FINAL REPORT

PEDESTRIAN WIND ASSESSMENT
UNIVERSITY OF LETHBRIDGE
LETHBRIDGE - ALBERTA

CONSULTING ENGINEERS & SCIENTISTS

Project Number: #0940066

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1. INTRODUCTION

Rowan Williams Davies & Irwin Inc. (RWDI) was retained by the University of Lethbridge to conduct a Pedestrian Wind Assessment on pedestrian areas around the proposed Markin Hall building, which is currently under construction. This assessment will also cover the existing pedestrian areas around the Anderson Hall, the 1st Choice Saving Centre, Turcotte Hall and the related west parking lots. The objective of this qualitative analysis is to estimate the pedestrian wind conditions on and around the identified areas. In addition, RWDI was also retained to provide preliminary comments relating to the door pressure problems currently experienced at north handicap entrance to 1st Choice Savings Centre, and the main entrance to Turcotte Hall.

Using the design drawings received by RWDI on March 31, 2009, the current assessment is based on:

- a wind flow workshop session in Lethbridge conducted by Harry Baker of RWDI on March 30, 2009, along with the site visit, on March 30 and 31, 2009;
- a review of the local long-term meteorological data;
- surrounding site information gathering during the site visit;
- our engineering judgement and knowledge of wind flows around buildings;
- our extensive experience (of more than 1500 projects) of wind tunnel modelling of various building projects; and,
- use of a numerical analysis software, referred to as *Windestimator*[1,2] developed by RWDI for estimating the potential wind comfort conditions around generalized building forms[2].

In the absence of wind tunnel testing, this numerical approach provides a screening-level estimation of potential wind comfort conditions at a massing-level. To quantify the wind comfort conditions or refine any conceptual wind control measures, physical scale model tests in a boundary layer wind tunnel facility would be required.

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[1] H. Wu, C.J. Williams, H.A. Baker and W.F. Waechter (2004). "Knowledge-based Desk-Top Analysis of Pedestrian Wind Conditions". ASCE Structure Congress 2004. Nashville, Tennessee.

[2] C.J. Williams, H. Wu, W.F. Waechter and H.A. Baker (1999). "Experience with Remedial Solutions to Control Pedestrian Wind Problems". *10th International Conference on Wind Engineering*. Copenhagen, Denmark.

2. PRINCIPAL RESULTS

The principal findings and results of the pedestrian wind assessment can be summarized as follows:

- Due to the wind climate and exposure condition of the study site, the existing wind comfort conditions around the site of the Markin Hall building are expected to be uncomfortable throughout the year. Our assessment also predicted that wind speeds at several areas around the Markin Hall study site did not meet the wind safety criterion.

- The addition of Markin Hall is not expected to significantly change wind conditions on and around the study site, as wind speeds are expected to remain uncomfortable at most times throughout the year. In addition, throughout the year, wind speeds at the corners of the proposed Markin Hall did not satisfy the wind safety criterion.

- Wind conditions at the parking lots to the west of Anderson Hall and 1st Choice Savings Center and at the surrounding sidewalks are expected to comfortable for walking in the summer and uncomfortable in the winter. Also in the winter, wind safety failures were predicted at some areas within the parking lot.

- The updated architectural drawings indicate significant landscaping consisting of a dense planting of trees around the north, west and south sides of Markin Hall. These are positive features for wind control and should be retained in the final design. We recommend that the layout of the proposed landscaping on the sidewalk between the Anderson Hall and the 1st Choice Buildings be revised to disrupt in the prevailing westerly winds.

- Wind control measures have been described to mitigate the high wind speeds at several areas around the study site. In view of the wind safety failures expected at the corners of the Markin Hall and at several areas on the parking lots, a water flume study is suggested to better understand the flow patterns causing these adverse conditions and to verify the effectiveness of the recommended wind control measures.

3. SITE INFORMATION

The attached Figure 1 is an orientation plan of the study area.

