APPENDICES: CHAPTER 13 – MICRO CLIMATE

APPENDIX 13.1: PEDESTRIAN LEVEL WIND MICRO CLIMATE ASSESSMENT

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Re-development of The National Maternity Hospital at St. Vincent's University Hospital Campus

Dublin, Ireland

Draft Report

Pedestrian Level Wind Microclimate Assessment

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Version History

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Objective

The objective of this study was to review the proposed Re-development of The National Maternity Hospital at St. Vincent's University Hospital Campus (here after referred to as the 'Proposed Development') in Dublin, in order to assess the impact of wind on pedestrian comfort and safety to support a submission for planning. This desk-based assessment is informed by the use of computational fluid dynamics (CFD). The assessment is based on extensive professional experience of assessing the interaction of the wind with the urban environment gained from wind tunnel testing, computational simulations and full-scale observations over many years.

The results presented focus on the winter season and the summer season. Results are presented in terms of the RWDI Wind Comfort Criteria.

1. Summary

This report presents a qualitative assessment of the likely wind conditions around the Re-development of The National Maternity Hospital at St. Vincent's University Hospital Campus development. It outlines the overall methodology and the use of the RWDI Comfort Criteria to describe the expected on-site wind conditions. The assessment is based upon analysis of meteorological conditions for Dublin adjusted to the site, a computational fluid dynamics (CFD) assessment of the wind from the prevailing wind directions.

The site description is used mainly to identify building massing and features that are pertinent to the wind microclimate on site. The expected main flow interactions around the site are then described in terms of the RWDI Comfort Criteria.

This report presents a description of the methodology used and the results of three scenarios tested. These are shown below:

- Configuration 1: Existing Site with Existing Surrounds (baseline);
- Configuration 2: Proposed Development with Existing Surrounds; and
- Configuration 3: Proposed Development with Cumulative Surrounds;

Results are presented in terms of the RWDI Comfort Criteria with the main focus on the windiest (generally winter) and summer seasons.

Conditions around the existing building are acceptable for the intended pedestrian uses. Thoroughfare locations are expected to observe strolling conditions at worst, which is acceptable for thoroughfare use. All entrance locations are also expected to observe standing conditions or calmer, which is acceptable for the intended entrance use.

The ground level wind microclimate for the Proposed Development is compatible with the intended pedestrian use of the site, classified as acceptable for strolling or standing use during, with a small instance of walking conditions during the windiest season.

The main entrance to the Proposed Development is expected to be acceptable for its intended use throughout the year. The secondary entrance to the south is expected to observe strolling, which is winder than desired and will require mitigation measures, as discussed in Section 7 of this report.

During the summer season, the amenity spaces (the two courtyards at grounds level and the high level terrace) are classified as acceptable for standing and sitting use. Where standing conditions have been identified mitigation measures are recommended.

It should also be noted that Configuration 3 was not tested for this assessment, and that the wind conditions at the site are expected to be mostly acceptable for strolling use during the winter, and acceptable for standing use during the summer.

Overall with the proposed landscaping and suggested mitigation measures in-situ the site, would be expected to be acceptable for comfortable pedestrian use.

2. Site Description

2.1 Site Location and Surroundings

The site is located in the south of Dublin, in Ireland. The site is bounded by the junction of Nutley Lane and Merrion Road to the north and the Elm Park Sports and Golf Club to the south. St Vincent's Private Hospital is located directly to the east. The Ordnance Survey Landranger reference for the site is IO192309

Figure 1 shows an aerial view of the site including the existing buildings and their surroundings.

Figure 1: Aerial Photograph of the Existing site (approximate extent of site highlighted)

2.2 The Proposed Development

The proposed development comprises the redevelopment of the National Maternity Hospital at St. Vincent's University Hospital campus, Elm Park, Dublin 4. The proposed new National Maternity Hospital building will be located at the eastern side of the hospital campus and comprises the construction of a building that rises to 5 and 6 storeys above ground level, with one partial basement level, plus additional ancillary plant areas on the roof level. The gross floor area of the building will be up to 48,695sq.m including shared services for both the new National Maternity Hospital and the existing St. Vincent's University Hospital campus. The proposed development also includes an extension to the existing multi-storey car park at the north of the campus that will provide 400 car parking spaces.

An architect's visualisation of the proposed buildings and park are presented in Figure 2. A plan diagram detailing each of the blocks of the proposed buildings is also shown in Figure 3.

Figure 2 Architects visualisation of the overall SVUH Development (aerial view from the North-West)

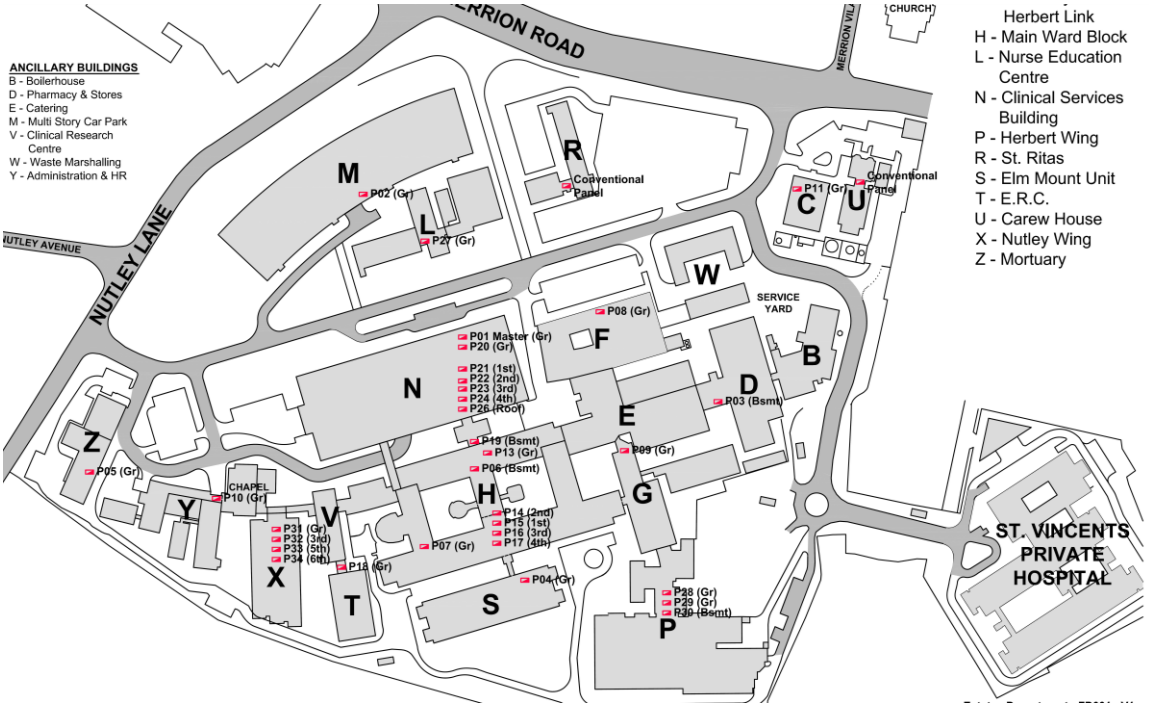


Figure 3 Plan Diagram detailing Blocks A-Z within the SVUH Development

3. Assessment Methodology

3.1 Methodology

The desk based assessment undertaken in this study is based on extensive professional experience of assessing the interaction of the wind with the urban environment gained from wind tunnel testing, computational simulations and full-scale observations over many years. Results are presented in terms of the RWDI Comfort Criteria and illustrated using the output from computational fluid dynamics simulations.

3.2 Baseline Conditions

Often a new development will alter the pedestrian activity (i.e. intended use) on site, and therefore, a comparison between the original wind conditions with those on the developed site is presented. For example, wind conditions which remain acceptable for strolling after Development is completed imply that there is no change in the microclimate but mitigation would be required if on the new Development the location of interest is outside a main entrance. Assessment in terms of the desired pedestrian activity on or around a site takes into consideration any change of use and this is where the comfort criteria are particularly helpful.

Existing wind conditions at the site would be expected to be largely acceptable for sitting, but to include some areas acceptable for strolling use; resulting from building-induced accelerations, in the windiest season.

3.2.1 Thoroughfares

A pedestrian thoroughfare should be acceptable for strolling or calmer during the windiest season. The assessment of significance for pedestrian thoroughfares focuses on the windiest season result

3.2.2 Entrances

Near building entrances a wind environment acceptable for standing or calmer is desired during the windiest season, because these are expected to be in use throughout the year. Should an entrance be placed near a location where strolling or walking conditions are predicted, this would be considered unsuitable for pedestrian egress and ingress and therefore would require mitigation. The assessment of significance for building entrances therefore focuses on the windiest season result.

3.3 Computational Fluid Dynamics (CFD) modelling

In this study computational fluid dynamics (CFD) simulations were undertaken using the CFD code OpenFOAM. CFD is an advanced computer modelling technique for numerically simulating wind flow in complex environments. For this study the flow simulation was modelled using Reynolds-Averaged Navier Stokes (RANS) equations, the output from which shows the average wind environment from a particular direction.

In the simulations, a simplified 3-D computer model of the Proposed Development was generated, capturing the overall geometry and massing of the buildings. In addition the massing of the immediate surrounding buildings was included because this will influence the wind as it approaches the Proposed Development. The simplified model of the layout and building massing was derived directly from the 3-D model provided by the architectural team. Images of the 3-D model used during the simulations are shown in Appendix A.

The CFD wind simulation were run from the following wind directions, 0°, 45°, 90°, 135°, 180°, 225°, 270° and 315°, measured from north. However, results from the south-east, south, south-west and west (135°, 180°, 225° and 270°) are the focus of discussion in this report as these wind directions are the dominant wind directions in Dublin as in described in Section 4; and induced the more significant results for this assessment.

Wind speed contour plots from the simulations at a height of 1.5m above the ground (which represents the wind environment in the pedestrian domain) are presented in Appendix B. The contour plots are scaled from red (highest wind speeds) to blue (lowest wind speeds) and show relative windy and calm areas for each wind directions for the Proposed Development.

Views of specific flow features captured within the CFD modelling are presented as a part of the discussion in Section 6.

4. Meteorological Data

Knowledge of the prevailing wind climate focuses attention on the likely impact of the prevailing winds on the site, except where the Proposed Development massing/layout indicates that winds from other directions are likely to be important.

4.1 General Meteorological Data

Meteorological data derived from the meteorological station at Dublin Airport have been corrected to standard conditions of 10m above open flat level country terrain. The meteorological station data is then adjusted to the Site conditions using the methodology implemented in the BREVe3.2 software package.

Wind statistics recorded at Dublin Airport between 1973 and 2013 were analysed for two seasons, namely a windiest season (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 3 below 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-south-west with a secondary peak for south-easterly winds. Based upon the background wind climate Dublin is a relatively windy city prior to any further wind-building interactions that might occur.

The combination of meteorological data, Site altitude and velocity ratios permits the percentage of time that wind speeds are exceeded at ground level on the Site to be evaluated. The locations can then be assessed using the RWDI 'comfort criteria', as described below.

Figure 3: Directional Distribution (%) of Winds, Dublin Airport (1973 - 2014) (Blowing From)

The meteorological data indicate that the prevailing wind direction throughout the year is from the south-west. This is typical for many areas of Dublin. There is a secondary peak from south-easterly winds, especially during the spring, and these tend to be cold winds.

The combination of meteorological data, site altitude and velocity ratios permits the percentage of time that wind speeds are exceeded at ground level on the Site to be evaluated. The locations can then be assessed using 'comfort criteria', as described on the following page.

4.2 Terrain Roughness

Another consideration is the terrain roughness in each wind direction because wide, open spaces permit the wind to blow down to ground level generating conditions similar to those of open countryside even within a built-up area. An assessment of the terrain roughness for the site was conducted using the BREVe3 software.

Table 1 presents the 'mean factors' for the site where the mean factor represents the ratio of wind speed on site, at the stated reference height, as a fraction of the wind speed in open, flat countryside at a height of 2m and 10m. The mean factors for the site at 10m ranged from 0.80 to 1.23 and these mean factors are typical for a suburban site.

Wind Direction>>	0	30	60	90	120	150	180	210	240	270	300	330
Mean Factor at 2m	0.60	0.96	0.97	0.99	0.47	0.46	0.46	0.44	0.44	0.43	0.43	0.43
Mean Factor at 10m	0.92	1.20	1.21	1.23	0.87	0.85	0.85	0.82	0.82	0.80	0.81	0.80

Table 1: BREVe3 mean factors at 2m and 10m above ground level

5. Benchmarking

5.1 Comfort Criteria

The RWDI pedestrian wind criteria were used in the current study. These criteria have been developed by RWDI through research and consulting practice since 1974 (References 1 through 6). 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 2 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 acceptable) 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.

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.		
Safety Criterion	**Gust Speed (km/h)**	**Description**
Exceeded	> 90	Excessive gust speeds that can adversely affect a pedestrian's balance and footing. Wind mitigation is typically required.
Note: Based on an annual exceedance of 9 hours or 0.1% of the time for 24 hours a day.		

Table 2: Pedestrian Wind Comfort Criteria

5.2 Strong Winds

Previous experience has shown that the business walking and roadway classifications are associated with relatively strong winds Beaufort Force 7 or 8 during the windiest season. Wind conditions in excess of Beaufort Force 7 would be expected to require mitigation in an urban development.

6. Wind Conditions around the Proposed Development

The output of CFD modelling the results of the wind in the directions discussed in this report (135°, 180°, 225° and 270°) is presented in Appendix B.

Plots illustrating the expected conditions at ground level across the site in terms of the RWDI Criteria are presented in Appendix C.

6.1 Configuration 1: Existing Site with Existing Surrounds (baseline)

6.1.1 Thoroughfares

Pedestrian thoroughfares around the site are expected to be acceptable for walking or calmer during the windiest season. The greatest acceleration expected when the wind is from a south-west direction is illustrated in Figure 14.

6.1.2 Entrances

Entrances around the existing site are expected to observe standing conditions or calmer, which is acceptable for the desired use. The greatest acceleration expected when the wind is from a south-west direction is illustrated in Figure 14.

6.2 Configuration 2: Proposed Development with Existing Surrounds

6.2.1 Thoroughfares

Wind conditions on thoroughfares across the Proposed Development are expected to range from sitting to strolling use throughout the year, with a small instance of walking conditions in the south-east corner of the Proposed Development. Overall, conditions are expected to be acceptable for the intended pedestrian thoroughfare use. The following features should be noted.

- The prevailing winds are expected to accelerate around the south-east corners creating conditions during the windiest season which are expected to experience walking conditions which are one category windier than desired. These conditions could be considered acceptable if these areas aren't on main thoroughfares or are locations which won't be used frequently by the general public, such as roads or maintenance routes. The greatest acceleration expected when the wind is from a south-westerly direction is illustrated in Figure 6. Mitigation measures for these areas are discussed in Section 7 of this report.
- It is also expected that the prevailing south-westerly winds will be accelerated around the north-west and north-east corners of National Maternity Hospital; which is expected to create strolling conditions during the windiest season. The greatest acceleration expected when the wind is from a south-westerly direction, as illustrated in Figure 6.

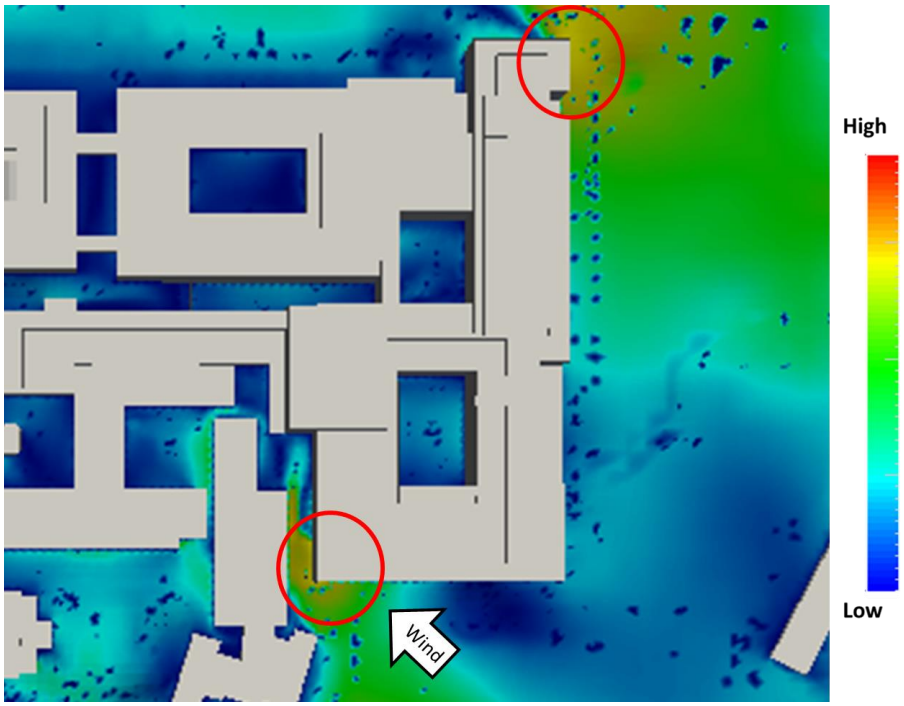


Figure 4 - South-easterly wind accelerates in passageway along the south-west along with the north-east corner of National Maternity Hospital

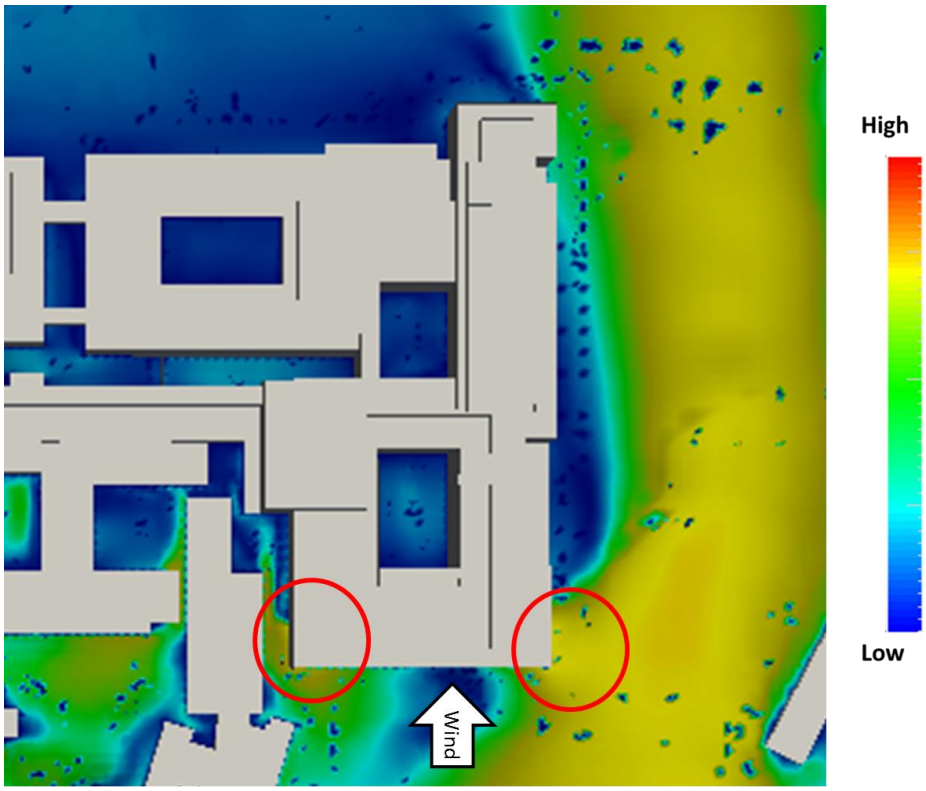


Figure 5 - Southerly winds are again accelerated in passageway along the south-west, as well as the south-east corners of National Maternity Hospital.

