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January 26, 2026

Preliminary Pedestrian Level Wind Assessment
Home Base Youth Centre
Yellowknife, Northwest Territories

Theakston Project No. 26278

Submitted To:

Taylor Architecture Group
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Yellowknife, Northwest Territories
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Submitted By:

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1. EXECUTIVE SUMMARY

Based upon our analysis, wind conditions on and around the site, once the Home Base Youth Centre is complete, are predicted to be reasonably comfortable and suitable for walking, standing, or better, year round under normal to high ambient wind conditions. Under strong or gusty wind conditions, with wind from specific directions, higher than average ground level winds will be encountered at the corners of the proposed Youth Centre; and in the Covered Street Level Drive-Through. The Home Base Entrance (located on the northwest side of the building) along with the Event Space Entrance and the Market Rental Entrance (located along the northeast façade) are expected to be windy with winds from specific directions, however, these entrances are expected to retain a rating as suitable for walking during the winter months, and standing during the balance of the seasons, and remain suitable to the intended purpose, with the proposed wind mitigation in place. Recessing the Home Base Entrance and the Event Space Entrance into the building's façade would improve comfort conditions, as would a windscreen perpendicular to the northeast façade, near the east corner of the building, improve comfort conditions at the Market Rental Entrance. These recommendations would also improve the function of the door mechanisms and the pedestrian level comfort on the occasion of strong or gusty winds.

The proposed Development utilises wind friendly design elements, such as stepped massing, overhangs, moderate height, and others, which effectively moderate the building's downwash, deflecting and slowing the winds that may travel down from the building prior to influencing the pedestrian level. As such, we expect the proposed massing of the Home Base Youth Centre will allow much of the impending wind climate opportunity to flow over and/or around, as opposed to down, the building, with the component that does flow down exhibiting less energy for the above-mentioned reasons, reducing the potential effects of downwash, attributable to the proposed development, at the pedestrian level.

The design features of the Home Base Youth Centre effectively mitigate winds from several significant directions, which are in turn mitigated upon approach to varying degrees by the surrounding terrain, and as such, are of reduced velocity at the site, particularly during the warmer seasons when deciduous plantings are most apt to moderate wind velocity. Winds approaching from the northwest and north are the exception with the site being quite open to winds from these directions. Overall, anticipated pedestrian comfort conditions will be suitable to the area's intended purpose. Comfort conditions expected at the proposed Development site are considered better than those required to suit the suburban context, based upon qualitative analysis. Additional wind mitigation beyond that which is proposed is not required at this point and is more appropriately assessed at the detailed design stage.

Should you have questions or comments, please do not hesitate to call.

Kindest Regards

Cal Gagnon M.Sc. Stephen Pollock P.Eng

2. INTRODUCTION

Theakston Environmental was retained by Taylor Architecture Group, of Yellowknife Northwest Territories, to conduct a Preliminary Pedestrian Level Wind Assessment for the Home Base Youth Centre, located to the southwest of the intersection of 53 Street and 49 Avenue in Yellowknife, Northwest Territories. The objective of this preliminary analysis is to estimate pedestrian level wind conditions resulting from the inclusion of the proposed Youth Centre, with respect to pedestrian comfort and safety. The analysis is based upon the historical wind conditions and our experience with microclimatic analyses that were conducted on similar properties. The qualitative assessment utilises numerical analysis of local wind data predicted at the site and provides a synopsis of pedestrian comfort conditions anticipated on, and adjacent to, the property.

3. SITE INFORMATION & PROPOSED RENEWAL

Yellowknife is a community of approximately 21,000 people that is situated on the west shore of Yellowknife Bay on the North Arm of Great Slave Lake, in the Northwest Territories, north of the 62nd parallel, within a zone of extensive discontinuous permafrost. The proposed Youth Centre is located centrally in Yellowknife. The Site occupies a portion of the block bounded by 53 Street to the northeast, Franklin Avenue to the southeast, Matonabee Street to the southwest, and Frame Lake to the northwest (Figure 1). The property's terrain is relatively flat, sloping gently toward Frame Lake to the northwest.

The Development involves a proposal to replace an existing one storey residential building with a nine storey (plus mechanical penthouse) building with a stepped massing (Figures 2a and 2b). Vehicular access will be from 53 Street, on the northeast side of the building, through a covered street level drive through to parking along the southwest property line.

Proposed Youth Centre Site Looking West (Image from Google Street View)

4. SURROUNDING AREA

For the Proposed Youth Centre Project, the upstream wind flow will, for all intents and purposes, be an atmospheric boundary layer passing over residential/commercial buildings, boreal forest, portions of Great Slave Lake, smaller lakes, bedrock outcroppings, and combinations thereof. The immediate surrounds surface characteristics can be divided into two groups; *i*) low -rise commercial and residential buildings, and *ii*) water and boreal forest with bedrock outcroppings. The area northwest of Frame Lake, which is to the north through west of the Proposed Youth Centre, is primarily occupied by boreal forest with bedrock outcroppings and water. Lands to the northeast and south to southwest are occupied primarily by low-rise commercial and residential buildings, with the most prominent building in the immediate surroundings the 5 storey office building to the immediate south. (Figure 1). Also of note are several multi-story towers along Franklin Avenue to the east and east by southeast of the development site.