The proposed Markin Hall currently under construction (see Images 1 and 2) is a four-storey building, situated in the central portion of the University of Lethbridge campus. It is bound on the south by the four storey Turcotte Hall (see Image 3) and the two storey 1st Choice Savings Centre (see Image 4). To the west, it is bounded by the Anderson Hall. There are open fields to the immediate north and east surrounding Markin Hall. Further west are the faculty and visitors parking lots.

Beyond the immediate surrounding buildings, the terrain consists primarily of open areas to the north, east and south directions, with low-rise buildings to the southwest through northwest directions.

Outdoor pedestrian areas on and around the study area include main entrances, exits and surrounding sidewalks.

Image 1 – Markin Hall (southwest view)

Image 2 – Markin Hall (southeast view)

Image 3 – Turcotte Hall (west view)

Image 4 – 1st Choice Savings Centre (northwest view)

4. METEOROLOGICAL DATA

Wind statistics recorded at the Lethbridge Airport between 1953 and 2006 were analysed for the summer (May through October) and winter (November through April) seasons. Figure 2 graphically depicts the distributions of wind frequency and directionality for these two seasons. The upper-left wind rose identifies the summer wind data, while the lower-left wind rose is the winter wind data. Winds from the west, west-southwest and southwest directions are predominant in both the summer and winter seasons, when all winds are considered. Calm winds occur for 4.3 % of the time in the summer and 5 % of the time in the winter.

Strong winds of a mean speed greater than 30 km/h measured at 10 m above grade at the airport occur for 15.3 % and 23.1 % of the time during the summer and winter seasons, respectively. Strong winds from the west and west-southwest directions are prevalent for both seasons, as demonstrated by the two right-hand wind roses in Figure 2. Based on the above analysis of wind data and the potential for local wind acceleration caused by the proposed building, winds from the west-southwest and west directions are considered important in the assessment of pedestrian wind conditions, although all other wind directions have been considered in our analysis.

5. WIND COMFORT CRITERIA

The pedestrian wind comfort criteria developed at RWDI are used in this assessment. They are categorized by three typical pedestrian activities:

- **Sitting:** Low wind speeds during which one can read a newspaper without having it blown away. Recommended for outdoor cafes, outdoor daycare areas and other amenity spaces that promote long term sitting.

- **Standing:** Slightly higher wind speeds that are strong enough to rustle leaves. These wind speeds are appropriate at major building entrances, bus stops or other areas, such as a bench along a sidewalk, where people may linger but not necessarily sit for extended periods of time.

- **Walking:** Winds that would lift leaves, move litter, hair and loose clothing. Appropriate for sidewalks, intersections, plazas, parks or playing fields where people are more likely to be active and receptive to some wind activity.

Wind conditions are considered suitable for sitting, standing or walking if the wind speeds are expected for at least four out of five days (80% of the time). An **uncomfortable** designation means that the criterion for walking is not satisfied.

Safety is also considered by the criteria and is associated with excessive gust wind speeds that can adversely affect a pedestrian's balance and footing. If winds sufficient to affect a person's balance occur more than two times per summer or wind season, the wind conditions are considered severe. Wind control measures are typically required at locations where winds are rated as uncomfortable or they exceed the wind safety criterion.

6. ASSESSMENT OF WIND CONDITIONS

Generally, wind conditions suitable for walking are appropriate for sidewalks and parking lots, while lower wind speeds comfortable for standing are preferred at major building entrances.

Due to the windy climate in Lethbridge (see Figure 2), and the exposure of the study site, uncomfortable wind conditions, with the potential for wind safety failures, were predicted at different areas around the study site throughout the year.

The following describes the anticipated pedestrian wind conditions at notable areas (see Figure 1) on and around the study site.

6.1 MARKIN HALL AND SURROUNDINGS (AREAS A_1 THROUGH A_6)

The existing wind conditions at different areas on and around the site for the proposed Markin Hall were predicted to be uncomfortable throughout the year as confirmed by the University of Lethbridge Staff during the March 31, 2009 workshop. Also, throughout the year, wind safety failures are expected at several areas across the study site.

