600 Southgate Drive
Guelph ON Canada
N1G 4P6
Tel: +1.519.823.1311

MEMORANDUM

DATE:	2023-09-20	**RWDI Reference No.:** 2201458
TO:	Darren Nielsen - HNTB	**EMAIL:** DNielsen@hntb.com
CC:	Paul Griesemer - HNTB	**EMAIL:** PGriesemer@hntb.com
FROM:	Tim Wiechers - RWDI Jason Munn - RWDI	**EMAIL:** Tim.Wiechers@rwdi.com Jason.Munn@rwdi.com
RE:	**Representative Pedestrian Wind Comfort around Proposed Site Northwestern University Ryan Field (NURF) Redevelopment Evanston, IL**	

Dear Darren,

RWDI has been retained in the capacity of wind engineering consultant for the proposed Northwestern University Ryan Field (NURF) Project. RWDI's engagement has involved the study of various wind interactions with the stadium structure. Specifically, RWDI has evaluated generalized wind flow patterns as it pertains to *Pedestrian Wind Comfort* within and closely adjacent to the proposed stadium. RWDI understands that at the current juncture an interest has been raised with respect to wind analysis around public sidewalks and ground level areas surrounding the stadium.

For the purposes of this memorandum and the intent herein, RWDI has presented select imagery from the computational fluid dynamics analysis to illustrate comparative conditions between the existing site conditions and potential future conditions given representative stadium massing.

1. Objective

The objective of this assessment is to provide an evaluation of the potential wind conditions in pedestrian areas in the immediately surrounding neighborhood based on the CFD modeling. The assessment is based on the following:

- A review of the regional long-term meteorological data from applicable nearby airport stations;
- A representative 3D model of the proposed Project received in Schematic Design;
- The use of *Orbital Stack*, an in-house proprietary CFD tool;

- RWDI's engineering judgment, experience, and expert knowledge of wind flows around buildings; and,
- The RWDI wind comfort criteria (refer to Section 3, herein).

2. CFD for Wind Simulation

Computational Fluid Dynamics (CFD) is a numerical technique that can be used for simulating wind flows in complex environments. For this analysis, CFD techniques were used to generate a virtual wind tunnel where flows around the site and its surroundings were simulated in full scale. The computational domain that covered the site and its surroundings was divided into millions of small cells where calculations were performed, yielding a prediction of wind conditions across the entire study domain. CFD excels as a tool for wind modeling, presenting early design advice, comparing different design and site scenarios, resolving complex flow physics, and helping diagnose problematic wind conditions. While the computational modeling method used in the current assessment does not explicitly simulate the transient behavior of turbulent wind, its effects were estimated based on other calculated quantities.

CFD simulations were completed for the existing site condition and a representation of the proposed site condition within the context of the existing site surroundings. Landscaping and other smaller architectural and accessory features were not included in the computer model in order to provide more conservative wind conditions (as is the norm for this level of assessment).

The winds approaching the modelled area were simulated for 16 directions (starting at 0°, at 22.5° increments around the compass), accounting for the effects of the atmospheric boundary layer and terrain impacts. Wind data were obtained in the form of ratios of wind speeds at approximately 5 ft above concerned levels, to the mean wind speed at a reference height. The data was then combined with meteorological records obtained from appropriate nearby meteorological stations to determine the wind speeds and frequencies in the simulated areas.

3. RWDI Pedestrian Wind Criteria

The RWDI pedestrian wind criteria, which have been developed by RWDI through research and consulting practice since 1974, are used in the current study. These criteria have been widely accepted by municipal authorities as well as by the building design and city planning community. Regional differences in wind climate and thermal conditions as well as variations in age, health, clothing, etc. can affect a person's perception of the wind climate. Therefore, comparisons of wind speeds for the existing and proposed building configurations are the most objective way in assessing local pedestrian wind conditions. In general, the combined effect of mean and gust speeds on pedestrian comfort can be quantified by a Gust Equivalent Mean (GEM).