5. METEOROLOGICAL DATA

For this study, historical weather data recorded at the Yellowknife Airport Weather Station during the summer and winter seasons, May through September and October through April respectively, was used. The resulting wind roses are presented as velocity and percent frequency in Figure 3. The velocities presented in the wind roses are measured at an elevation of 10*m*. Thus, based upon the power law profile for the atmospheric boundary layer, representative ground level velocities at a height of 1.5*m*, for an urban macroclimate, are 52% of the mean values indicated on the wind rose (for suburban and rural (open) macroclimates the values are 63% and 78% respectively).

The macroclimate for this area is dependent upon wind direction and varies with direction but for assessment purposes is considered suburban or open. Winds from the south by southeast through east to east by northeast are predominant during the summer months with south by southeasterly and east by northeasterly directions most significant, as indicated in Figure 3 - Summer. Winds from the east by southeast through to northeast as well as from the northwesterly quadrant dominate the winter, as indicated in Figure 3 - Winter.

6. COMFORT CRITERIA

The assignment of pedestrian comfort takes into consideration pedestrian safety and comfort attributable to gust wind speeds, and mean, respectively. Gusts have a significant bearing on safety, as they can affect a person's balance, while winds flowing at or near mean velocities have a greater influence upon comfort. The effects of mean and gust wind conditions are evaluated by whether they are suitable for Sitting or Standing or Walking over 80% of the time. In order for a point to be rated as suitable for Sitting, for example, the wind conditions must be less than 10 km/h for over 80% of the time. The Sitting category would include conditions ranging from calm up to wind speeds that would rustle tree leaves or wave flags slightly. As the name infers, the Sitting category is recommended for outdoor space such as terraces and patios where people might sit for extended periods and generally applied to the summer months.

The Standing category is slightly more tolerant of wind, including wind speeds from calm up to 14km/h. In this situation, the wind would rustle tree leaves and, on occasion, move smaller branches and flags would be partially extended. This category is suitable for locations where people might sit for short periods or stand in relative comfort, such as building entrances and drop-off areas. The Walking category includes wind speeds from calm up to 19km/h. These winds would set tree limbs in motion, lift leaves, litter and dust. This category is suitable for sidewalks and parking. The Uncomfortable category covers a broad range of wind conditions at speeds above 19km/h. These winds would set trees in motion, cause inconvenience when walking, and are not generally suitable to activities. Safety concerns are associated with wind speeds that are beyond the uncomfortable category, being sufficient to affect a person's balance.

Many variables contribute to a person's perception of the wind environment beyond the seasonal variations presented. While people are generally more tolerant of wind during the summer months than during the winter, due to the wind cooling effect, people become acclimatized to a particular wind environment. Persons dwelling near the shore of an ocean, large lake or open field are more tolerant of wind than someone residing in a sheltered wind environment.

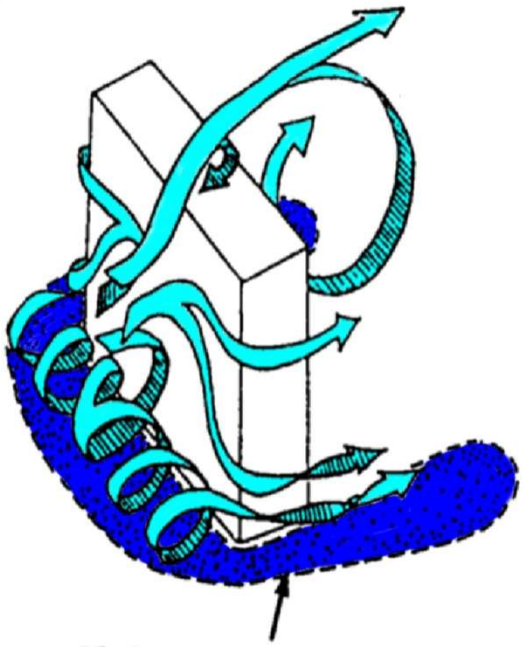
7. PEDESTRIAN LEVEL WIND ASSESSMENT

Variables beyond the orientation and conformation of a proposed development must be considered in predicting wind speed and occurrence at a given location. These include the previously discussed historical wind climate, surrounding terrain, and neighbouring buildings, each of which is quantified and/or analysed in the microclimatic analysis of pedestrian level winds. The results of such quantitative analyses have afforded a knowledge base that allows an estimation of pedestrian level wind conditions.

The site and the surrounds, in the present circumstances as a primarily residential and commercial neighbourhood with nearby lakes, have a sympathetic relationship with the existing wind climate. Urban development provides turbulence inducing surface roughness that can be wind friendly, while open settings afford wind the opportunity to accelerate as the wind's boundary layer profile thickens at the pedestrian level, owing to lack of surface roughness. Transition zones from open

to urban settings can prove problematic, as winds exacerbated by the open setting are redirected to flow over, down, around and between buildings.

