19 WIND MICROCLIMATE

19.1 Introduction

19.1.1 This Chapter, prepared by Arup, reports the likely significant effects of the Proposed Development in terms of Wind Microclimate in the context of the Site and surrounding area. In particular it considers the likely significant effects of the Proposed Development on the local wind environment, with respect to pedestrian wind comfort and safety, during operational phases.

19.1.2 This Chapter describes the methods used to assess the effects of wind microclimate, the baseline conditions currently existing at the Site and surrounding area, and the likely effect of wind conditions around the Proposed Development in operation.

19.1.3 This Chapter (and its associated appendices) is not intended to be read as a standalone assessment and reference should be made to the front end of this ES (Chapters 1 – 6), as well as the final chapters, 'Summary of Residual and Cumulative Effects' and 'Conclusions' (Chapters 21 - 22).

19.2 Legislation, Policy and Guidance

19.2.1 No applicable legislation has been identified. The relevant policy and guidance are listed below, with details provided in Appendix 19.1.

Planning Policy

19.2.2 The applicable planning policy is summarised as follows:

- Planning Policy Wales (Edition 11, February 2021)
- Welsh Government Technical Advice Note 12: Design (2016)
- Future Wales: The National Plan 2040 (24 February 2021)
- Cardiff Local Development Plan 2006-2026 (January 2016)

Guidance

19.2.3 The applicable guidance is summarised as follows:

- City of Cardiff Council 'Tall Buildings Supplementary Planning Guidance' (2017)
- Design Commission for Wales 'Designing for Tall Buildings' (2015)

19.3 Assessment Methodology and Significance Criteria

Scope of the Assessment

19.3.1 The EIA Scoping Report (Appendix 5.1) set out the proposed scope of the wind microclimate assessment.

19.3.2 An environmental wind desk study based on professional judgement has been carried out to assess the suitability of wind conditions at the Site for intended pedestrian activities.

19.3.3 The assessment considers three scenarios, which include the Site in its existing arrangement (baseline) and with the Proposed Development in existing and cumulative surroundings.

Effects Not Considered within the Scope

19.3.4 Wind effects during construction have been scoped out as these are not likely to be significant. Temporary plant and machinery do not give rise to significant adverse windiness at street level. Hoardings and temporary crash decks around the perimeter of the Site would provide shelter for pedestrians. As the buildings gets taller and cladding is installed, wind effects would become more pronounced. However, the full extent of wind effects would only be experienced as a result of the completed development.

Extent of the Study Area

19.3.5 The assessment presented in this Chapter is informed by professional judgement. The assessment takes into consideration the Proposed Development and surrounding buildings within a radius of up 400 metres (m) from the centre of the Site. Environmental wind conditions within and around the Site are not considered to be significantly influenced by building developments beyond this radius.

Consultation Undertaken to Date

19.3.6 Consultation activities have not been undertaken in support of the preparation of this Chapter.

Assessment Methodology

19.3.7 An environmental wind desk study assessment based on professional judgement has been undertaken to assess wind microclimate conditions within and around the Proposed Development. The assessment has been based on a review of architectural

drawings[1] provided by the design team in June and July 2021, evaluation of aerial views of the Site and surroundings and Arup's previous experience of wind tunnel testing for developments of similar scale and wind exposure.

19.3.8 The wind climate in Cardiff, as described in the Assessment Methodology and in Appendix 19, has been reviewed using long-term wind records from the area and our previous knowledge of the wind climate in the region.

19.3.9 The acceptability of windiness is subjective and depends on a number of factors, most notably the activities to be performed in the area being assessed. The comfort and safety criteria used to describe windiness are those of T.V. Lawson LDDC[2], as described in Appendix 19.2.

19.3.10 Acceptable comfort conditions for various activities in order of increasing windiness are described in Table A19.1.

Table A19.1: Comfort criteria as defined by TV Lawson	
Comfort Criterion	**Description**
'Sitting': Long term sitting	Reading a newspaper, eating and drinking
'Standing': Standing or short term sitting	Bus stops, window shopping and building entrances[(a)] and parks
'Strolling': Walking or strolling	General areas of walking and sightseeing
'Business walking': Business walking	Areas where people are not expected to linger

[(a)] The use of this criterion for entrances is to avoid difficulties with maintaining balance when transitioning from a sheltered indoor location.

