Revised Appendix B

Wind Tunnel Analysis

BUROHAPPOLD ENGINEERING

Memorandum

To	Bryan Leroy, Nixon Peabody LLP	Date	Wednesday, August 29, 2018
From	Ron Elad (BH), Bernardo Vazquez (BH)	Job no	036123
Copied to	Julian Parsley (BH), file		
Subject	LACMA wind desktop assessment effects		

1.0 Introduction

The purpose of this memo is to compare the wind effects of the proposed Museum Building to the existing conditions over the public walkways along Wilshire Boulevard and surroundings. A desktop assessment has been carried out as a screening to determine the potential change in pedestrian comfort conditions on site. The pedestrian comfort is assessed following the recommendations given as part of the Lawson Criteria, a well-known, recognized and international pedestrian comfort criteria. The latest design proposal as per June 2018 has been studied. This study overrides previous version of this Memorandum.

2.0 Executive Summary

- Wind frequencies and directions for the last 20 years from Los Angeles International Airport were acquired and assessed. The wind data from the airport, which is in relatively close proximity for the purpose of this study, is considered to be representative of conditions on site, and has been used for the current wind desktop assessment.
- The prevailing wind is from the southwest and west for most of the year. The highest wind speeds occur during the spring.
- Preliminary assessment of the existing design suggests that the height of the 5900 Wilshire building to the south of the site is likely to influence conditions on site. The shape and massing of the 5900 Wilshire building is likely to create façade downwash, which creates wind acceleration at ground level along Wilshire Boulevard and along the south façade of the existing LACMA buildings, resulting in discomfort for pedestrians, under baseline conditions.
- The proposed Museum Building is also likely to be affected by the wind acceleration created by the 5900 Wilshire building. The proposed Museum Building façade is, partially, farther away from Wilshire Boulevard and is predominantly 60 feet in height, which presents a lower resistance to the wind acceleration caused by the existing 5900 Wilshire building. However, the proposed structure above Wilshire Boulevard could cause additional wind acceleration under the building.
- In comparing the existing site with that of the proposed Museum Building, wind conditions can be expected to improve slightly when compared with the existing situation, as more wind is likely to skim over and under the proposed Museum Building.

- Including the additional wind acceleration through the underpass, total wind speeds are likely up to 6 to 10 m/s (13.5 to 22.5 mph), which will occasionally result in some pedestrian discomfort but tolerable for pedestrian walking.

If detailed measurement of wind acceleration is desired, physical wind tunnel tests and/or CFD simulations can be conducted at later stages of development.

3.0 Comfort Criteria

Areas within and around the proposed Museum Building have been assessed for comfort and safety. In this memo, qualitative advice is given regarding comfort at the ground level and outdoor open areas based on previous project experiences of the consultant wind engineers at BuroHappold. Although the assessment is qualitative in essence, the Lawson criteria – a known quantitative comfort criteria used in the UK and internationally – will be referenced.

3.1 The Limits of Comfort: Strong Wind Conditions

The method developed by T.V. Lawson from Bristol University has been used in this study as a reference to assess comfort. This method has been widely accepted and is comparable with international guidance. The pedestrian comfort criteria have been developed around the Beaufort scale, extending its applicability to environments in and around buildings. The comfort and safety scales are shown in Tables 1 and 2, respectively, with additional information in the figure below.

Table 1, Comfort Scale

Wind Speed Class	Mean Wind Velocity Range	Beaufort scale equivalent	Tolerable Activities
A	0-4 m/s (0-9 mph)	Light breeze	Pedestrian sitting for a long time, wind velocity in the vicinity of entrance doors
B	4-6 m/s (9-13.5 mph)	Gentle Breeze	Pedestrian standing or sitting for a short time
C	6-8 m/s (13.5-18 mph)	Moderate breeze	Pedestrian walking e.g. strolling and sightseeing
D	8-12 m/s (18-27 mph)	Fresh breeze	Fast pedestrian walking e.g. walking to a destination and cycling

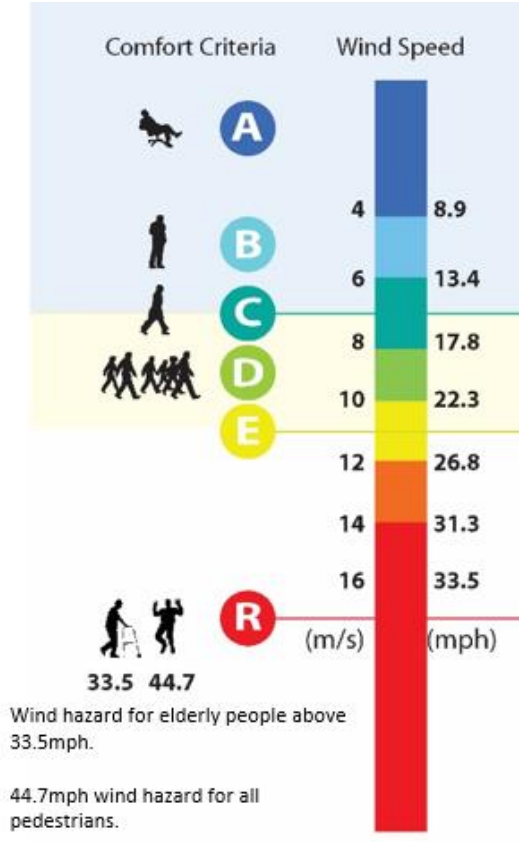


Table 2, Safety Scale

Wind Speed Class	Mean Wind Velocity	Tolerable Activities
Distress	15 m/s (34 mph) and above	Indicates wind capable of causing injuries to elderly or frail individual. Not to be exceed once per year

Explanation:

Comfort will strongly depend on the individual activity. The comfort categories are based on the calculation of the mean and gust wind speeds exceeded 5% of the time. The safety factor is based on occasional wind speeds exceeding 15 m/s approximately once a year.

This study focuses on the following identified areas and conditions:

- people around the base of the 5900 Wilshire building
- walking areas along Wilshire Boulevard
- walking areas around the existing LACMA buildings and proposed Museum Building.

The activities within these zones can be related to the descriptions within Tables 1 and 2.

Wind speed in classes A to D are not likely to result in significant discomfort for the activities above. However, any wind velocity above class D may require mitigation. In that case, the design team should look to shield occupants from high speed winds, which would cause discomfort.