High and mid-rise buildings may exacerbate wind conditions within their immediate vicinity, to varying degrees, by redirecting wind currents to the ground level and along streets and open areas. In general wind will split upon impact with a high-rise building, with portions flowing down the face of the building to the pedestrian level as downwash, where it is deflected, or otherwise redirected to flow along the building and around its corners, creating localized zones of increased pedestrian level wind. Conversely, points situated to the leeside, or in the wake of buildings will often enjoy an improvement in pedestrian comfort. As such, it is reasonable to expect inclusion of the proposed development will alter wind conditions under specific wind directions and velocities from those of the existing site condition, resulting in an improvement over the existing conditions at some points, with more windy conditions at others.



East by Northeasterly winds make up a significant percentage of the prevailing wind climate; they tend to be of moderate velocity and are preconditioned upon approach by low-rise buildings and related parking areas in the near surround, followed by taller buildings along Franklin Avenue, to the immediate east by northeast. As such, the suburban terrain will induce turbulence into the wind's approach flow, moderating the wind's energy from this wind direction at the pedestrian level, to a degree. Conversely, the relatively smooth terrain of parking areas will afford wind opportunity to accelerate, however, overall, the suburban terrain presents a relatively coarse approach that will moderate winds, resulting in relatively comfortable conditions in the existing setting, with winds from this direction.

East by Northeasterly winds approaching the site in higher streamlines, once upon the proposed massing of the Youth Centre, will split upon contact with the building to flow up and over the building, without consequence, or along the building, around its corners, and beyond, also without significantly influencing the pedestrian level. However, a limited portion of the wind's upper streamlines will be deflected to the pedestrian level as downwash, and flow along the northeast and southeast façades, as well as through the Covered Street Level Drive-Through (Figure 2a).

The proposed Youth Centre's massing is stepped along it's northeast and southeast façades. These stepped conditions reduce the building's height apparent to the wind to 4 storeys at the northeast façade and 2 storeys along the southeast façade, considerably less than the total building height of 9 storeys (plus the mechanical penthouse). As such, the Youth Centre's massing presents a relatively short façade to wind. This, considered in concert with the building's façade

being skewed to east by northeasterly winds, will effectively moderate wind, through deflection and/or dampening, that may downwash from the building. As a result, winds approaching the site in upper streamlines will have limited influence upon predicted pedestrian comfort conditions.

East by northeasterly winds approaching the development site at or near the pedestrian level are moderated by the windward surroundings. Once upon the Development they will split upon contact with the east-most corners of the proposed massing of the Youth Centre, with the bulk of the flow deflected to travel along the windward façades of the building, around the corners and beyond. This will result in moderately windy conditions, from time to time, along the windward northeasterly and southeasterly façades of the building, which accommodates the Event Space Entrance, and the Market Rental Entrance. Pedestrian comfort conditions in the area are expected to be suitable for walking during the winter months and standing during the summer. Note that the Market Rental Entrance is recessed beneath the northeastern façade. Recessing the Event Space Entrance into the building's façade would improve comfort conditions, as would a windscreen perpendicular to the northeast façade, near the east corner of the building, improve comfort conditions at the Market Rental Entrance.

East by Northeasterly winds as well as easterly winds in general will accelerate through the Covered Street Level Drive-Through, and as such, pedestrian comfort conditions in the drive-through are predicted to be uncomfortable during the winter months and suitable for walking during the summer, on the occasion of strong east by northeasterly winds.

The Home Base Entrance is located on the northwest side of the building approximately 9.5m from the north corner of the proposed building, and as such, is well protected from east by northeasterly winds. Conditions at this entrance is therefore expected to be relatively comfortable, suitable for standing during the winter and for activities requiring longer exposures during the balance of the year, with east by northeasterly winds. Similarly, the Level 4 Terrace, along the northwest façade (Figure 2b) is well protected from east by northeasterly winds.

The proposed Home Base Youth Centre occupies a modest footprint, is not overly tall, and the building utilises mitigative design features such as stepped conditions, overhangs, and notched building façades, which considered in concert, moderate the pedestrian level wind. As such, the balance of the site will be relatively sheltered from east by northeasterly winds and expected to realize comfort conditions suitable to the respective areas' intended purposes.

South by Southeasterly winds similarly make up a significant percentage of the prevailing wind climate, particularly during the summer months, tend to be of higher velocity, and are preconditioned upon approach by the adjacent 5 storey building and low-rise buildings and related parking (and open areas) in the near surround, followed by taller buildings along Franklin Avenue, to the immediate south by southeast. As such, the suburban terrain will induce turbulence into the wind's approach flow, moderating the wind's energy from this wind direction at the pedestrian level to a degree. Conversely, the relatively smooth terrain of parking and open areas will afford wind opportunity to accelerate, however, overall, the suburban terrain presents

a relatively coarse approach that will moderate winds, resulting in relatively comfortable conditions in the existing setting, with winds from this direction.

South by southeasterly winds approaching in upper streamlines will come into contact with the windward façades of the building where they will split to flow up and over the building, or along the façades of the building, around the corners, and beyond, without significantly influencing the pedestrian level.

South by Southeasterly winds approaching the building at or near the pedestrian level are mitigated to a degree by the windward surroundings; however, they will from time to time be inherently stronger than the east by northeasterly winds discussed above. Once upon the windward elements of the Property, they will split upon contact with the southmost corner to flow along the respective windward faces of the proposed massing, around the corners, and beyond. The portion deflected to flow along the southwest façade of the proposed Youth Centre will display a propensity towards causing windy conditions at the staff parking area, before diffusing into the open area once beyond the building, without consequence. A portion will be deflected to flow along the southeast façade, without consequence.

