

FINAL

# Snow Drifting Assessment Report

Highway 413 Preliminary Design and Assessment of Environmental Impacts

December 2025



## RWDI Statement of Qualifications and Limitations

This report entitled, Highway 413 Preliminary Design and Assessment of Environmental Impacts (Highway Snow Drifting Assessment), dated December 2, 2025, was prepared by RWDI AIR Inc. (“RWDI”) for the Ontario Ministry of Transportation (“Client”). The assessment and recommendations presented in this report are based on the design drawings provided to RWDI on August 19, 2025. The interpretation of wind and snow patterns determined by this snow drift assessment is applicable to the particular study area and road configuration examined, and the existing surroundings.

It should be noted that snow removal operations themselves may impact snow deposition on the roadway. Snowbanks from snow clearing operations and any concrete safety barriers may obstruct wind flow and initiate additional drifting downwind. It is the responsibility of the MTO to assess the appropriateness and safety of the snowdrift conditions on the proposed highway throughout the course of the winter and to act accordingly for user safety.

In the event of any significant changes to the design or construction of the proposed highway or snow barriers, or changes to the immediate surroundings in the future (within a 3 km radius of the centre line), 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.

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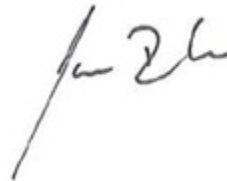


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## Acronyms

**407 ETR**      **407 Express Toll Route**

**AECOM**      **AECOM Canada ULC**

**cm**            **centimetre**

**ECCC**        **Environment and Climate Change Canada**

**km**            **kilometre**

**KM/H**        **kilometres per hour**

**m**             **metre**

**MTO**         **Ontario Ministry of Transportation**

**ROW**         **Right-of-Way**

**STP**          **Snow Transport Potential**

**WSP**         **WSP Canada Inc.**

# Executive Summary

The Ontario Ministry of Transportation (MTO) has retained WSP Canada Inc. (WSP) and AECOM Canada ULC (AECOM) in collaboration with various sub-consultants and technical firms to undertake the Highway 413 Preliminary Design and Assessment of Environmental Impacts, hereinafter referred to as “the Project”. The Project is following the requirements of the Highway 413 Act, 2024.

The focus of the current assessment was to predict the potential for snow drifting conditions that could interfere with road operability or visibility. This report provides a description of the local meteorological conditions, the snow drift potential results, and recommendations for improved conditions as well as general principles for highway design from a snow control perspective.

Due to the exposure and openness of the surrounding terrain in most areas around the proposed highway and the road alignment in context of the prevailing winds, most sections of the proposed highway are expected to have a moderate to high potential for problematic wind-driven snow accumulations. However, these can be ameliorated with road designs that take advantage of the strong wind exposure to scour snow from the road, or other forms of mitigation.

General best-practice considerations for highway design from a snow perspective are provided in Section 2 of this report. Specific mitigation recommendations for key areas of the proposed highway identified with a moderate to high potential for adverse snow drifting conditions are discussed in Section 4. These include reinforcing existing vegetation; incorporating living or conventional wind screens; and/or promoting wind scour by keeping the proposed highway elevated relative to the surrounding terrain with smooth transitions to keep wind flows attached as they pass across the road.

It is recommended that wooded areas within a 3 km radius from the proposed highway be retained for snow control. However, it is noted that MTO’s jurisdiction and control will be limited to the highway ROW. The wetland and/or forest restoration opportunities may be beneficial for blowing snow and snow drift control.

Implementing these strategies are expected to reduce the frequency of problematic snow drifting and of poor visibility due to wind-driven snow. Further, a strategic design or mitigation approach can offer cost savings on snow removal efforts. Where these measures are infeasible due to other design constraints, RWDI recommends that increased observation and maintenance efforts be considered to achieve a similar performance.

# 1. Introduction

## 1.1 Project Overview

The Ontario Ministry of Transportation (MTO) has retained WSP Canada Inc. (WSP) and AECOM Canada ULC (AECOM) in collaboration with various sub-consultant and technical firms to undertake the Highway 413 Preliminary Design and Assessment of Environmental Impacts, hereinafter referred to as “the Project”.

The Project is following the requirements of the *Highway 413 Act, 2024*.

The Project includes the 52-kilometre (km) Highway 413 corridor, a 4 km extension to Highway 410, and a 3 km extension to Highway 427 (both facilitating connections to the Highway 413 corridor), for a total of 59 km of new infrastructure (**Figure 1-1**). The highway will have 11 interchanges at municipal roads. Features such as stormwater management ponds, service centres, carpool lots, commercial vehicle inspection facilities, maintenance facilities, and the potential for electric vehicle charging stations, have been explored as part of Preliminary Design.

Highway 413 will connect Highway 401 and Highway 407 ETR (Express Toll Route) in the Regional Municipality of Halton and the Regional Municipality of Peel with Highway 400 in the Regional Municipality of York.

The typical Right-of-Way (ROW) will be 170 metres (m) which includes 110 m for the typical mainline highway and 60 m for a proposed transitway. A multi-use trail (MUT) parallel to Highway 413 may be accommodated within the proposed transitway ROW. The right-of-way is expanded at interchanges and high fills areas to accommodate ramps to/ from the crossing roads, as well as in locations with ancillary highway facilities as mentioned above. The Preliminary Design consists of a typical 6-lane cross-section (3 lanes in each direction) with a grassed median. The ROW has been designed to accommodate up to 10-lanes (5 lanes in each direction) should future traffic conditions warrant additional capacity. These additional lanes would be provided by widening the highway towards the median.

The proposed transitway will be a separate corridor running alongside the highway, dedicated for public transit, including stations to facilitate passenger access at key locations. The proposed transitway and stations will be subject to a separate future assessment of environmental impacts.



The future Highway 413 is expected to:

- Relieve traffic on local roads and parallel highways;
- Help accommodate travel demand;
- Reduce travel times for commuters and goods movement;
- Reduce the social, environmental, and economic costs of congestion;
- Provide greater connectivity between urban growth centres;
- Provide better connections to residential and employment lands; and
- Provide an alternate route in the event of an incident or road closure on local and regional roads.

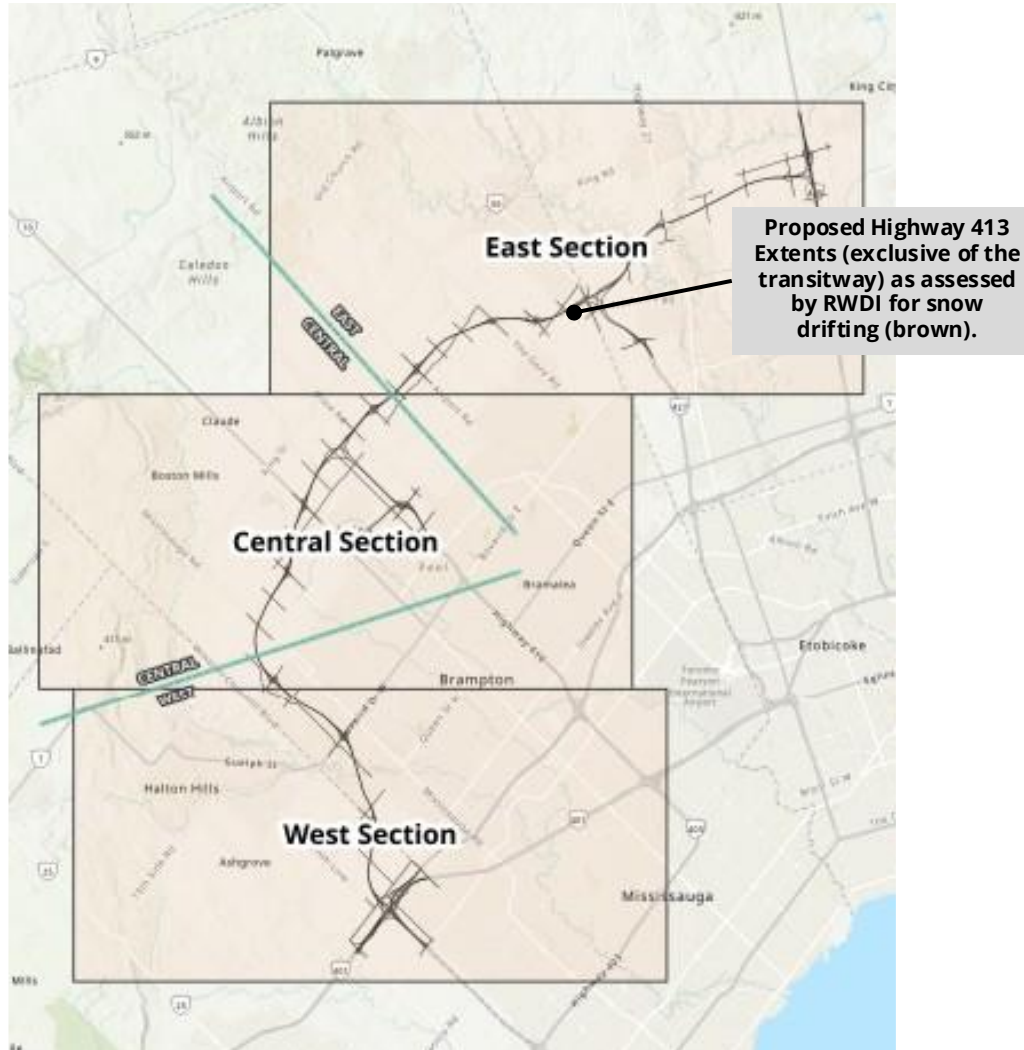
## 1.2 Purpose of Report

This report documents the Highway Snow Drifting Assessment of the Preliminary Design associated with the Highway 413. Readers are encouraged to view this report in its entirety. The purpose of the study was to quantify the potential for the proposed highway to experience undue snow drifting conditions, and to recommend strategies to minimize adverse snow conditions, where feasible. The focus of the assessment was the potential for snow drifting conditions that could interfere with road operability or visibility.