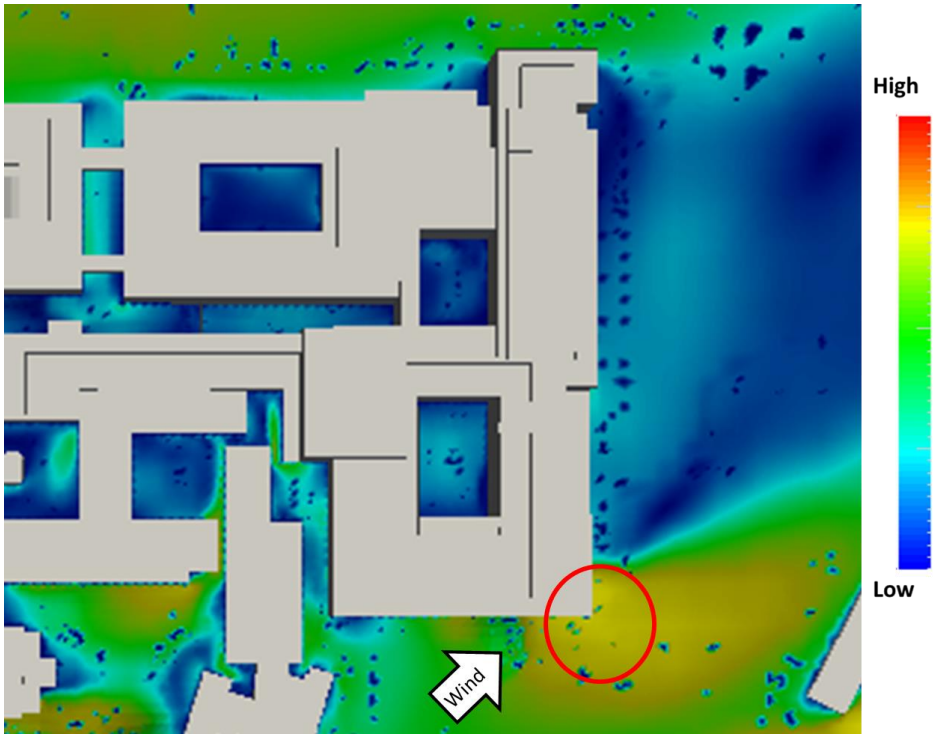


Figure 6 – South-westerly winds are around the south-east corner of National Maternity Hospital

6.2.2 Entrances

Entrances on the southern façade of the building are expected to experience strolling conditions which are one category windier than desired. This can be mitigated either by recessing the entrance, or through the inclusion of vertical screening on either side of the entrance to achieve the desired standing conditions. This issue is induced by the winds from the south-westerly direction, as illustrated in Figure 6.

6.2.3 Drop-Off Area

The drop-off area located along the north façade of the Proposed Development is expected to observe standing conditions during the windiest season, which is acceptable for the intended use. As such, no mitigation measures are required at this location.

6.2.4 Amenity Spaces

Courtyard amenity spaces at ground level located within the proposed development are expected to observe sitting conditions during the summer season and no mitigation is required.

The raised terrace amenity space in the west block is expected to experience standing conditions during the summer season which is windier than desired and would require mitigation measures such as soft landscaping combined with 2m vertical screens to achieve conditions acceptable for long term sitting.

6.2.5 Strong Winds

It is not expected that occasional strong winds exceeding Beaufort Force 7 will occur in the areas mentioned in section 6.2; as highlighted in Figures 4-6 above.

6.3 Configuration 3: Proposed Development with Cumulative Surrounds

As mentioned in Section 1 of this report, Configuration 3 was not tested as part of this assessment due to its similarity with Configuration 2. Expert judgement was therefore used, and it is expected that conditions will be mostly acceptable for strolling use in winter; while sitting and standing wind conditions are expected during the summer season.

6.3.1 Thoroughfares

Wind conditions in this scenario are similar to that of Configuration 2, with most thoroughfare locations being acceptable for the intended pedestrian use.

6.3.2 Entrances

Entrance locations in Configuration 3 are expected to observe the same wind conditions to those in Configuration 2. The entrance on the southern façade of the building are still expected to experience strolling conditions; and mitigation is recommended as described in Section 7.

6.3.3 Drop-Off Area

Conditions along the drop-off zone expected in this configuration are again expected to experience standing conditions which is acceptable for areas where people will be waiting.

6.3.3 Amenity Spaces

Conditions at amenity spaces (courtyards at ground, along with the high level terrace) in this configuration are again very similar to that of the previous scenario; and would require the same recommendations as made in section 7.

6.3.4 Strong Winds

As in Configuration 2, it is not expected that occasional strong winds exceeding Beaufort Force 7 will occur in the areas mentioned in section 6.2; as highlighted in Figures 4-6 above.

7. Mitigation

The assessment was undertaken without any planting or landscaping around or within the Proposed Development in order to achieve a conservative (i.e. windier) scenario. The presence of planting and other landscape enhancements would generally be expected to increase shelter within the Proposed Development compared to the wind conditions described in Section 6, particularly when the trees and plants are established and in full leaf.

7.1. Thoroughfares

Some areas along the north-east and south-east corners are expected to experience walking conditions which are one category windier than desired for a main thoroughfare. Mitigation in the form of additional evergreen planting or vertical horizontal screens are recommended to improve conditions in these areas to achieve the desired strolling conditions.

7.2. Entrances

The main entrance location to the Proposed Development, located along the north facade is expected to observe standing conditions during the windiest season, which is acceptable for the intended use. Secondary entrance locations at ground level can also be seen in Figure 17 and are expected to observe strolling conditions which one category windier than desired for entrance use. Mitigation measures in the form of recessing or vertical screens on either side of the entrance are therefore recommended.

7.3. Amenity Spaces

The courtyards spaces at ground level are expected to observe sitting conditions during the summer season are acceptable for the intended amenity use. The raised terrace amenity space in the west block of the Proposed Development is expected to observe standing conditions during the summer season. This is two categories windier than desired and would require mitigation measures such as soft landscaping and/or 2m vertical screens to achieve the desired sitting conditions.

8. Concluding Remarks

In conclusion:

1. The meteorological data for the site indicate prevailing winds from the south-west throughout the year and a secondary wind from the south-east which is most prevalent in the spring.
2. This assessment was conducted on a model devoid of trees or landscape detail in order to obtain conservative, or 'worst case', results (i.e. generate a relatively windy microclimate).
3. As such, the inclusion of added landscaping will likely provide beneficial shelter to the Proposed Development and, in turn, create calmer wind conditions around the Site.
4. The background exposure of the site, due to the surrounding terrain roughness, is similar for all directions, and reflects the general urban terrain around the site. For the existing site the wind microclimate at ground level is expected to be generally acceptable for standing during the windiest season.
5. The ground level wind microclimate for the Proposed Development is expected to be comfortable for the intended pedestrian use of the site, classified as acceptable for strolling, standing or sitting use during the windiest season.
6. Conditions within the Proposed Development are, at worst, classified as acceptable for walking, which is windier than desired for some of the thoroughfare locations around the site. Localised mitigation, such as recessing the entrance, some form of planting or physical screens is recommended. It is acknowledged that the proposed scheme includes mitigation measures in line with the suggested recommendations.
7. Conditions in the courtyard amenity spaces ground level and the high level terrace within the Proposed Development are classified as acceptable for standing and sitting use during the summer season. Where standing conditions have been identified, planting in addition to vertical 2m high screens is expected to improve conditions in these areas.

Appendix A – CFD geometry

Figures 7 and 8 below show the simplified geometry used within the CFD simulation for the two configurations tested.

The surrounding buildings included in both configurations are shown in green. The existing part of the site is in red. The portion of the site to be demolished is shown in brown.

The Proposed Development is shown in blue. The extent of the surrounding terrain is shown in grey

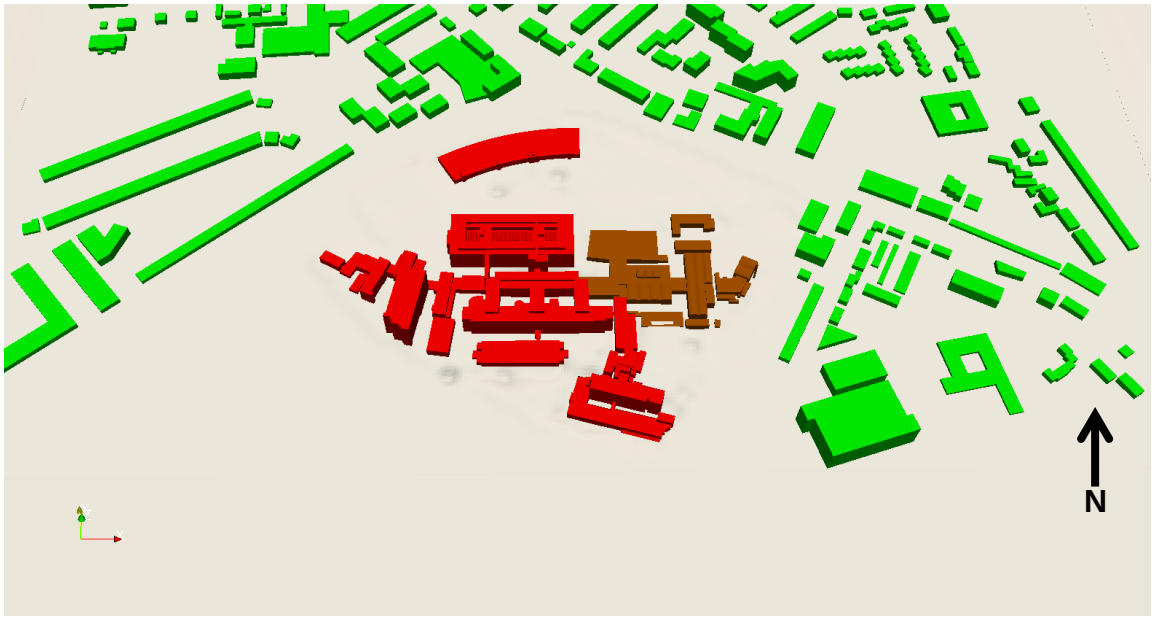


Figure 7 - Configuration 1: Existing Site + Existing Surrounds

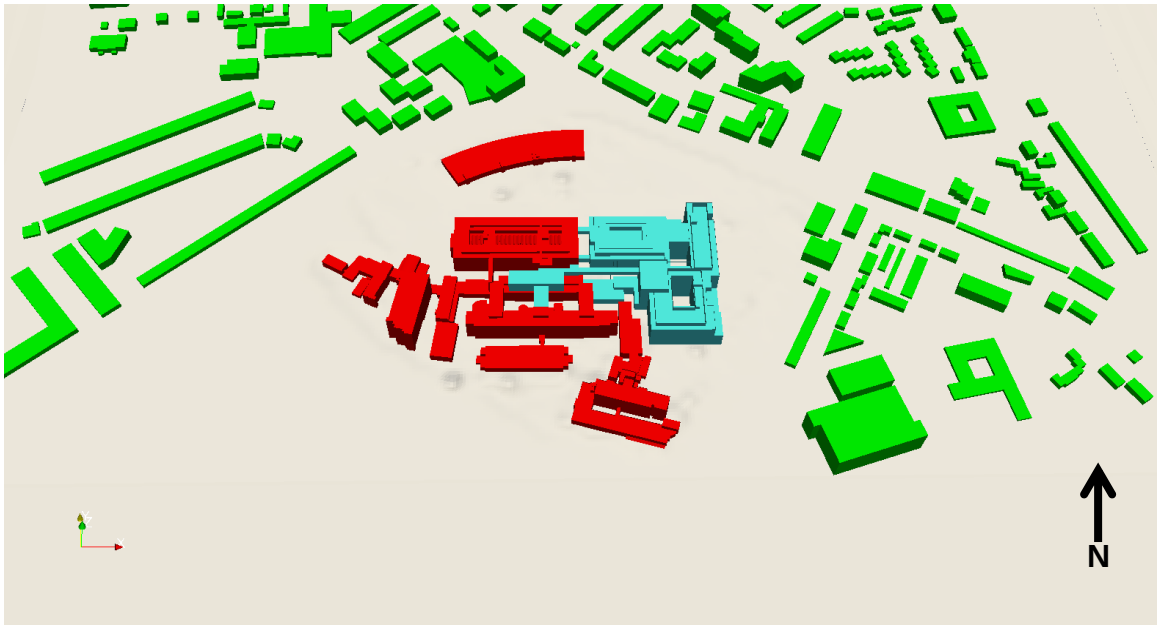


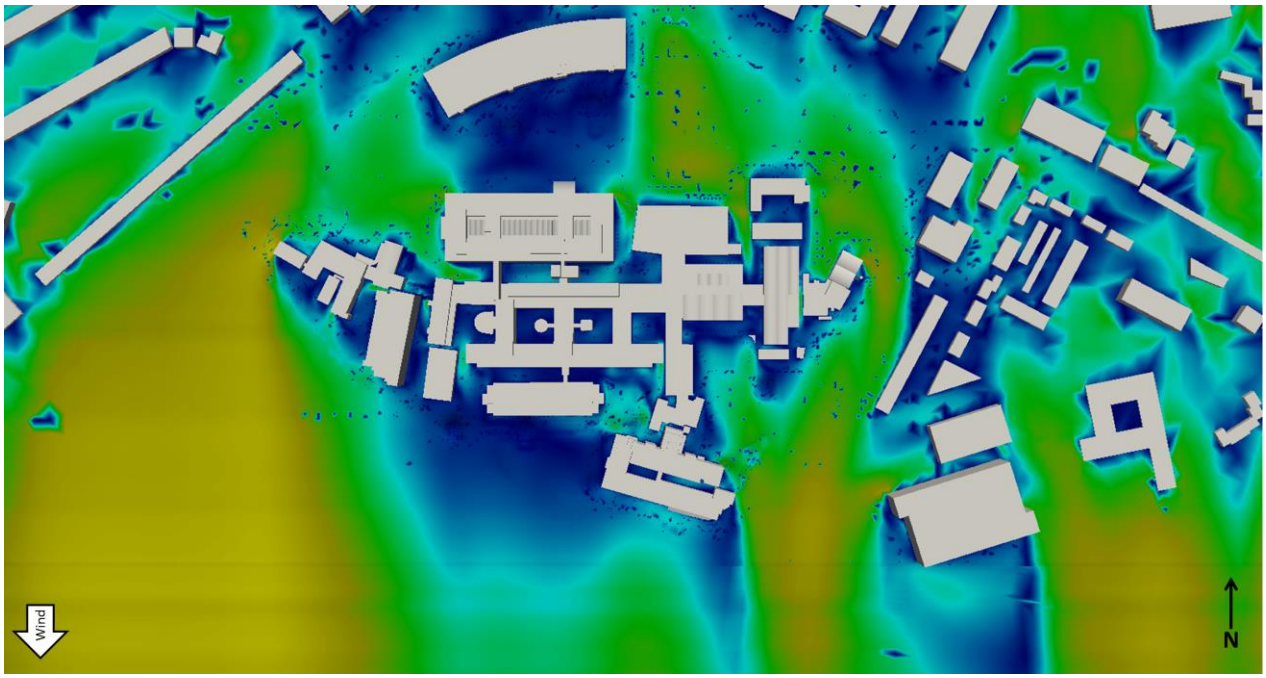
Figure 8 - Configuration 2: Proposed Development + Existing Surrounds

Appendix B – CFD Modelling Output

Figures 9 – 16 below, present the output from the computational fluid dynamics modelling of the wind from the south-east south, south-west and west in the form of velocity contours at a height of 1.5m above the ground. Two images are shown for each wind direction, the first shows the wider extents of the CFD model and the second shows a view of the Proposed Development.

Figures 9-12 show results from Configuration 1, the existing site with existing surrounds.

Figures 13-16 show results from Configuration 2, the proposed development with existing surrounds.



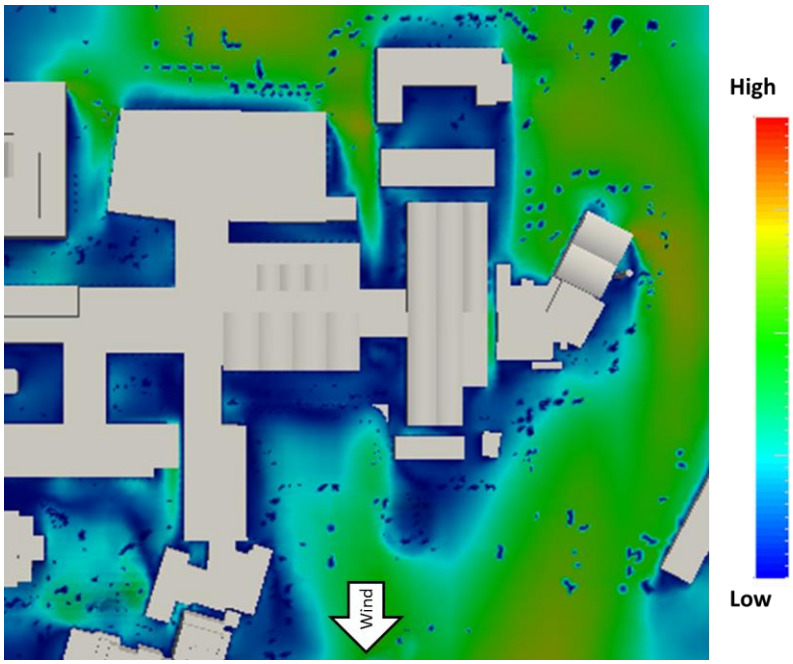
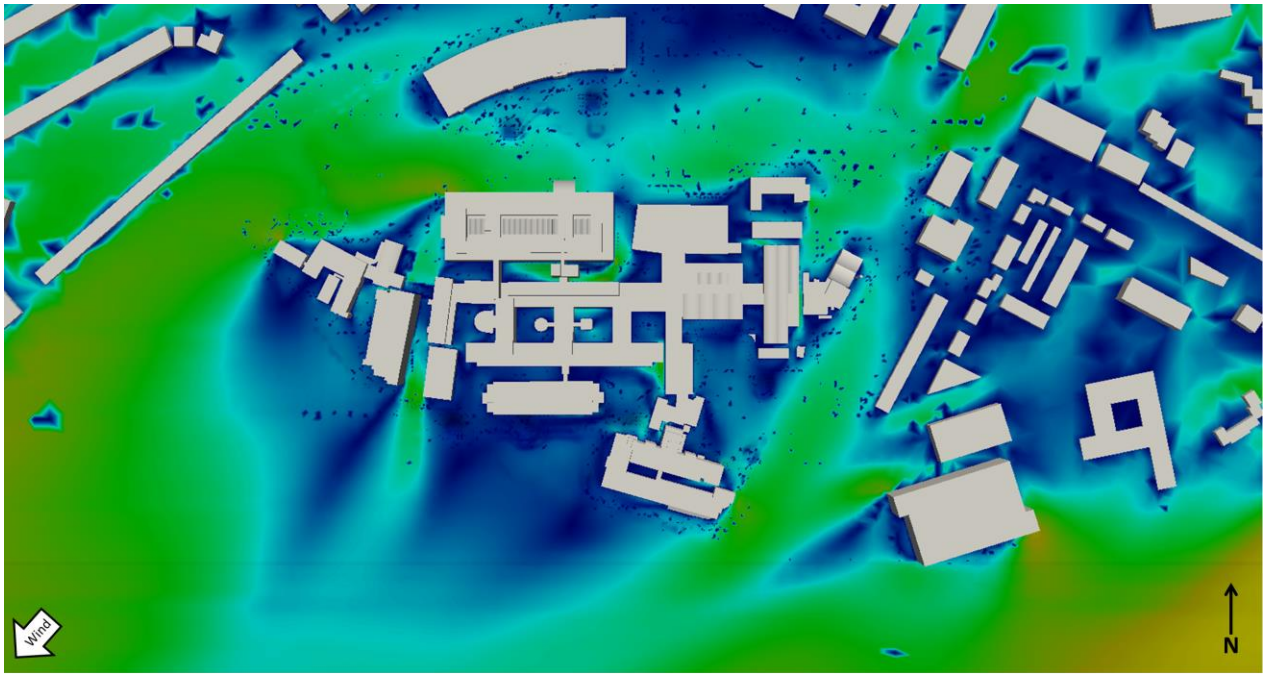