[1]These included: 3D massing model of the Proposed Development and surrounding areas ('0371 Hybrid Application 3D Model' dated 8th July 2021); architectural plan views of the Arena ('CAH-HOK-AX-00-DR-A-00-1001', 'CAH-HOK-AX-00-DR-A-00-1002', 'CAH-HOK-AX-00-DR-A-00-1003', 'CAH-HOK-AX-00-DR-A-00-1005' dated 15th July 2021); architectural plan views and 3D views of the Hotel ('CAH-HOK-HX-00-DR-A-00-1101' , 'CAH-HOK-HX-00-DR-A-00-1102', 'CAH-HOK-HX-00-DR-A-00-1103', 'CAH-HOK-HX-00-DR-A-00-1104', 'CAH-HOK-HX-00-DR-A-00-1105', 'CAH-HOK-HX-00-DR-A-00-1106' , 'CAH-HOK-HX-00-DR-A-00-1107', 'CAH-HOK-HX-ZZ-DR-A-00-3001', 'CAH-HOK-HX-ZZ-DR-A-00-3100', 'CAH-HOK-HX-ZZ-DR-A-XX-0030' dated 5th July 2021); zoning parameters ('0371-RIO-XX-XX-RP-A-060110_1 Revised Zoning Parameters' dated 13th July 2021)

[2] Lawson, T.V. 'The evaluation of the windiness of a building complex before construction: London Docklands Development Corporation', 1990

There are also distress criterion for 'General Public Access' and 'Able-Bodied Access' to be exceeded less than once a year. The pedestrian safety criteria are provided in full in the Table A19.2.

Table A19.2: Distress (safety) criteria as defined by TV Lawson	
Distress criterion	**Description**
'General Public Access'	Above which the less able and cyclists may at times find conditions physically difficult
'Able-Bodied Access'	Above which it may become impossible at times for an able bodied person to remain standing.

Significance Criteria

19.3.11 Wind conditions from the assessment scenarios have been compared to the required levels for intended pedestrian activities to identify areas where significant effects may occur. Effects that are deemed to be significant for the purposes of this assessment are those that are described as being of a moderate or major beneficial or adverse level.

19.3.12 A significant adverse effect has been defined as an area where wind conditions would be higher than the required levels for the intended use as a result for the Proposed Development. Exceedances of the distress criteria would present a potential safety risk in areas regularly used by pedestrians. Such conditions would be unacceptable for areas accessed by the general public and are therefore considered to be significant adverse effects.

19.3.13 An increase in windiness would be considered not significant if the conditions remained suitable for the intended activity.

19.3.14 Table 19.1 defines the significance criteria used in this assessment in relation to the industry standard Lawson LDDC Criteria[1] for comfort and safety.

Table 19.1 Significance of Impact		
Significance of Impact	**Expected Impact on Wind Microclimate**	**Lawson Description**
Major adverse impact	Windiness with adverse impact on future wind 'safety', in areas of everyday use, such as main public access routes and building entrances. NB Substantial mitigation, for example possibly including alteration of building massing, may be required to reduce levels of windiness within acceptable limits.	Exceedance of Lawson's distress criteria in areas used regularly by the Public. Exceedance of 'Standing' conditions at major entrances. Exceedance of Lawson's 'Able-Bodied' distress range in any area accessible by the public (including vehicular routes)
Moderate adverse impact	Windiness with adverse impact on wind 'comfort' and 'safety' in less critical areas. NB Re-categorisation of intended usage, and/or mitigation measures may be desirable, depending on importance.	Exceedance of acceptable conditions in areas of less critical use, which may affect usage at times.
Minor adverse impact	Windiness with adverse impact only on non-critical future usage, e.g. changes in areas that are normally used only in suitable weather conditions, or minor or temporary exceedance of the relevant criteria in less critical areas. NB Wind conditions either remain acceptable for future intended use, or some mitigation may be desirable.	Marginal exceedance of acceptable conditions or exceedance in non-critical areas.
Negligible impact	Windiness with negligible impact on the future usage of the development, and in the surrounding areas. This includes areas where appropriately described wind mitigation has been incorporated into the scheme.	Acceptable conditions.
Minor beneficial impact	Windiness levels that contribute to future usage of the Development and surrounding areas.	Conditions are at least one-category calmer than acceptable in areas of non-critical usage.

