitable for standing use is tolerable and represents a **negligible** effect. However, if outdoor seating is intended at these spaces standing use wind conditions is one category windier than required representing a **minor adverse** effect and mitigation is needed.

Probe locations 147, 148, 177 and 178 have strolling wind conditions during the summer season, and probe location 160 has walking use wind conditions during the summer season. These wind conditions represent a **moderate adverse** and **major adverse** effects respectively, and therefore mitigation is required.

Probe locations 140, 141 and 158 is a rooftop maintenance area, and therefore walking wind conditions are tolerable representing a **negligible** effect.

Balconies

The majority of balcony locations had wind conditions suitable for sitting use or standing use during the summer season.

Balcony locations 130 to 136 and 179 had wind conditions suitable for sitting use during the summer season which represents a **negligible** effect.

Balcony locations 137 to 139, 150, 161, 174, 175 and 180 had wind conditions suitable for standing use during the summer season. Stranding use wind conditions are tolerable at private balcony locations, and represent a **negligible** effect.

Balconies on the north-western elevation had windier conditions, ranging from suitable for strolling use (probes 168 and 173) to walking use (probe locations 165, 167 and 169) during the summer season. This represents a **moderate adverse** and **major adverse** effect respectively, and mitigation is required at these locations.

Safety

Safety exceedances are shown in Figure 11 of the Appendix.

Probe location 44 (located at the south west corner of the Site) and 160 (a roof level location to the south-west), had strong gusts exceeding the safety criterion of 90km/h for more than 0.1% of the time annually during Configuration 2. Mitigation measures are required at these locations.

13.11 MITIGATION MEASURES

Construction Phase

The effects on wind microclimate at the Site during the construction phase have been assessed using professional judgement.

As construction of the Proposed Development progresses the wind conditions at the Site would gradually adjust to those of the completed development, and mitigation measures would need to be implemented before completion and operation.

Operational Phase

The assessment described above (for Configurations 1 and 2) assumed that no planting or landscaping was present around or within the Site or on the Proposed Development, in order that the assessment was based upon a conservative (i.e. windier) scenario. To determine the effectiveness of the landscaping scheme, wind tunnel tests with winter trees (bare) and summer trees (full leaf) were assessed to give the wind conditions in the winter and summer season respectively.

Mitigation measures, in addition to the proposed landscaping scheme (See Appendix), were developed through wind tunnel testing. The mitigation measures comprise:

- Planters/shrubs of 1.2m height along the western thoroughfare (locations indicated in the proposed landscaping scheme);
- 1.2m planters/shrubs either side of the entrances at probe locations 17 and 18;
- 1.2m planter/shrub to the west of the entrance at probe location 117;
- 1.2m shrubs or planters around the columns near probe location 101;
- Four additional deciduous trees of at least 4m planted height to the south 0f the central seating area;
- 50% porous 1.2m tall screening to the south and west of seating (the width of the seating area) at the central seating area near probe 115;
- 2m balustrades at private terraces at probe locations 142 to 145;
- 50% porous 1.2m tall screening to the south of seating (the width of the seating area) at rooftop terraces;
- Seating to the south of the lower southern terrace (probe location 160) needs to be directly behind the 1.2m solid balustrade;
- All seating at the western thoroughfare is to have 1.2m planting around the seat (on three sides);
- Winter gardens at one column of southern balconies (represented by probe location 161);
- 1.5m solid balustrades at the balconies represented by probe locations 137, 138, 139 and 173 to 175;
- 1.5m solid balustrade and 2m solid screens at the southern side of balconies represented by 150, 162, 167, 168, 173 and 180;
- 1.5m solid balustrade and a 3m solid screens at the southern side of balconies represented by 166; and
- 1.5m balustrade with 2m side screens and a 1m wide 3m tall front screen at the western balconies represented by 165 and 169.

The mitigation measures have been shown in the Appendix.

The following further mitigation measures were included after wind tunnel testing and have been assessed qualitatively:

- Probe 137 – 2m side screens at the west facing balconies of the central block (as demonstrated at probe location 180) are expected to result in sitting use wind conditions.
- Probes 165 and 169 – changed to winter gardens (number of balconies shown in Figure 26 of Technical Appendix).

13.12 PREDICTED IMPACTS

Construction Phase

Mitigation measures required with the completed scheme in situ will need to be implemented during construction prior to completion and occupation of the Proposed Development. During the construction phase the predicted impacts are classified as **negligible**.

Operational Phase

Configuration 4 tested the Proposed Development with landscaping and existing surrounding buildings. The inclusion of the landscaping results in the majority of wind conditions which are either the same or calmer in comparison to Configuration 2 (the Proposed Development without landscaping).

The wind conditions throughout the Site are largely improved with the inclusion of the Proposed Development and landscaping scheme.

Figures 17 and 18 of the Appendix show the wind conditions at ground/roof level and balcony levels during the winter season, and Figures 19 and 20 show the wind conditions at ground/roof levels and balcony levels during the summer season.

Thoroughfares

Wind conditions on thoroughfares generally ranged from being suitable for sitting use to walking use during the winter season, with two instances of uncomfortable wind conditions.

The landscaped thoroughfare at probe locations 43, 45, 48, 50, and 54 are calmer with the inclusion of landscaping at ground level, and are now suitable for sitting use to strolling use during the winter season, representing a moderate beneficial to **negligible** effect.

Walking use wind conditions occur at probe locations 1, 23, 24, 26, 27, 28, 32, 37, 39 to 42, 97, 110, 187 and 188. These locations are all general thoroughfares where pedestrians are not expected to linger and therefore represent a **negligible** effect.