4.0 Wind climate analysis

The assessment is based on 20-year averaged wind data collected at the Met Office weather station in Los Angeles International Airport (1996-2015), which is expected to be a suitable approximation of the prevailing wind conditions at the site. The prevailing wind at the site is from the southwest (29% average occurrence) with some secondary wind contributions from the west (19% average occurrence). Strong western winds were occasionally recorded.

Summer wind pattern: westerly and south-westerly low wind speeds are constant during the summer months with a periodic increase in light westerly wind. Summer winds include speeds below 6 m/s (13.5 mph) for high frequency south-westerly winds.

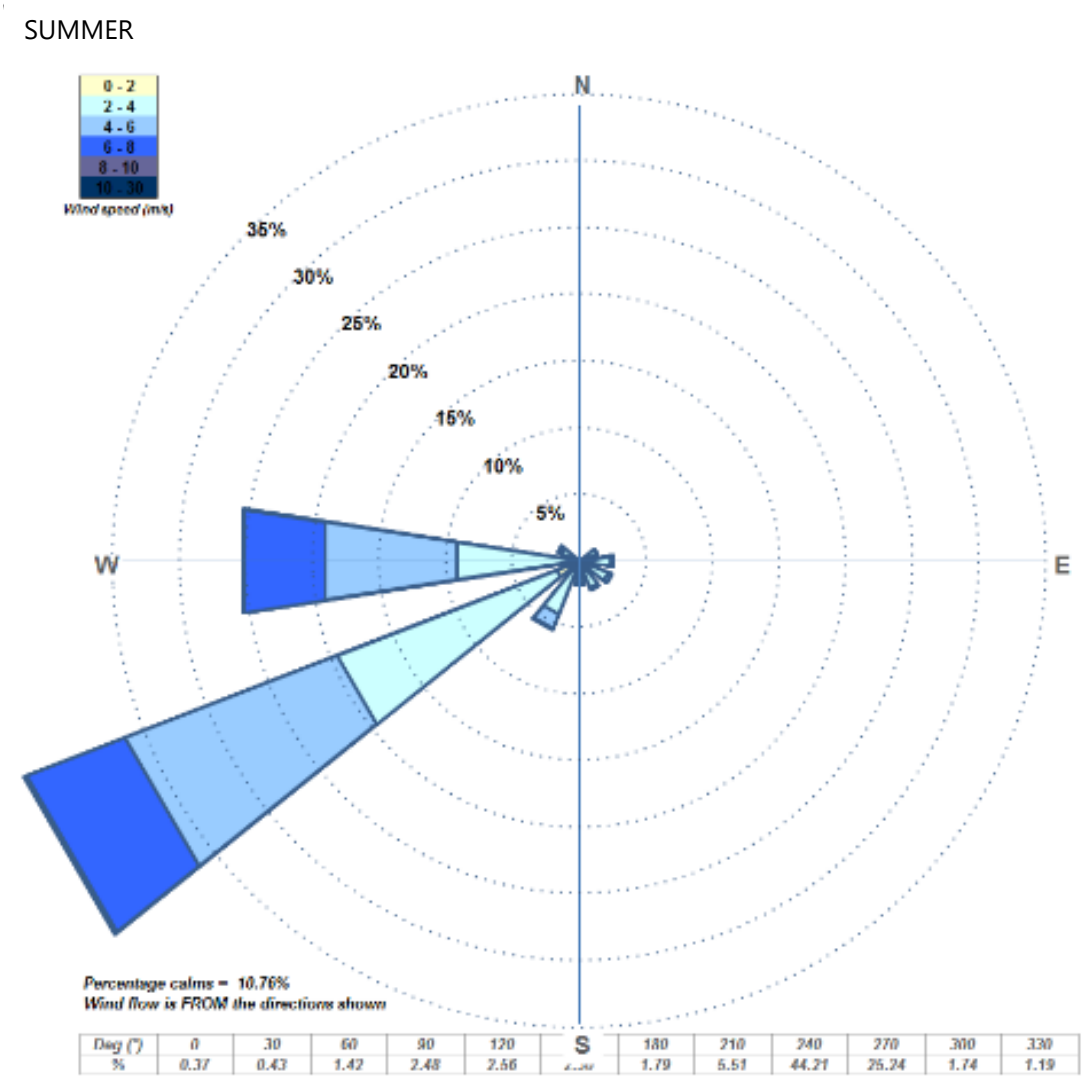


Figure 4-1: Predicted wind rose for Los Angeles International Airport 10m above ground (summer).

Autumn wind pattern: presents the same trend as summer, where prevailing winds come from the southwest and west, with wind speeds below 6 m/s (13.5 mph); with low frequency.