Figure 9 - Configuration 1: Existing Site + Existing Surrounds - Wind from the North



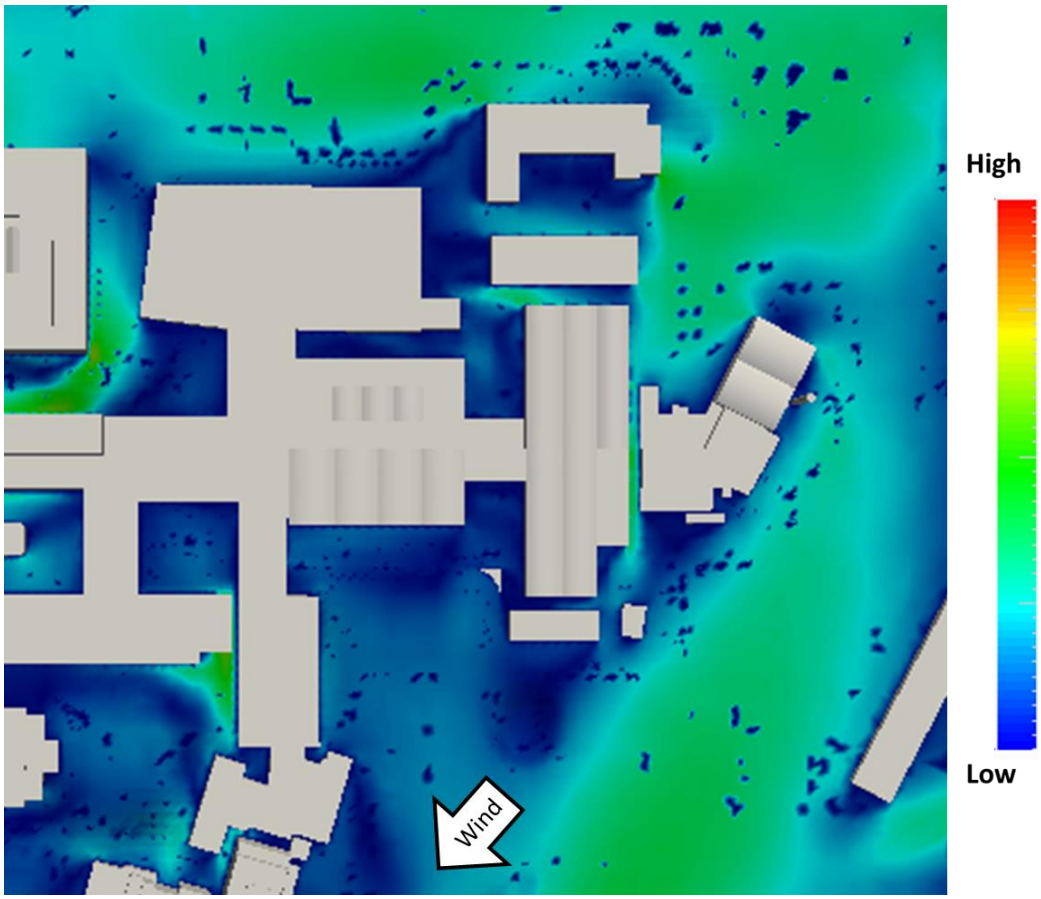
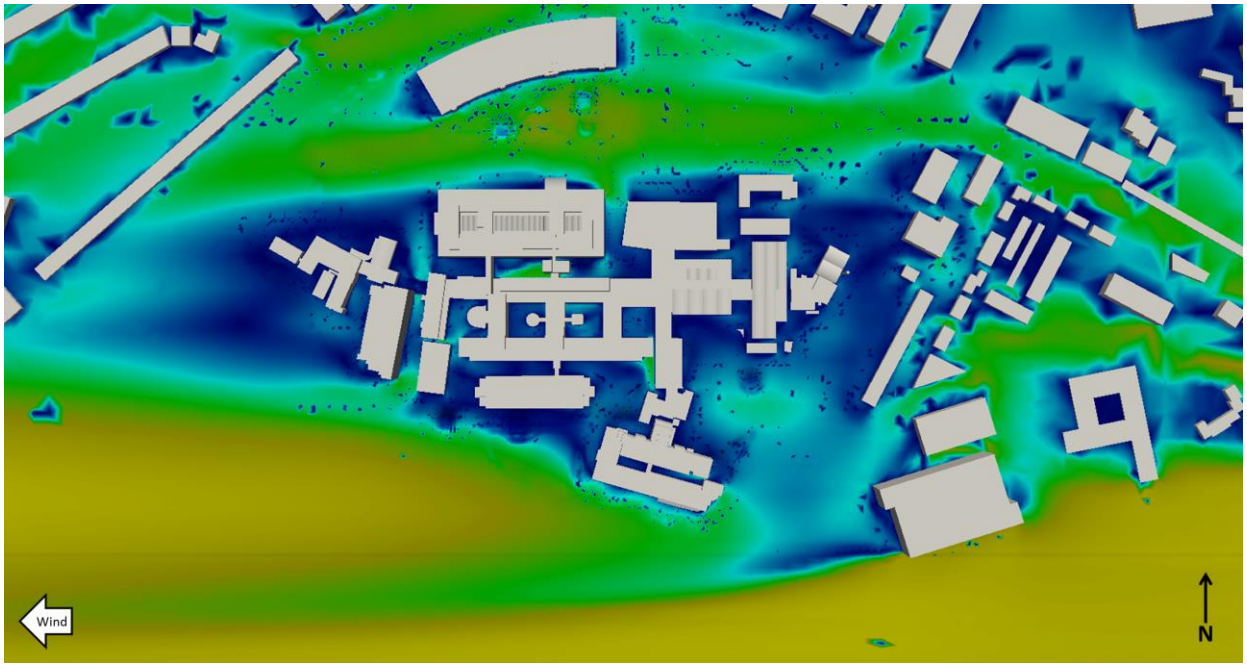


Figure 10 - Configuration 1: Existing Site + Existing Surrounds - Wind from the North-east



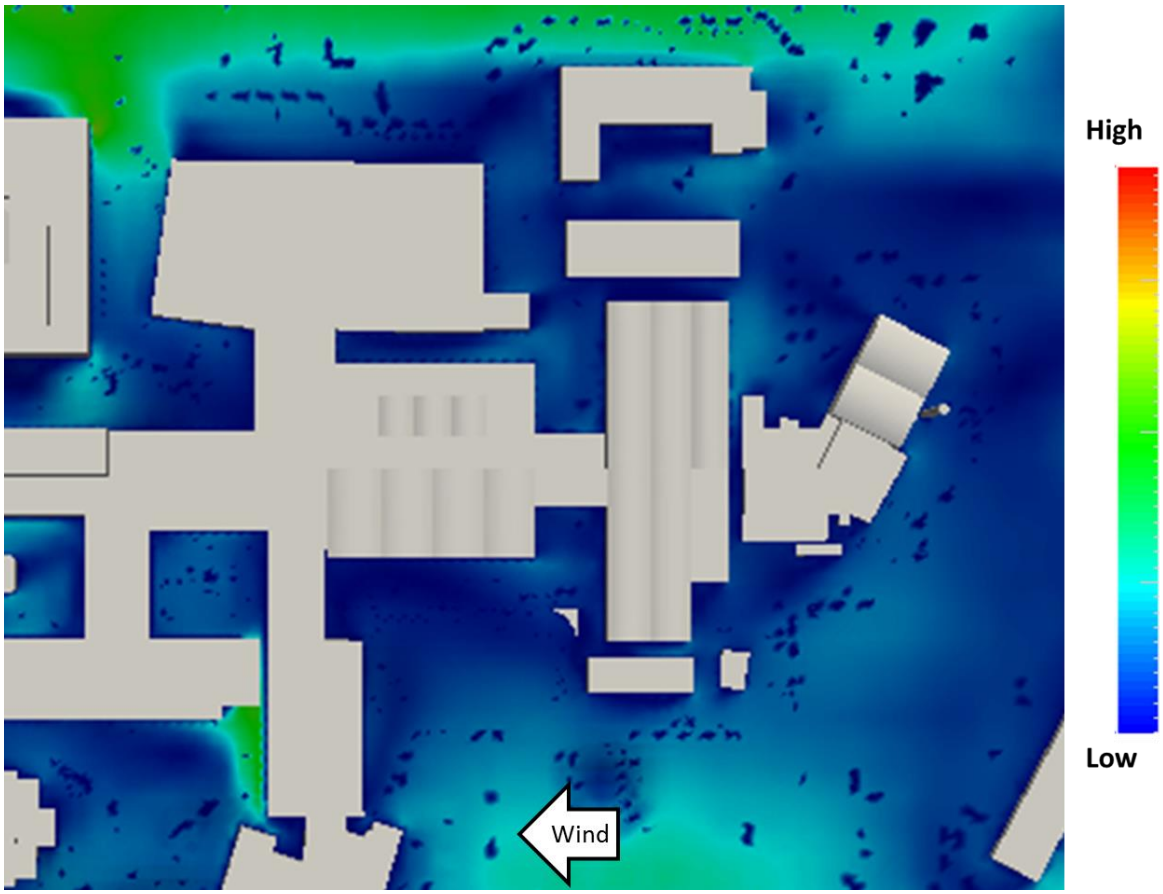
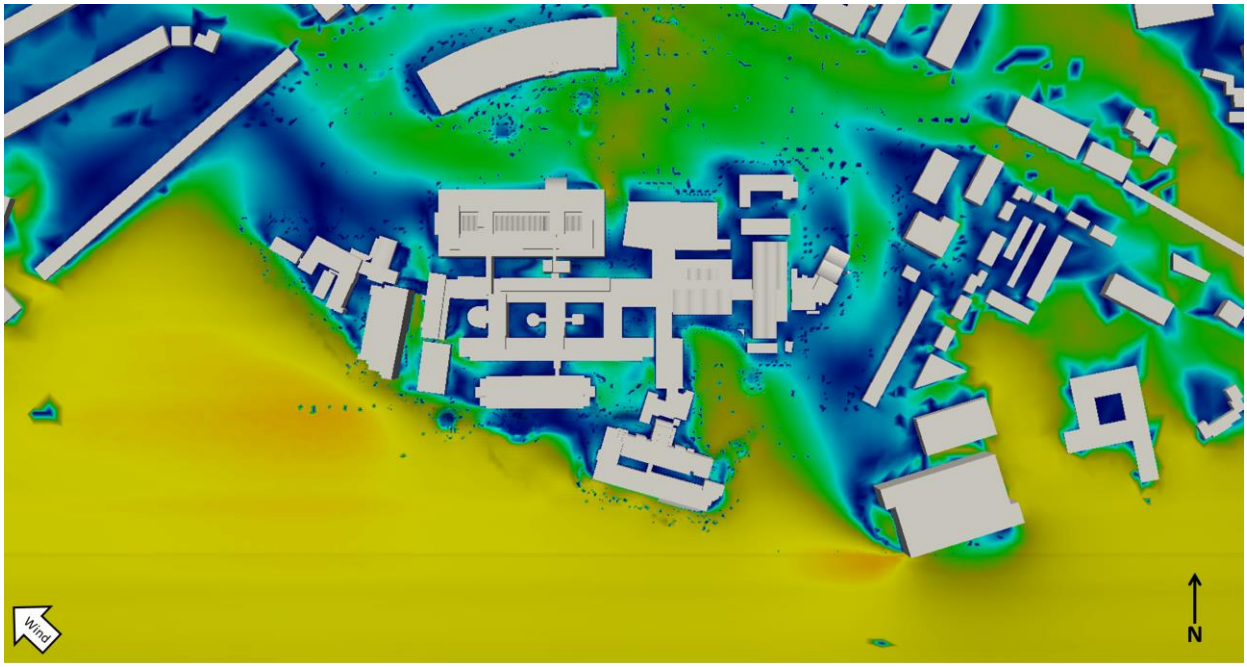


Figure 11 - Configuration 1: Existing Site + Existing Surrounds - Wind from the East



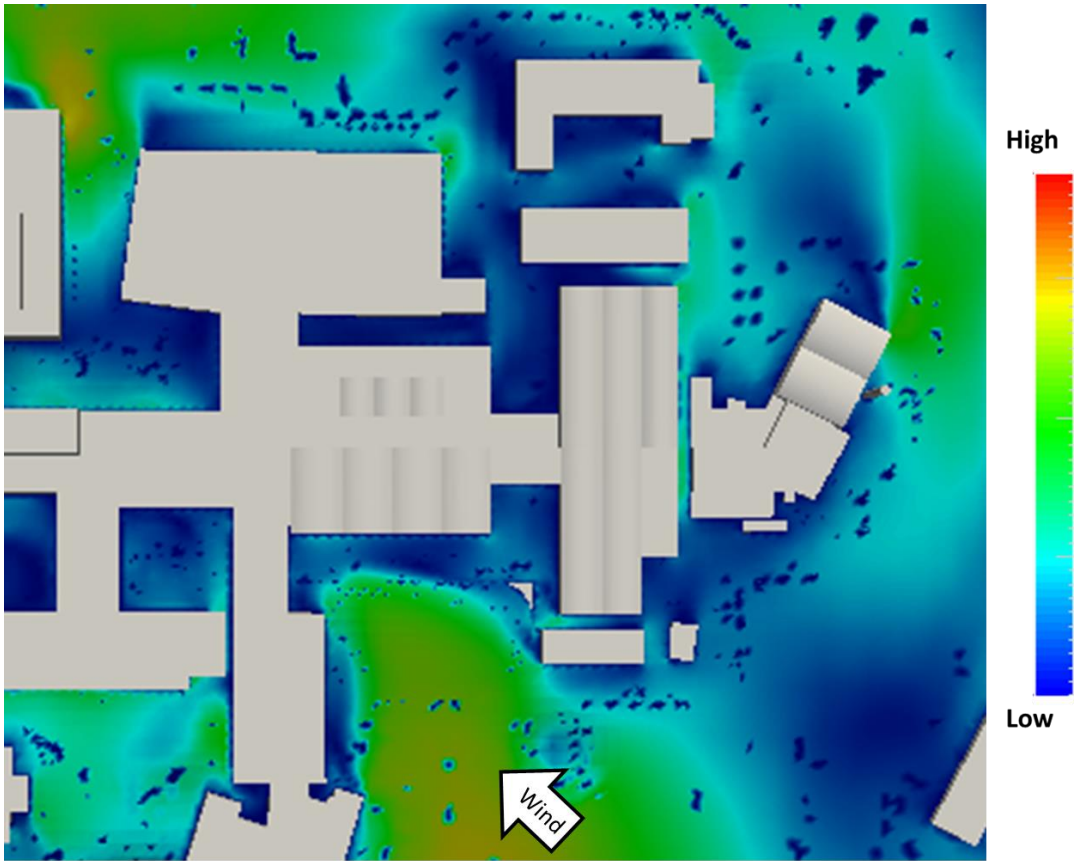


Figure 12 - Configuration 1: Existing Site + Existing Surrounds - Wind from the South-east

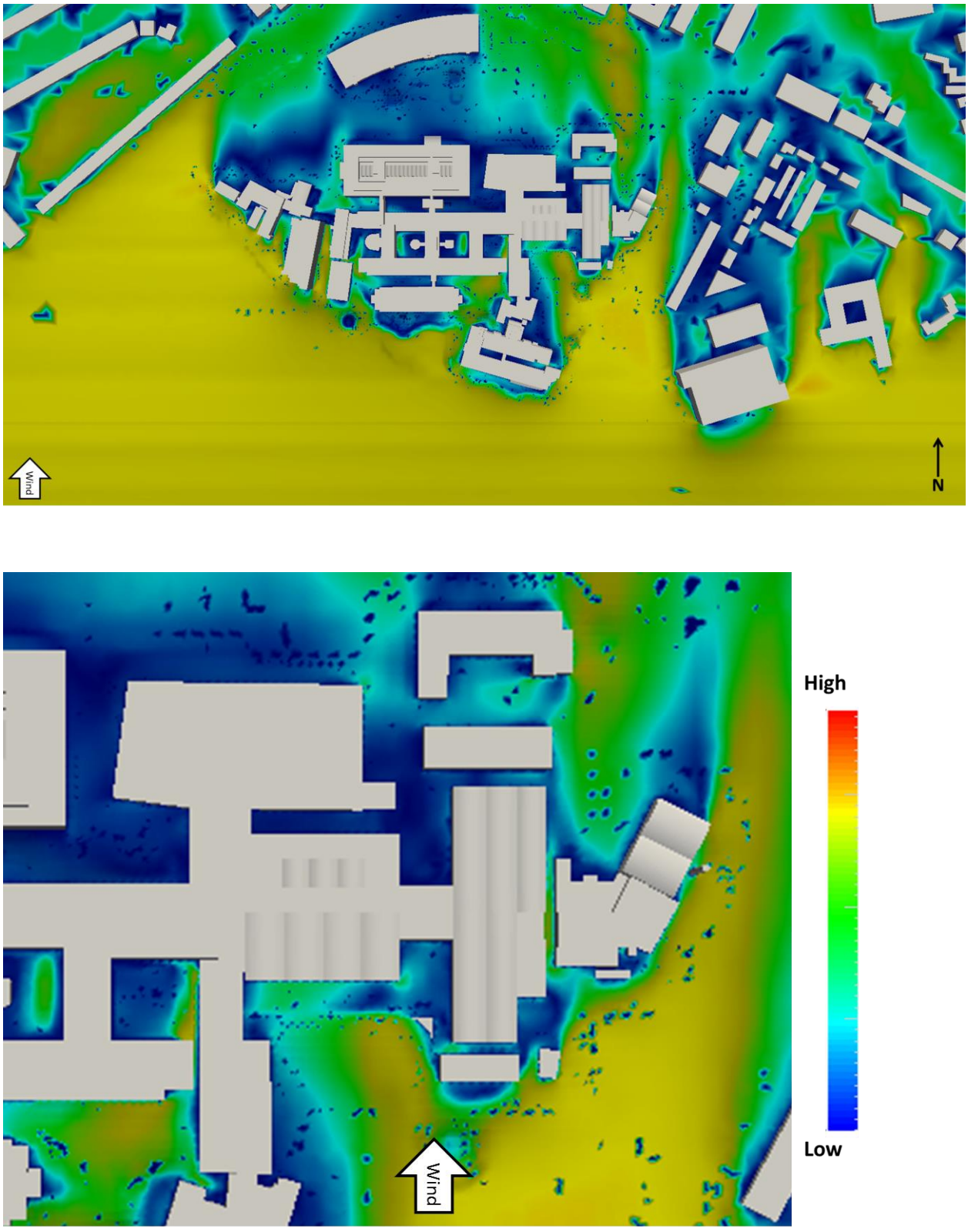
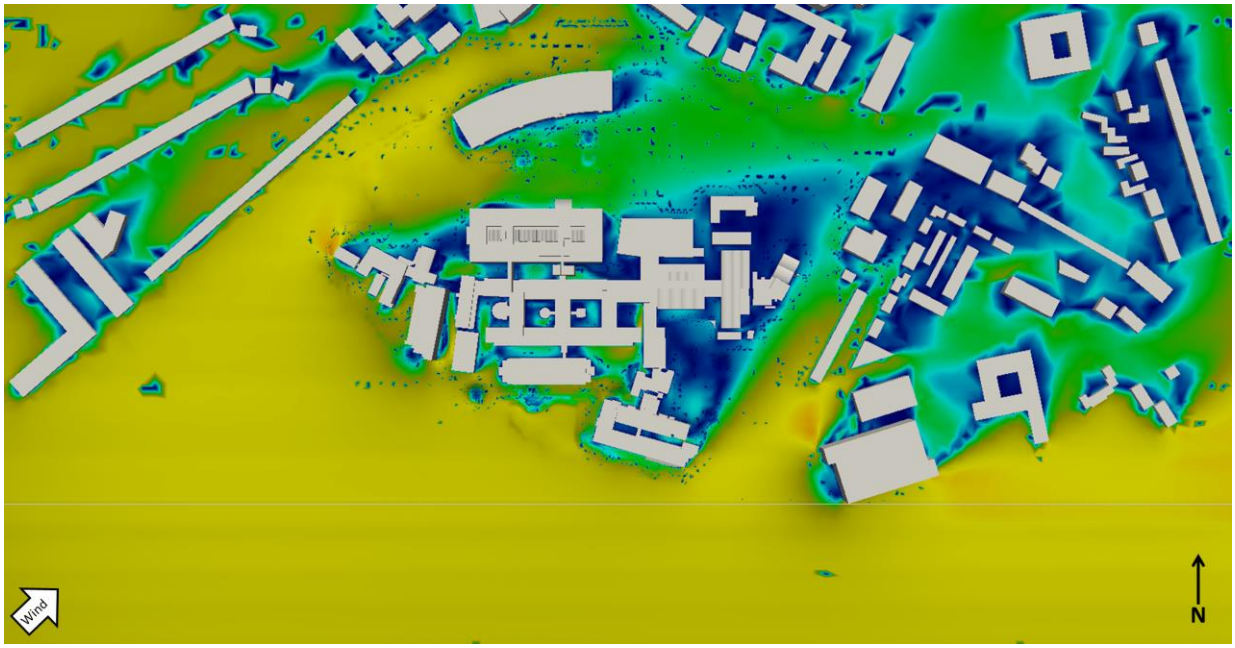