With the proposed Markin Hall in place, the north, west and south sides of the building will be exposed to winds from the prevailing southwest through west directions flowing above the adjacent Anderson Hall towards the new building. Considering winds from all directions, based on our assessment, wind conditions at pedestrian areas along the sides (A_1 through A_4) and corners of the proposed Markin Hall are expected to range from being comfortable for walking to uncomfortable in the summer. In the winter, wind conditions around the building are expected to be uncomfortable particularly at the areas west of Markin Hall (A_4 and A_5).

The existing sidewalk along the east side of Anderson Hall (A_6) is in direct protection of Anderson Hall and is expected to experience better wind conditions than the areas between Locations A_4 and A_5. To further reduce wind activity at the sidewalk east of Anderson Hall (A_6), we suggest that the landscaping within the vicinity of the sidewalk should consist of coniferous trees with under planting or porous windscreens similar to the present layout at the curved landscaped area south of Anderson Hall (see B_3 in Figure 1 and Image 5).

Image 5 – Landscape Buffer

Regarding pedestrian wind safety, throughout the year, pedestrian areas along the sides and corners (Locations A_1, A_2, A_3 and A_4) of proposed Markin Hall did not meet the criterion.

The updated architectural drawings indicate the layout of significant landscaping along the four sides of the new building and along the area between Anderson Hall and Turcotte Hall (A_5). The drawings also show proposed deciduous landscaping along the east and west sides of the

sidewalk between Markin Hall and the existing Anderson Hall. These features are positive for wind control; hence we suggest that they be retained in the final design. We also suggest additional landscaping (as shown in Figure 3) within the vicinity of Area A_5, to reduce wind activity at this area. In addition, as the proposed deciduous landscaping will have limited effects in the winter, the landscaping needs to have a significant amount of coniferous trees with under planting to be effective, similar to what currently exist south of Anderson Hall (see Image 5 above).

6.2 SIDEWALK NORTH OF 1ST CHOICE SAVINGS CENTRE (B_1, B_2 AND B_4)

Sidewalks along the north side of 1st Choice Savings Centre are exposed to the prevailing westerly winds. Based on our assessment, wind conditions in these areas are expected to be comfortable for walking in the summer. In the winter, wind conditions are expected to be uncomfortable along the entire sidewalk (B_1, B_2 and B_4). To disrupt the flows on this sidewalk, we suggest a change in the layout and orientation of the sidewalk. The sidewalk should have a meandering layout with landscape buffers staggered at alternate sides of the sidewalk, starting from the northwest corner of the 1st Choice Saving Centre (B_4). To be effective in the winter time, the landscape buffer should consist of coniferous trees with under planting similar to what currently exist at Location B_3 (see Image 5 above). The suggested layout of the sidewalk is presented in Figure 3.

To refine this concept, a water flume study will be required to provide further details on the shape and location of the meandering sidewalk, with the suggested trees.

6.3 FACULTY AND VISITOR PARKING LOTS ALONG WITH SERVICE BUILDING COMPOUND (C_1 THROUGH C_5)

Most areas in the parking lots are exposed to the winds from the prevailing westerly directions. During the site visit by RWDI, wind speed measurements were taken at pedestrian level at Locations T_1 through T_6 to obtain an indication of the relative windiness at the different measurement areas. The highest reading was obtained at T_1, using this as a reference, the averaged wind speeds decreased to the west, closer to the berm (see Figure 1 and Image 6). At T_3, the wind speeds are about 40 % lower than T_1.

Image 6 – Existing Landscape Berm west of Parking Lot

Similarly, the wind speed decreased westward, from T_4 to T_6. The readings at T_4 and T_6 are 30 % and 70 % lower than that at T_1, respectively. These locations are protected by the existing coniferous trees located at the top of the berm in that area. This series of measurements illustrates the effectiveness of the adjacent coniferous trees to reduce the wind speeds in the area. If this reduction in the wind speed could be applied to the remaining parking lots by adding the proposed trees within the parking lot areas shown in Figure 3, improved wind conditions suitable for walking or better could be expected year round.