The Home Base Entrance is located on the northwest side of the building while the Event Space Entrance, and the Market Retail Entrance are located along the northeast façade (Figure 2a). These entrances are well protected from south by southeasterly winds. Conditions at these entrances are therefore expected to be relatively comfortable, suitable for standing during the winter and for activities requiring longer exposures during the balance of the year, with east by south by southeasterly winds. Similarly, the Level 4 Terrace, along the northwest façade (Figure 2b) is well protected from south by southeasterly winds.

South by Southeasterly winds will accelerate through the Covered Street Level Drive-Through, and as such, pedestrian comfort conditions in the drive-through are predicted to be uncomfortable during the winter months and suitable for walking during the summer, on the occasion of strong south by southeasterly winds.

The proposed Home Base Youth Centre occupies a modest footprint, is not overly tall, and the building utilises mitigative design features such as stepped conditions, overhangs, and notched building façades, which considered in concert, moderate the pedestrian level wind. As such, the balance of the site will be relatively sheltered from south by southeasterly winds and expected to realize comfort conditions suitable to the respective areas' intended purposes.

Northwesterly winds make up a significant percentage of the prevailing wind climate, particularly in winter, tend to be of higher velocity, and approach over the relatively open areas of Frame Lake, the Jumpstart Playground, and the associated parking, however, there is a mix of coniferous and deciduous trees along the shore of Frame Lake. This presents a mostly open approach terrain which moderates the wind's energy at the pedestrian level, to a small degree. As such, this affords the wind opportunity to accelerate, resulting in generally more windy, less comfortable wind conditions at the site, with northwesterly winds. As such, the proposed

development site will realize windy, and occasionally uncomfortable conditions in the existing setting, on the occasion of strong winter winds emanating from the northwesterly quadrant.

Northwesterly winds approaching the site in higher streamlines, upon contact with the building, will split to flow up and over the building, without consequence, or along the building, around its corners, and beyond, also without significantly influencing the pedestrian level. A portion of the wind's upper streamlines will be deflected to the pedestrian level as downwash, with Northwesterly winds approaching from angles near perpendicular to the building's façade.

Northwesterly winds approaching the development site at or near the pedestrian level, once upon the Development will split upon contact with the northwest façade of the proposed massing of the Youth Centre, with the bulk of the flow deflected to travel along the windward façade of the building, around the corners and beyond. This will result in windy conditions, from time to time, along the windward façade of the building, which accommodates the Home Base Entrance. Similarly, winds swirling around the northmost corner will cause windy conditions at the Event Space Entrance on the occasion of strong northwesterly winds. The Level 4 Terrace, along the northwest façade is exposed to northwesterly winds and will experience windy conditions on the occasion of strong northwesterly winds. A portion of the Level 4 Terrace is recessed beneath the floors above. This will improve the comfort conditions on the Terrace to a degree. Further, recessing the Home Base Entrance and the Event Space Entrance into the building's façade would improve comfort conditions.

The Market Rental Entrance is located on the northeast side of the building, and as such, is protected from northwesterly winds. Conditions at this entrance are therefore expected to be relatively comfortable, suitable for standing during the winter and for activities requiring longer exposures during the balance of the year, with northwesterly winds. Similarly, the Covered Street Level Drive-Through is open to the northeast and southwest façades, and as such, is protected from northwesterly winds.

The proposed Home Base Youth Centre occupies a modest footprint, is not overly tall, and the building utilises mitigative design features such as stepped conditions, overhangs, and notched building façades, which considered in concert, moderate the pedestrian level wind. As such, the balance of the site will be relatively sheltered from northwesterly winds and expected to realize comfort conditions suitable to the respective areas' intended purposes.

Northerly winds make up a less significant percentage, but still notable portion of the prevailing wind climate in summer and winter and, similar to northwesterly winds, approach over the relatively open areas of Frame Lake, an open parklike area, and associated parking. This presents an open approach terrain which moderates the wind's approach energy at the pedestrian level, to a small degree. As such, this affords the wind opportunity to accelerate, resulting in generally more windy, less comfortable wind conditions at the site, with northerly winds. As such, the proposed development site will realize windy, and occasionally uncomfortable conditions in the existing setting, on the occasion of strong winter winds emanating from the north quadrant.

Northerly winds approaching in upper streamlines will come into contact with the windward façades of the building where they will split to flow up and over the building, or around the

northmost corner, and along the northwest and northeast façades beyond, without significantly influencing the pedestrian level. Northerly winds with easterly components, that contact the façade of the building at angles approaching perpendicular, will display a greater propensity to downwash, however, this will be offset by a small step in massing presented to the northeast, moderating the building's apparent height to the wind, which will help to deflect wind that may downwash from the building, effectively preventing or controlling contact with the pedestrian level.