## 1.3 Study Area

This proposed highway corridor will extend from Highway 400 (between Kirby Road and King-Vaughan Road) in the east, to the Highway 401/407 ETR interchange area in the west, connecting the regions of York, Peel, and Halton, and will feature a 400-series highway, a transitway, and potential goods movement priority features (**Figure 1-2**). The Project includes the proposed 52 km Highway 413 corridor, a 4 km extension to Highway 410, and a 3 km extension to Highway 427, for a total of 59 km of new infrastructure. The total proposed ROW will be 170 m (110 m for the highway and 60 m for the transitway).

**Figure 1-2: Study Area Along Proposed Highway 413  
(Extents Indicated in Brown)**



## 2. Methodology

### 2.1 Background Information Review

The assessment is based on:

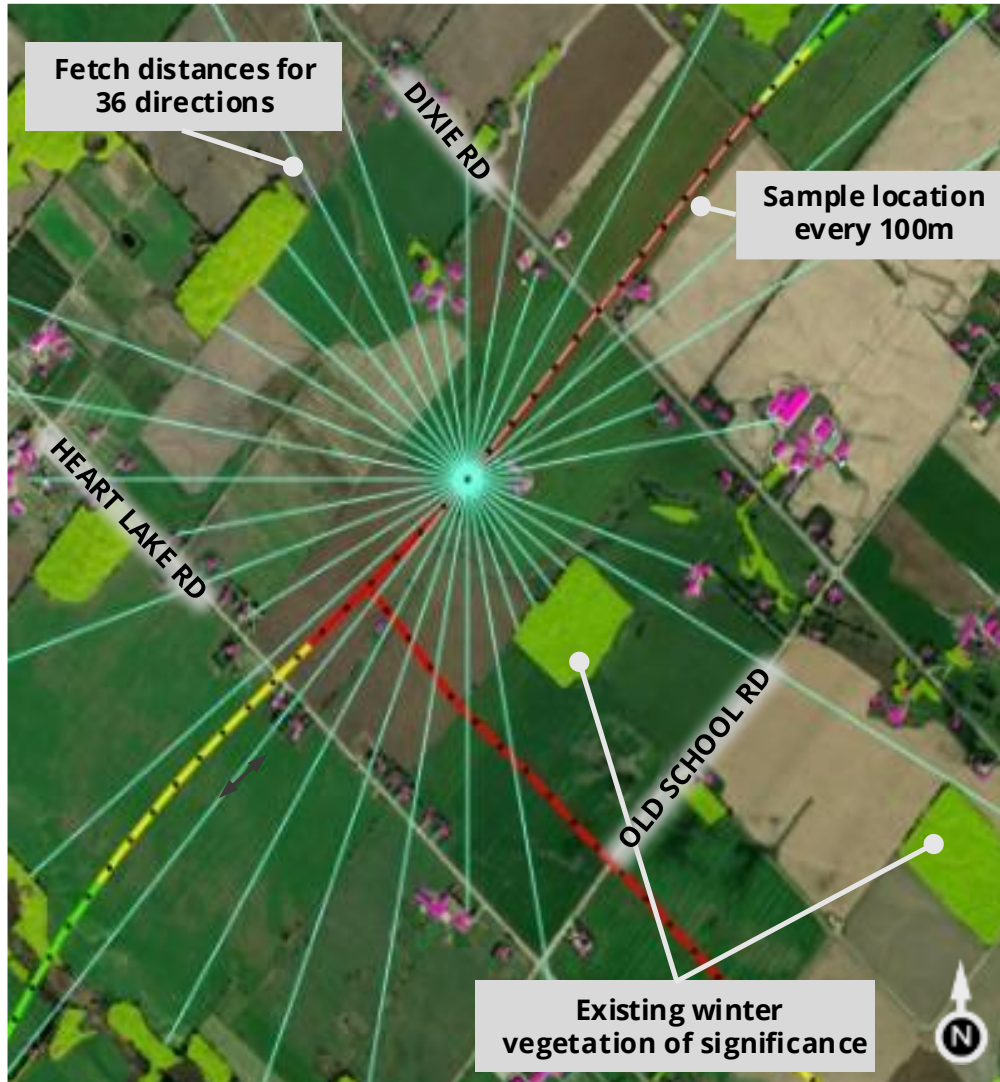
- Road alignment drawings received on August 19th, 2025;
- A review of the local topography and upwind terrain conditions along the proposed highway;
- A numerical analysis of the potential volume of snow to reach the proposed highway, called the snow transport potential (STP);
- An understanding of the local meteorological conditions using weather data obtained from Toronto Pearson International Airport for the period of 1953 to 2020; and,
- RWDI's expertise with regards to wind and snow behaviour.

### 2.2 Snow Transport Potential

To understand the potential for snow to be wind-driven to the site, in addition to snow which falls directly on the road, an assessment of the upwind terrain with respect to the area of interest was undertaken. It is known that areas of the proposed highway that are surrounded by open fields are more exposed to wind action and are therefore susceptible to problematic drift conditions. These areas typically require increased snow removal efforts.





For every 100 m section of proposed highway, a radial analysis was performed over the surrounding area to determine the nearest snow boundary identified in the figures in Appendix A (example in **Figure 2-1**). A snow boundary is a feature such as a dense row or grouping of trees, a large ditch, buildings, a wind screen, etc. that would define the start of an open area where snow could be blown towards the site. A fetch distance is the distance upwind from the edge of the proposed highway to the nearest major boundary. In our analysis, fetch distances for 36 compass points were calculated at each representative location (aqua lines in **Figure 2-1**). This information was combined with surface roughness (i.e., open field, pasture, dense shrubs, etc.), as well as wind directionality and frequency to determine the STP for each 100 m section of the proposed highway.

**Figure 2-1: Example Snow Boundary Analysis of the Proposed Highway 413 Between Dixie Road and Highway 410 Extension (Satellite Imagery Courtesy of ArcGIS) Location 261**



Once determined, the STP criterion (**Table 2-1**) is used to evaluate the potential for snow to cause adverse conditions over an area of interest. The STP was determined by comparing the snow transport at the representative location on the proposed highway relative to the snow transport potential for the same area where it is surrounded by completely open terrain (worst case). The STP is expressed as a percentage of the snow transport for a reference open site with no snow barriers within a 3 km radius.

**Table 2-1: Snow Transport Potential Criteria**

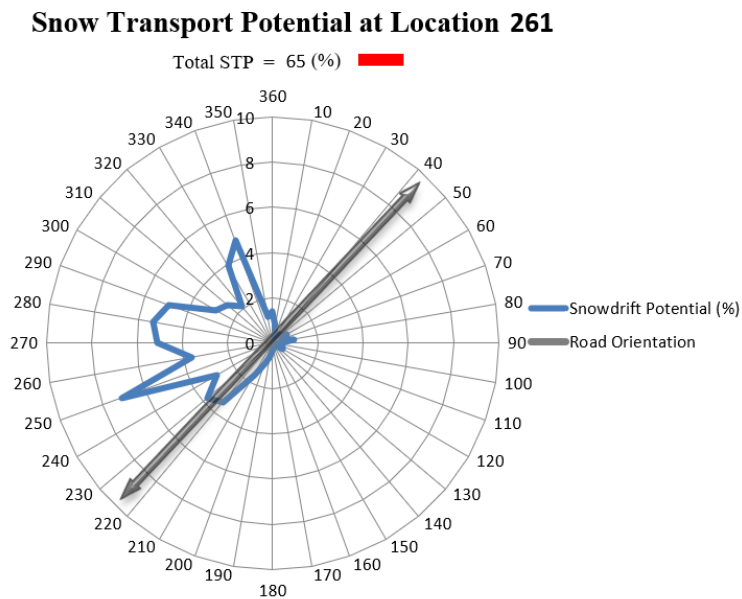
STP%	Description
 <b>Insignificant 0-20%</b>	Little potential for undue snow drifting (beyond that which falls directly). Likely well-sheltered by nearby forests or in an urban environment.
 <b>Low 21-40%</b>	Some potential for additional snow accumulation but typically handled by routine snow clearing practices.
 <b>Moderate 41-60%</b>	An increased frequency of snow drifting that may be problematic or hazardous is anticipated. Typically characterized by open terrain, a cut zone, and/or a rapid transition from a sheltered to exposed wind environment (drivers may not be prepared to adjust). Mitigative strategies and/or increased maintenance frequency should be strongly considered.
 <b>High &gt;60%</b>	A high STP evaluation indicates an area where there is likely to be (or known to be) significant, routine exposure to problematic snow conditions. Mitigation should be implemented.
<i>Where 100% equates to an open reference site.</i>	

Based on our experience, if the STP percentage is approximately 60% or greater for a given location, it is considered to be high, and mitigation is needed. An STP in the range of 40% to 60% is a moderate snow drifting condition, and remedial action may need to be considered. An STP between 20% and 40% is considered low, and below 20% suggests that an insignificant snow drifting condition is anticipated, and mitigation would not typically be considered. Areas of the proposed highway where snow control strategies should be considered are presented in Section 4. In general, areas that are surrounded by open fields that are in alignment with the prevailing winds, or road fetches that are lower in elevation than adjacent topography, have a high STP.

An example of the STP analysis for the section of proposed highway associated with Location 261 is shown in **Figure 2-2** on the next page.

The snow boundaries and fetch distances (i.e., upwind area serving as source for blowing snow) were measured for 645 regions along the proposed highway. An example of the STP analysis for the section of proposed highway associated with Location 261, which has an STP of 65%, is shown in **Figure 2-2**. The diagram in **Figure 2-2** combines the local wind distributions and the fetch distances associated with snow transport at that location.