Overall, based on our assessment, wind conditions across the parking lots and service building compound are expected to be comfortable for walking in the summer. During the winter, wind speeds at areas close to the berm (C_5) and at the Services Building Compound are expected to range from comfortable for walking to uncomfortable on windy days. At other areas on the parking lot (C_1 through C_4), the wind speeds will be uncomfortable in the winter, with the potential for wind safety failures. As indicated by the wind measurements, the wind speeds generally increased eastward from the existing berm, hence to reduce wind speeds on the parking lot, we recommend the planting of coniferous trees on top of the berm. In addition, the client team should create a landscaped island, aligned perpendicular to the prevailing westerly wind direction. The landscaping on the road island should consist of coniferous trees with under planting or porous vertical windscreens. The density of the landscaping should be similar to what currently obtained at the curved landscaping layout south of Anderson Hall. With these features in place, lower wind speeds will be experienced at the parking lot. A layout of these conceptual wind control features is presented in Figure 3.

We recommend further study in the water flume to visualize the wind patterns causing these windy conditions in the parking lot and confirm the effectiveness of the conceptual wind control features.

6.4 SUMMARY OF WIND CONDITIONS

Overall, due to the exposure of the study site, windy conditions are expected at different areas across the site. At most times throughout the year, uncomfortable wind speeds with the potential for wind safety failures were predicted at sidewalk areas around proposed Markin Hall.

Wind conditions at the sidewalks north of the 1st Choice Savings Centre and at the adjacent parking lots are expected to be comfortable for walking in the summer. In the winter, uncomfortable wind speeds were predicted at these areas. Conceptual wind control measures have been suggested to reduce wind speeds at several pedestrian areas across the study site. In

view of these wind conditions, we recommend testing of a scale model in a water flume to identify the wind patterns causing the adverse wind conditions and refine the suggested wind control measures.

7. PRELIMINARY COMMENTS ON DOOR PRESSURE ISSUES (LOCATIONS P_1 AND P_2)

There are operational problems at the north handicap doorway to the 1st Choice Savings Centre (P_1) and the main entrance to the Turcotte Hall (P_2). These locations are identified in Figure 1. It is our impression that the problems are related to air infiltration and wind pressure at the doors.

The purpose of this section is to provide brief comments based on our site visit on March 30 and 31, 2009; discussions with the client representatives; review of the local wind climate for the Lethbridge Area (Figure 2); our experience of wind flows around doors and openings in buildings; and, a review of the building's architectural drawings.

In general, wind problems relating to door operations can be classified into two categories. One category is the effect of high speed winds moving past the entrances to the buildings, causing uncomfortable conditions for pedestrians and excessive wind activity that affects the operation of the entrance doors. Examples of this can be seen in cases where doors are caught by winds and blown open, breaking the door hinges and closers (observed at Location P_1). The second category is air entering and leaving the building through openings in the exterior building facade due to pressure differentials inside and outside of the building. These situations are discussed below in relation to the concerned doors.

7.1 HANDICAP ENTRANCE TO THE 1ST. CHOICE SAVING CENTRE (P_1)

The prevailing westerly winds (Figure 2) as they interact with the west side of Turcotte Hall cause increased wind activity in the vicinity of P_1. These high wind speeds also interfere with the operations of the door at P_1.

To reduce the exterior wind activity within the vicinity of this door, we recommend the provision of a wind break such as a vertical wind screen to the east of P_1. The orientation and allignment of this wind screen relative to the door is shown in Figure 3. With this feature in place, lower wind activity will be experienced at P_1.

Presently at P_1, when the door is open, there is a significant air infiltration into the 1st Choice Savings Centre. During the site visit by RWDI, it was noted that the air rushes into the building, through the open door, continues through the opening above the vestibule wall into the stairwell and through the exhaust in the ceiling of the vestibule (see P_3 in Figure 3). As a result of this continuous air flow path, there were damages to some sections of the suspended ceiling above the vestibule at P_1. To reduce the air infiltration into the building when the door is open, we recommend the replacement of the suspended ceilings with a fixed ceiling and extension of the vestibule walls to the ceiling. This measure will block the continuous path for air flow into the building when P_1 is open.