Table 19.1 Significance of Impact		
Significance of Impact	**Expected Impact on Wind Microclimate**	**Lawson Description**
Moderate beneficial impact	Windiness with beneficial impact on wind 'comfort' and 'safety' in less critical areas.	Conditions are calmer than acceptable in areas that were previously exceeded the relevant Lawson 'comfort' and 'safety' criteria.
Major beneficial impact	Improvement to windiness in important areas that previously exceeded the relevant 'comfort' and 'safety' requirements.	Conditions become at least acceptable in a critical location.

19.4 Baseline Conditions

19.4.1 The existing Site, e.g. the Baseline, as shown in Figure 19.2 (Appendix 19.3) is occupied by: the Cardiff County Hall building (of 3-storeys above ground) located within the northeast area of the Site; the Red Dragon Centre (with total height of ~ 12 m above ground) and the Travelodge Hotel (of 5 storeys above ground), located in the southwest area of the Site; and car parking areas.

19.4.2 The prevailing wind directions for Cardiff are mainly from the west and southwest; almost all cases of serious annoyance due to strong winds around buildings are caused by winds from these directions. During spring, northeast winds are almost as common as the west southwest winds but are weaker.

19.4.3 The surrounding buildings along the prevailing wind directions are predominantly low to medium rise and offer some limited degree of sheltering. A view of the existing Site and surrounding buildings from the west is shown in Figure 19.3 (Appendix 19.3).

19.4.4 Windiness levels across the existing car parking areas are expected to remain within upper 'Strolling' levels. These conditions would be acceptable for pedestrian access and car parking use.

19.4.5 'Strolling' conditions may also generally be anticipated around the perimeter of the Travelodge and Red Dragon Centre buildings, which are exposed to the prevailing winds from the southwest and west, and to the less frequent north-easterly winds blowing across the car parking area. The Travelodge benefits from some degree of

sheltering offered by the existing landscaping immediately to the west. These conditions would remain suitable for pedestrian access use.

19.4.6 'Standing' to 'Strolling' conditions are likely to be experienced around the perimeter of the Cardiff County Hall building which is in part sheltered by local landscaping of similar height as the building. These conditions would remain suitable for pedestrian access use.

19.4.7 Primary entrance locations for the existing buildings are marked up in Figure 19.2.

19.4.8 The main entrance to the Travelodge is located on the south-eastern façade, and is part sheltered by the building massing; the local windiness is likely to be in upper 'Standing' range which would remain acceptable for entrance use. An additional entrance is on the north-western façade and is sheltered by a canopy; 'Standing' conditions are likely to be achieved locally.

19.4.9 The primary entrances to Red Dragon Centre are facing east and are either recessed or protected by a canopy; the local windiness is likely to remain within 'Standing' levels.

19.4.10 The main entrance to the Cardiff County Hall building is on the south-eastern façade and is protected by a canopy; 'Standing' conditions, acceptable for primary entrance use, are likely to be achieved locally. A number of secondary entrances are on the north-western façade, where the local windiness is likely to remain within 'Standing' or lower 'Strolling' levels, acceptable for secondary entrance uses.

Sensitive Receptors

19.4.11 Sensitive receptors within the Site and surrounding areas include building entrances, pedestrian access routes, any outdoor seating areas, any public terraces or balconies, waiting areas such as bus stops, cyclists, and vehicular routes.

Limitations

19.4.12 The assessment presented in this Chapter is based on a desktop study approach. This is based on a review of architectural drawings provided by the design team and Arup's previous experience of wind tunnel testing for developments of similar scale and wind exposure.

19.4.13 Maximum parameter plans have been conservatively considered for the assessment of wind effects within and around the outline plots which form the Bute East Dock

Quarter, the Waterfront Quarter, the Car Parking Quarter, the Cultural Quarter and Mixed-Use Quarter of the illustrative Masterplan. The use of quantitative analyses, for example wind tunnel testing or Computational Fluid Dynamics (CFD), would be recommended to be carried out at detailed design stage to confirm acceptability of geometry and scope of external wind mitigation.

19.4.14 Outcomes of the assessment presented in this Chapter are for the scenarios described. Future changes to the height, massing of the Proposed Development and building surroundings may affect windiness levels reported.