Figure 13 - Configuration 1: Existing Site + Existing Surrounds - Wind from the South



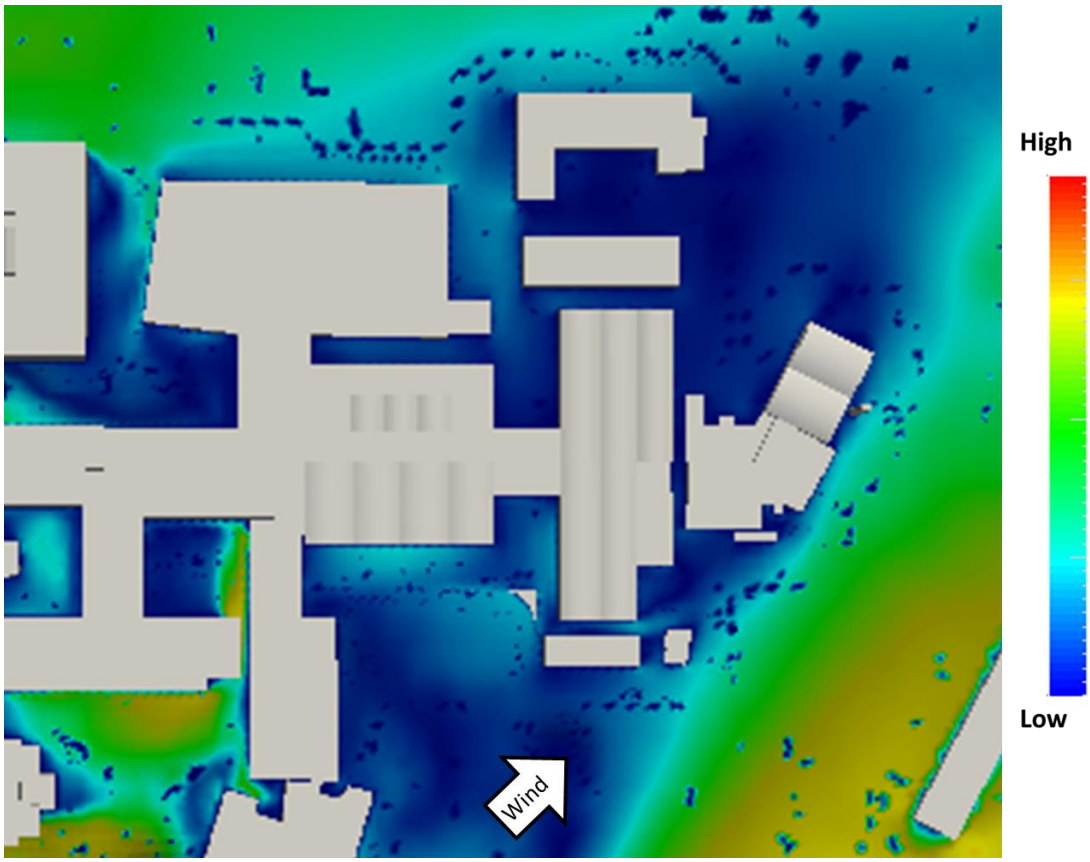


Figure 14 - Configuration 1: Existing Site + Existing Surrounds - Wind from the South-west

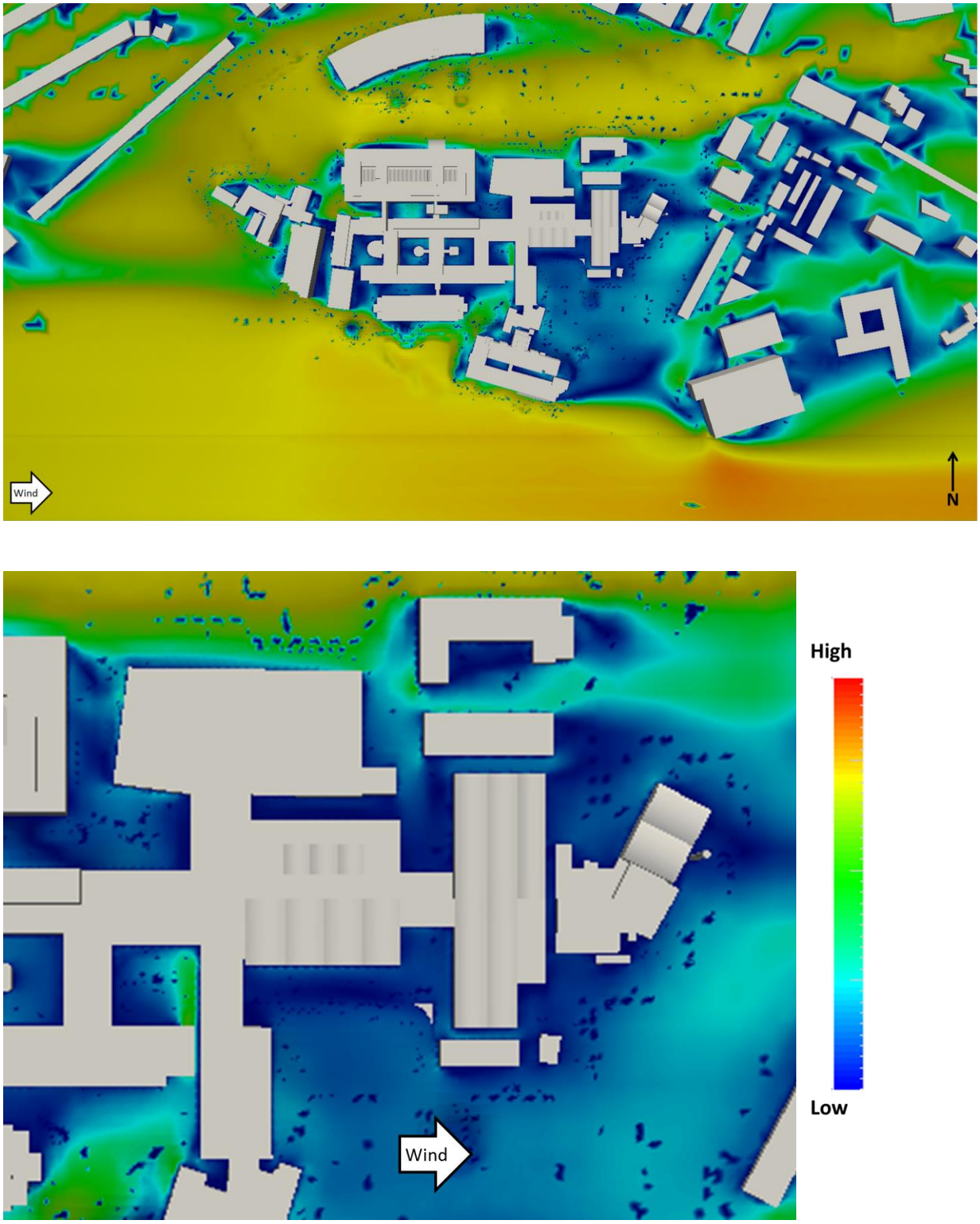
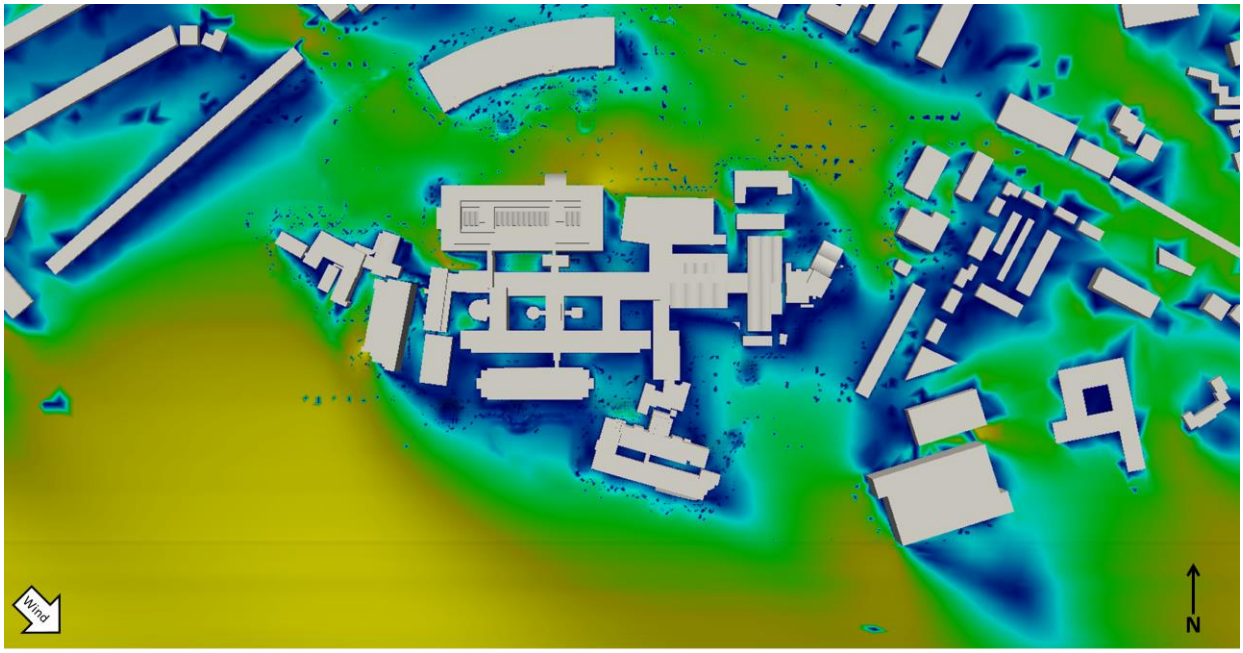


Figure 15 - Configuration 1: Existing Site + Existing Surrounds - Wind from the West



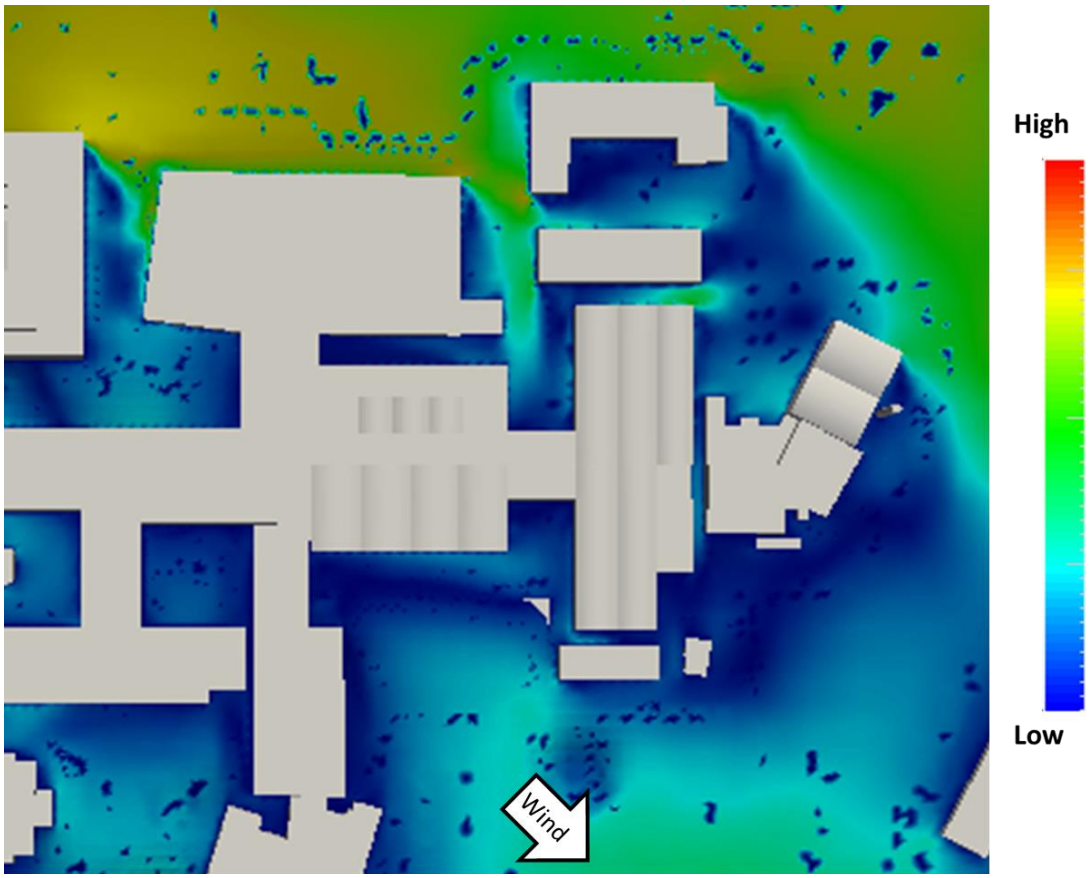
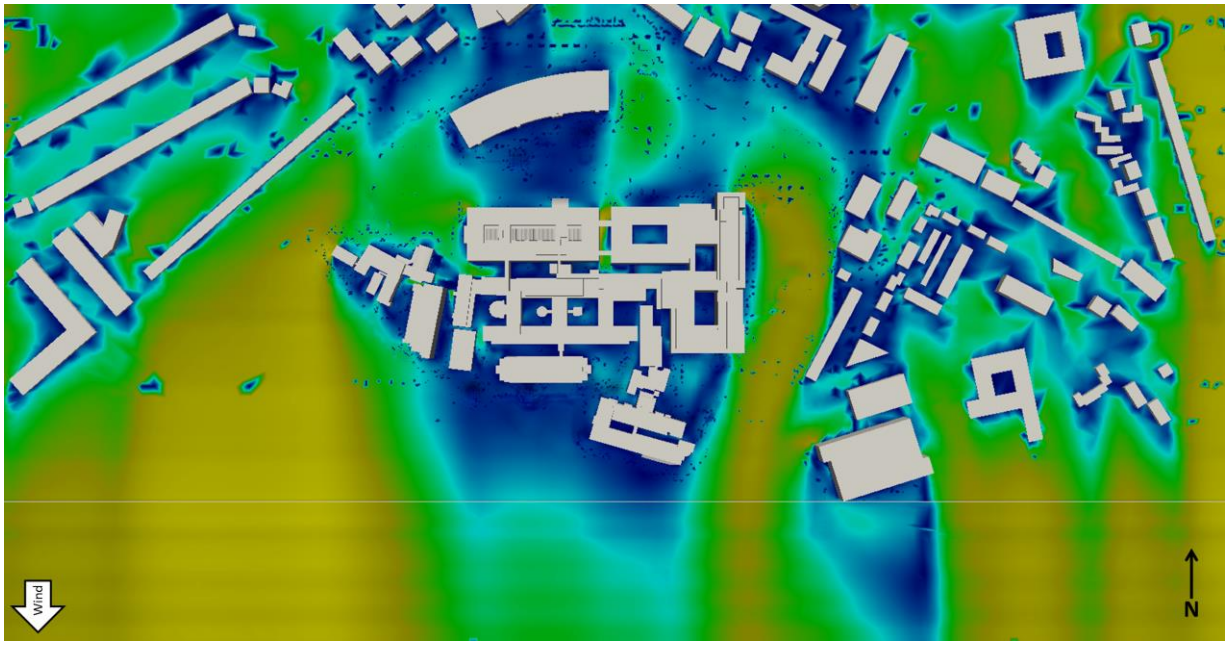


Figure 16 - Configuration 1: Existing Site + Existing Surrounds - Wind from the North-west



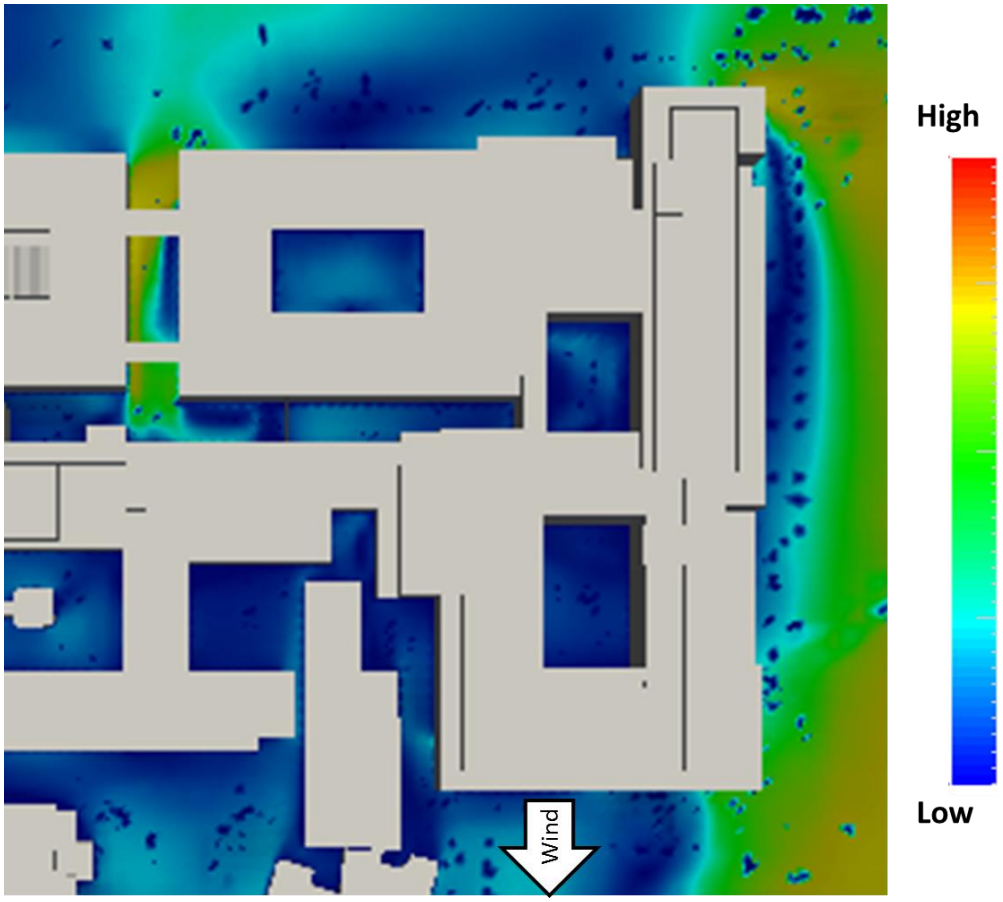


Figure 17: Configuration 2: Proposed Development + Existing Surrounds – Wind from the North