**Figure 2-2: Example STP Analysis for Location 261**



## 2.3 Meteorological Analysis

### 2.3.1 Summary of Meteorological Analysis

The analysis of long-term weather data from Toronto Pearson International Airport (1953-2020) identified predominant wind directions associated with drifting snow. Winds greater than 15 km/h, especially during snowfall or blowing snow events mainly come from the west, west-southwest, and north-northwest, with a secondary component from the east.

Environment Canada climate normals from Toronto Pearson International Airport (1991-2020) show an average annual snowfall of 114.5 cm, with average winter snow depths between 2 and 7 cm, and extreme events up to 30 cm in a day. An extreme value analysis of peak daily snowfall events indicated that a 13 cm snowfall event occurs annually, while a 25 cm event has a 10-year recurrence interval.

Based on Environment climate normals from Toronto Pearson International Airport (1991-2020), the number of days with maximum temperatures below 0°C, which affects snow drifting potential, averages 49.5 days per year, indicating significant potential for drifting snow in the region.

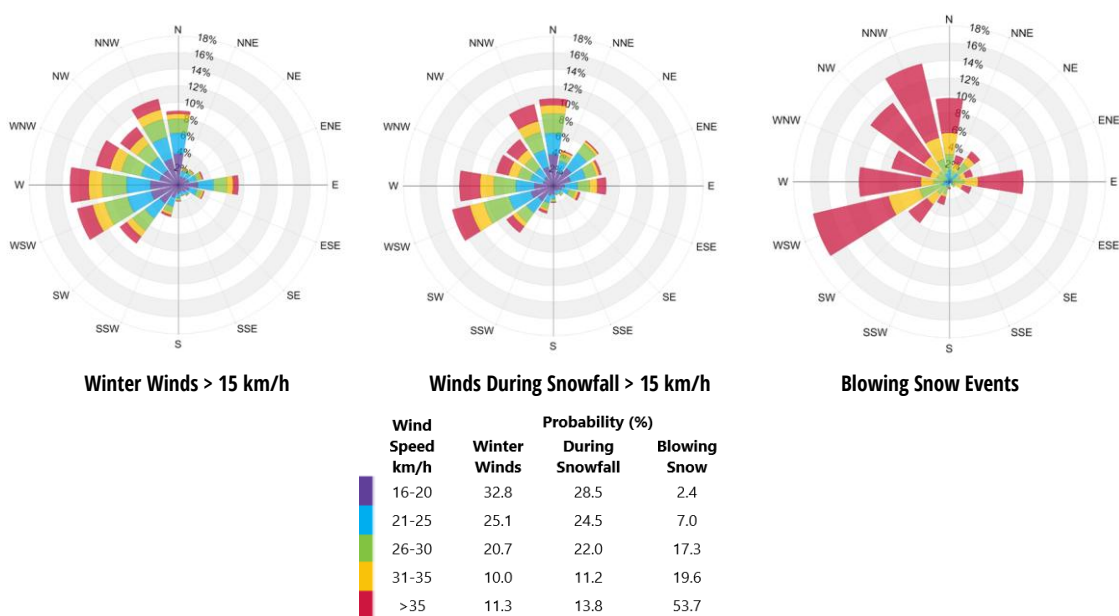
### 2.3.2 Snowfall and Wind

To determine the prevailing wind directions which would be associated with drifting snow at the project site, long-term weather data recorded at Toronto Pearson International Airport (for the period of 1953 to 2020) were analyzed. The following analyses of the winter winds determined the predominant direction/frequency of winds associated with drifting snow:

- All winter winds greater than 15 km/h;
- Winter winds greater than 15 km/h with snowfall; and
- Winter winds with blowing snow events.

The movement of drifting snow at wind speeds less than 15 km/h is negligible, so this threshold wind speed was used to filter for the predominant wind directions that could potentially create snow drifting problems around the study site. The wind speed is measured at the weather station using an anemometer, which is typically located on a mast approximately 10 m above the ground. Winter winds with blowing snow represent higher wind speeds often associated with storm events and significant drifting. As shown in the adjacent snow roses in **Figure 2-3**, each of the analyses illustrate the predominance of winds from the west, west-southwest, and north-northwest, with a secondary component from the east. The probabilities shown in the table are relative percentages of occurrences for each meteorological dataset.

**Figure 2-3: Directional Distribution of Winds Approaching Toronto Pearson International Airport (1953 to 2020 From November to April)**

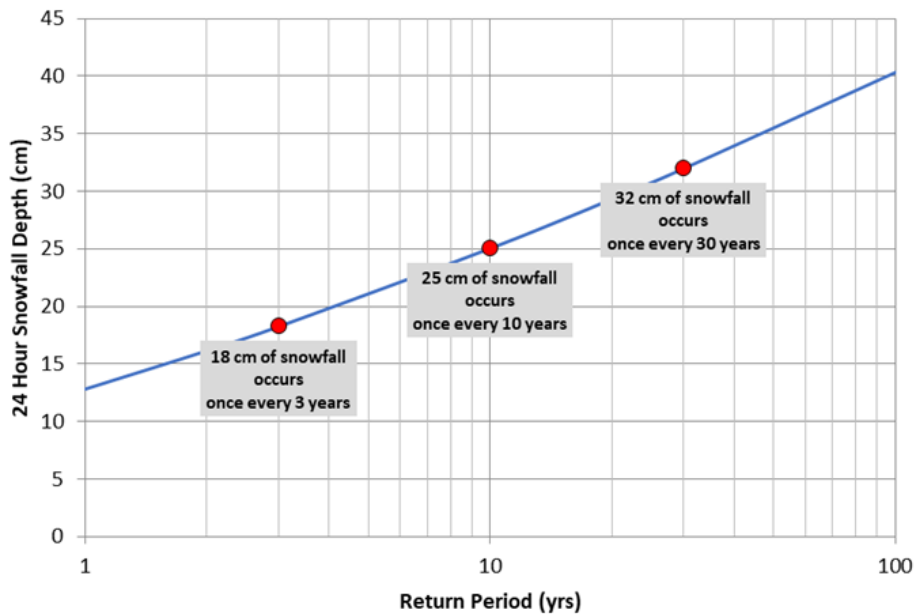


### 2.3.3 Snow Depths

To understand the potential volumes of snow that fall at the site, climate normals from Environment Canada and snowfall data from Toronto Pearson International Airport were considered. In the Toronto area, there was an average of 114.5 cm of annual snowfall between 1991 and 2020 (courtesy of Environment Canada climate normals). The average snow depth for the winter months ranges between 2 and 7 cm, however, snowfall events up to 30 cm in a single day were also recorded in Toronto, with total snow depths up to 67 cm.

An extreme value analysis of the peak daily snowfall amounts was conducted to determine the severity of the snow events in the historical record as provided by Environment Canada from the Toronto Pearson International Airport weather station. A Fisher-Tippett Type I distribution was selected to fit the data. As shown in **Figure 2-4**, a winter storm producing approximately 13 cm of snowfall in a single 24-hour event occurs once a year on average, and a winter with a 24-hour snowfall event of 25 cm of snow has a mean recurrence interval of 10 years.

**Figure 2-4: 24-Hour Snowfall Depth vs. Frequency of Occurrence (Return Period) Based on Meteorological Data Measured at Toronto Pearson International Airport (from 1953 to 2020)**



### 2.3.4 Temperature Considerations

While snowfall and wind directionality provide information on where the snow will drift from and how much snow could drift, another consideration is the number of days with a maximum temperature less than 0°C. This number reflects the potential for freeze/thaw cycles, which will influence the potential for drifting. If there are only few days with maximum temperatures below freezing (i.e., 0 to 15 days) then snow drifting will not be as significant, as the snow will melt or fix in place before it can drift. If there are a considerable number of days (i.e., greater than 30), these colder temperatures indicate there is less melting, and thus more snow is available for drifting.

The 30-year normals between 1991 and 2020 (provided by Environment Canada) for the Toronto Pearson International Airport Station to the project site indicate that the average number of days per year with a maximum temperature below or equal to 0°C is 49.5 days. This represents a significant period of time during which snow is more likely to be in a driftable state and indicates a regional potential for drifting snow.

## 2.4 Design Guidelines

The following section presents several best-practice considerations for new roadway design from a snow perspective. Following these guidelines will reduce the potential for problematic snow drifting and poor visibility conditions associated with wind-blown snow. Where meeting these guidelines is not feasible for other design considerations and/or there is a high potential for problematic snow conditions, mitigation measures such as upwind wind screens, ditches, or additional snow removal efforts may be considered to improve snow drifting and accumulation at the proposed highway in the key areas as presented in **Section 4**.

It should be noted that snow mitigation does not address snow that lands directly over the road and will not prevent all available snow from nearby surroundings from reaching the proposed highway. As a result, instances of reduced visibility and snowdrift formation will still occur. However, the strategies presented herein will improve the performance with respect to wind-driven snow.

## 2.4.1 Summary of Design Guidelines

- Keep roadways elevated preferably 1 to 2 m above the surrounding terrain where possible.
- If possible, keep batter slopes shallow. Sharp transitions increase the likelihood of snow deposition. Conversely, shallow slopes combined with wind exposure promotes snow scour and improved visibility conditions.
- Where screens or hedgerows are intended adjacent to the proposed highway, RWDI recommends a setback distance of approximately 15x the height between the feature and the edge of the road. If this is not feasible, strategies such as ditches or multiple rows of coniferous trees may be considered to trap snow. Otherwise, the barrier is likely to propagate drifts over the road.
- Where possible, avoid berms adjacent to the proposed highway, as they act as a wind barrier and are likely to propagate snow formations over the road. A ditch between a berm and the proposed highway is a positive countermeasure for snow capture where berms may not be set back at a sufficient distance.
- It is recommended that wooded areas within a 3 km radius from the proposed highway be retained for snow control. However, it is noted that MTO's jurisdiction and control will be limited to the highway ROW. The wetland and/or forest restoration opportunities may be beneficial for blowing snow and snow drift control.