FALL

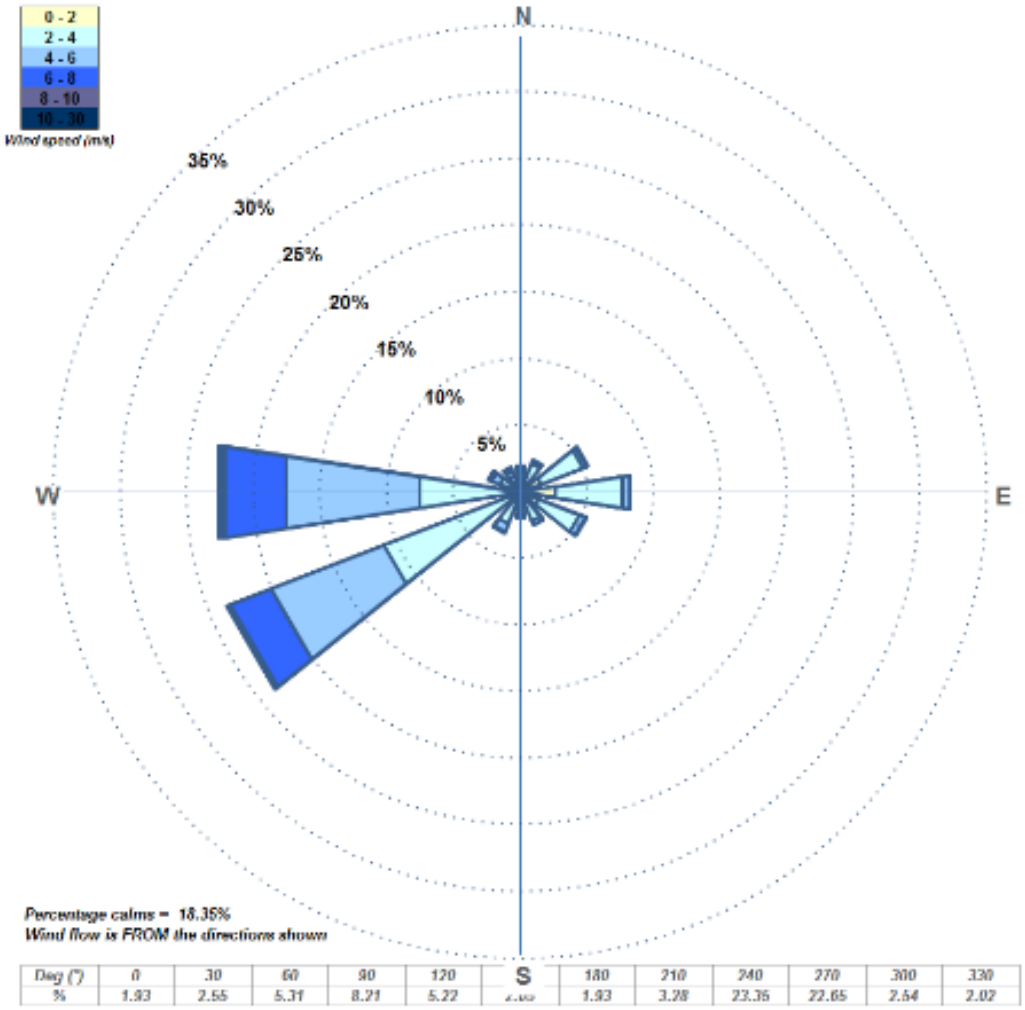


Figure 4-2: Predicted wind rose for Los Angeles International Airport 10m above ground (fall).

Winter wind pattern: winter shows lower average wind speed and low frequency. The wind from the east, which is below 4 m/s (9 mph) and the wind from the west, which is below 6 m/s (13.5 mph) have similar frequencies.

*Santa Ana Winds: these are known to occur during winter for short periods and low frequencies. Typical wind speeds are in the 18 – 25 m/s (40 – 55 mph) and in extremely rare cases, local wind gusts can be as high as 45 m/s (100 mph). These winds speeds will pose a safety hazard to pedestrians in all open areas. A study** carried out to determine historical and design wind speeds in the Los Angeles area notes the study of the Santa Ana Winds. The report states that the areas of wind acceleration affected by the Santa Ana Winds are likely to be located at the mountains and low areas to the North and South of the proposed site. According to the report the Museum site and the Los Angeles Airport are located in an area of similar low speeds (as LAX) and are not likely to be affected by the Santa Ana Winds higher wind speeds.

WINTER

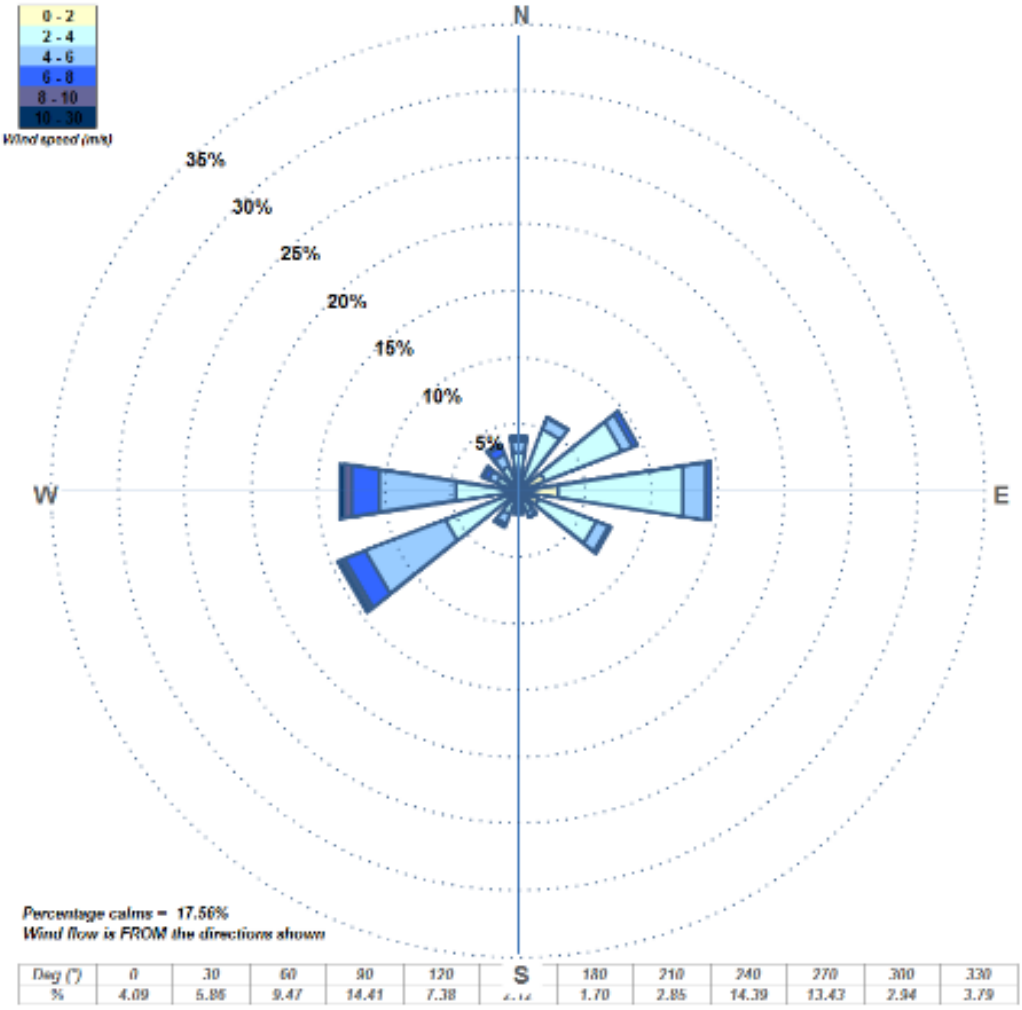


Figure 4-3: Predicted wind rose for Los Angeles International Airport 10m above ground (winter).

** Structural Engineers Association of Southern California, March 10, 2010: Study of Historical and Design Wind Speeds in the Los Angeles Area. By: SEAOSC Ad-Hoc Wind Committee

Spring wind patterns: the higher wind speeds 6 – 8 m/s (13.5-18 mph) are shown to occur during spring with few storms expected to occur in rare occasions (see Figure 4-4).