19.5 Assessment of Effects

Design Solutions and Assumptions

19.5.1 As stated in the Assessment Methodology section, the assessment presented in this Chapter is based on architectural drawings provided by the design team in June and July 2021. These included a 3D massing model of the Proposed Development and surrounding areas, architectural plan views of the Arena and the Hotel, zoning parameter plans; drawings references are listed in the Assessment Methodology section. Proposed external landscaping features, as well as external building attachments (such as canopies) as represented in the architectural 3D model have been accounted for in the pre-mitigation assessment scenario as presented in this section.

Assessment of Effects

19.5.2 Windiness levels around key areas of the Proposed Development (as defined in Figure 19.4) are discussed below.

The Arena

19.5.3 A summary of windiness levels around the Arena is provided in Figures 19.5 - 19.7 and below.

19.5.4 The Arena (~ 30m above ground) is taller than the building surroundings immediately to the west and southwest. As illustrated in Figure 19.5, the Arena will deflect the upper-level winds from these directions to ground level; these wind components will be accelerated around the north-western and south-western corners of the Arena.

19.5.5 The proposed landscaping within the area immediately to the west of the Arena (consisting of 10m trees) will have a beneficial impact on the local windiness at ground

level. With the proposed landscaping, 'Standing' to lower 'Strolling' conditions may be anticipated locally. Similar conditions may be anticipated within the car parking area of the residential units immediately to the southwest of the Site. These conditions would be acceptable for intended pedestrian access uses; therefore, it is concluded that no significant effects would occur locally.

19.5.6 Upper 'Strolling' conditions may be anticipated within the passage between the Arena and plot M (immediately to the south). A café entrance is proposed along south-western façade of the Arena, facing this passage. These conditions would remain suitable for pedestrian access but may be uncomfortable for primary entrance use, queuing or mild walking activities; therefore, it is concluded that a minor adverse impact would be experienced locally. The use of local mitigation measures would therefore be recommended to improve the local windiness to 'Standing' (as appropriate for primary entrance use) or lower 'Strolling' .(as appropriate for mild walking). Examples of mitigation measures are described in the Mitigation section of this Chapter.

19.5.7 Wind conditions within the passage between the Arena and plot M, and the associated mitigation as recommended should be reviewed once the massing details of Plot M are defined.

19.5.8 'Standing' to lower 'Strolling' conditions may be anticipated within the area immediately to the southeast of the Arena. These conditions would be suitable for intended queuing uses or marginally in excess of these limits; therefore, it is concluded that no significant effects or a minor significant impact would occur locally. The use of wind mitigation measures within the gap between the Arena and plot M (as described in the Mitigation section) would also improve the local windiness.

19.5.9 'Standing' conditions are anticipated at the entrances to the Arena on the south-eastern façade, which is sheltered by a canopy (~4m). These conditions would be suitable for intended entrance uses; therefore, it is concluded that no significant effects would occur locally.

19.5.10 The surroundings buildings which form part of the Bute East Dock and Waterfront Quarters provide sheltering from the north-easterly winds. The proposed trees (of 10m height) along the eastern façade would also be beneficial to the local windiness

along the eastern façade of the Arena.

19.5.11 'Standing' or lower 'Strolling' conditions may be anticipated along the eastern façade of the Arena. These conditions would be suitable for pedestrian access and secondary entrance uses; therefore, it is concluded that no significant effects would occur locally.

19.5.12 Similar conditions ('Standing' or lower 'Strolling') may also be anticipated at the box office which is located on the eastern facade of the Arena. These conditions would be suitable for primary entrance use or marginally in excess of this limit; therefore, it is concluded that no significant effects or a marginally adverse effect would occur locally. The use of local mitigation measures would therefore be recommended to improve the local windiness to 'Standing' at the box office entrance (as appropriate for primary entrance use). Examples of mitigation are discussed within the Mitigation section of this Chapter.

19.5.13 Wind conditions along the eastern façade of the area and the need for localised mitigation should be revisited once the once details of massing of the Bute East Dock and Waterfront Quarters are defined.

19.5.14 'Strolling' conditions may be anticipated along the north-western side of the Arena at roof level. These conditions would remain suitable for secondary access use (e.g. roof maintenance activities); therefore, it is concluded that no significant effects would occur locally.