Also it was noted that the roof hatch at the top of the exit stairs connected to the east side of the vestibule was not closing tightly. Repairing this hatch will also reduce the air infiltration at the main entrance doors

7.2 MAIN ENTRANCE TO TURCOTTE HALL (P_2)

Regarding the main entrance to Turcotte Hall (P_2), there appears to be an imbalance of air flow, which has led to pressure differential between the interior and exterior portions of the Turcotte Hall, particularly during strong wind events. In addition, due to the small length of the vestibule space, the exterior sliding door at P_2 and interior door often open at the same time resulting in significant infiltration of air into the building. These issues have interfered with the operation of the exterior sliding doors.

To reduce the air infiltration issues, we suggest the client consider replacing the sliding doors at P_2 with a revolving door. This measure will block off the direct flow path for air into the building and balance the pressures exerted on the door surfaces. Alternatively, the client team may consider creating an enclosed extended vestibule to the west of P_2. This added vestibule will increase the travel time between the interior and exterior doors, reducing the probability of the exterior doors and interior doors being open simultaneously.

In addition, the air intake louvers and exhaust system (P_3 in Figure 1) for the Turcotte Hall building are situated on the roof of the 1st Choice Savings Centre. These features are located at a location that is expected to be negatively pressurized for the prevailing westerly winds. With this condition, the wind flow can result in reduced supply air and increased exhaust flow, causing lower internal building pressures. If either of the above vestibule recommendations are not feasible, we recommend that the client team review the pressurization of the buildings to ensure

that supply and exhaust air systems are roughly balanced. If necessary, the system should be modified to better suit the pressure balance between the interior and exterior building pressures.

7.3 SUMMARY

In summary, we recommend the following considerations:

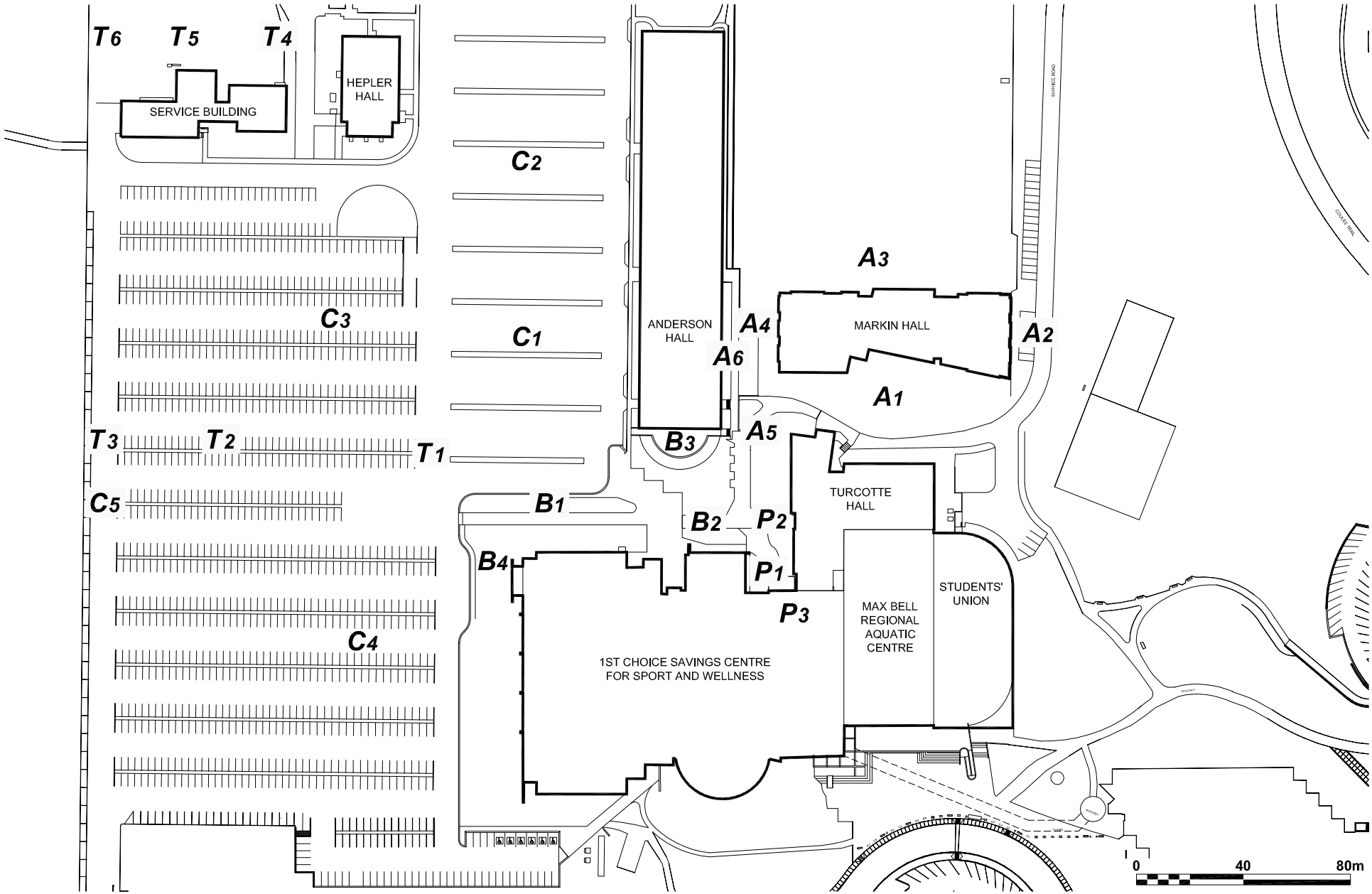
- Provision of wind breaks (such as wind screens) to reduce the wind speeds within the vicinity of the handicap entrance to the 1st Choice Savings Centre (P_1);
- Replacement of the suspended ceiling on the 1st Choice Saving Centre with a fixed ceiling, and extension of the vestibule walls to the ceiling (P_1) ;
- Replacement of the present sliding doors at P_2, with a revolving door to limit air flow into Turcotte Hall; and/or,
- Creation of an extended vestibule west of P_2, to increase the length of the existing vestibule;
- Further review of the existing pressurization system for Turcotte Hall to ensure a properly balanced system is in place.

8. APPLICABILITY OF RESULTS

The assessment and recommendations presented in this report are based on the proposed geometry and design drawings provided to RWDI. The interpretation of wind flows determined by this pedestrian wind assessment are applicable to the particular building configurations examined and the existing and future surroundings identified to RWDI.

In the event of any significant changes to the design, construction or operation of the building or addition to the surroundings in the future, RWDI could provide an assessment of their impact on the design considered in this report. It is the responsibility of others to contact RWDI to initiate this process.