SPRING

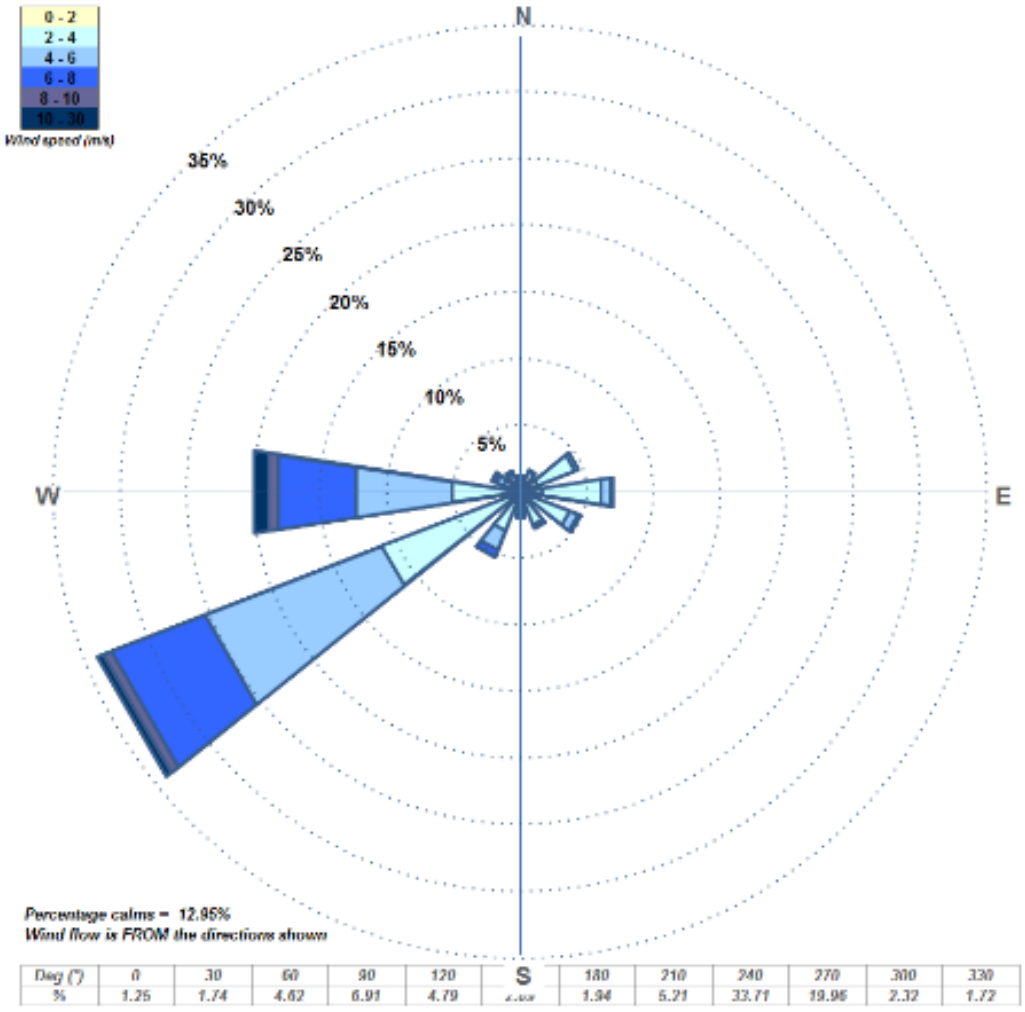


Figure 4-4: Predicted wind rose for Los Angeles International Airport 10m above ground (spring).

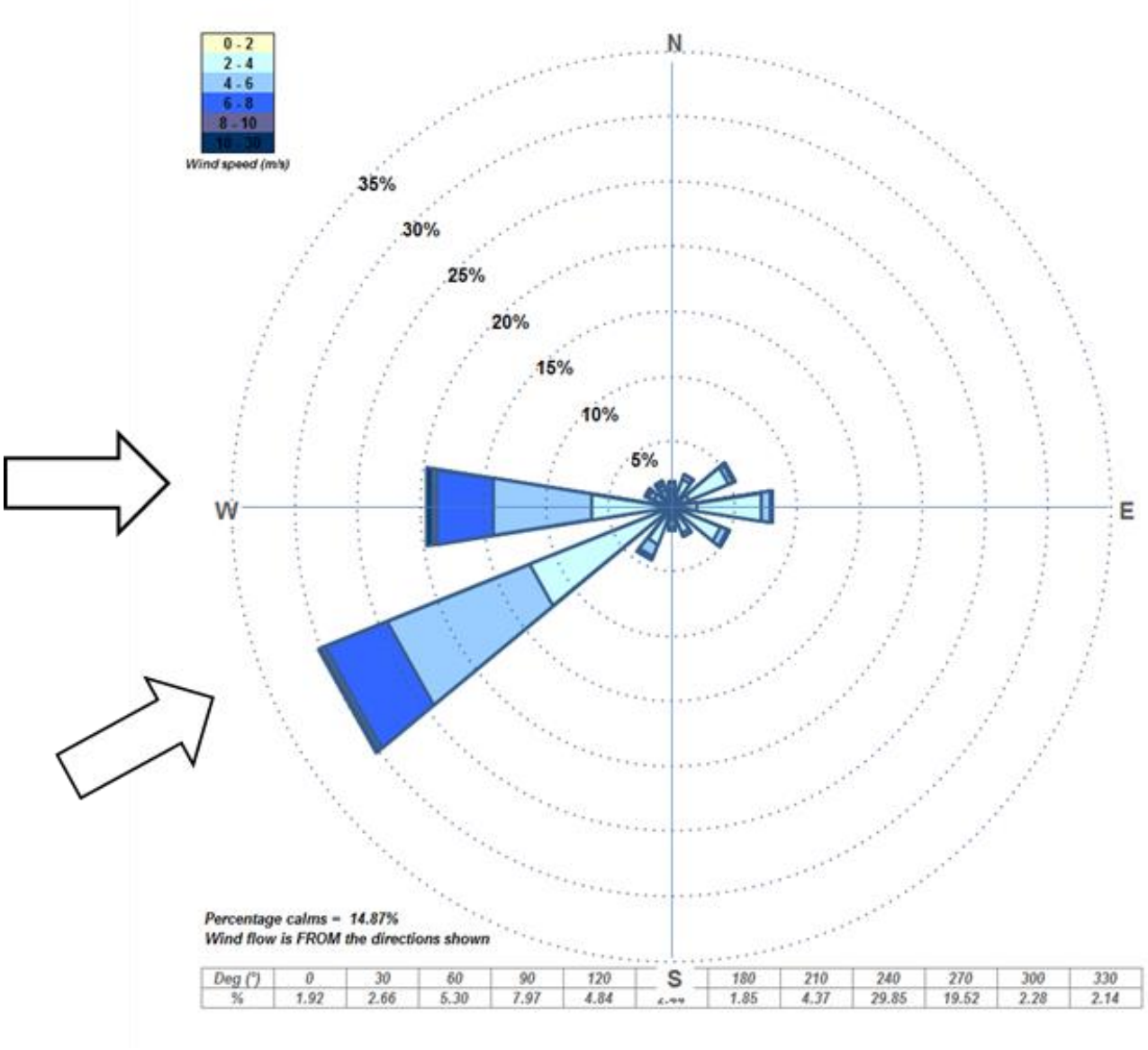


Figure 4-5: Predicted wind rose for Los Angeles International Airport 10m above ground (Annual).