Northerly winds approaching the development site at or near the pedestrian level, once upon the Development will split upon contact with the northmost corner of the proposed massing of the Youth Centre, with the bulk of the flow deflected to travel along the windward façades of the building, around the northwest and northeast corners, and beyond. This will result in windy conditions, from time to time, along the windward façades of the building, which accommodate the Home Base Entrance (along the northwest façade), as well as the Event Space Entrance and the Market Rental Entrance (along the northeast façade, on the occasion of strong northerly winds. Similarly, the Level 4 Terrace, along the northwest façade is exposed to northerly winds and will experience windy conditions on the occasion of strong northerly winds. A portion of the Level 4 Terrace is recessed beneath the floors above. This will improve the comfort conditions on the Terrace to a degree. Further, recessing the Home Base Entrance and the Event Space Entrance into the building's façade would improve comfort conditions, as would a windscreen perpendicular to the northeast façade, near the east corner of the building, improve comfort conditions at the Market Rental Entrance.

Northerly winds will accelerate through the Covered Street Level Drive-Through, and as such, pedestrian comfort conditions in the drive-through are predicted to be uncomfortable during the winter months and suitable for walking during the summer, on the occasion of strong northerly winds.

Other Wind Directions approaching from westerly, northeasterly, and southwesterly directions will contact the façades of the proposed development at angles near those discussed above, resulting in similar conditions. Components of said winds will from time to time contact the building at or near right angles. This generally results in increased propensity for wind to downwash to the pedestrian level, the magnitude of which is dependent upon several variables. Those variables commanding primary consideration are the building height, and the effective width of the presented façade. It is intuitively obvious that narrow short façades will reduce the propensity for downwash, and the short façades of the proposed Development presented to these wind directions will display a marked tendency to deflect wind to flow over and/or around the building.

Mitigation of downwash is well understood and was applied to the design through the employment of stepped and notched massing. These strategies were, or can be, included, as discussed in the Mitigation Strategies Section of this report, to mitigate the effects of winds at the pedestrian level. At the pedestrian level, landscape features incorporating wind screens, raised planters, coarse plantings, fencing, and others help to control pedestrian comfort conditions.

8. MITIGATION STRATEGIES

The proposed development employs, or could employ, wind mitigative design features that include:

- recessed entrances
- overhangs
- parapet walls
- canopies
- stepped building façades
- wind screens
- landscaping

and others, that will increase surface roughness apparent to the wind.

The proposed Home Base Youth Centre plans establish a context for development in terms of height, massing, and location that allow the potential wind issues to be addressed both now and in conjunction with the more detailed design stage, by establishing entrance locations and configuration, canopy details, landscaping, other architectural features, etc. Comfort conditions expected at the proposed Development site are considered better than those required to suit the suburban context, based upon qualitative analysis.

The Home Base Entrance (located on the northwest side of the building) along with the Event Space Entrance and the Market Rental Entrance (located along the northeast façade) are expected to be windy with winds from specific directions. Recessing the Home Base Entrance and the Event Space Entrance into the building's façade would improve comfort conditions, as would a windscreen perpendicular to the northeast façade, near the east corner of the building, improve comfort conditions at the Market Rental Entrance. Additional wind mitigation is not required, however, if desired, raised planters and coarse plantings positioned as near as practical to the windward corners of the building, and/or along their façades, might be employed. In addition, large rocks, and/or fences may be used to improve pedestrian comfort conditions. The positioning and scale of these mitigative features, if required, are best assessed in quantitative microclimatic analysis at the detailed design stage.