Probe location 44 had wind conditions which were uncomfortable for all uses, however this is an existing wind condition present in the baseline scenario (Configuration 1), which is improved (regarding hours of strong winds) with the Proposed Development in situ. Therefore, this wind condition represents a **negligible** effect.

Probe location 20 also has uncomfortable wind conditions during the winter season, however this is a marginal exceedance in a road where pedestrians are unlikely to be. Therefore, this represents a **negligible** effect.

All other thoroughfare probe locations are suitable for sitting to strolling use during the winter season representing a **moderate beneficial** to **negligible** effect.

Entrances

All on-site and off-site entrances are suitable for standing use or sitting use during the winter, which represents a **negligible** to **minor beneficial** effect.

Crossings

Wind conditions at probe locations 27, 39 and 41 have wind conditions suitable for walking use and represents a **negligible** effect.

Probe location 31 has wind conditions suitable for strolling use, representing a **negligible** effect

Ground Floor Amenity

The ground level play spaces at probe locations 91 and 127 are both suitable for sitting use during the summer season, and therefore represent a **negligible** effect.

Ground level seating locations on the western thoroughfare will have direct shelter provided by 1.2m planting suitable for sitting use (represented at probe location 54) and therefore these wind conditions represent a **negligible** effect.

Seating at the central amenity space have wind conditions suitable for sitting use during the summer season and therefore represents a **negligible** effect.

Roof Terraces

Wind conditions at roof terraces ranged from suitable for sitting use to walking use during the summer season.

Probe locations 152, 154 to 156, 164, 170, 171 and 181 are suitable for standing use and represent a **negligible** effect.

Private amenity terraces (probe locations 142 to 147, 154 to 157, 163, 164, 170 to 172 and 181 have wind conditions suitable for a mixture of sitting use or a mixture of sitting use and standing use. Therefore, all private amenity terraces have an area suitable for sitting use where seating can be placed. These wind conditions represent a **negligible** effect.

Rooftop amenity areas (probes 148, 149, 152, 153 and 176 to 178) are suitable for a mixture of sitting use and standing use during the summer season. Designated seating will have direct shelter provided so seating areas will be suitable for sitting use. These wind conditions represent a **negligible** effect.

Balconies

The majority of balcony locations had wind conditions suitable for sitting use during the summer season, representing a **negligible** effect, with the mitigation measures developed through wind tunnel testing.

Further mitigation measures were desired at probe location 137, which had standing use wind conditions during the summer season. These conditions are tolerable and represented a **negligible** effect, however additional measured were desired to enhance the balcony space.

Therefore, an additional 2m screen is to be included at the side of the balcony (as developed at probe 180) which is expected to result in sitting use wind conditions. This represents a **negligible** effect.

Probe locations 165 and 169 were suitable for strolling use with the tested mitigation measures, and therefore these balconies are to be replaced with winter gardens. As this is an internal space, the wind conditions have no effect.

Safety

There were no strong winds exceeding the safety threshold with the Proposed Development and mitigation measures in situ.

13.12.1 CUMULATIVE EFFECTS

Configuration 5 tested the Proposed Development with landscaping and cumulative surrounding buildings.

Figures 21 and 222 of the Appendix show the wind conditions at ground/roof level and balcony levels during the winter season, and Figures 23 and 24 show the wind conditions at ground/roof levels and balcony levels during the summer season.

The addition of cumulative buildings (with landscaping and mitigation measures in place) generally does not result in changes to the expected wind effects at the Site and surrounding area when compared to that of the existing context (Configuration 4), as most of these developments are downwind and therefore have no sheltering effect in relation to the prevailing winds.

The only notable change in wind conditions is at probe location 20, which is calmer in the presence of cumulative surrounding buildings and suitable for walking use (where previously it was marginally uncomfortable for all uses).

Overall, with cumulative developments in situ, wind conditions will represent a **negligible** to **moderate beneficial** effect.

13.13 CONCLUSION

Meteorological data for Dublin Airport shows the prevailing wind direction throughout the year is from the west-southwest with a secondary peak for south-easterly winds. The background wind environment is generally windy (compared to other large cities such as London, for example) which leads to a particularly uncomfortable environment in the existing (baseline) scenario.

The baseline results (existing Site with existing surrounding buildings and no landscaping) showed windy conditions throughout the Site and surrounding area. There were particularly windy conditions at the south west corner of the Site, as well as uncomfortable conditions on and off-site. In addition to uncomfortable winds, strong winds were also measured which represents a safety concern.

The windier conditions show that these uncomfortable conditions to the south-west already exist, and are not caused by the Proposed Development.

The inclusion of the Proposed Development generally improved wind conditions throughout the Site by providing additional shelter. Locations to the south-west (on and off-site) saw calmer wind conditions with the Proposed Development in situ (however, these locations still remained windier than desired for the intended use).

Although most locations had calmer conditions, some areas did have an increase in wind speeds due to the Proposed Development (without landscaping); including areas on the road directly south of the Proposed Development. These areas require wind mitigation which is provided by the landscaping scheme and developed measures listed in section 13.5

On-Site, several entrances and roof/balcony level amenity spaces were also too windy for the intended use, and require mitigation measures.

With the inclusion of mitigation measures, all locations are suitable for the intended use with no strong winds exceeding the safety threshold occurring at any location at ground level, or accessible terrace/balcony areas.

The addition of cumulative developments does not change the suitability of wind effects at the Site and surrounding area when compared to the Proposed Development in the context of existing surrounding buildings with landscaping and mitigation measures in place.