The study did not translate winds from LAX site to the Museum site for the following reasons:

- Differential translation of wind from one site to the other is required when the distance between the site is a larger than 10 miles, or when topographies surrounding the sites are substantially different. For quantitative assessment, the tallest building on site will be use as a reference to calculate wind speed ratios, this will only affect the wind intensity the frequency will remain unchanged.
- The distance between LAX and the Museum site is relatively small (around 8 miles), therefore it is considered to be a good representation of the conditions on site.
- Both sites, LAX and the Museum are situated on flat grounds, therefore LAX wind data is a good representation of site wind conditions
- The actual wind speeds on site will be influenced by local and surrounding topography and building massing on the site.

5.0 Site Location

The site is located 8 miles to the northeast of the Los Angeles International Airport (Figure 5-1). The mountains to the north of the site are likely to influence the southwesterly prevailing winds, increasing the probability of westerly winds on site.

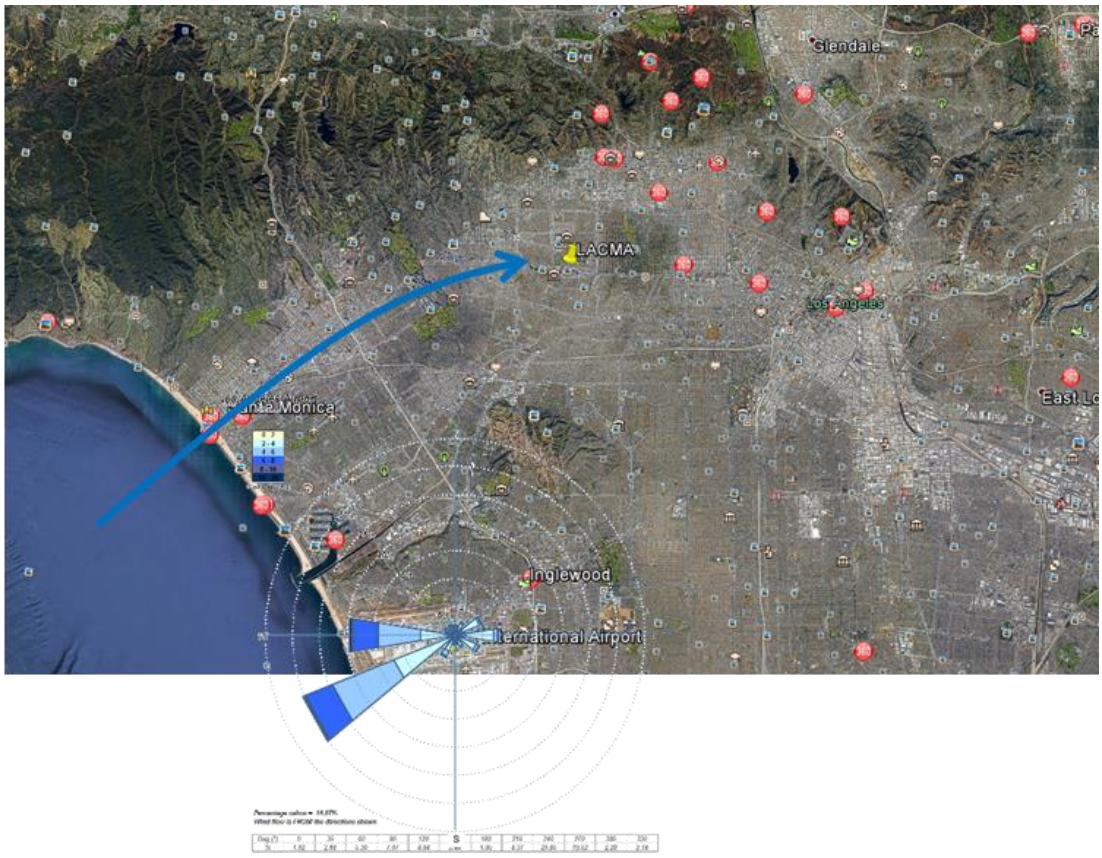
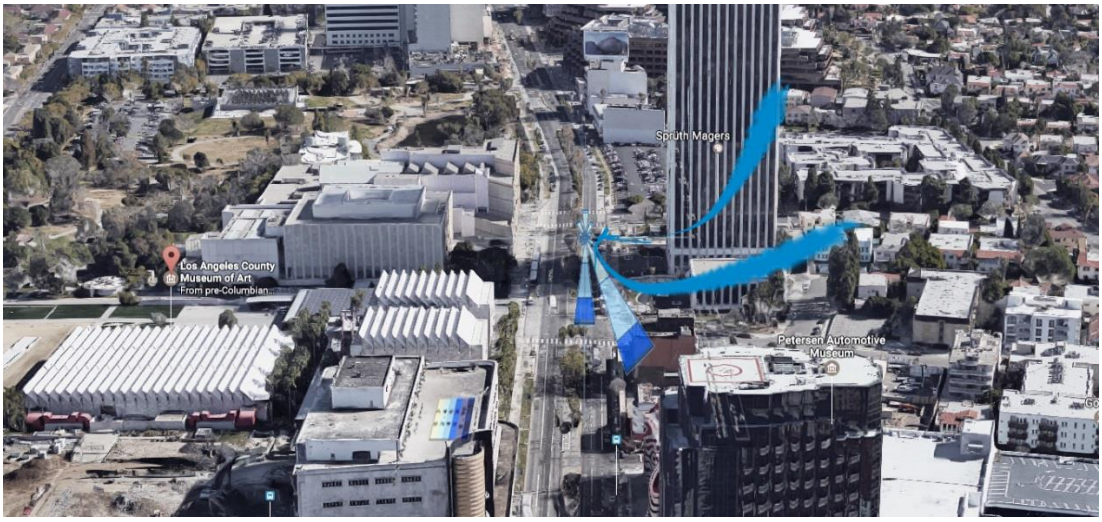


Figure 5-1 Site Location

- The Museum's site is considered flat.
- Buildings within a 1000 ft radius of the new Museum Building are considered for the assessment.
- There are low-height buildings surrounding the Museum's site to the north, east and south.
- The 5900 Wilshire building is tall, with a height of approximately 433 ft, and is located to the south and west of the site.
- Further west, buildings ranging from 115 to 330 ft height can be found, such as the rest of the LACMA site, the Petersen Museum, and the taller City National Bank (see Figure 5-2).
- The SAG-AFTRA building complex and residential buildings are located further to the east, with heights of 8 to 10 floors.