In general, there are two main approaches to snow control for highways. A primary consideration for new highway design is to create a road profile that is elevated relative to the surrounding topography with shallow side slopes (**Section 2.4.1**). This promotes keeping the approaching wind flows attached as they pass over the road, allowing snow to be entrained by the wind and carried past the proposed highway. With the right profile and road exposure, fetches of the proposed highway associated with moderate or high STP may not be as problematic as the wind may be harnessed advantageously. Sharp transitions create turbulence, which leads to snow deposition and drifting. An elevated road profile exposed to wind action is a long-term solution that is more permanent than typical wind screening. Further, retroactive elements such as wind screens and landscaping require maintenance and may be affected by changes to land ownership. For this reason, the profile treatment is considered a more resilient approach.

Where an aerodynamic road profile is not feasible, another approach is to trap snow upwind of the proposed highway. Introducing a physical barrier creates a low-wind zone where snow will settle out of the airstream and deposit before reaching the area of interest – essentially forcing a snowdrift to form off to the side in a controlled manner. This strategy can be achieved through the use conventional wind screens (**Section 2.4.2**) or landscaping, including living wind screens (**Section 2.4.3**). Ditches are often recommended in conjunction with these measures, as the required setback distance for

a snow barrier is often beyond the ROW. The side of the road on which barriers should be implemented depends on the local wind directionality and orientation of the proposed highway. Landscaping and wind screen dimensions can be provided based on the feasibility of mitigation in each area and the amount of property available on either side of the proposed highway.

## 2.4.2 Local Topography & Batter Slopes

The local topography around the roadway has an influence on the severity of snow accumulations. In general, there are three types of road cross-section: fill, even, and cut. Where feasible, a fill scenario with shallow side slopes is recommended to reduce the potential for snow deposition on the proposed highway.

### Fill

A fill situation is where the top of the road surface is elevated above the surrounding natural terrain, with sloping sides. When side slopes are steep, wind flows over the road surface will create turbulence, resulting in snow accumulations and/or drifting on the proposed highway, as well as the potential for reduced visibility. Per the Guidelines for Controlling Snowdrifting on Canadian Highways, batter slopes approaching 1:7 or shallower are recommended to support keeping the wind flows attached and the snow particles entrained over the roadway. We understand the proposed highway design includes 1:6 slopes, which is anticipated to perform well and is close to the recommendations of the Guidelines for Controlling Snowdrifting on Canadian Highways.

To improve overall exposure, the fill sections of the road should be designed to be at a minimum of 1m above the surrounding natural terrain, although 2 m above is preferred. While concrete safety barriers in the middle of the proposed highway will also induce turbulence, this 1 to 2 m exposure is still expected to offer a significant benefit from a snow perspective.

### Even

An even situation is where the top of the road surface is within  $\pm 50$  cm of the surrounding natural terrain. This case would be where the road slopes toward the ditch, and beyond the ditch the ground is relatively level with the paved surface of the road. In this case, wind passing over the terrain will tend to deposit snow and fill in depressions such as shallow ditches, effectively creating a smooth, uniform surface. Snow deposition is routinely expected over the road, though it will be aerodynamically limited and typically in uniform formations (assuming the absence of snow piles from plowing

activities). Where possible, shallow side slopes of 1:7 or shallower and elevating the proposed highway to a minimum of 1m above the surrounding natural terrain is recommended to improve exposure. Alternatively, mitigation that collects snow upwind may be considered (**Sections 2.4.2 and 2.4.3**).

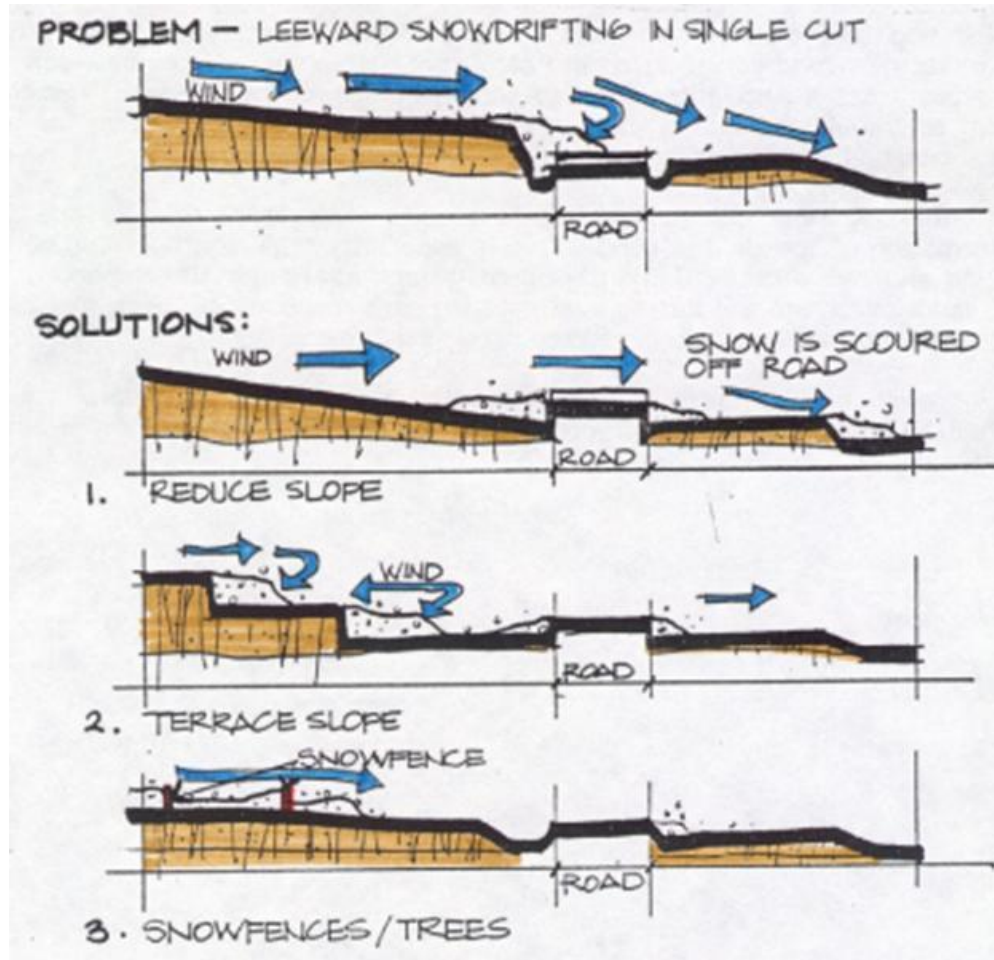
## Cut

A cut situation is where the top of the road surface is below the original natural terrain by at least 50 cm. In this situation, whether it is a double cut (on both sides of the proposed highway) or single cut (one side), the steepness of the side slopes minimizes the exposure to wind flows (unfavourable). This wind-sheltered cut zone allows for heavy snow deposition, which cannot be blown out. This can result in significant accumulations on the road, as well as reduced visibility. Where a cut situation is unavoidable and the road will be lower than the surrounding terrain, options to improve conditions include: utilizing shallow approaching slopes of 1:7 or shallower (**Figure 2-5(1)**); using terraced back-slopes to collect the snow before it reaches the road (**Figure 2-5(2)**); and/or using wind screens or strategic landscaping upwind to capture snow before it reaches the cut (**Figure 2-5(3)**).

Berms adjacent to the highway create similar conditions to the cut scenario. If possible, berms are recommended no closer to the proposed highway than 15 times their height so that drifts remain off to the side. This is particularly relevant for any berms or similar obstructions on the west and north sides of the proposed highway. Alternatively, a large ditch with the capacity to carry the maximum volume of snow expected in a design winter is recommended on the leeward side of the berm.

Where a cut situation occurs together in an area with a high potential for problematic snow drifting, there is an increased potential for hazardous conditions. Mitigation measures are strongly recommended in these cases.

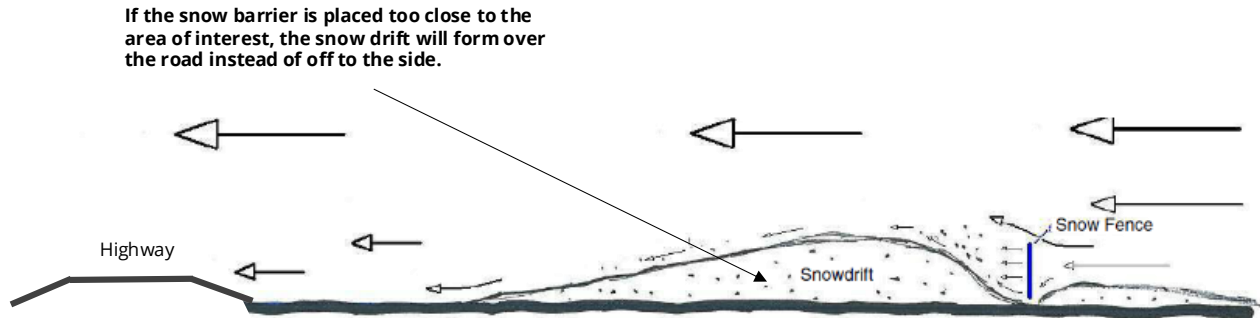
**Figure 2-5: Examples of Possible Solutions to Improve Snow Drifting on a Roadway in a Single Cut Scenario**



### 2.4.3 Wind Screens

A wind screen can be designed to collect snow before it reaches an area of interest (Figure 2-6). As outlined in Figures 2-7 and 2-8, the primary action of a wind screen is to locally slow wind speeds such that entrained snow is precipitated out into a drift formation in an area that will not pose a concern. A wind screen would need to be designed to have sufficient height to collect the anticipated volume of snow that may be transported to the site over the winter months and be located sufficiently upwind to provide an adequate catchment area.