FIGURES



Site Plan

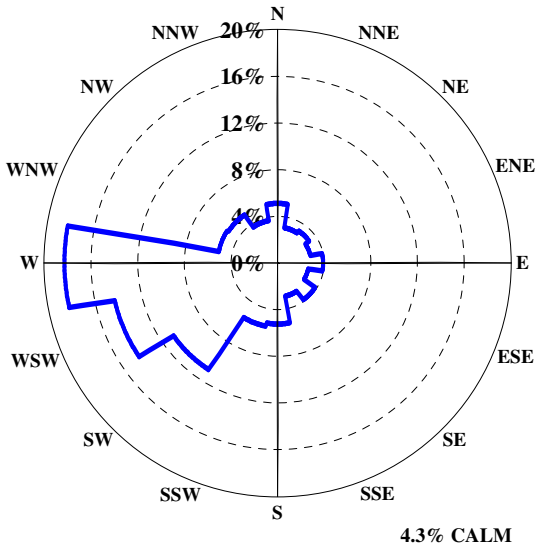
True North

University of Lethbridge - Lethbridge, Alberta

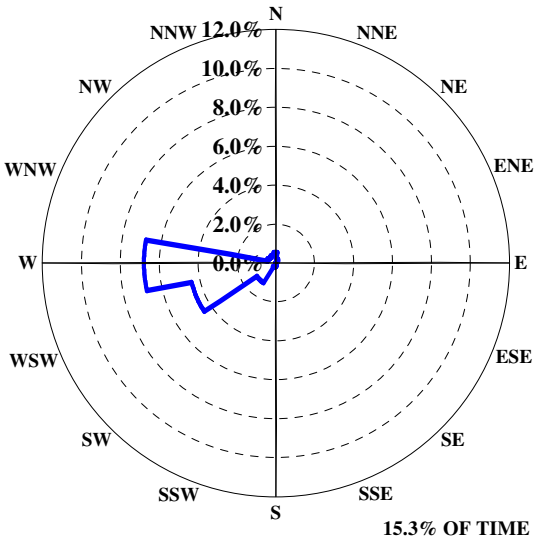
Project #0940066

Drawn by: ACM	Figure:	1
Approx. Scale:	1:2000	
Date Revised:	May 8, 2009	

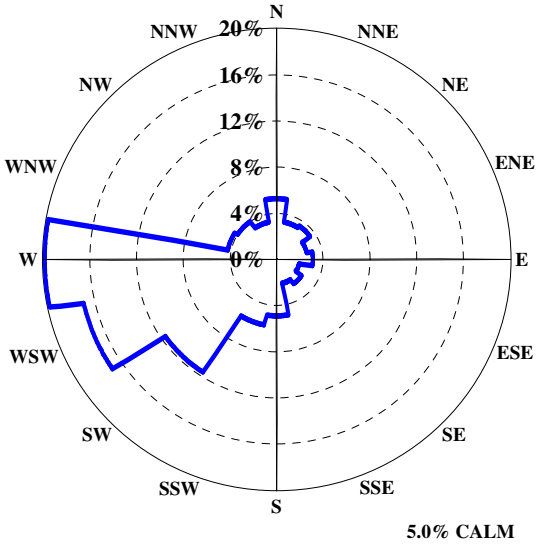
RWDI



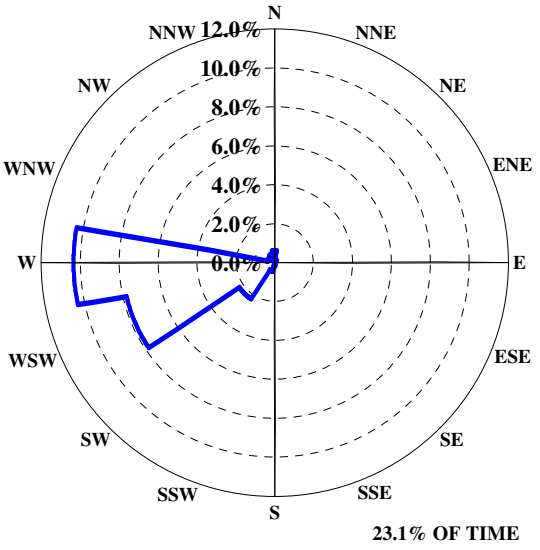
ALL SUMMER WINDS



SUMMER WINDS EXCEEDING 30 km/h

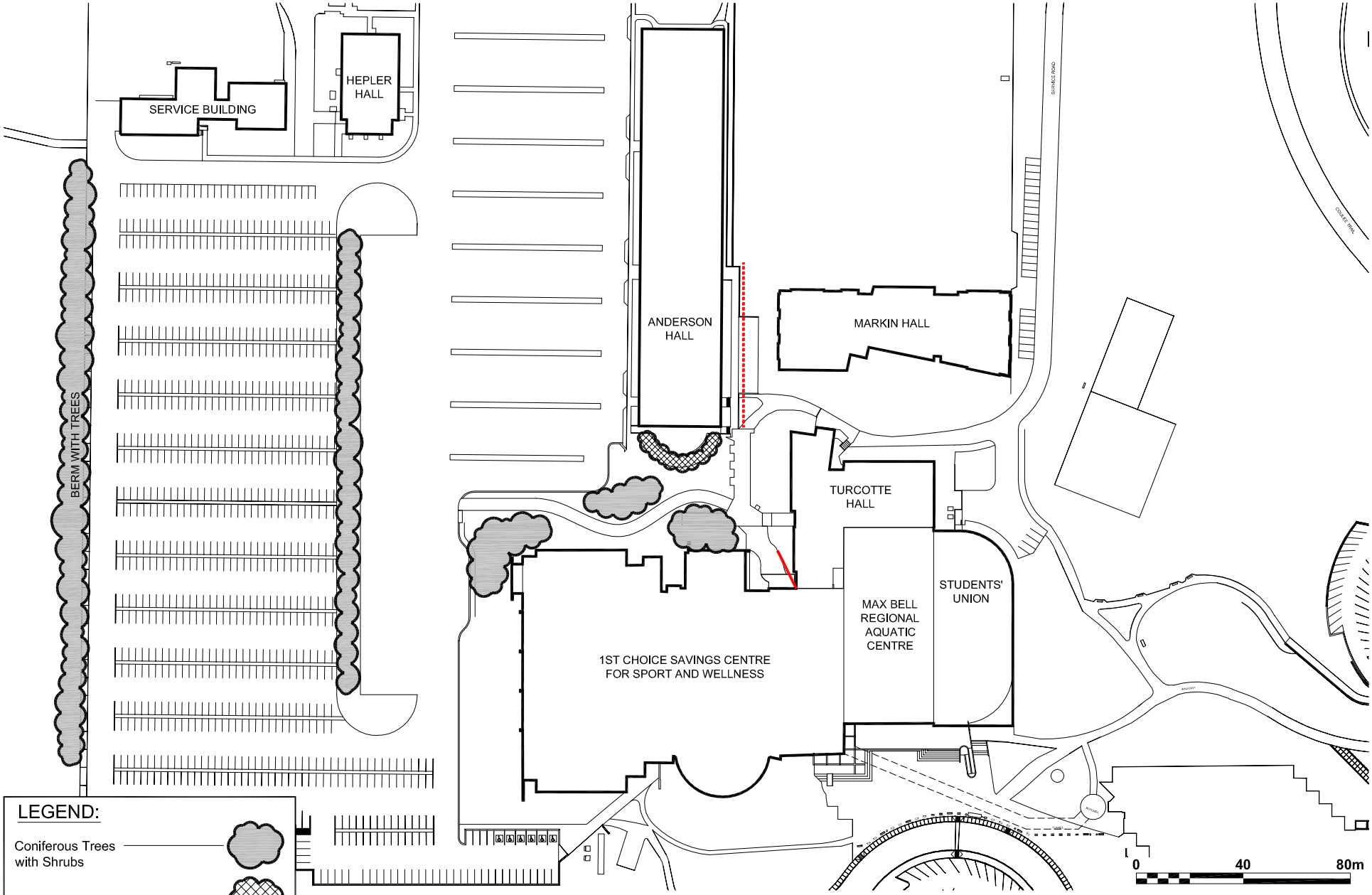


ALL WINTER WINDS



WINTER WINDS EXCEEDING 30 km/h

Directional Distribution (%) of Winds (Blowing From) **Station: Lethbridge Airport, AB (1953 - 2006)** University of Lethbridge - Lethbridge, Alberta Project #: 0940066	Figure: **2** Date: May 8, 2009	RWDI



Suggested Wind Mitigation Measures

University of Lethbridge - Lethbridge, Alberta

Project #0940066

True North

Drawn by: ACM	Figure: 3	RWDI
Approx. Scale: 1:2000		
Date Revised: May 8, 2009		