Comfort Category	GEM Speed (mph)	Description
Sitting	≤ 6	Calm or light breezes desired for outdoor restaurants and seating areas where one can read a paper without having it blown away
Standing	≤ 8	Gentle breezes suitable for main building entrances, bus stops, and other places where pedestrians may linger
Strolling	≤ 10	Moderate winds that would be appropriate for window shopping and strolling along a downtown street, plaza or park
Walking	≤ 12	Relatively high speeds that can be tolerated if one's objective is to walk, run or cycle without lingering
Uncomfortable	> 12	Strong winds of this magnitude are considered a nuisance for all pedestrian activities, and wind mitigation is typically recommended

Notes:

(1) *GEM Speed = max (Mean Speed, Gust Speed/1.85)* and *Gust Speed = Mean Speed + 3*RMS Speed*;
(2) Wind conditions are considered to be comfortable if the predicted GEM speeds are within the respective thresholds for at least 80% of the time.
(3) The comfort assessment was conducted for two seasonal periods, summer (May to October) and winter (November to April) because in a climate such as that found in Evanston, there are distinct differences in pedestrian outdoor behaviors between these two-time periods.

4. Simulation Results and Discussion

The predicted seasonal wind comfort conditions for the existing site and with the proposed stadium development in place are presented in Images 1 and 2. The results are presented as color contours of wind speeds based on the wind criteria (Section 3). The contours represent wind speeds at a horizontal plane approximately 5 ft above the concerned level.

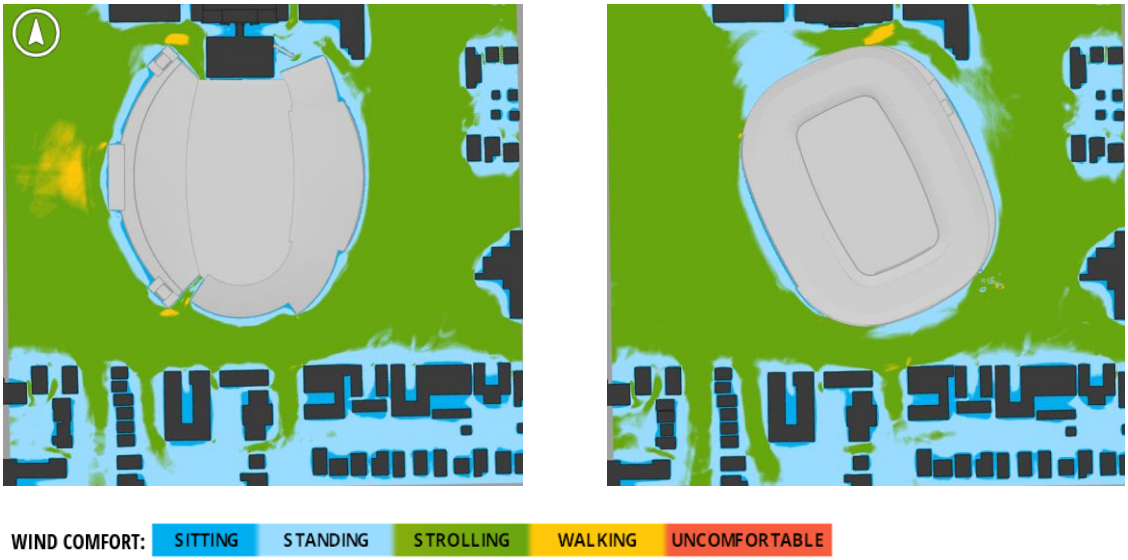

Image 1 – Pedestrian Wind Comfort Prediction for Summer (May through October) Conditions for Existing Configuration (left) versus Representative Proposed Configuration (right)