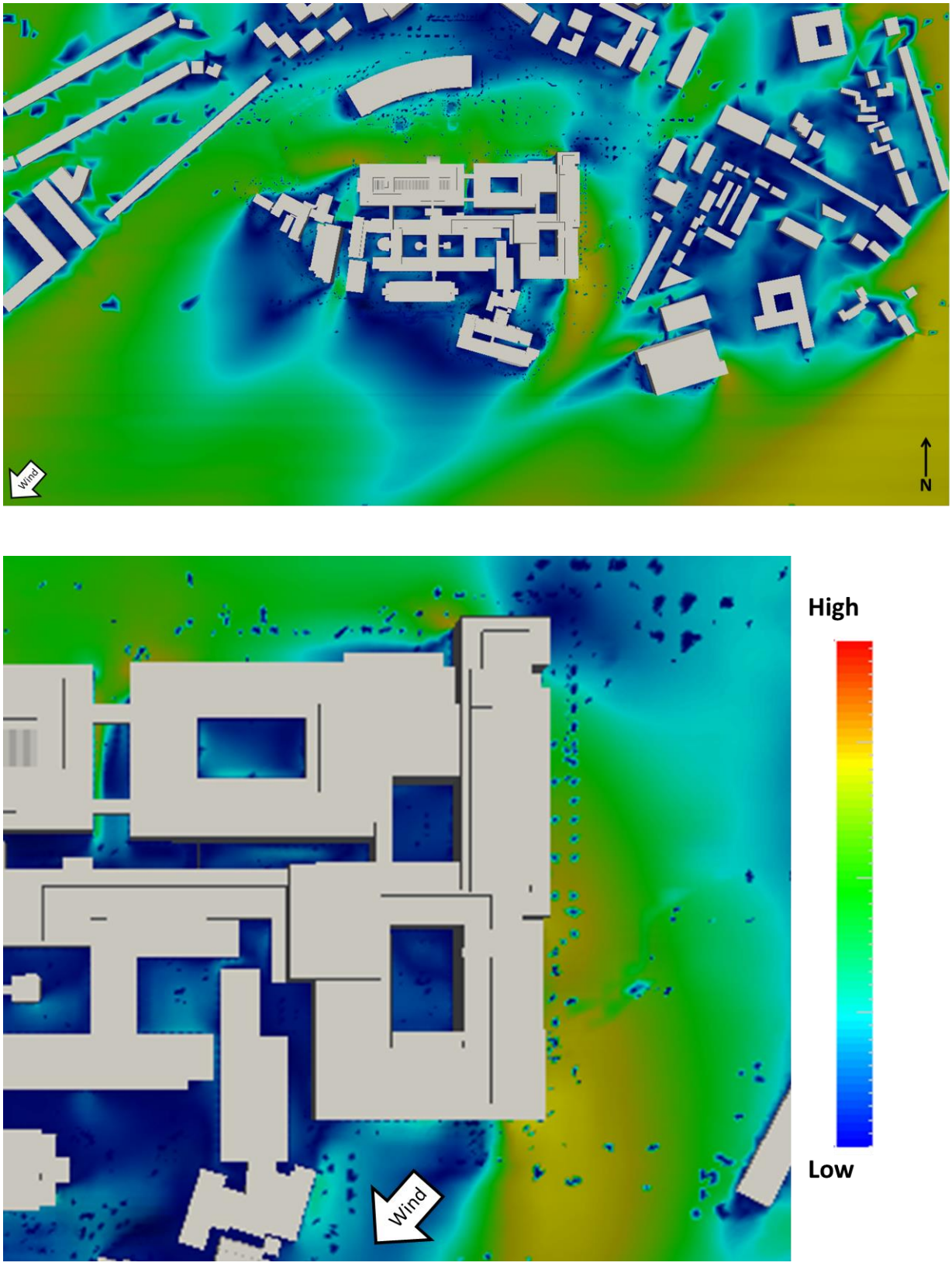
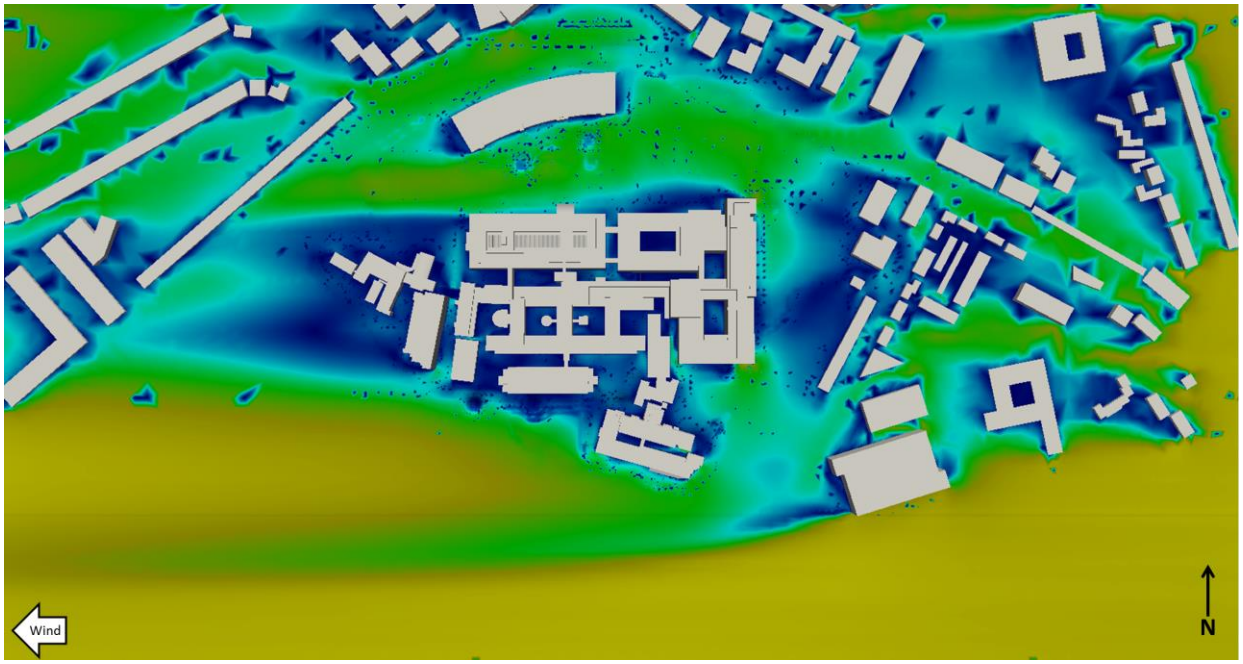


Figure 18 - Configuration 2: Proposed Development + Existing Surrounds – Wind from the North-east



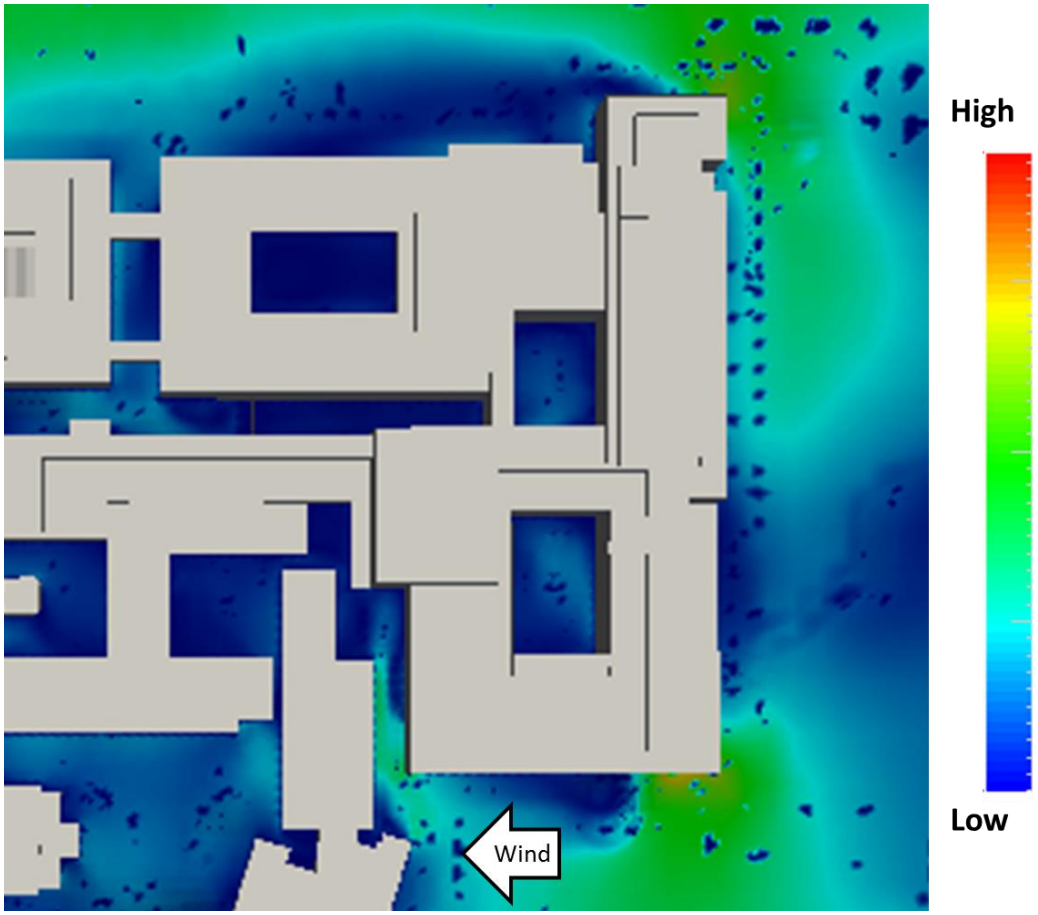


Figure 19 - Configuration 2: Proposed Development + Existing Surrounds – Wind from the East

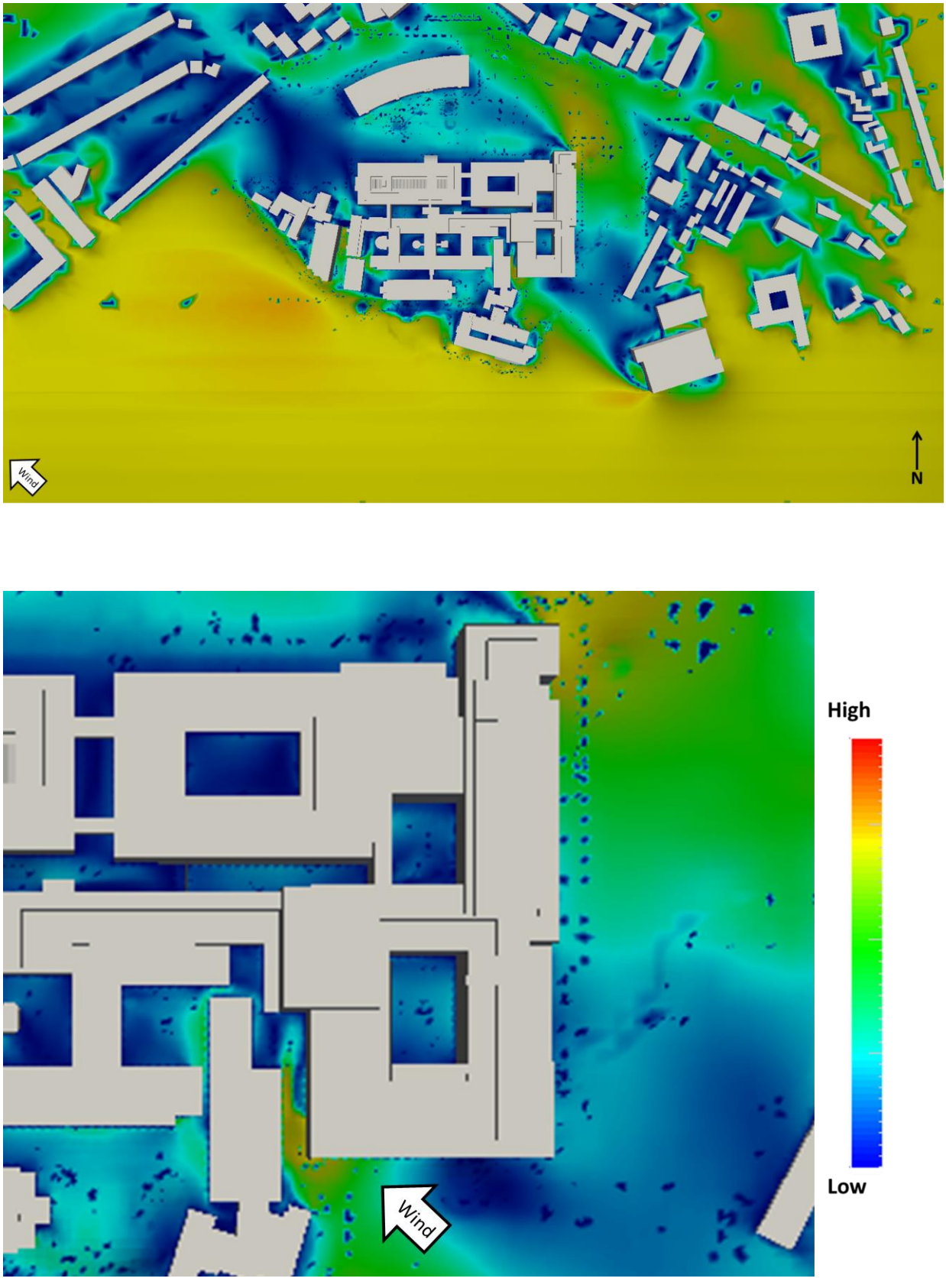
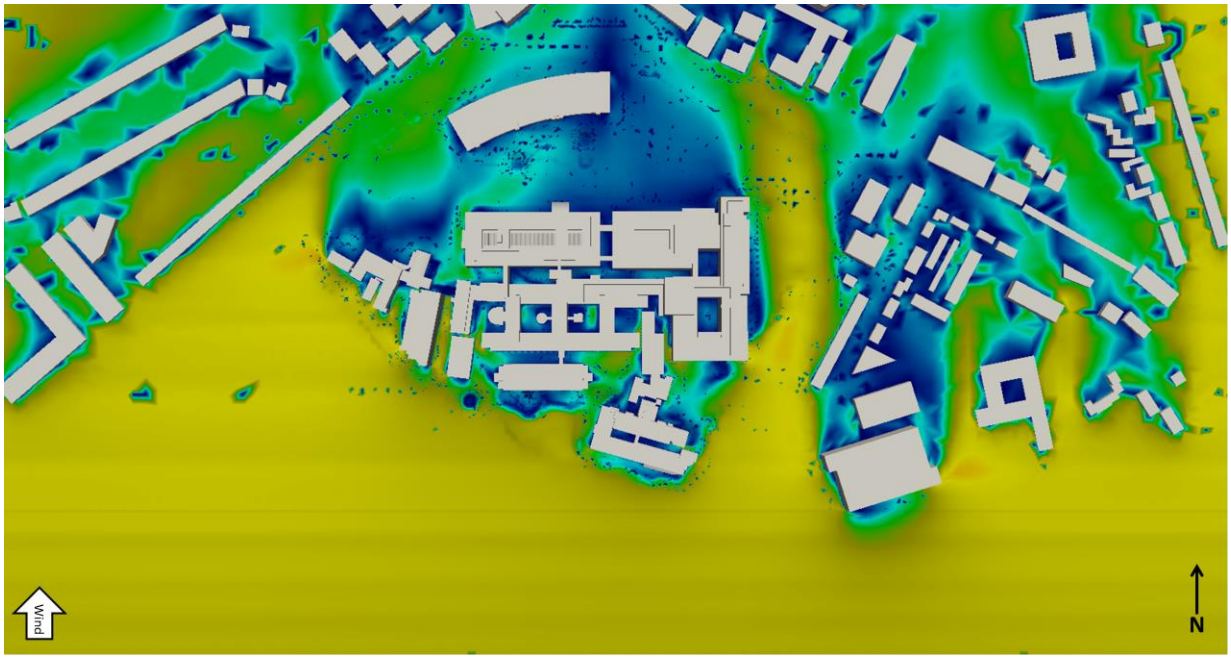


Figure 20 - Configuration 2: Proposed Development + Existing Surrounds – Wind from the South-east