Figure 5-2 Site Buildings

6.0 Building Massing Analysis



6.1 The Current Baseline

The 5900 Wilshire building to the south and west of the site is likely to influence conditions on site due to its height and proximity to the site.

Western Wind Effects:

Winds from the west (see Figure 6-1) are likely to downwash toward the base of the 5900 Wilshire building and accelerate along Wilshire Boulevard. The downwash is also likely to create wind acceleration along the existing south façade of the LACMA buildings as it moves across and along Wilshire Boulevard. Wind speeds are likely to be between 6 to 10 m/s (13.5 to 22.5 mph), which will result in occasional pedestrian discomfort. The current landscape, which consists of some larger trees along Wilshire, will only be effective close to the 5900 Wilshire building; the tree canopies will capture some of the wind down washing and moving around the 5900 Wilshire building.

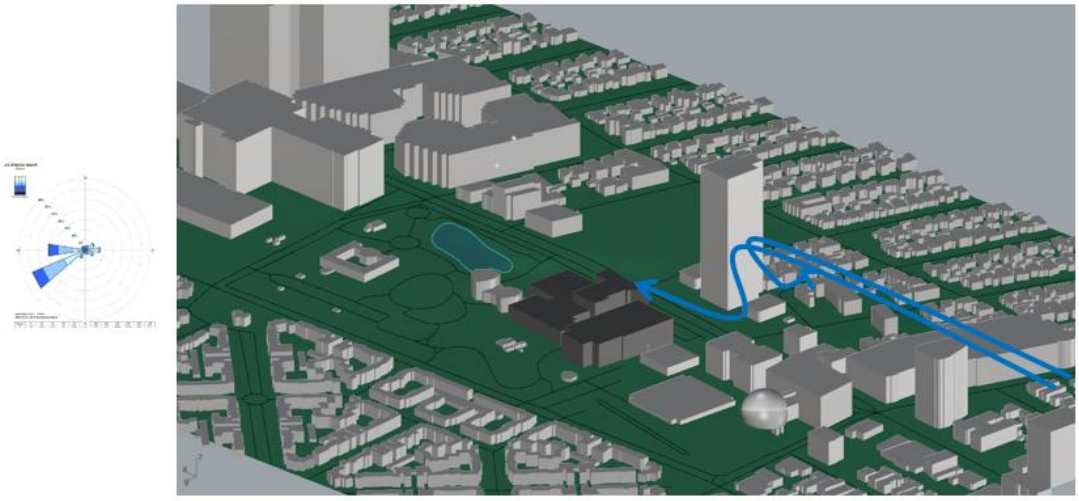


Figure 6-1: Existing site westerly wind effects

South-Western Wind Effects:

Wind from the southwest will approach the 5900 Wilshire building at an angle and this is likely to help reduce façade downwash; however, some wind acceleration is expected to occur at Wilshire Boulevard and along the south façade of the exiting LACMA buildings, as observed under westerly winds (see Figure 6-2 below).

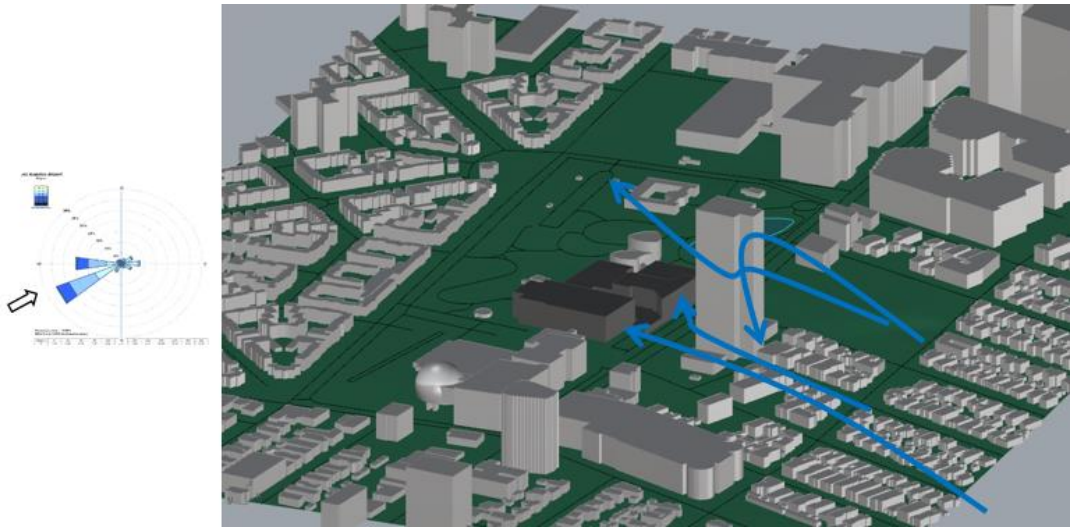


Figure 6-2: Existing site south-westerly wind effects

Easterly Winds Effects:

Winds from the East are likely to travel along Wilshire Boulevard where the existing LACMA buildings are likely to produce some wind acceleration due to façade downwash as shown in Figure 6-3. As indicated in section 4.0, the proposed Museum Building is located in an area of low wind speeds when Santa Ana Wind events occur (Fall and Winter), and wind speeds on site are likely to be between 0-4 m/s (0-9 mph) to 4-6 m/s (9-13.5 mph), which is suitable for most activities. The 5900 Wilshire building is downstream, and its effect under Easterly wind is negligible.