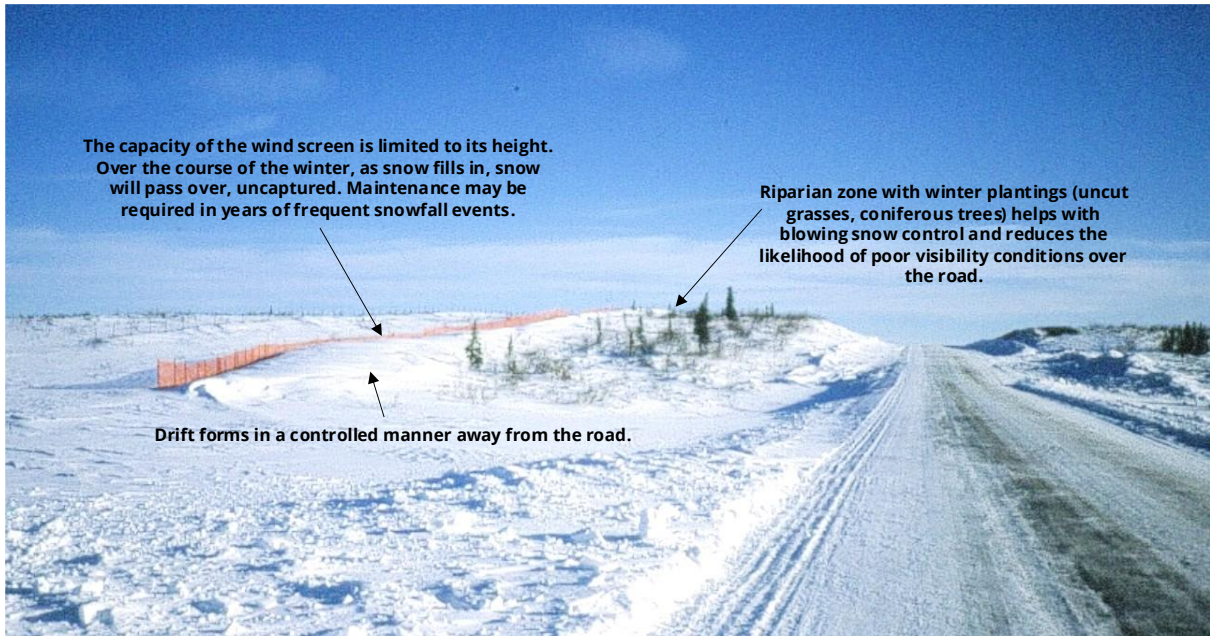
**Figure 2-6: The Importance of a Setback Distance**



**Figure 2-7: Example of a Conventional Wind Screen**



**Figure 2-8: Example of Good Design of Wind Screen and Plantings for Snow Control**



## 2.4.4 Landscaping

The addition of landscaping can be beneficial in reducing snow accumulations at a site. Landscaping such as coniferous trees, hedges, shrubs, corn rows and ground cover, often referred to as living wind screens, can reduce the potential for snow to drift or become air-borne when properly designed and installed. However, improperly locating landscaping features may result in an increase in snow volume over the proposed highway.

### Ground Cover

It is generally assumed that any ground cover (**Figure 2-9**) will hold approximately half its height in snow depth. Therefore, if the ground cover is 50 cm in height, it will retain 25 cm of snow and not allow the snow to drift in significant volumes. Planting ground cover is a typical approach on the embankments surrounding the proposed highway and in areas in and surrounding interchanges. 50 cm tall ground cover should be no closer than 2.5 m from the shoulder edge, to reduce local drifting along the roadway.

Examples of ground cover include long native grasses, shrubs and any other plant of a similar height. It should be noted that if grasses are relied on, they should not be cut prior to the winter

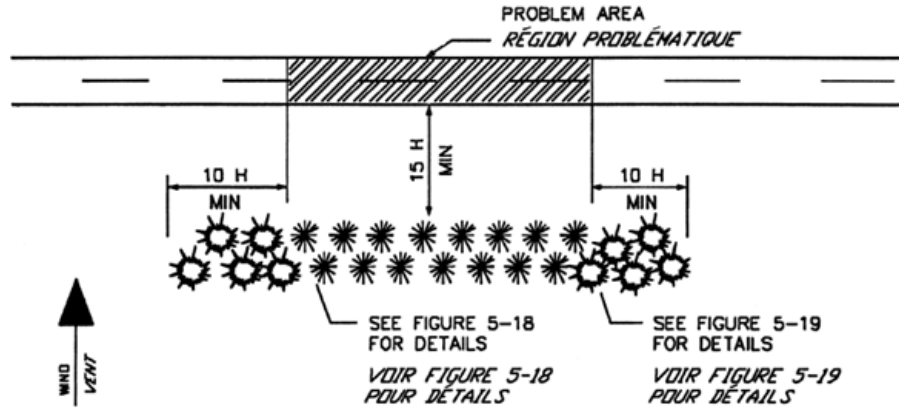
**Figure 2-9: Example of Ground Cover**

### Dense Landscaping

One of the most effective methods of limiting snow transport is the use of dense landscaping, or a living wind screen. While this method may not be immediately effective, as the trees need to be a certain height/maturity in order to be useful, it does provide a long-term measure with low maintenance costs.

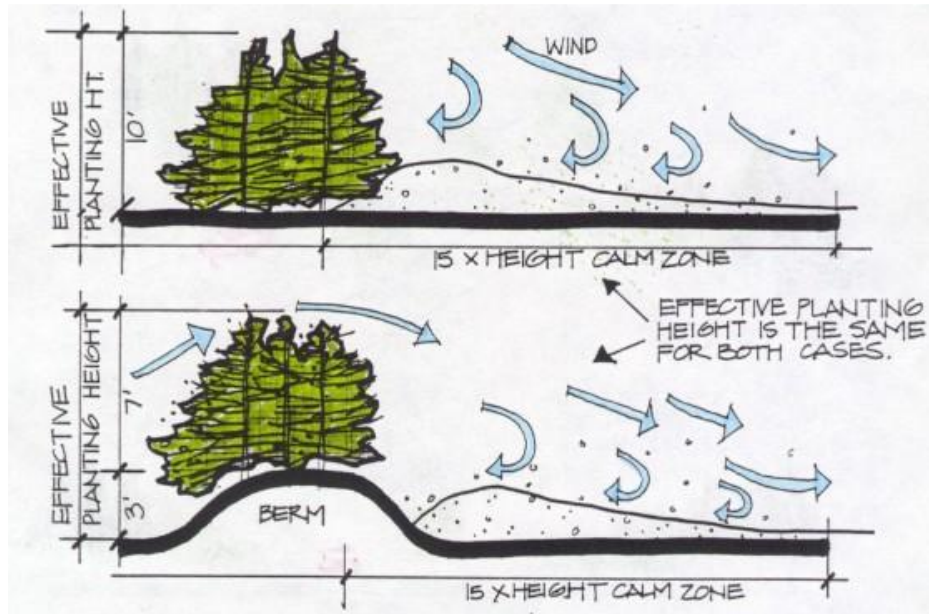
Where dense landscaping is used to collect snow approaching the proposed highway from an open space, a minimum of a double row of planting is recommended as outlined in **Figure 2-10**. Coniferous trees should be planted at minimum distance of 15 times their height from the edge of the shoulder (assume full height of plantings). Dense landscaping, such as coniferous trees or cedar hedges should be no less than 3 m to 5 m in height in order to be effective (**Figure 2-11**). If an entire forest is planted, which would constitute ten or more rows of trees, the trees can be located closer to the road. In this condition the trees are not considered a living fence but rather a solid boundary where drifting in the vicinity is minimal (**Figure 2-12**).

**Figure 2-10: Strategic Tree Placement for Effective Snow Control  
(Baker and Williams, 1990)**



Where landscaping and/or a wind screen is planned, MTO should be aware that the height required for landscaping is higher than that of a wind screen. For instance, where a 2 m high fence is recommended, the equivalent tree height is 3 m; for a 2.5 m high fence, the equivalent tree height is 4 m.