The Hotel

19.5.15 A summary of windiness levels around the Hotel is provided in Figure 19.8 - 19.9 and below.

19.5.16 The Hotel (6-storeys above ground) is orientated with its longer axis parallel to the prevailing winds from the west. This is generally beneficial as it minimises the extent of downdraft.

19.5.17 As illustrated in Figure 19.8, the westerly and south-westerly winds will be downdrafted by the Arena and accelerated around its north-western corner, onto the roof immediately to the south of the Hotel, which is not accessible by the general public. Winds downdrafted by the western façade of the Hotel will also be deflected on this space and along the northern façade of the Hotel. The local windiness at roof level is expected to be in the 'Strolling' range. These conditions would remain suitable

for secondary access use (e.g. roof maintenance); therefore, it is concluded that no significant effects would occur locally.

19.5.18 'Standing' to lower 'Strolling' conditions may be anticipated along the western façade of the Hotel, where the car park entrance is located. These conditions would be acceptable for pedestrian access use; therefore it is concluded that no significant effects would occur locally.

19.5.19 In the presence of the proposed landscaping consisting of 7m tall trees, 'Standing' to 'Strolling' conditions may be experienced along the northern façade of the Hotel, acceptable for pedestrian access, and secondary entrance use as currently proposed; therefore, it is concluded that no significant effects would occur locally.

19.5.20 'Standing' to 'Strolling' conditions may be experienced along the eastern façade of the Hotel which remains generally sheltered from the prevailing winds but exposed to secondary north-east winds. The main entrance to the Hotel lobby is along this façade; these conditions marginally exceed the criterion for primary entrance and access use; therefore, it is concluded that a minor adverse impact would be experienced locally. The use of local mitigation measures would therefore be recommended to improve the local windiness to 'Standing' (as appropriate for primary entrance use) or lower 'Strolling' (as appropriate for mild walking). Examples of mitigation measures are described in the Mitigation section of this Chapter.

Bute East Dock Quarter

19.5.21 The Bute East Dock Quarter is located at the north-eastern end of the Site. The proposed plots K1, K2 and H2 - H4 range in height between 10 and 17 storeys.

19.5.22 Plots H2 - H4 are similar in height to the Arena and will be sheltered from the prevailing winds from the southwest and west; these plots are also lower than H1, which will provide sheltering from the north-easterly winds. Plots K1 and K2 are taller than the Arena and will be more exposed to the prevailing winds from the southwest and west.

19.5.23 With the proposed arrangement of massing and street level landscaping, windiness levels within the Bute East Dock Quarter are likely to range between 'Standing' to 'Strolling' which would be suitable for access uses. Upper 'Strolling' to 'Business Walking' conditions may occur around the perimeter of the taller plots (K1 - K2); these conditions would remain suitable for pedestrian access uses. Generally, it is concluded that no significant effects would occur within this Quarter. However, the need for wind

mitigation measures should be considered once details of massing, entrance locations and uses of outdoor areas are fully defined.

Waterfront Quarter

19.5.24 The Waterfront Quarter includes Plot H1 of 19-storey and Plot K3 of 26-storey.

19.5.25 Plots K3 is taller than the upwind surroundings but it is orientated such that its longer axis is parallel to the prevailing winds. This is considered to be beneficial as it will minimise the extent of downdraft. The proposed landscaping around the perimeter of this plot would also contribute to dissipate local windiness.

19.5.26 Plot H1 is taller than Plots H2-H4 of the Bute East Quarter, and therefore exposed to the prevailing winds from south-west and west. It is also exposed to the less frequent winds from north-east blowing across the waterfront.

19.5.27 With the proposed arrangement of massing and street level landscaping, windiness levels within the Waterfront Quarter are likely to range between 'Standing' to 'Business Walking', with possibility of localised exceedance of the 'General Public Access' distress criterion in some of the more exposed areas; these conditions would be in excess of the acceptable limits for pedestrian access, where a major adverse wind impact would occur. The need for wind mitigation measures should be considered once details of massing, entrance locations and uses of outdoor areas are fully defined.

Mixed-Use Quarter

19.5.28 The Mixed-Use Quarter includes plots A, B, C, and M, which range in height between 4 to 6 storeys.

19.5.29 With the proposed arrangement of massing and street level landscaping, windiness levels within the Mixed-Use Quarter are generally expected to range between 'Standing' to 'Strolling', as acceptable for general access.