LIST OF FIGURES

Figure 1: Aerial View of Study Area

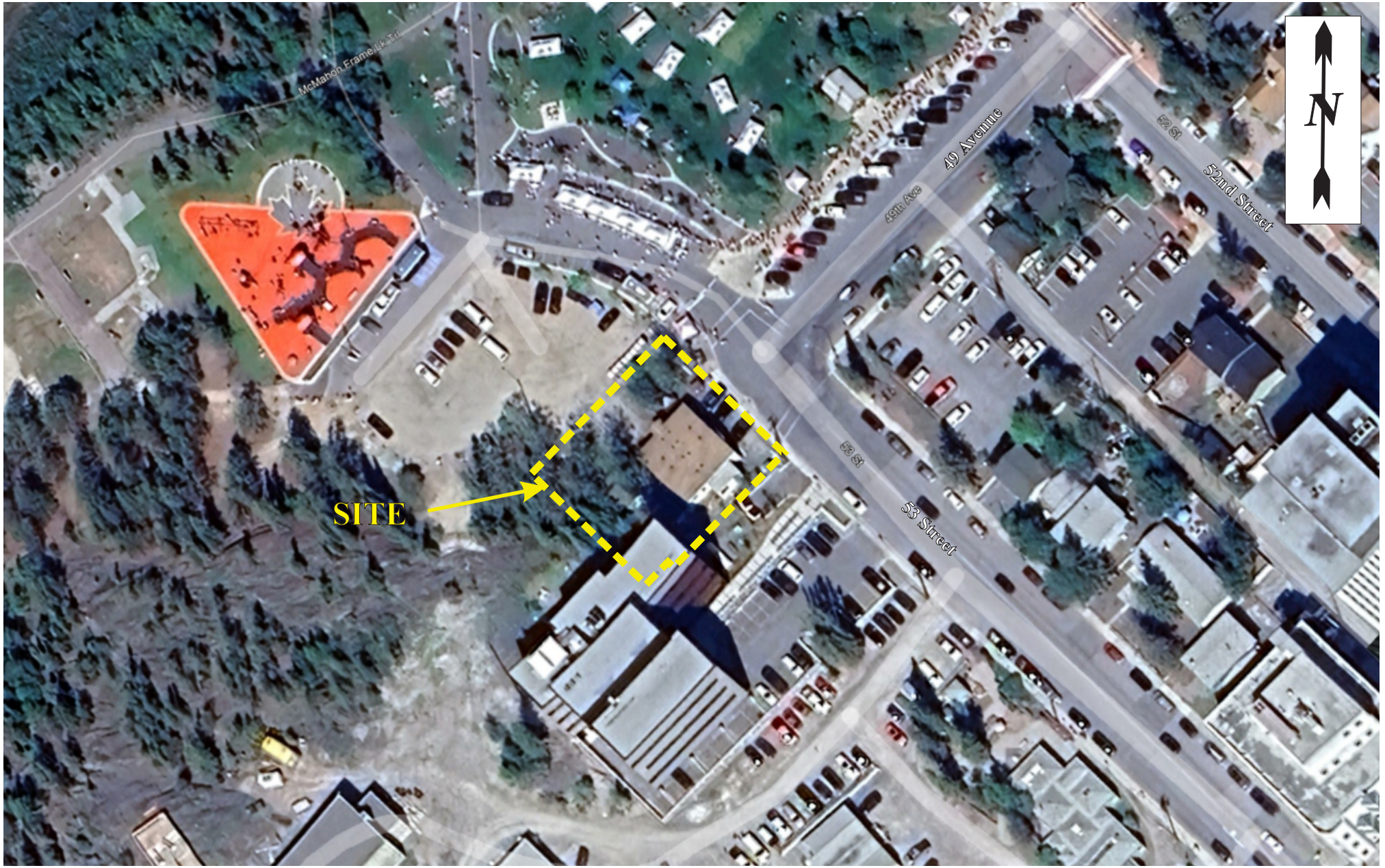
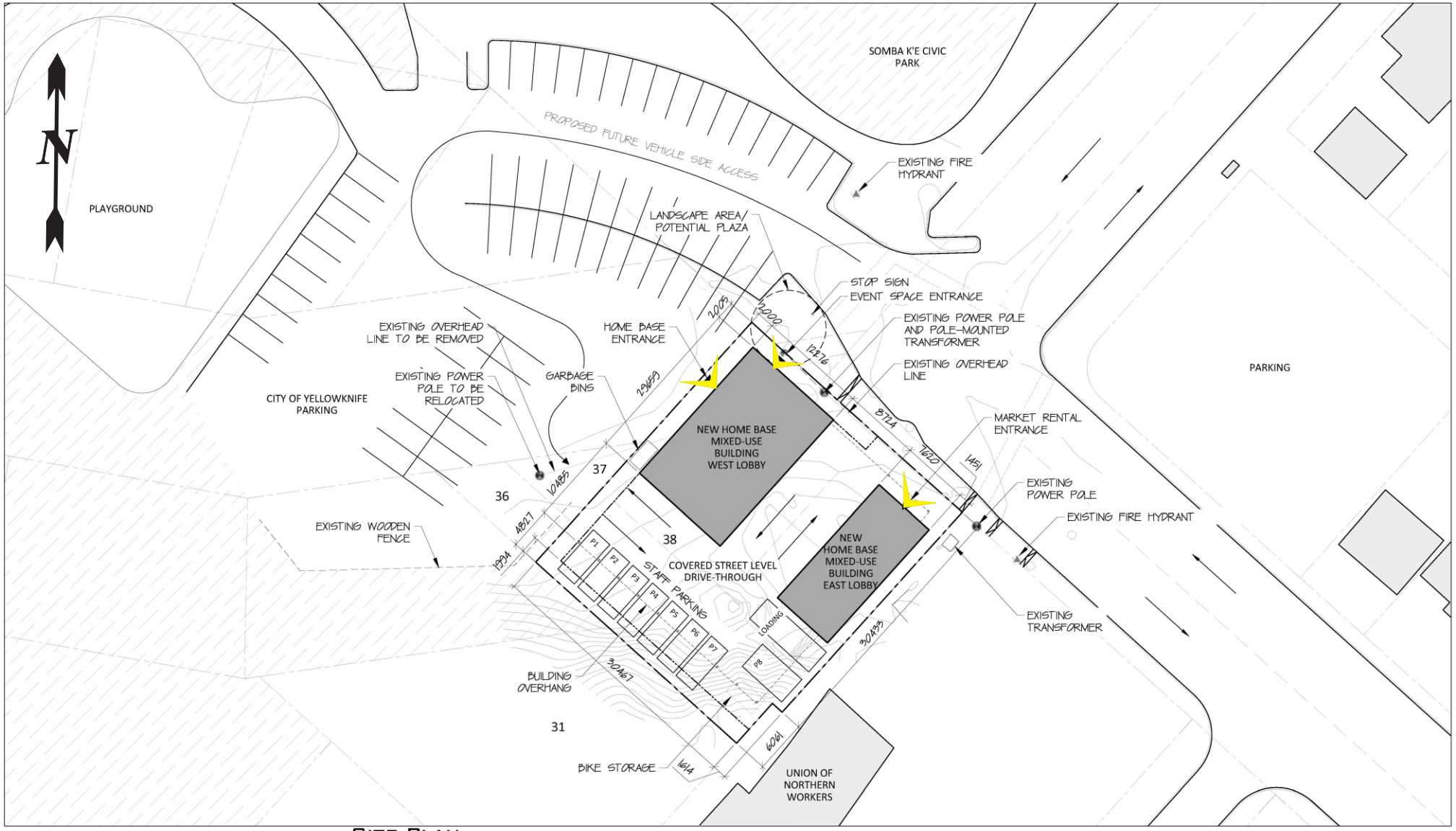