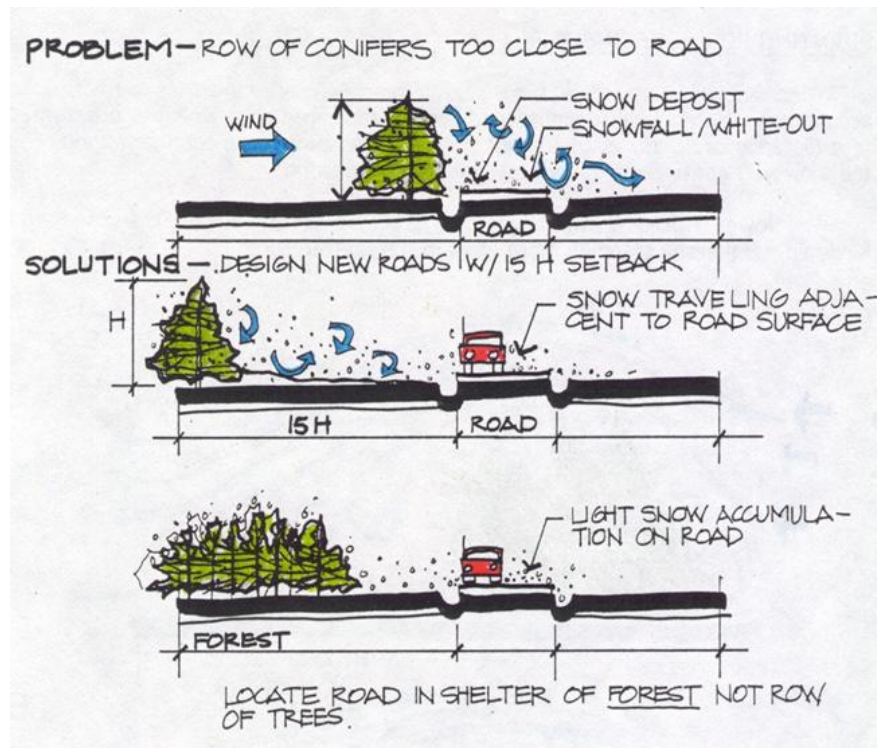
**Figure 2-11: Strategic Tree Placement for Effective Snow Control  
(Baker and Williams, 1990)**



**Where 3m tall mature trees are not feasible a berm may be used to supplement the height.**

When selecting landscaping for use as a snow collection device, a specialist in horticulture or forestry should be contacted to ensure that the plant will survive in the soil conditions and environment at the site.

**Figure 2-12: Forested Areas May be Located Closer to the Road**



Where plantings are sufficiently dense and remain healthy, a living fence approach can be over 10 times more efficient compared to a conventional slatted wind screen. This is especially true in regions where many winds approach at oblique angles to the tree line (as for the proposed Highway 413). In addition, this option is expected to have a significantly longer service life than conventional wind screens.

## 3. Potential Impacts and Mitigation

### 3.1 Snow Drifting Condition Assessment

RWDI has performed a quantitative analysis along the proposed highway corridor to assess the snow transport potential. In this assessment, the proposed highway corridor was broken down into 3 constituent areas (**Figure A** in **Appendix A**). Seven sections of the proposed Highway 413 are predicted to have a moderate to high STP (refer to **Table 2-1** for criteria and Appendix A for full results) and require mitigation (**Table 4-1**). This is due to the high wind exposure in many areas along the proposed corridor, which is surrounded primarily by fields and open terrain.

A buffer zone of 50 m on either side of the proposed highway centreline was applied to account for local terrain changes when the proposed highway is constructed. Beyond the buffer zone, the analysis considers the existing terrain information. Any future changes to the land elevations, plantings, or built environment beyond the buffer zone are not included in the analysis. Further, information on any seasonal or temporary wind screens was not available; no wind screens have been included in the current assessment.

The areas that have been identified with a moderate and/or high potential for problematic snow conditions are summarized in **Table 4-1**. These zones are presented and discussed in the following sections.

**Table 3-1: Summary of Fetches Associated with a Moderate or High STP**

Section of the Proposed Highway	Description	STP Rating
<b>Near Highway 401</b>	Exposure predominantly on west side. RWDI recommends considering an elevated road profile with shallow batter slopes and/or snow barriers at an appropriate setback distance.	Moderate to High
<b>Near Mayfield Road</b>	Openness on the west side. RWDI recommends considering an elevated road profile with shallow batter slopes and/or snow barriers at an appropriate setback distance.	Moderate to High
<b>Near Mississauga Road</b>	Exposure on both sides of proposed highway. Elevated highway with shallow batter slopes is recommended.	Moderate to High
<b>Near Highway 410 Extension</b>	Gaps between winter vegetation along proposed Highway 413; exposure on both sides of the Highway 410 Extension. If vegetation is retained, RWDI recommends eliminating gaps with screens or additional plantings.	Moderate to High
<b>Near Airport Road</b>	Priority for mitigation should be given to the northwest side. RWDI recommends considering an elevated road profile with shallow batter slopes.	Moderate to High
<b>Near Highway 50</b>	Priority for mitigation should be given to the northwest side. RWDI recommends considering an elevated road profile with shallow batter slopes.	Moderate to High
<b>Between Pine Valley Drive and Highway 400</b>	Mitigation recommended on both sides of the proposed highway. Increasing the density of the existing winter vegetation in the surroundings could be an effective strategy for snow control in this area.	Low to Moderate

## 3.2 Near Highway 401

As shown in **Figure 4-1**, interspersed patches of winter vegetation (lime green) on the west will impede snow locally (low STP in the middle), but exposure remains high for significant distances with respect to the proposed highway, resulting in moderate to high STP when unmitigated. In addition, dense developments to the east (pink) will help to trap snow before it arrives on the proposed highway.

A strategic road profile design, elevated with respect to the surrounding terrain with shallow batter slopes on both sides, is the preferred snow control solution as it offers a passive way to harness the wind exposure to scour snow from the road and reduces instances of poor visibility. Alternatively, physical measures such as wind screens or dense winter vegetation at an appropriate setback distance can also be effective. Mitigation is recommended in areas of moderate to high STP.

## 3.3 Near Mayfield Road

As indicated in the STP rose shown in **Figure 4-2**, the high degree of openness to the west coupled with alignment with prevailing winds associated with snow drifting from westerly directions results in a high potential for problematic snow drifting in the absence of mitigation. RWDI recommends MTO prioritize an elevated road profile design with shallow batter slopes, and/or snow barriers at an appropriate setback distance. Dense developments to the east (pink areas in **Figure 4-2**) will help to trap snow when winds approach from that direction.

Figure 3-1: STP for the Proposed Highway 413 near Highway 401

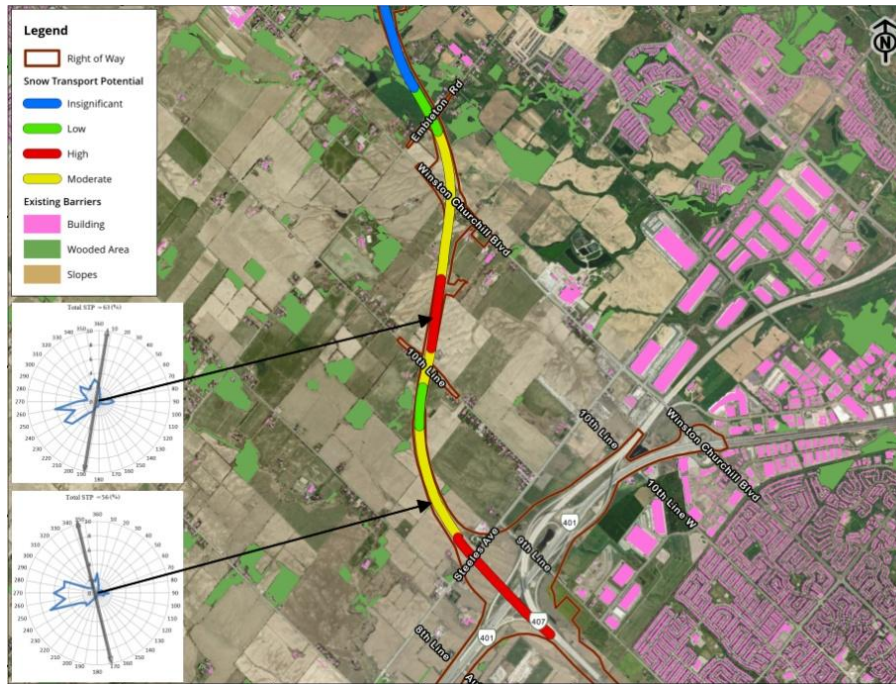
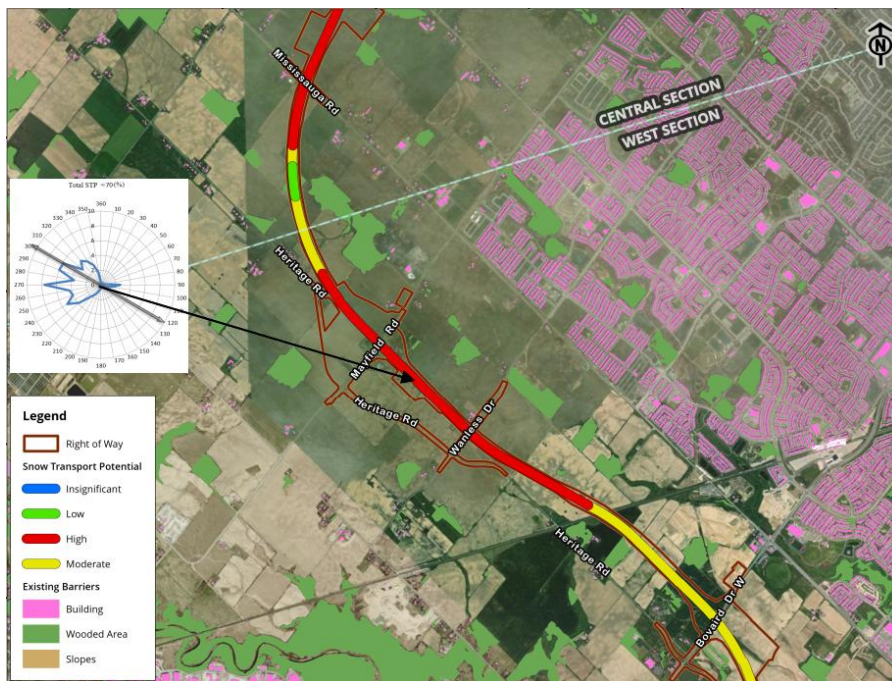