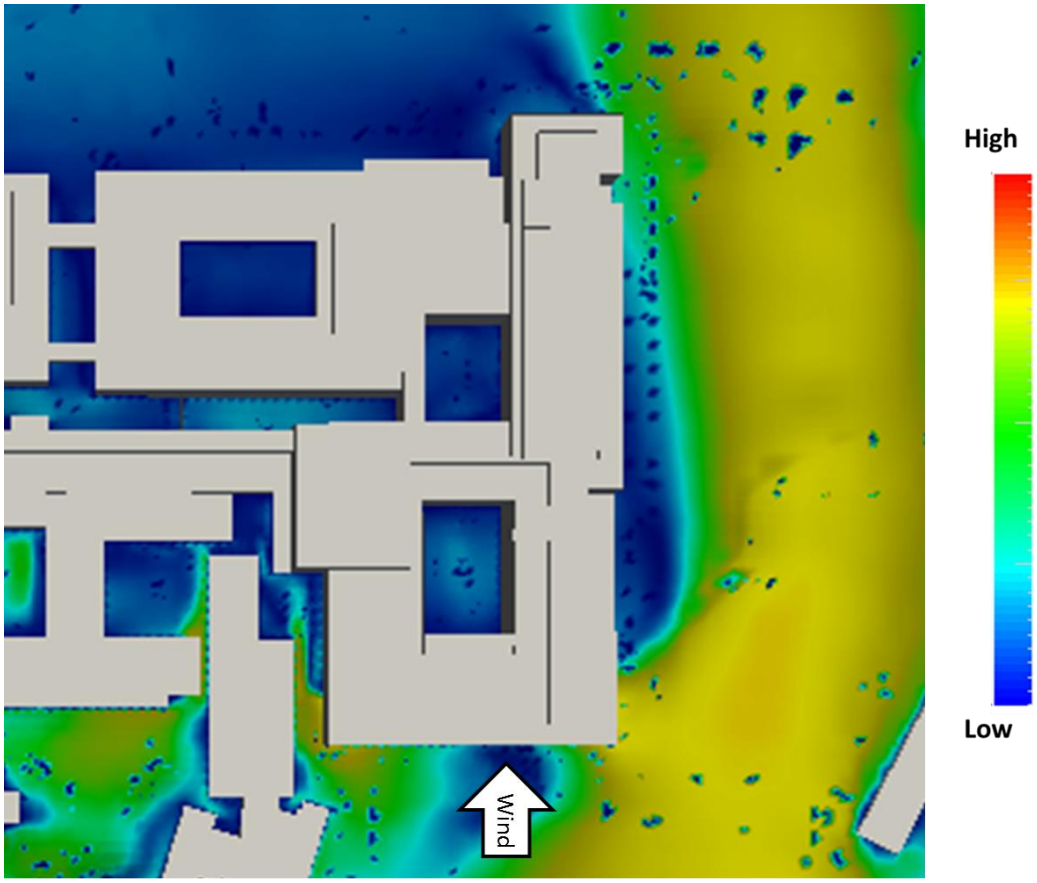
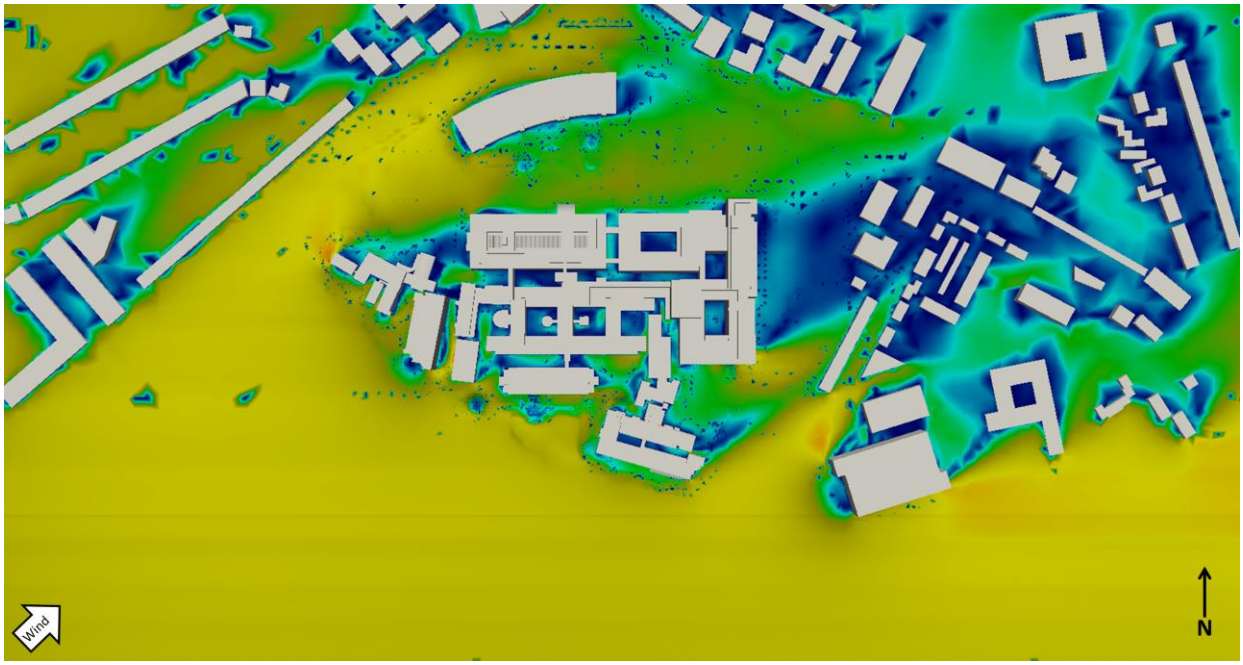


Figure 21 - Configuration 2: Proposed Development + Existing Surrounds – Wind from the South



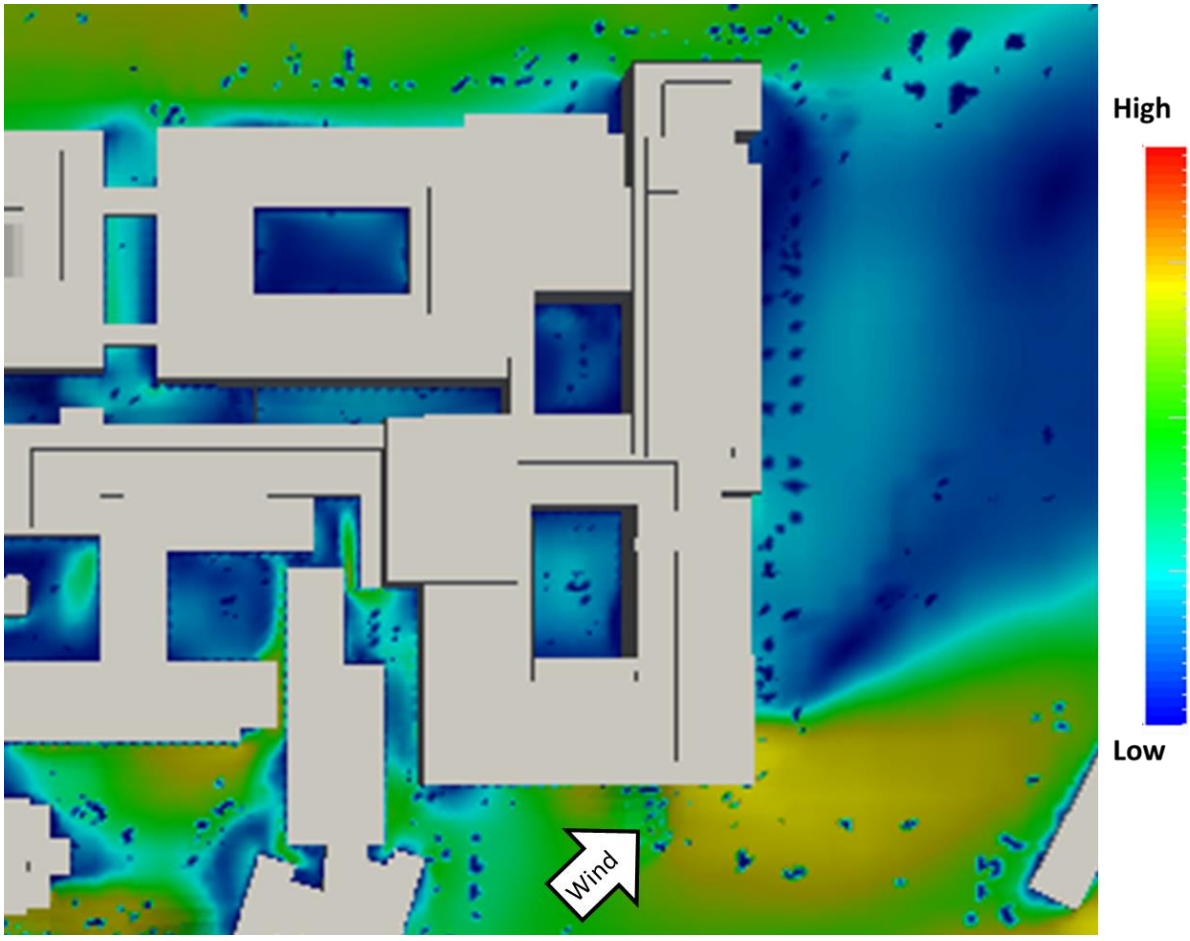
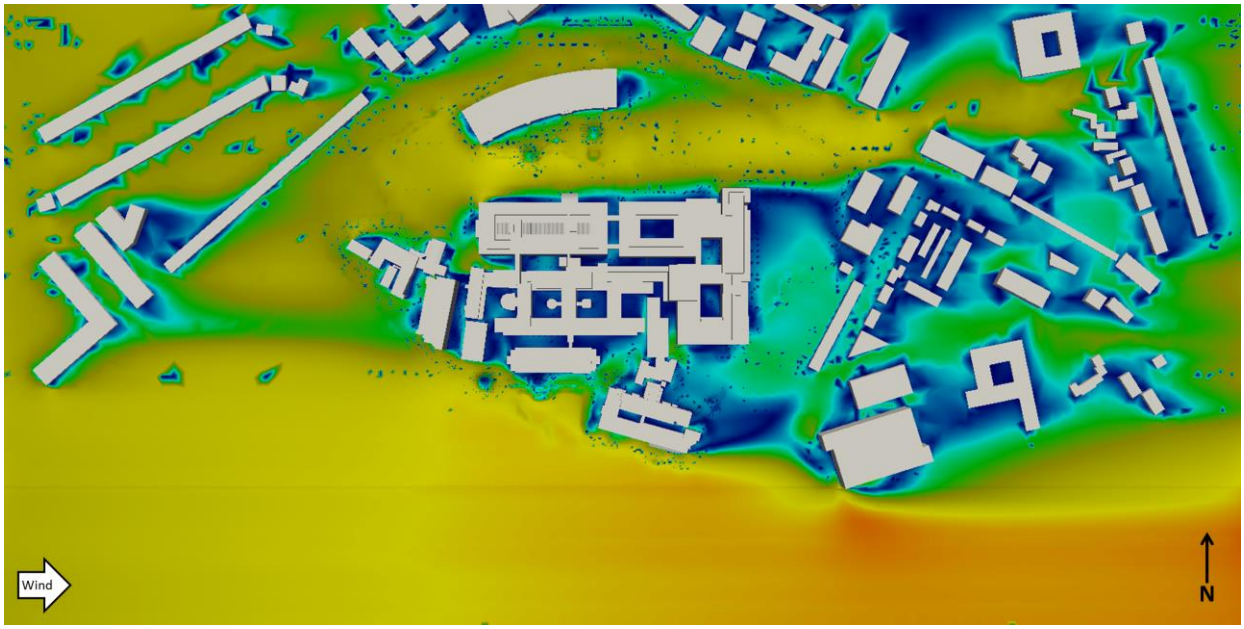


Figure 22 - Configuration 2: Proposed Development + Existing Surrounds – Wind from the South-west



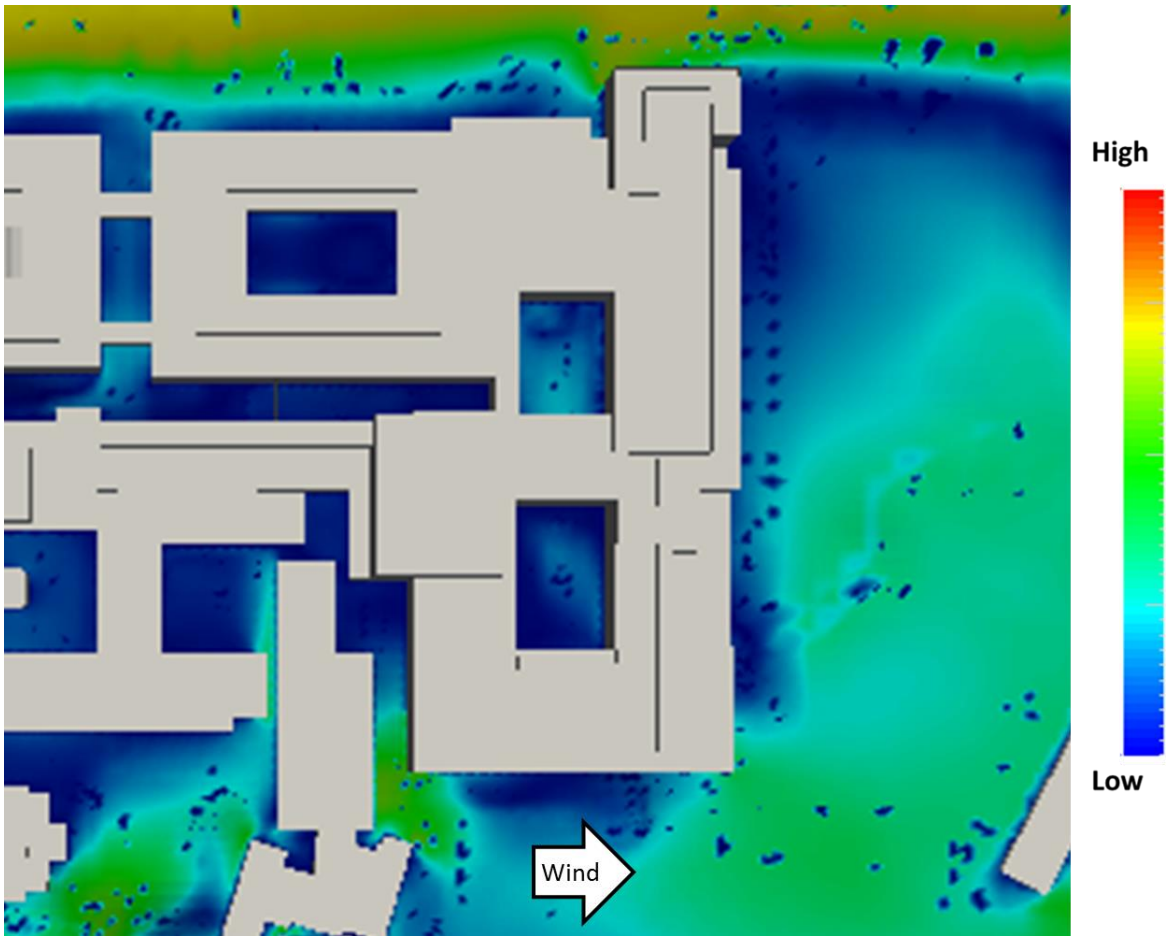
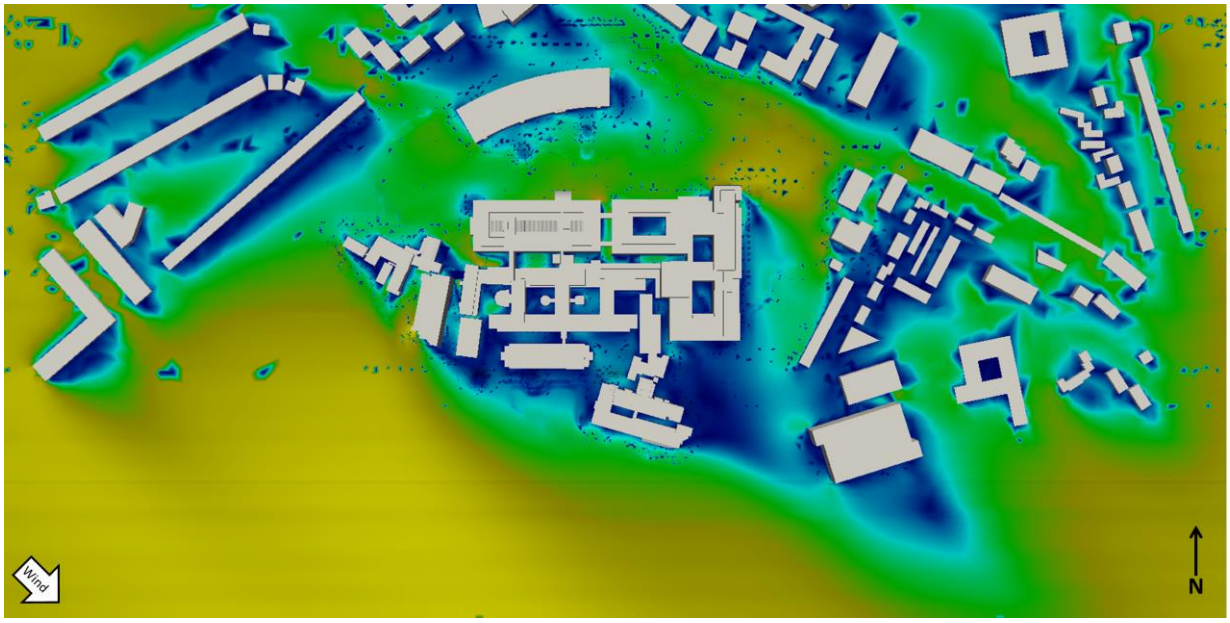


Figure 23 - Configuration 2: Proposed Development + Existing Surrounds – Wind from the West



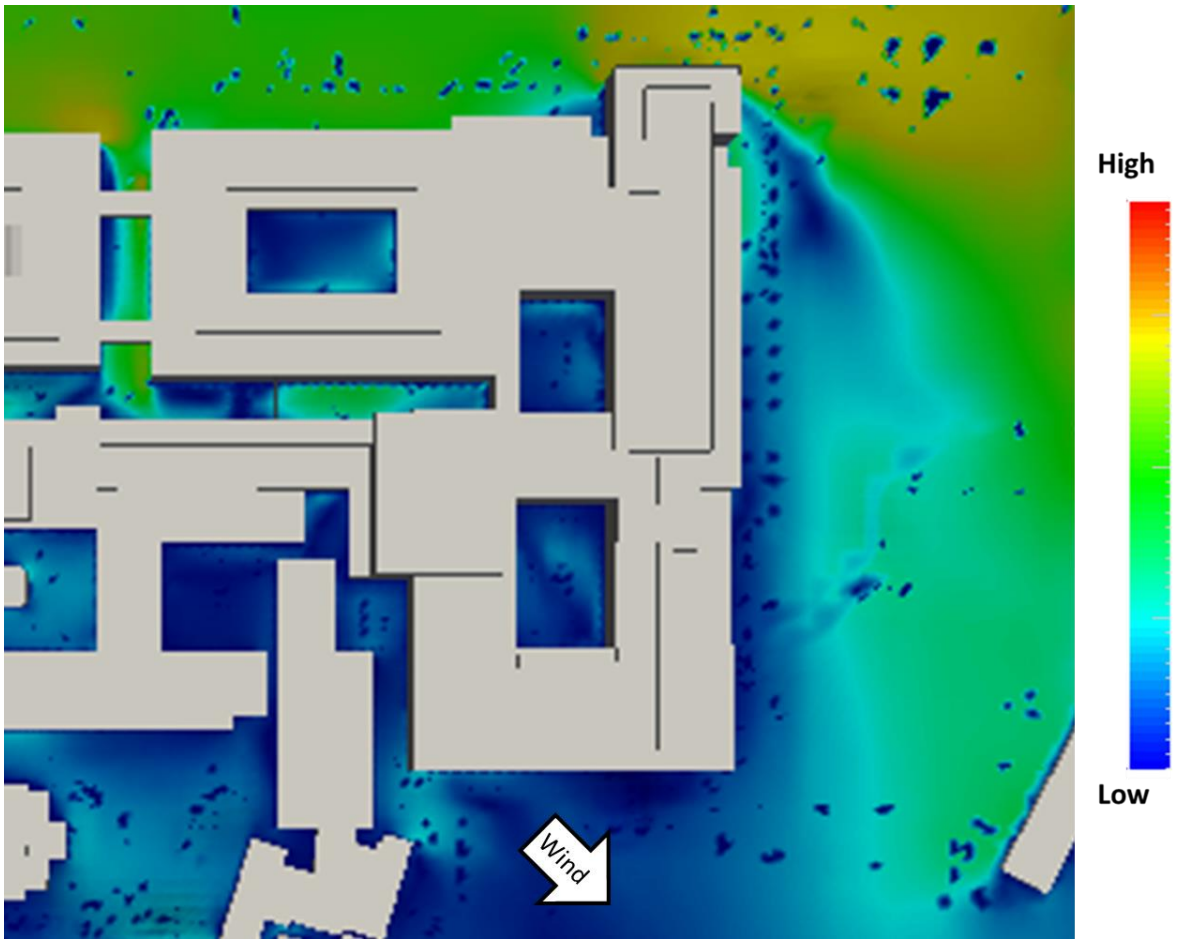


Figure 24 - Configuration 2: Proposed Development + Existing Surrounds – Wind from the North-west