Figure 2a: Site Plan



TAYLOR ARCHITECTURE GROUP

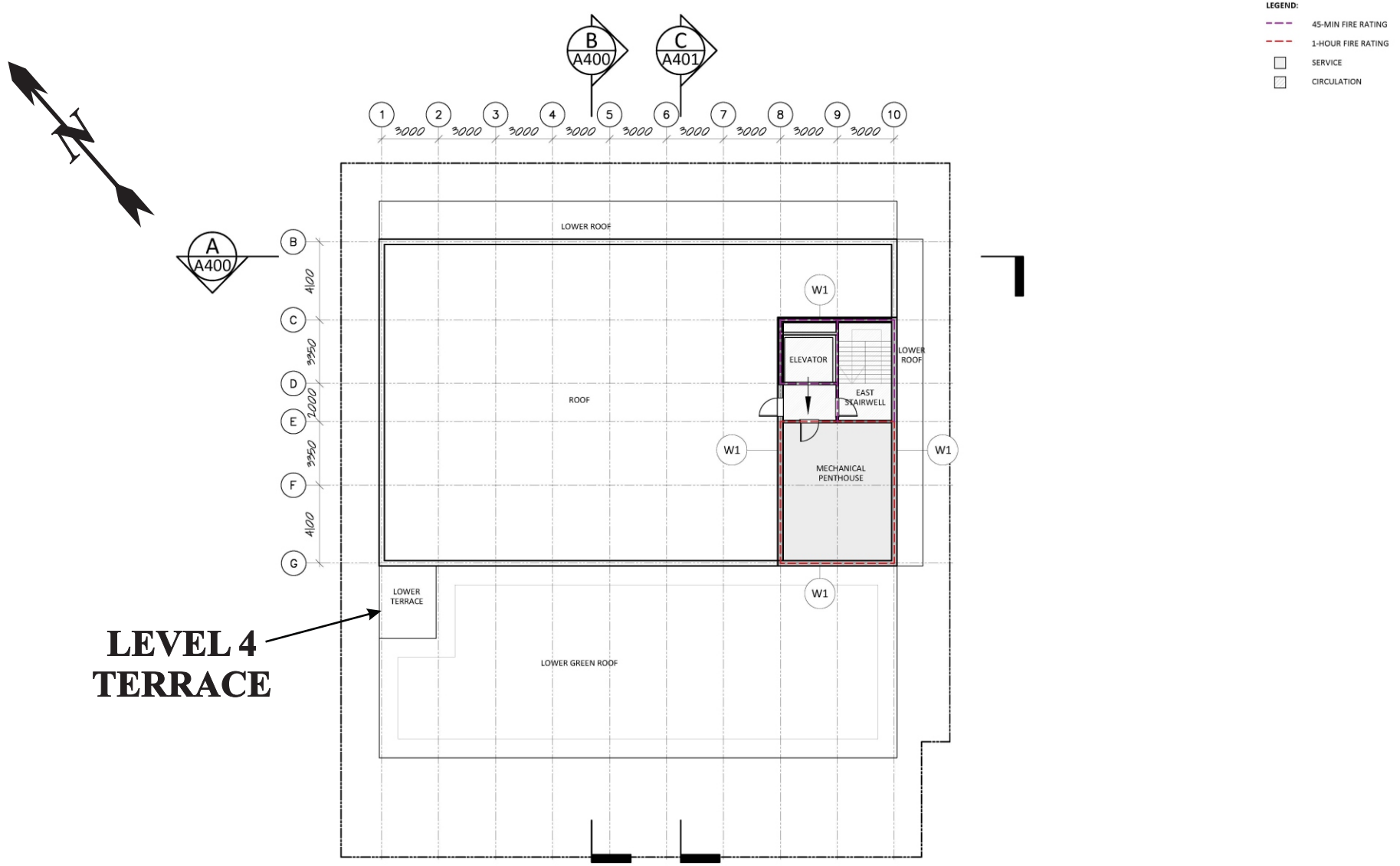
SITE PLAN

Home Base Mixed-Use Building Yellowknife, NT
August 19, 2024 Home Base Yellowknife
Schematic Design