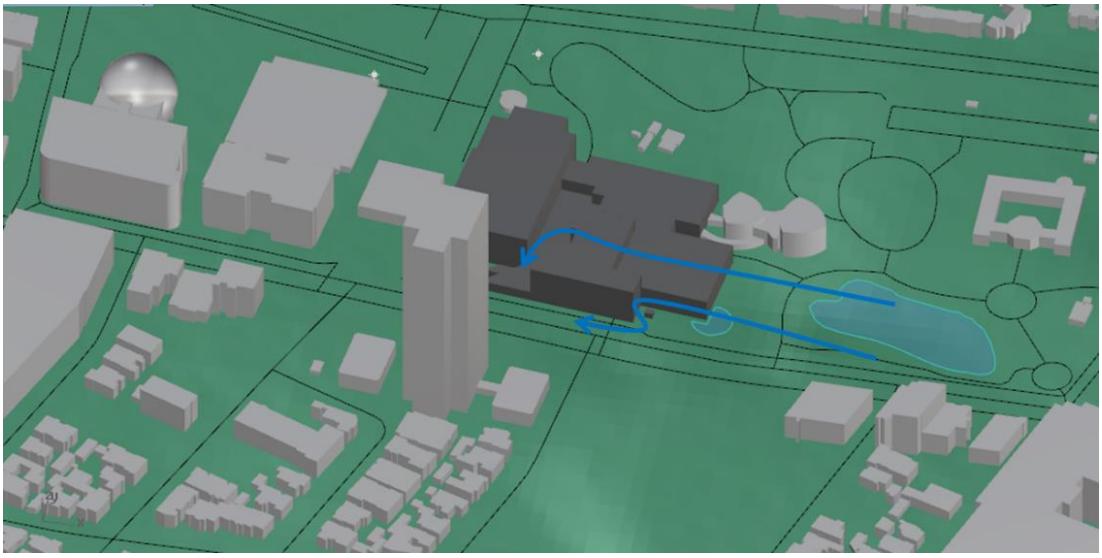


Figure 6-3: Existing site easterly wind effects

6.2 The Proposed Development

Western Winds Effects:

Winds from the west (see Figure 6-4) are likely to downwash toward the base of the 5900 Wilshire building and accelerate across and along Wilshire Boulevard. The relative low height of the proposed Museum Building is likely to help in reducing wind speeds along Wilshire Boulevard, as more wind is likely to skim over the proposed Museum Building. However, some wind acceleration is likely to occur under the proposed Museum Building, as wind will be funneled through the underpass. Wind speeds through the underpass are likely to be between 6 to 10 m/s (13.5 to 22.5 mph), which will result in occasional pedestrian discomfort. These wind speeds will be suitable for most activities and even during high wind events, the site conditions will be suitable for pedestrian walking and fast walking activities.

The degree of wind acceleration in the new conditions will be equivalent to the existing situation. Explanation: The existing LACMA buildings (186 feet in height) is much taller than the proposed Museum Building, and the proposed building (60 feet in height) presents a much more open ground condition. In the existing condition, the wind will accelerate along the taller façade and will be felt strongly along Wilshire. As for the proposed Museum Building, the wind will have less façade acceleration but will have some acceleration in the underpass. It is anticipated that average pedestrian comfort will be similar when comparing both cases.

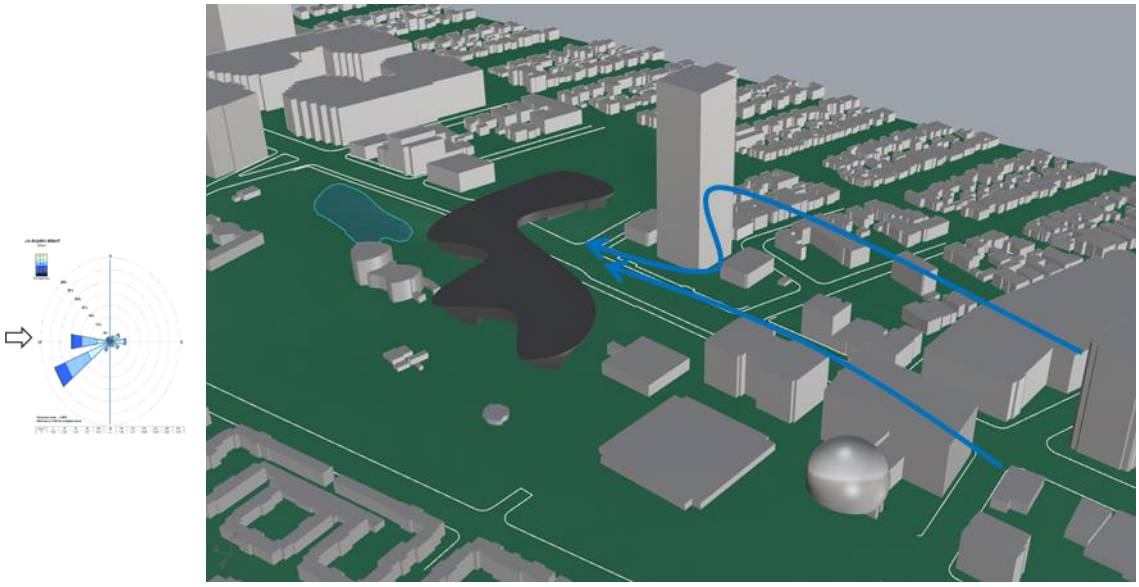


Figure 6-4: Proposed Museum Building's westerly wind effects.

Southwestern Winds Effects:

As shown for the existing baseline, wind from the southwest will approach the 5900 Wilshire building at an angle, reducing façade downwash. Wind acceleration will be experienced along Wilshire Boulevard and under the proposed Museum Building. Due to the height of the proposed Museum Building, wind is likely to skim over, helping to reduce wind speeds when compared with the existing baseline (see Figure 6-5 below). When compared with the existing situation, the degree of wind acceleration will be reduced and wind speeds are likely to be between 4-6 m/s (9-13.5 mph) to 6-8 m/s (13.5-18 mph), which is suitable for most activities.