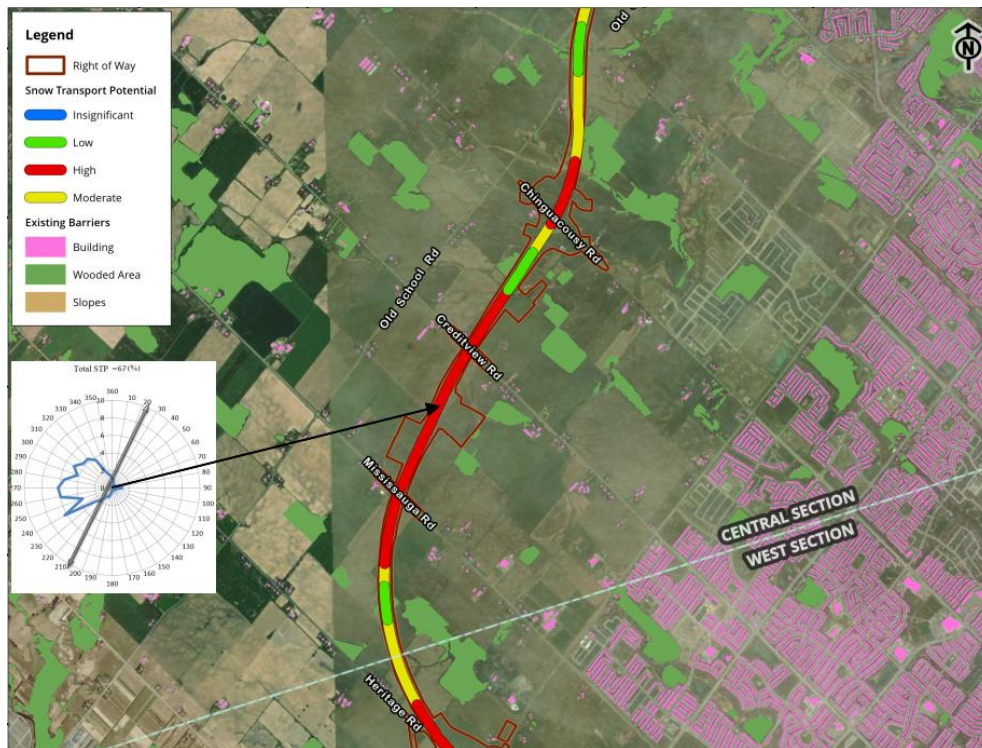
Figure 3-2: STP for the Proposed Highway 413 near Mayfield Road



### 3.4 Near Mississauga Road

The exposure to the west, from where prevailing winds associated with snow drifting approach, results in a high STP along the proposed highway in the absence of mitigation measures (**Figure 4-3**). Road profile treatment is the most passive and potentially least invasive method for snowdrift management. Recommend highway be elevated 1 to 2 m above the surrounding terrain with shallow batter slopes targeting a slope profile of 1:7 or shallower. This will support keeping wind flows attached and reducing snow deposition on the proposed highway. Care must be given to where snow is piled during snow clearing activities in the winter, as snow storage piles themselves can potentially propagate additional drifts on the road.

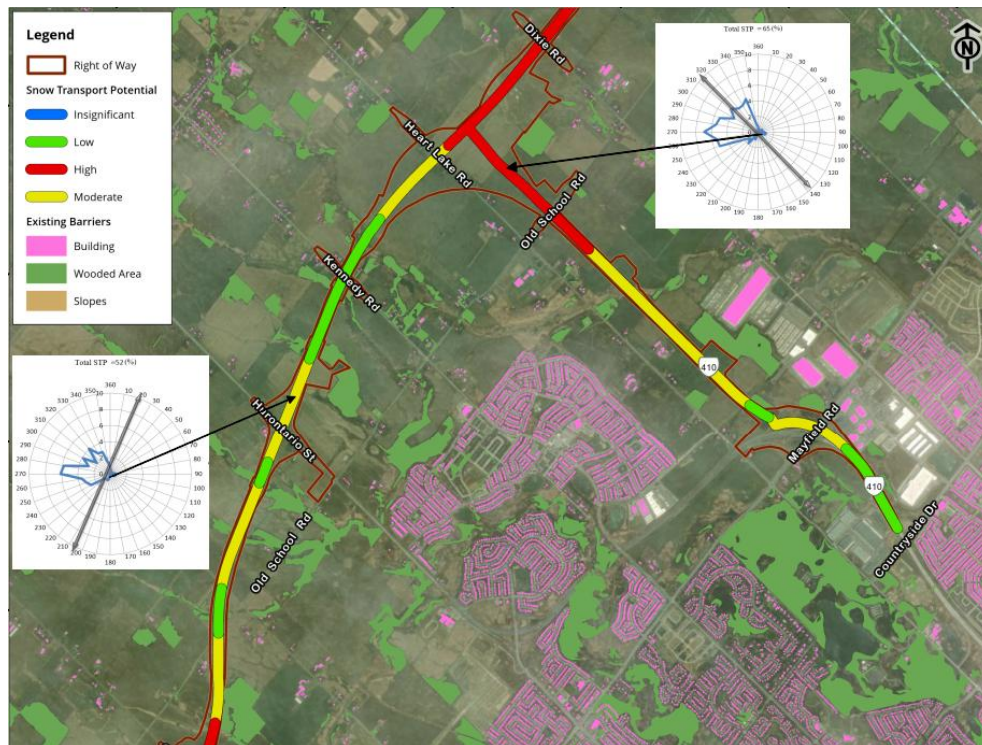
**Figure 3-3: STP for the Proposed Highway 413 near Mississauga Road**



### 3.5 Near the Highway 410 Extension

As indicated in the STP roses in **Figure 4-4**, mitigation efforts (as outlined in **Table 4-1**) should be prioritized on the west side of the proposed highway where there is approximately a north-south alignment.

Figure 3-4: STP for the Proposed Highway 413 near the Highway 410 Extension



### 3.6 Near Airport Road

As shown in the green area in **Figure 4-5**, the STP is reduced in areas where there is proximity to dense winter vegetation to the northwest. Conditions throughout this area may be improved passively via road profile design, and/or with the inclusion of snow barriers such as dense winter plantings or wind screens.

### 3.7 Near Highway 50

Where the proposed highway alignment is approximately east-west, as suggested in **Figure 4-6**, there is a greater skewness between the prevailing winds associated with snow drifting and the road. If physical snow barriers are pursued, they will need to extend beyond the areas of the proposed highway indicated with a moderate to high STP to properly intercept the approaching winds.

Figure 3-5: STP for the Proposed Highway 413 near Highway 50

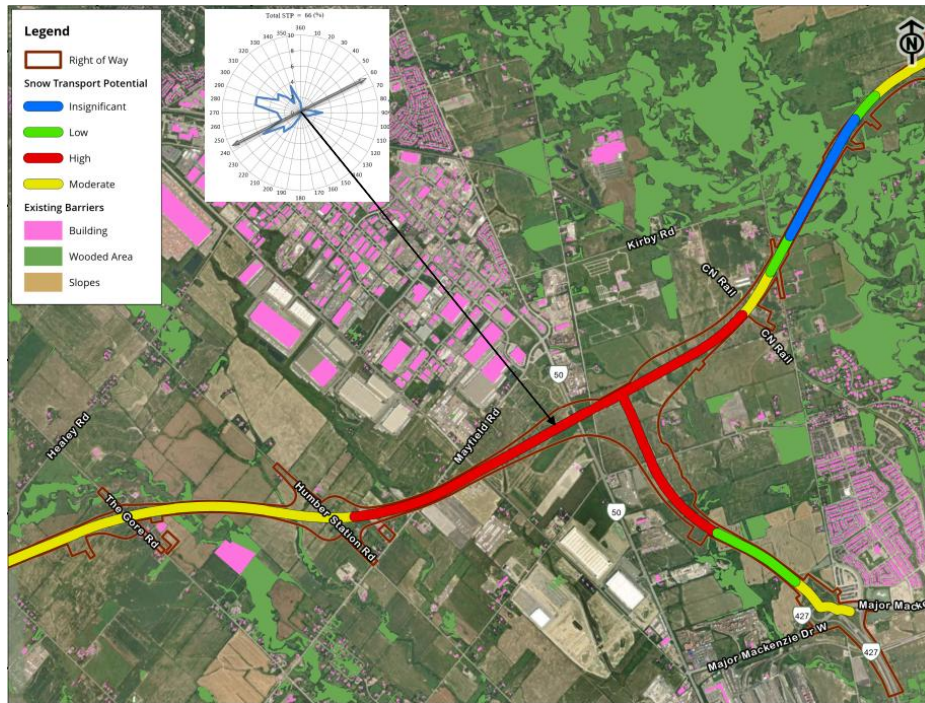
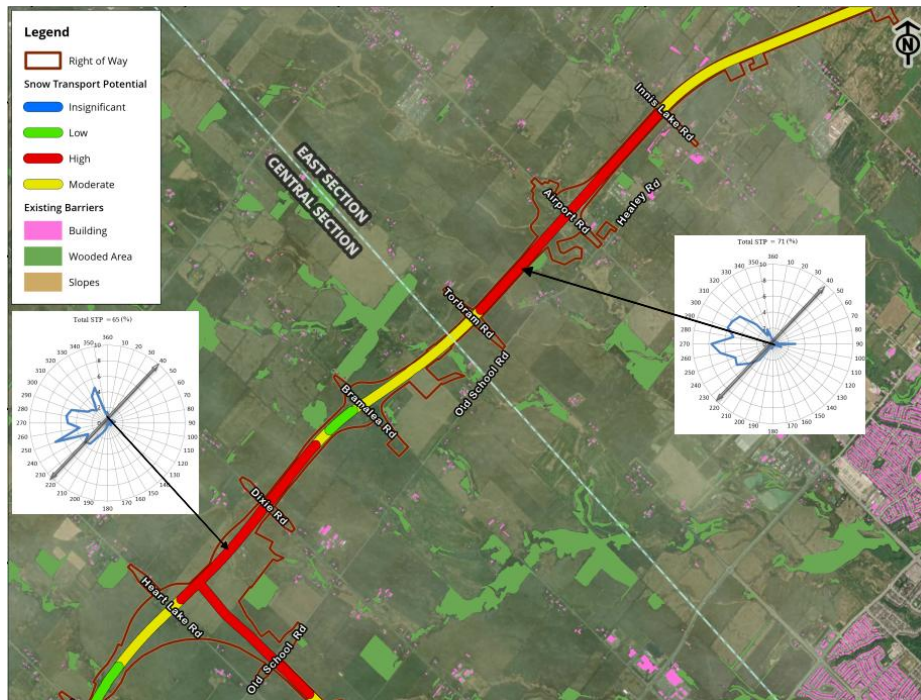


Figure 3-6: STP for the Proposed Highway 413 near Airport Road



### 3.8 Between Pine Valley Drive and Highway 400

Near Highway 400, the existing vegetation in the surrounding area is significant (**Figure 4-7**). If forested areas adjacent to the proposed highway are to be retained, the team may consider extending the planted area to improve the moderate STP conditions along the proposed corridor. Ideally, mitigation in the form of extended planted areas would be pursued on both sides of the road for the east-west alignment (see STP rose in **Figure 4-7**) and at minimum on the west side for the north-south alignment.