Appendix C – Wind Assessment in terms of the RWDI Criteria

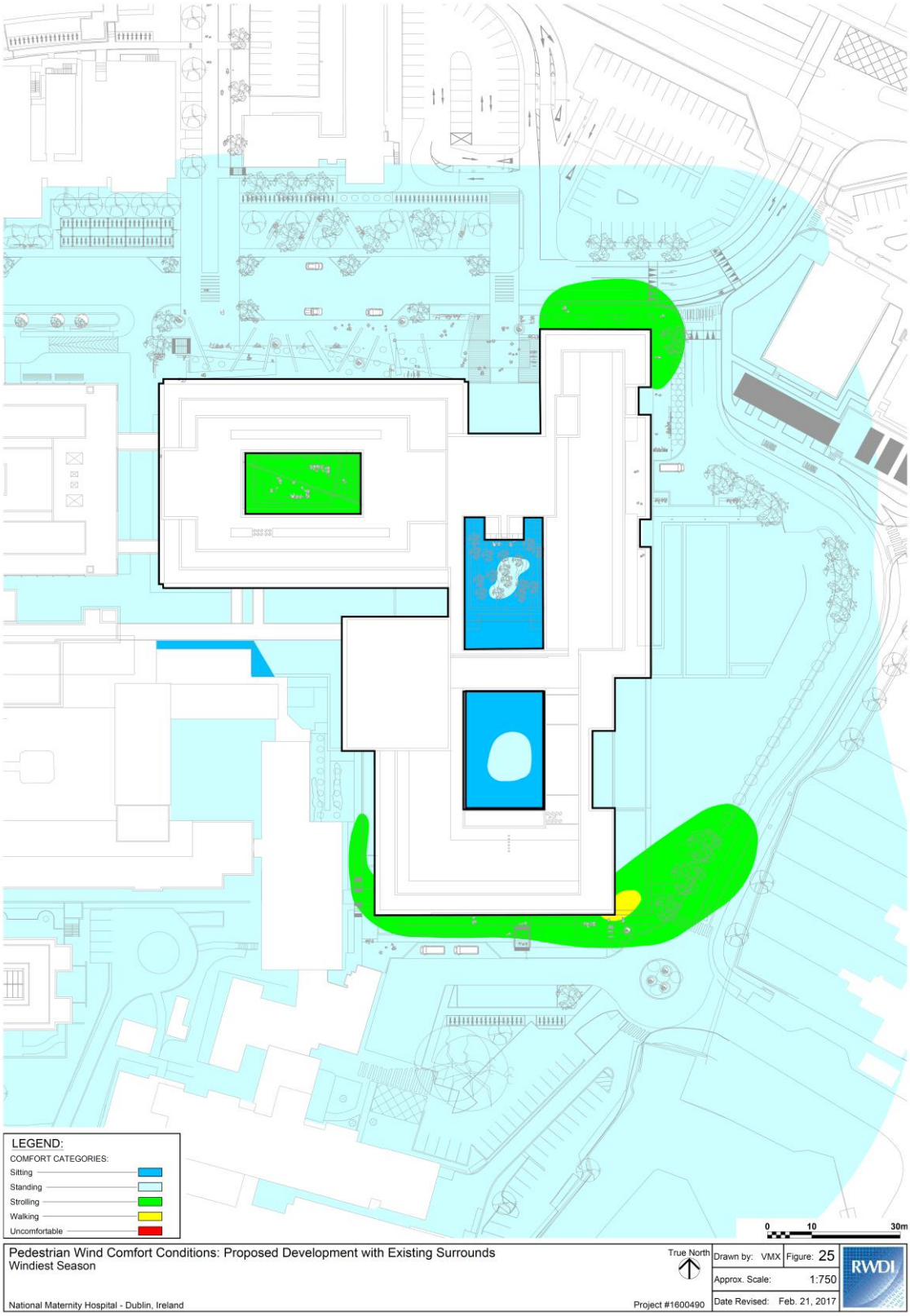


Figure 25 - Configuration 2: RWDI Criteria Assessment - Winter Season

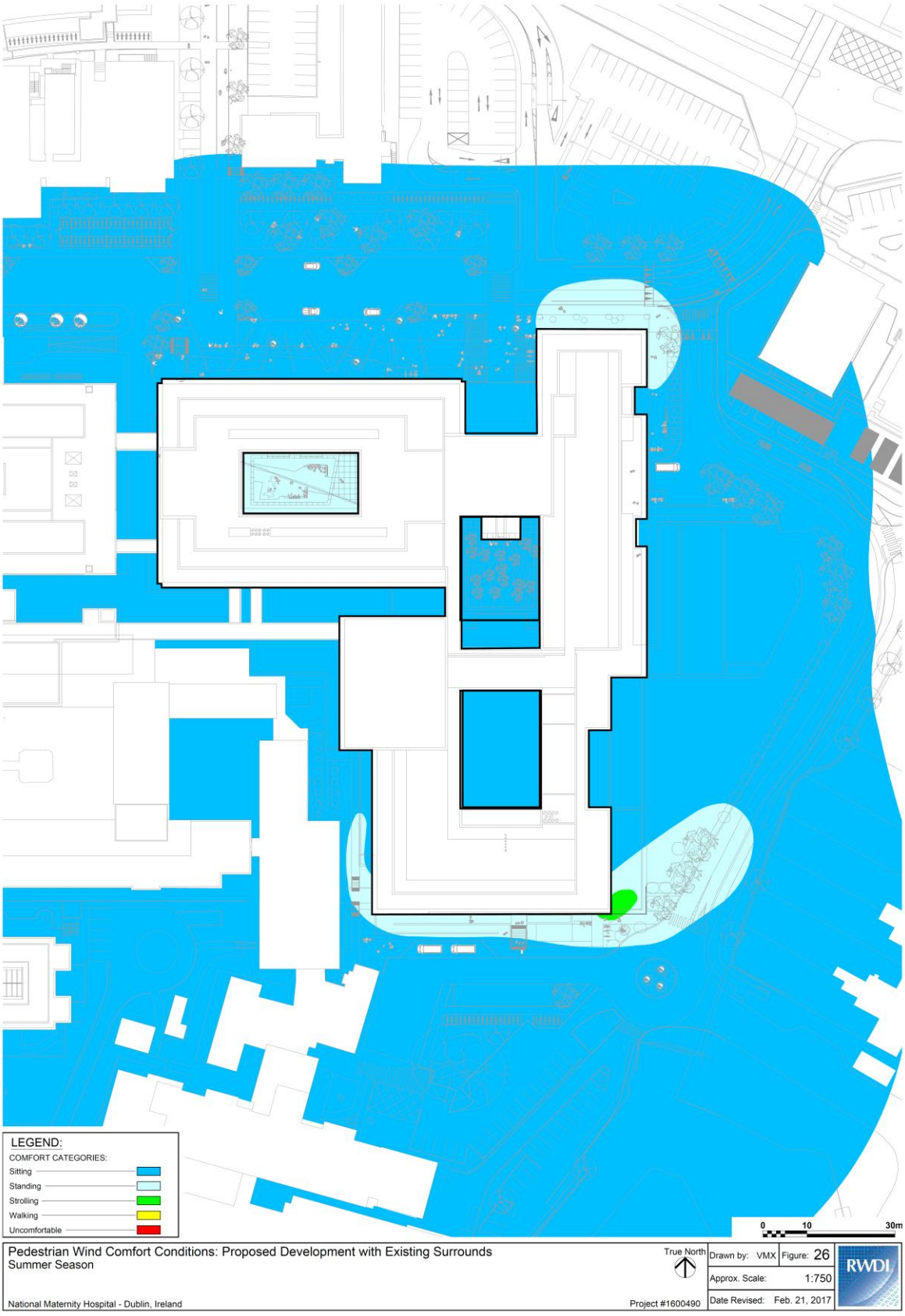
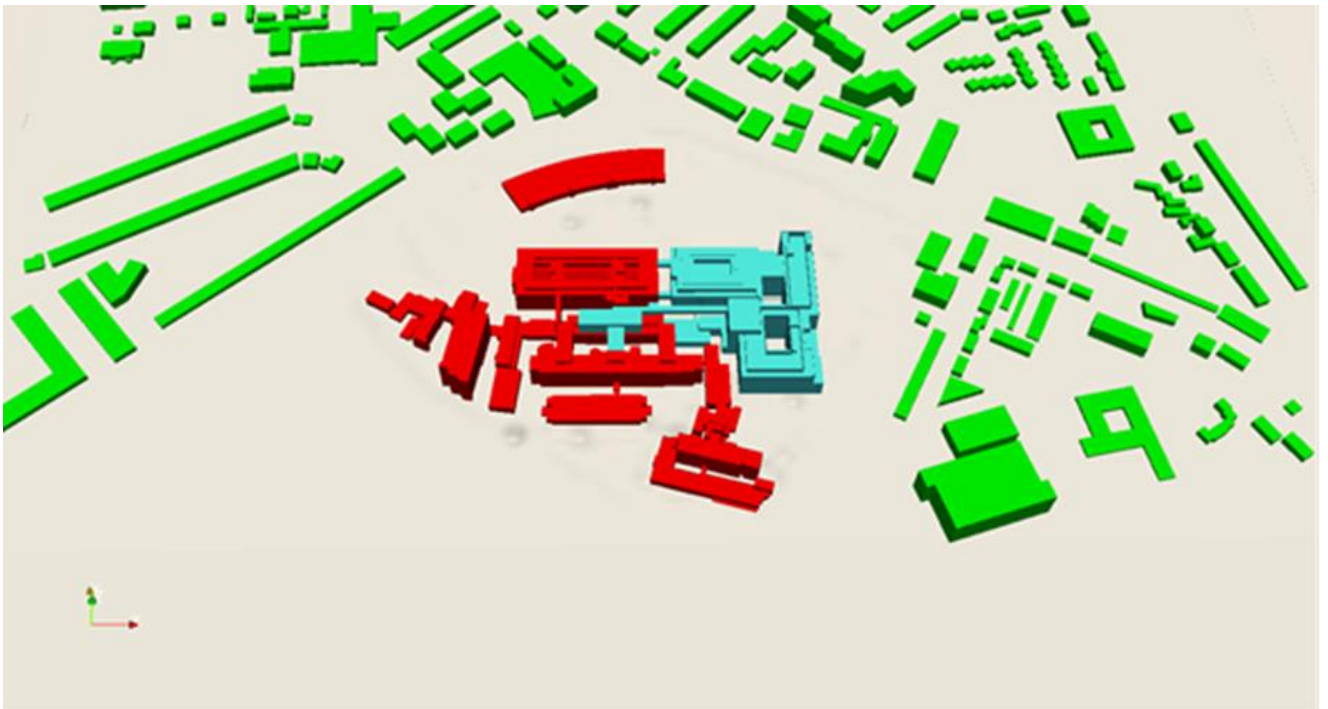


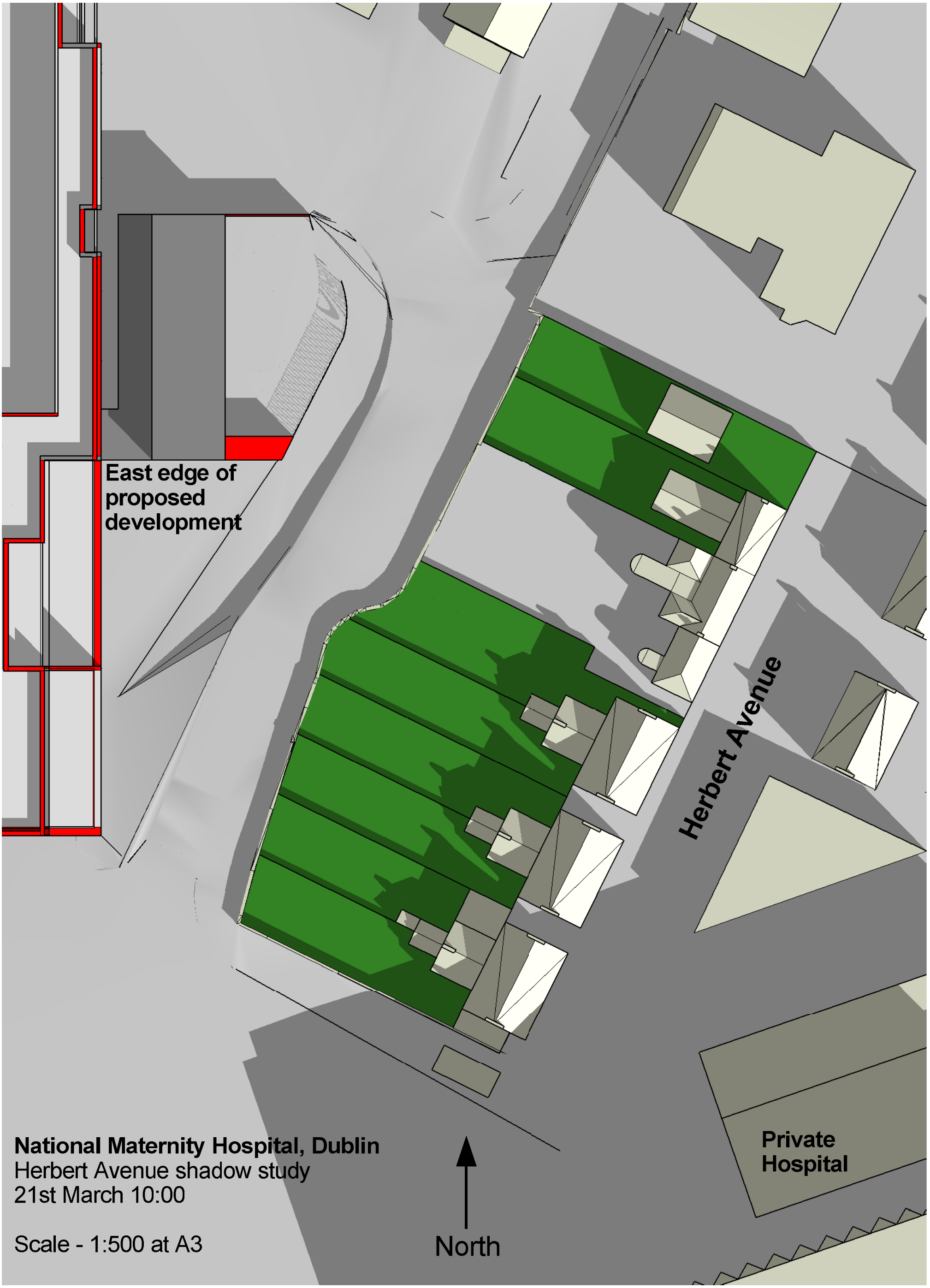
Figure 26 - Configuration 2: RWDI Criteria Assessment - Summer Season

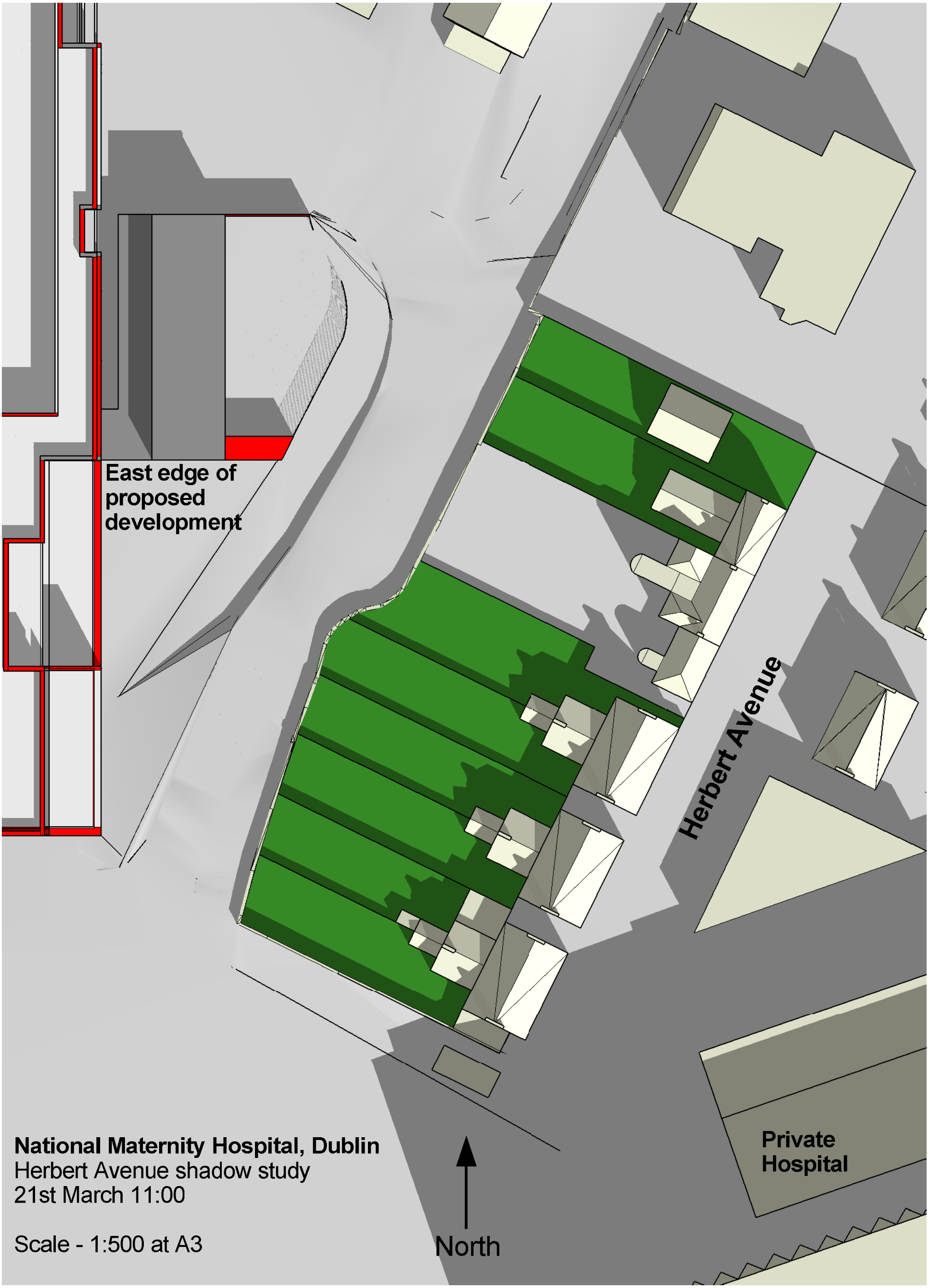
APPENDIX 13.2: IMAGES OF 3-D MODEL



APPENDIX 13.3: SHADOW PLOTS

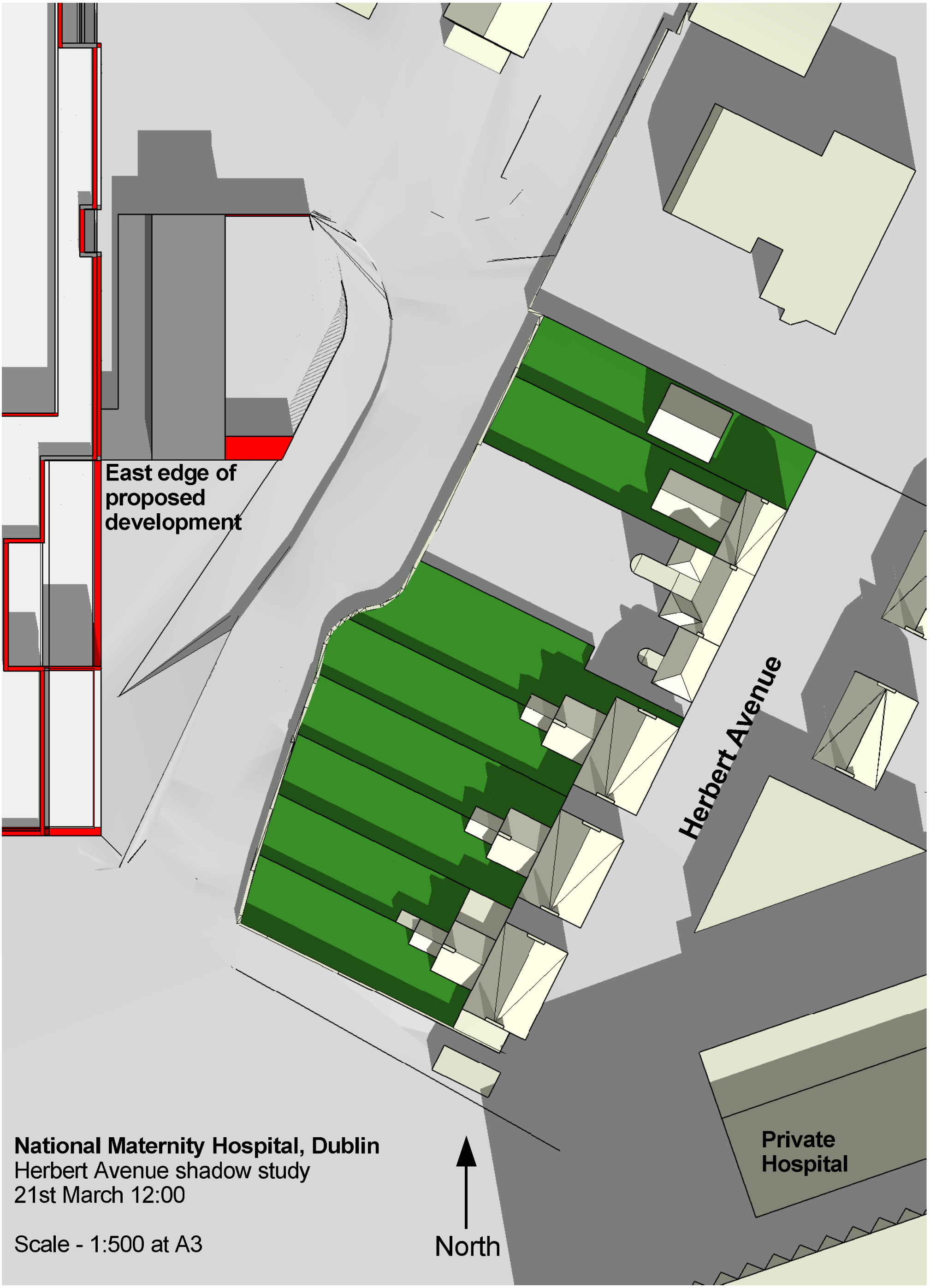

East edge of proposed development
Herbert Avenue
Private Hospital
National Maternity Hospital, Dublin
Herbert Avenue shadow study
21st March 09:00
Scale - 1:500 at A3
North