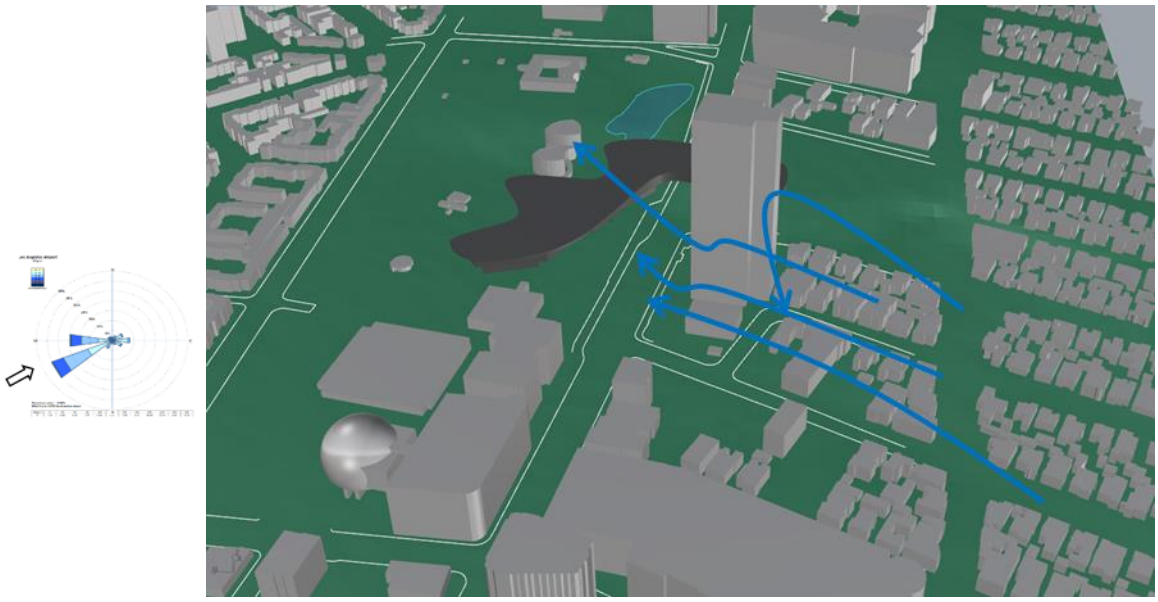


Figure 6-5: Proposed Museum Building's south-westerly wind effects.

Easterly Winds Effects:

The proposed Museum Building design is likely to produce some funneling under Easterly wind. However, the low profile of the building will help reduce this effect. As indicated in section 4.0, the proposed Museum Building is located in an area of low wind speeds when Santa Ana Wind events occur (Fall and Winter), and wind speeds on site are likely to be between 0-4 m/s (0-9 mph) to 4-6 m/s (9-13.5 mph), which is suitable for most activities. The 5900 Wilshire building is downstream and its effect under Easterly wind is negligible.

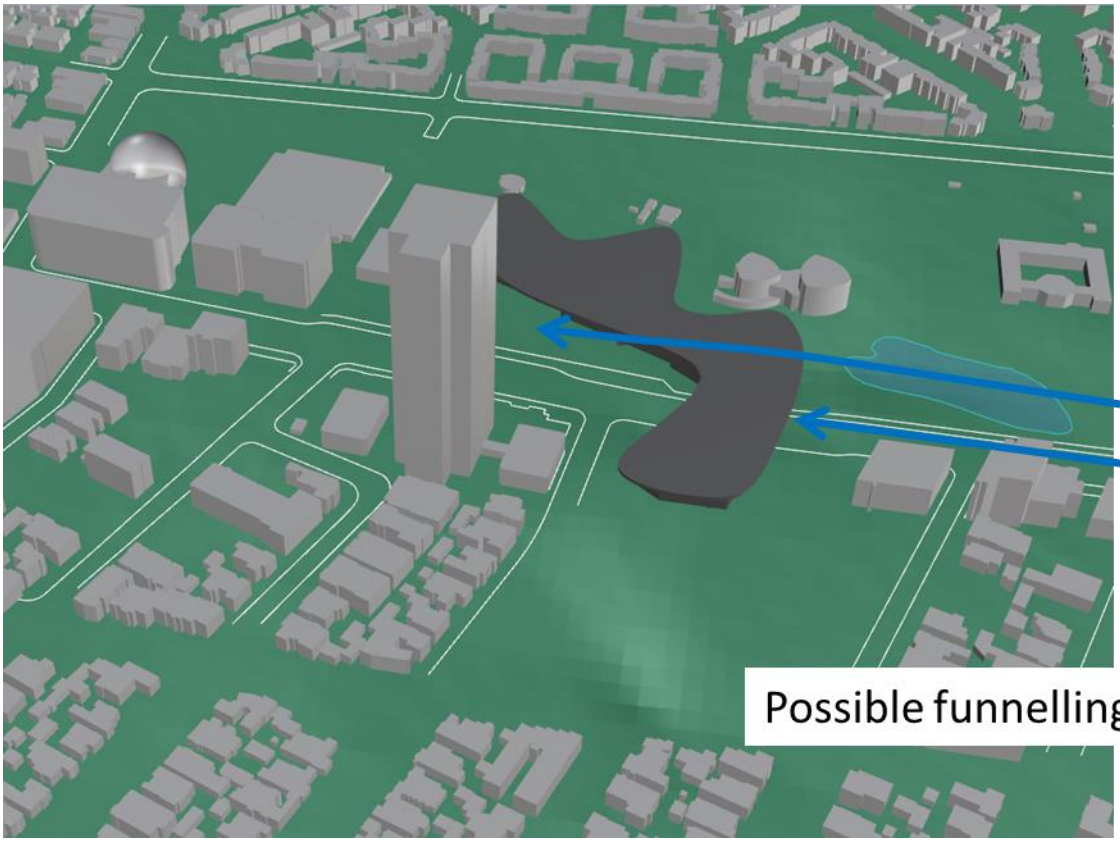


Figure 6-6: Proposed Museum Building's easterly wind effects.

7.0 Conclusions

Preliminary assessment of the existing LACMA site suggests that the height of the 5900 Wilshire building to the south of the site likely influences conditions on site. The shape and massing of the tall 5900 Wilshire building likely creates façade downwash that is expected to create wind acceleration at ground level across and along Wilshire Boulevard and along the south façade of the existing LACMA buildings, resulting in current discomfort for pedestrians.

The proposed Museum Building will also be affected by the wind acceleration created by the tall 5900 Wilshire building. The proposed façade is further away from Wilshire Boulevard than the existing LACMA buildings, and is not as tall, which will allow for more wind to pass over the building and result in lower wind acceleration. However, the proposed Museum Building includes an underpass section over Wilshire Boulevard and in between Pavilions, where wind could accelerate.

In comparing the existing site with that of the proposed Museum Building, wind conditions can be expected to improve slightly, as more wind is likely to skim over the Museum Building.

The proposed Museum Building is likely to produce equivalent wind acceleration to that of the existing under westerly wind. Under south-westerly wind the proposed Museum Building is likely to improve conditions on site when compared with the existing situation.