19.5.30 Upper 'Strolling' conditions may be anticipated within the gap between the Arena and plot M; these conditions would remain acceptable for general public access. However, the use of local mitigation could be considered to improve the local windiness to 'Standing' or lower 'Strolling' levels as would be required for queuing and mild walking activities.

19.5.31 'Standing' to 'Strolling' conditions may be also anticipated within the open area (the

Event Square) between plots M, C, A and the Arena to the north in the 'worst season'; these conditions are likely to be reduced to 'Standing' levels in the summer, which would be suitable for short term seating.

19.5.32 Generally, it is concluded that no significant effects would generally occur within this Quarter. However, the need for wind mitigation measures should be considered once details of massing, entrance locations and uses of outdoor areas are fully defined.

Cultural Quarter

19.5.33 The Cultural Quarter is located in the southwest area of the Site. The proposed plots E, D and L range in height between 4 to 6 storeys.

19.5.34 Windiness levels in areas around these plots is likely to range between 'Standing' to 'Strolling' which would be suitable for access uses; therefore, it is concluded that no significant effects would occur locally for this intended use. Generally, it is concluded that no significant effects would generally occur around these plots. However, the need for wind mitigation measures should be considered once details of massing, entrance locations and uses of outdoor areas are fully defined.

Car Parking Quarter

19.5.1 The Car Parking Quarter includes plot F of 11 storeys.

19.5.2 Windiness levels around plot F are likely to range between 'Standing' to 'Strolling' which would be suitable for general access uses. It is therefore concluded that no significant effects would generally occur around this plot. However, the need for wind mitigation measures should be considered once details of massing, entrance locations and uses of outdoor areas are fully defined.

19.6 Mitigation

19.6.1 Upper 'Strolling' conditions have been anticipated within the passage between the Arena and Plot M, where the south-westerly and westerly winds are accelerated. Wind mitigation measures consisting of temporary pedestrian level mitigation (porous screens or art) are recommended to be included within this area to improve the local windiness to 'Standing' or lower 'Strolling' levels, as required for queueing during event days. Examples of wind mitigation are illustrated in Figure 19.10. Temporary wind screens are also proposed for the café to be erected around the outdoor seating when required on non-event days and removed on event days when additional space is required for queuing.

19.6.2 Permanent side screens (1m deep and solid or up to 50% porous) or equivalent recessing (as illustrated in Figure 19.11) are recommended at the café entrance located on the south-western façade of the Arena, at the box office entrance located on the eastern façade of the Arena and at the eastern entrance to the Hotel to improve the local windiness to 'Standing' levels as appropriate for primary entrance use.

19.6.3 Additional wind mitigation measures such as landscaping, canopies or other external measures may be required within some of the more exposed areas around the outline illustrative masterplan plots (particularly the Waterfront Quarter and the Bute East Dock Quarter). Specifics of required mitigation would be established once the details of building massing, entrance locations and uses of outdoor areas are fully defined. Quantitative analyses such as wind tunnel testing or CFD would be recommended to be carried out at detailed design stage to confirm acceptability of geometry and scope of wind mitigation.

19.7 Residual Effects

19.7.1 With proposed mitigation measures within the passage between the Arena and plot M, the local windiness may be reduced to 'Standing' or lower 'Strolling', as required for queuing activities and mild walking. The associated residual impact would be negligible.

19.7.2 With proposed mitigation measures at the Arena café and box office entrances the local windiness may be reduced to 'Standing', as required for primary entrance use. The associated residual impact would be negligible.

19.7.3 It is expected that windiness levels around the Waterfront Quarter, the Car Parking Quarter, the Cultural Quarter and Mixed-Use Quarter could be controlled to acceptable levels with additional mitigation. With mitigation, the associated residual impact would be negligible. Specifics of required mitigation would be established once the details of building massing, entrance locations and uses of outdoor areas are fully defined.

19.8 Assessment of Cumulative Effects

19.8.1 The cumulative surroundings which include properties along Bute Street and Pierhead Street (as illustrated in the architectural 3D model) have been considered for the assessment of cumulative effects.