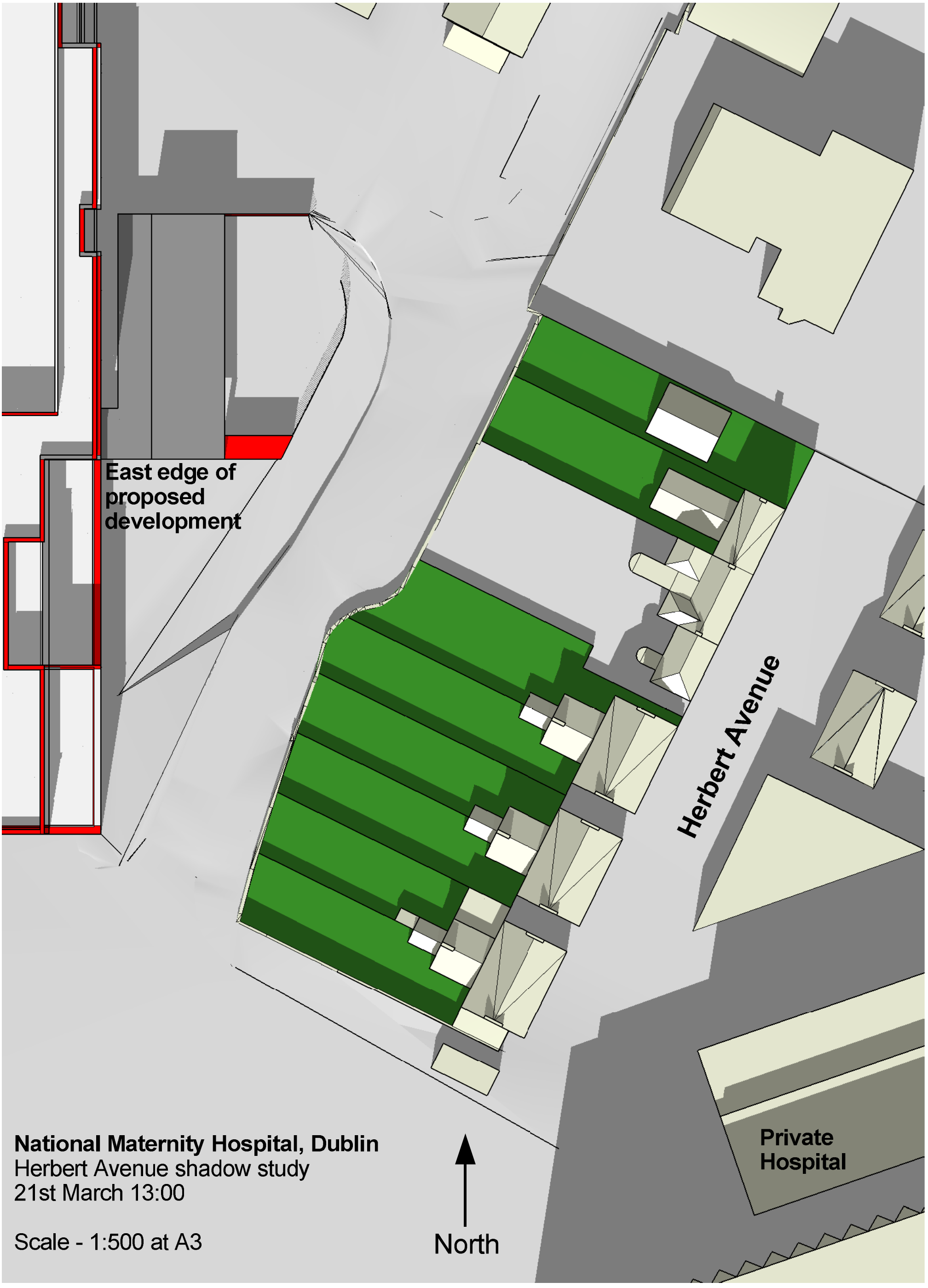

East edge of proposed development
Herbert Avenue
Private Hospital
National Maternity Hospital, Dublin
Herbert Avenue shadow study
21st March 10:00
Scale - 1:500 at A3
North



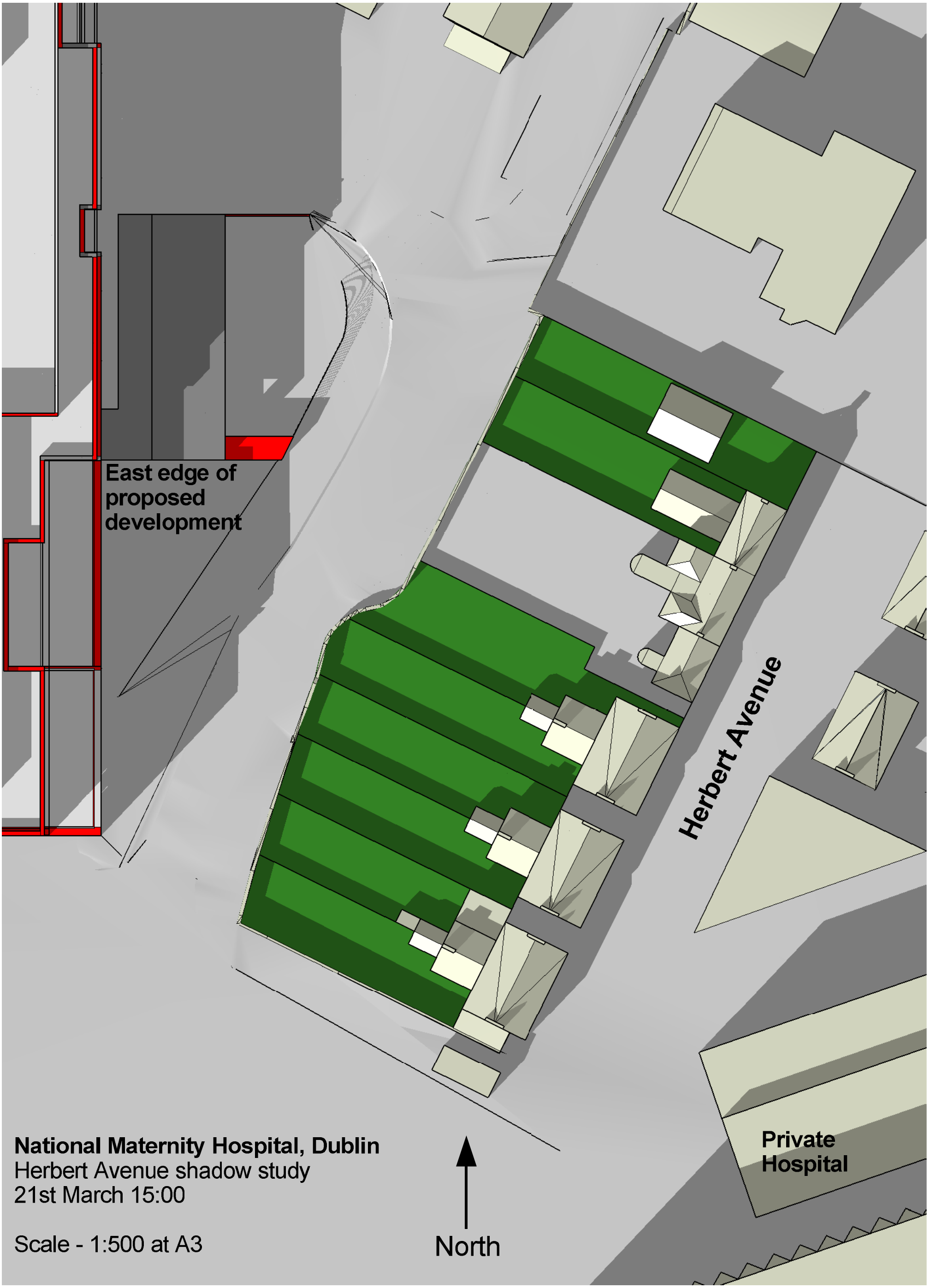
National Maternity Hospital, Dublin
Herbert Avenue shadow study
21st March 11:00

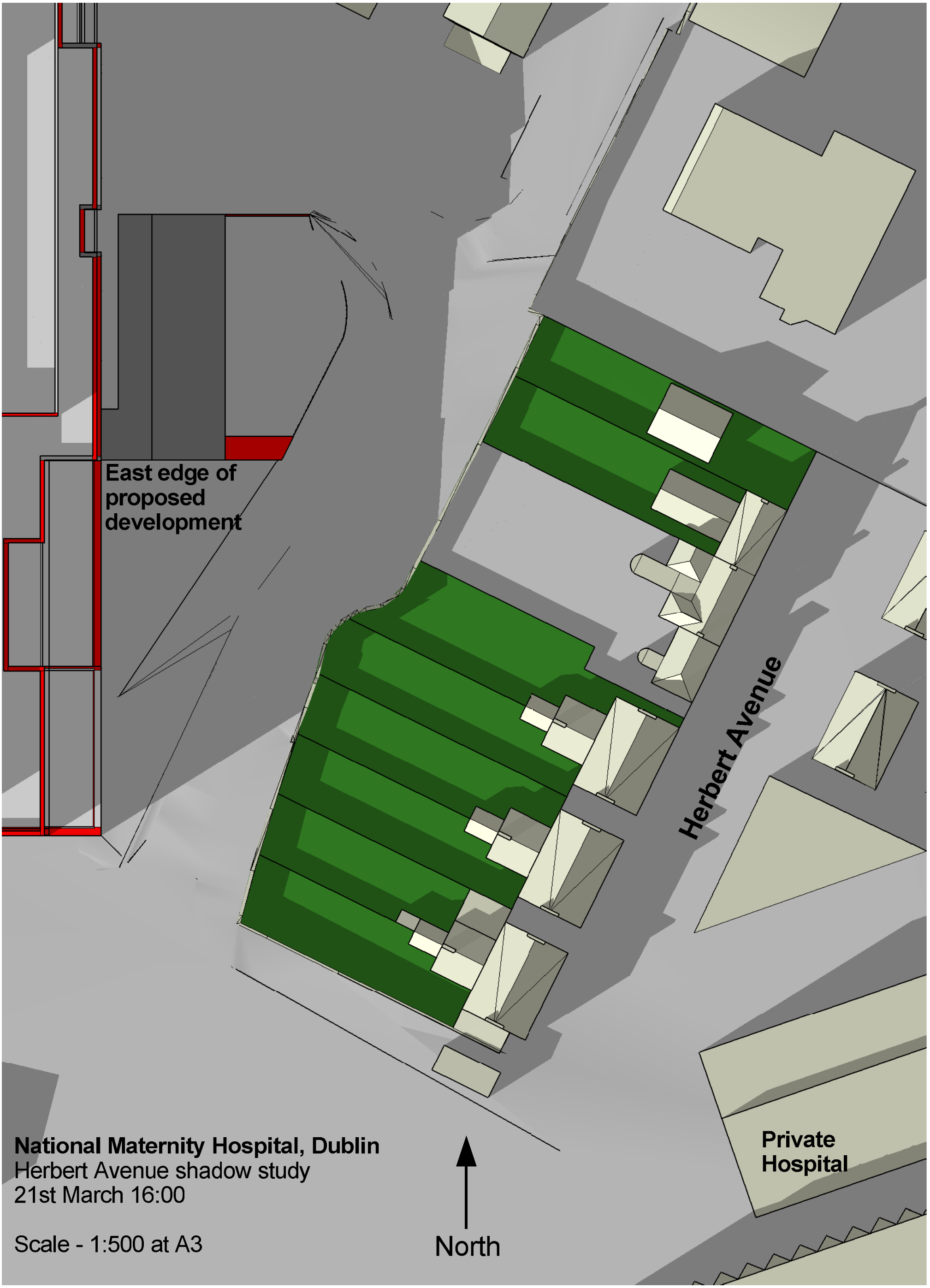
Scale - 1:500 at A3


East edge of proposed development
Herbert Avenue
Private Hospital
National Maternity Hospital, Dublin
Herbert Avenue shadow study
21st March 12:00
Scale - 1:500 at A3
North


East edge of proposed development
Herbert Avenue
Private Hospital
National Maternity Hospital, Dublin
Herbert Avenue shadow study
21st March 13:00
Scale - 1:500 at A3
North

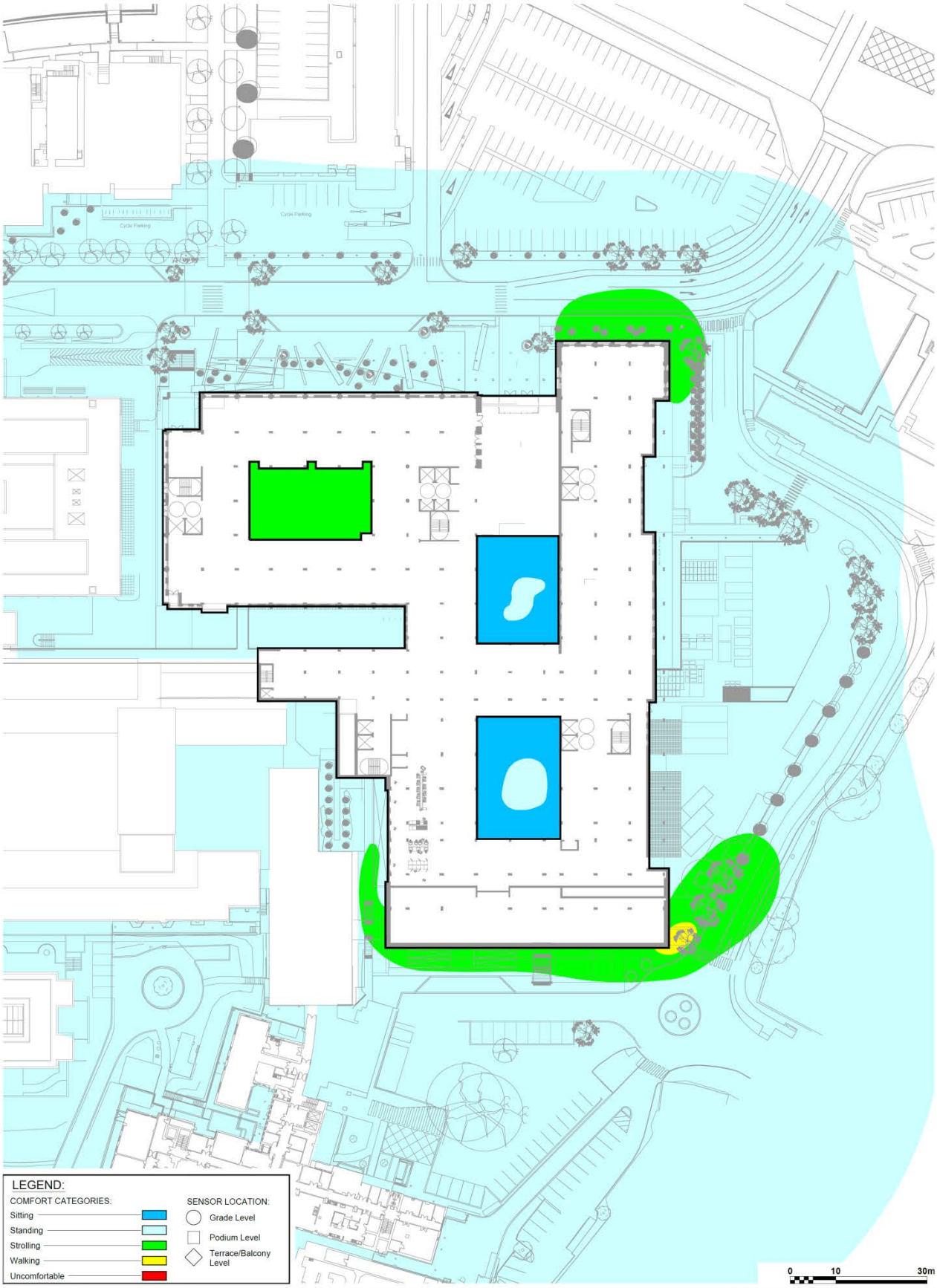

East edge of proposed development
Herbert Avenue
Private Hospital
National Maternity Hospital, Dublin
Herbert Avenue shadow study
21st March 14:00
Scale - 1:500 at A3
North


East edge of
proposed
development
Herbert Avenue
Private
Hospital
National Maternity Hospital, Dublin
Herbert Avenue shadow study
21st March 15:00
Scale - 1:500 at A3
North


East edge of proposed development
Herbert Avenue
Private Hospital
National Maternity Hospital, Dublin
Herbert Avenue shadow study
21st March 16:00
Scale - 1:500 at A3
North


East edge of
proposed
development
Herbert Avenue
Private
Hospital
National Maternity Hospital, Dublin
Herbert Avenue shadow study
21st March 17:00
Scale - 1:500 at A3
North

APPENDIX 13.4: PEDESTRIAN WIND COMFORT CONDITIONS: WINDIEST SEASON



Pedestrian Wind Comfort Conditions: Proposed Development with Existing Surrounds
Windiest Season

National Maternity Hospital - Dublin, Ireland

Project #1600490

True North

Drawn by:	ME	Figure:	25
Approx. Scale:			1:750
Date Revised:			Dec. 02, 2015

RWDI

APPENDIX 13.5: PEDESTRIAN WIND COMFORT CONDITIONS: SUMMER SEASON

Pedestrian Wind Comfort Conditions: Proposed Development with Existing Surrounds
Summer Season

National Maternity Hospital - Dublin, Ireland

Project #1600490

True North

Drawn by:	ME	Figure:	26
Approx. Scale:			1:750
Date Revised:	Dec. 02, 2015		

RWDI