project north
true north

A100
1:400

Figure 2b: Roof Plan



TAYLOR ARCHITECTURE GROUP

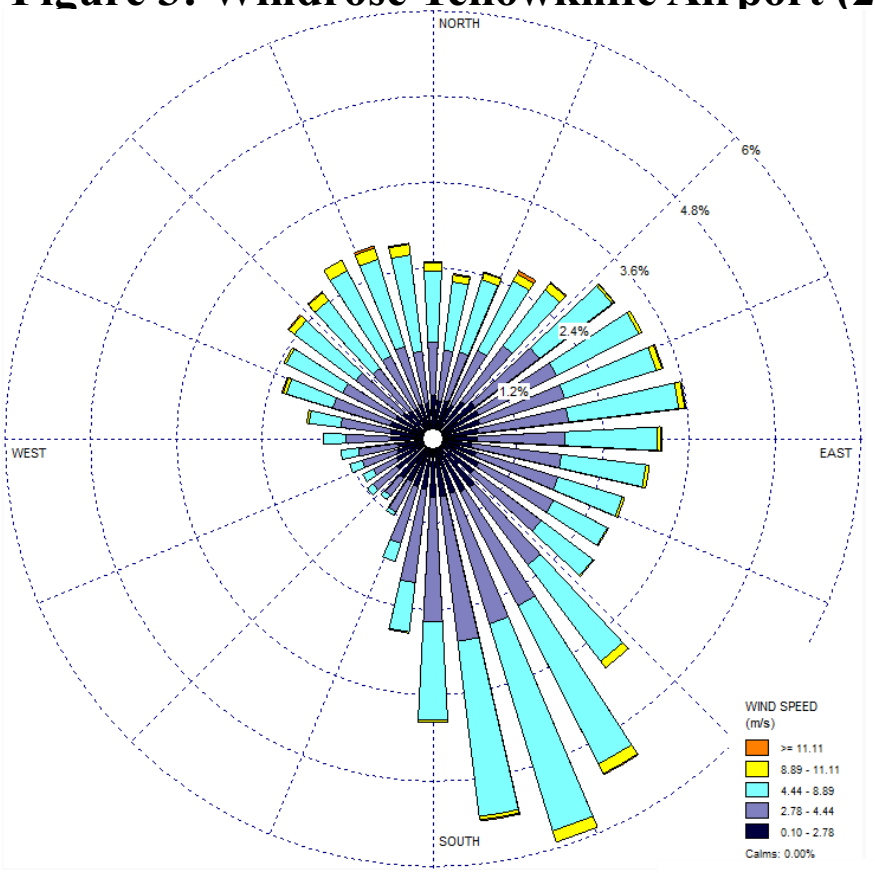
ROOF

Home Base Mixed-Use Building Yellowknife, NT
August 19, 2024 Home Base Yellowknife
Schematic Design

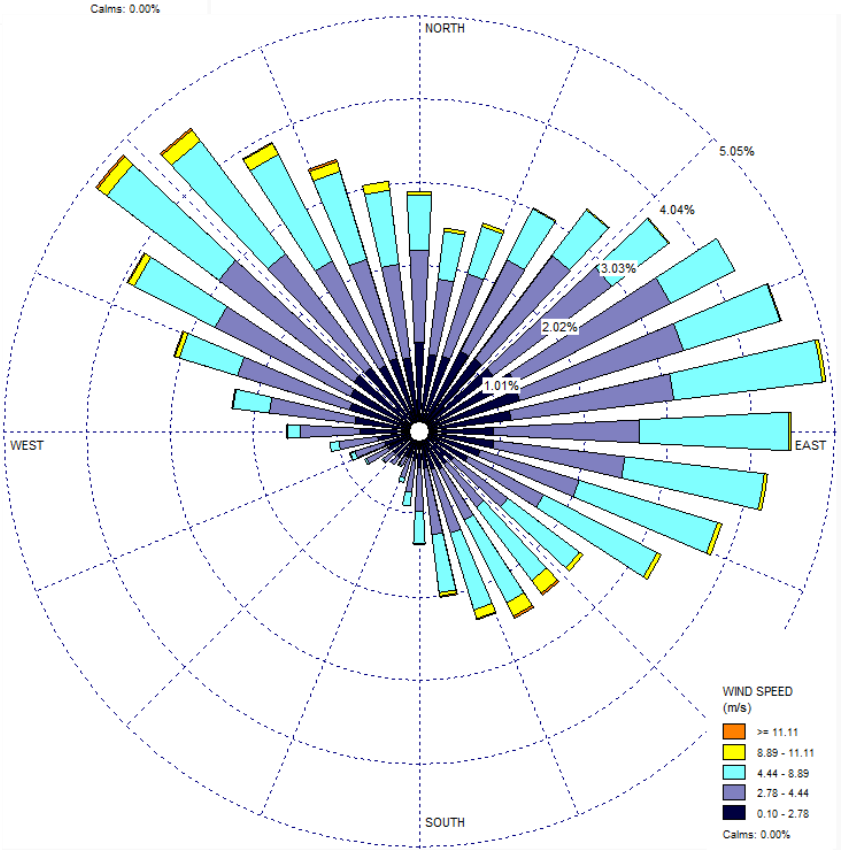
project north
true north

A110
1:200

Figure 3: Windrose Yellowknife Airport (2014 - 2025)



Summer - May through September



Winter - October through April