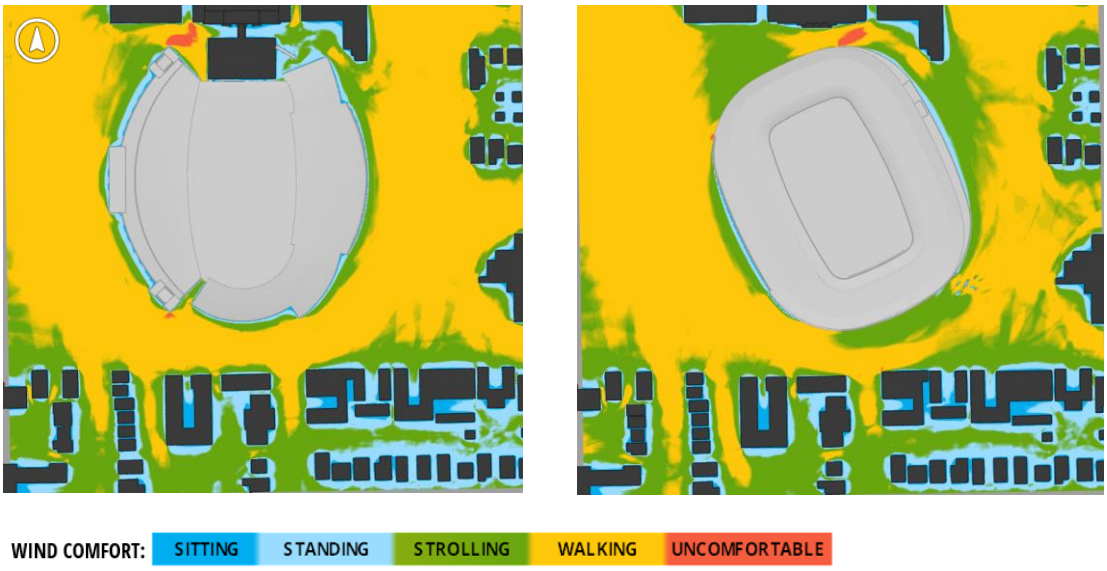

Image 2 – Pedestrian Wind Comfort Prediction for Winter (November through April) Conditions for Existing Configuration (left) versus Representative Proposed Configuration (right)

Based on the above simulation findings, it can be evidenced that by-and-large Pedestrian Wind Comfort conditions around the stadium site are expected to be consistent with the existing site conditions. The generalized orientation and massing of the proposed stadium with respect to predominant winds, may result in somewhat more tenable conditions wind comfort conditions at certain areas immediately adjacent to the stadium. Site features, as well as landscaping elements, can be implemented to further enhance the wind environment around the stadium.

In both scenarios evaluated conditions at or around the stadium are expected to be comfortable for conditions ranging from standing to walking. RWDI expects that these conditions align with the intended usage of the areas around the site.

An exception of potentially increased wind environment exists between the existing (and proposed) Stadium and Welsh Ryan Arena. The 'constriction' of wind at this area is expected to cause localized accelerations in wind flow. It is worth nothing that this acceleration is expected to be localized and not significantly extend into the patron realm of the adjacent neighborhood to the east of the stadium.

5. Conclusion

We trust that the representative results from computational fluid dynamics (CFD) simulations herein assists and provides a useful summary of information pertaining to portions of wind study conducted by RWDI for the proposed Northwestern University Ryan Field Redevelopment Project.

Yours truly,

ROWAN WILLIAMS DAVIES & IRWIN INC. (RWDI)

Statement of Limitations

This memorandum was prepared by Rowan Williams Davies & Irwin Inc. ("RWDI") for HNTB ("Client"). The findings and conclusions presented have been prepared for the Client and are specific to the project described herein ("Project"). The conclusions and recommendations contained in this memorandum are specific to conditions modelled and based on the information provided to RWDI at certain junctures in the lifecycle of the Project. Because the contents of this memorandum may not reflect the final design of the Project or subsequent changes made after the date of this memorandum, RWDI recommends that it be retained by Client during the final stages of the project to verify that the results and recommendations provided have been correctly interpreted in the final design of the Project.

The conclusions and recommendations contained in this memorandum have also been made for the specific purpose(s) set out herein. Should the Client or any other third party utilize the memorandum and/or implement the conclusions and recommendations contained therein for any other purpose or project without the involvement of RWDI, the Client or such third party assumes any and all risk of any and all consequences arising from such use and RWDI accepts no responsibility for any liability, loss, or damage of any kind suffered by Client or any other third party arising therefrom.

Finally, it is imperative that the Client and/or any party relying on the conclusions and recommendations in this memorandum carefully review the stated assumptions contained herein and to understand the different factors which may impact the conclusions and recommendations provided.