19.8.2 Given their massing details, height and distance from the Site, the cumulative surroundings are not expected to have any adverse impact on the local windiness within and around the Proposed Development.

19.8.3 Therefore, the conclusions reported in the Assessment of Effects section remain valid in the presence of cumulative surroundings.

19.9 Conclusion

19.9.1 An environmental wind desk study assessment based on professional judgement has been undertaken to assess wind microclimate conditions within and around the Proposed Development. The assessment has been based on a review of architectural drawings provided by the design team in June and July 2021, evaluation of aerial views of the Site and surroundings and Arup's previous experience of wind tunnel testing for developments of similar scale and wind exposure.

19.9.2 The wind climate in Cardiff has been reviewed using long-term wind records from the area and Arup's previous knowledge of the wind climate in the region. The prevailing wind directions for Cardiff are mainly from the west and southwest; almost all cases of serious annoyance due to strong winds around buildings are caused by winds from these directions. During spring, northeast winds are almost as common as the west southwest winds but are weaker.

19.9.3 The acceptability of windiness is subjective and depends on a number of factors, most notably the activities to be performed in the area being assessed. The criteria used to describe windiness are those of T.V. Lawson LDDC, as described in Appendix 19.2.

19.9.4 The existing Site, e.g. the Baseline, is occupied by the Cardiff County Hall building (3-storeys above ground); the Red Dragon Centre (with total height of ~ 12m above ground) and the Travelodge Hotel (5 storeys above ground); and car parking areas. Windiness levels across the existing Site are generally expected to remain within upper 'Strolling' levels acceptable for access and car parking use. 'Standing' conditions may be anticipated at the primary entrances to existing buildings on Site.

19.9.5 The Proposed Development will include: the Arena (~ 30m above ground) and the Hotel (6 storeys, 19.5m above ground), the Waterfront Quarter, the Car Parking Quarter, the Cultural Quarter and the Mixed-Use Quarter.

19.9.6 The Arena (30m above ground) is taller than the building surroundings immediately to the west and southwest and will deflect the upper level winds from these directions

to ground level; these wind components will be accelerated within the passage between the Arena and plot M where upper 'Strolling' wind conditions are anticipated. Wind mitigation measures consisting of landscaping elements (7-10m trees) or pedestrian level mitigation (porous screens or art) within the passage are recommended; inclusion of side screens (1.5m) or equivalent recessing at the Arena café entrance are additionally recommended.

19.9.7 The surroundings buildings which form part of the Bute East Dock and Waterfront Quarters shelter the Arena from the north-easterly winds. The proposed trees (of 10m height) along the eastern façade of the Arena would also be beneficial to the local windiness along the eastern façade of the Arena.

19.9.8 'Standing' or lower 'Strolling' conditions may be anticipated along the eastern façade of the Arena, and at the box office which is located on the eastern facade of the Arena. Local mitigation consisting of side screens (1.5m) or equivalent recessing is recommended at the box office entrance.

19.9.9 Windiness levels in other areas around the Arena and Hotel are expected to remain suitable for intended pedestrian activities and no additional mitigation measures have been recommended around these plots.

19.9.10 Details of mitigation measures around the Arena should be reviewed once the massing of the buildings forming Waterfront Quarter, the Bute East Dock Quarter, the Car Parking Quarter, the Cultural Quarter and Mixed-Use Quarter is defined.

19.9.11 Windiness levels around the outline masterplan plots which form the Waterfront Quarter, the Bute East Dock Quarter, the Car Parking Quarter, the Cultural Quarter and Mixed-Use Quarter are generally expected to remain suitable for general public access. Additional wind mitigation measures such as additional landscaping canopies or other external measures may be required within some of the most exposed areas around the outline plots (particularly the Waterfront Quarter and the Bute East Dock Quarter). Specifics of required mitigation would be established once the details of building massing, entrance locations and uses of outdoor areas are fully defined. Quantitative analyses such as wind tunnel testing or CFD would be recommended to be carried out at detailed design stage to confirm acceptability of geometry and scope of wind mitigation.

19.9.12 The cumulative surroundings which include properties along Bute Street and Pierhead Street have been considered for the assessment of cumulative effects. Given their

massing details, height and distance from the Site, the cumulative surroundings are not expected to have any adverse impact on the local windiness within and around the Proposed Development.