**Figure 3-7: STP for the Proposed Highway 413 between Pine Valley Drive and Highway 400**



### 3.9 Proposed Mitigation – General Commentary

RWDI understands that the design will include several landscaping features as well as wind screens along much of the proposed highway. As the design progresses, it is recommended that these elements be reviewed in more detail from a snow perspective. Depending on the porosity/density, shape, and height of the screens/landscaping, the snow conditions over the proposed highway may potentially be worsened. For example, if a wind screen is mostly solid and within 15x the fence height to the edge of the proposed highway, snow drift formations over the road are expected to be frequent and may be severe if the road is in an even or a cut road profile.

In general, areas that are reforested with dense, coniferous trees are expected to improve the snow control along the proposed highway. From a snow perspective, a forest is an area where trees are approximately 10 rows deep between approaching westerly through northerly winds and the proposed highway. Guidelines for winter vegetation and screen design for highways from a snowdrift perspective are provided in **Section 2.4** of this report. **Table 5-1** below summarizes the mitigation measures specific to snow drift.

**Table 3-2: Summary of Preliminary Design Environmental Mitigation Measures**

ID	Summary of Mitigation Measures
<b>SD.01</b>	Considering an elevated road profile with shallow batter slopes and/or snow barriers at an appropriate setback distance near Highway 401, where moderate to high STP is predicted
<b>SD.02</b>	Considering an elevated road profile with shallow batter slopes and/or snow barriers at an appropriate setback distance near Mayfield, where moderate to high STP is predicted
<b>SD.03</b>	Elevated highway with shallow batter slopes is recommended near Mississauga Road, where moderate to high STP is predicted
<b>SD.04</b>	If winter vegetation is retained along the proposed Highway 413 near Highway 410 Extension, RWDI recommends eliminating gaps between the winter vegetation with screens or additional plantings, where moderate to high STP is predicted
<b>SD.05</b>	Considering an elevated road profile with shallow batter slopes near Airport Road where moderate to high STP is predicted. Mitigation should be prioritized to the northwest side of the highway.
<b>SD.06</b>	Considering an elevated road profile with shallow batter slopes near Highway 50 where moderate to high STP is predicted. Mitigation should be prioritized to the northwest side of the highway.
<b>SD.07</b>	Increasing the density of the existing winter vegetation in the surroundings on both sides of the proposed Highway 413 between Pine Valley Drive and Highway 400, where moderate STP is predicted.

## 4. Summary and Conclusions

Overall, the snow drifting potential along the Highway 413 corridor is expected to be moderate to high in most areas. Where the road profile may be elevated with shallow side slopes, snow drifting in areas associated with moderate to high STP is expected to be less problematic, as the wind would be harnessed advantageously to promote scouring over the proposed highway. Under this approach, RWDI expects that the snow transport potential, frequency of poor visibility due to snow, and maintenance and snow removal costs will all be reduced.

Where plantings or other snow barriers are intended near the proposed highway (reforestation zones, enhanced landscape, wetland/riparian zones) and the prescribed setback distance is prohibitive for other design constraints, ditches between the plantings and the roadway may be considered for improved snow capture. Otherwise, increased snow removal efforts may be required in these areas.

The results presented herein have assumed that the existing terrain (slopes, vegetation, and developments) remains the same beyond a 50 m buffer on either side of the proposed highway centre line.

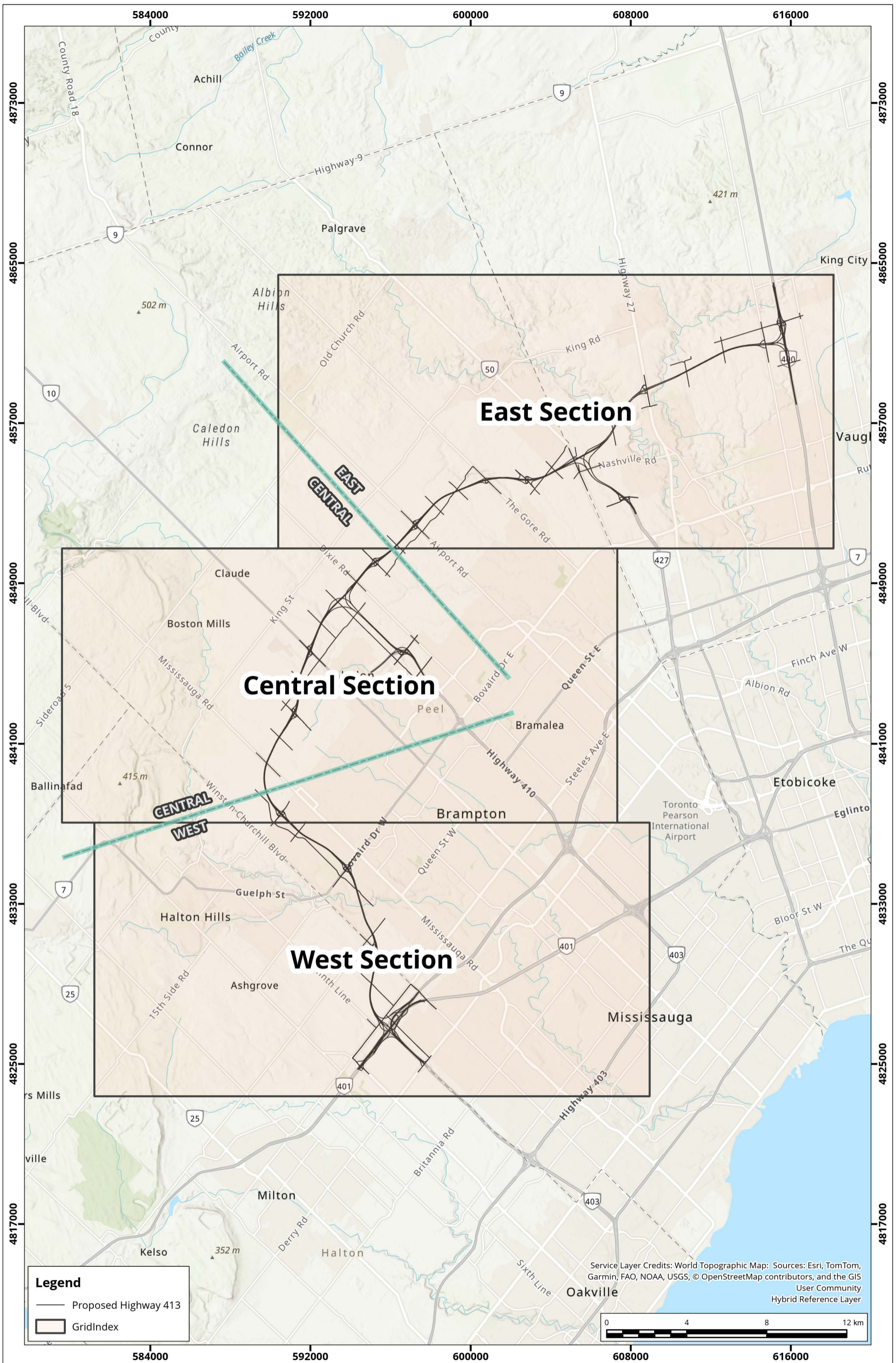
## 5. References

- R. Tabler (1994), "Design Guidelines for the Control of Blowing and Drifting Snow," Strategic Highway Research Program for the National Research Council (NRC) of Canada.
- H. Baker, C.J. Williams (1990), "Guidelines for Controlling Snowdrifting on Canadian Highways," Rowan Williams Davies & Irwin Inc.
- M.S. Perchanok (1998), "Design and Maintenance Procedures to Minimize Impacts from Drifting Snow on Highways – Provisional Guidelines," Ministry of Transportation Canada.
- J. Bond, A. Brooks, H. Wu (2016), "Evaluation of Windbreaks in the Built Environment," 14th International Conference on Wind Engineering.
- A. Brooks, J. Dale, S. Gamble, F. Kriksic (2015), "The Rapid Assessment of Snow Drifting Conditions using Physical Model Simulations," American Society of Civil Engineers (ASCE) Cold Regions Conference.
- A. Brooks, S. Gamble, J. Dale, J. Bond (2016), "Comparison of Physical Snow Accumulation Simulation Techniques." International Conference on Snow Engineering (ISCE).

# A

## Snow Transport Potential Assessment Results





# Snow Transport Potential Assessment - Index Map

Map Projection: NAD 1983 CSRS UTM Zone 17N  
 Highway 413 - Ontario

True North



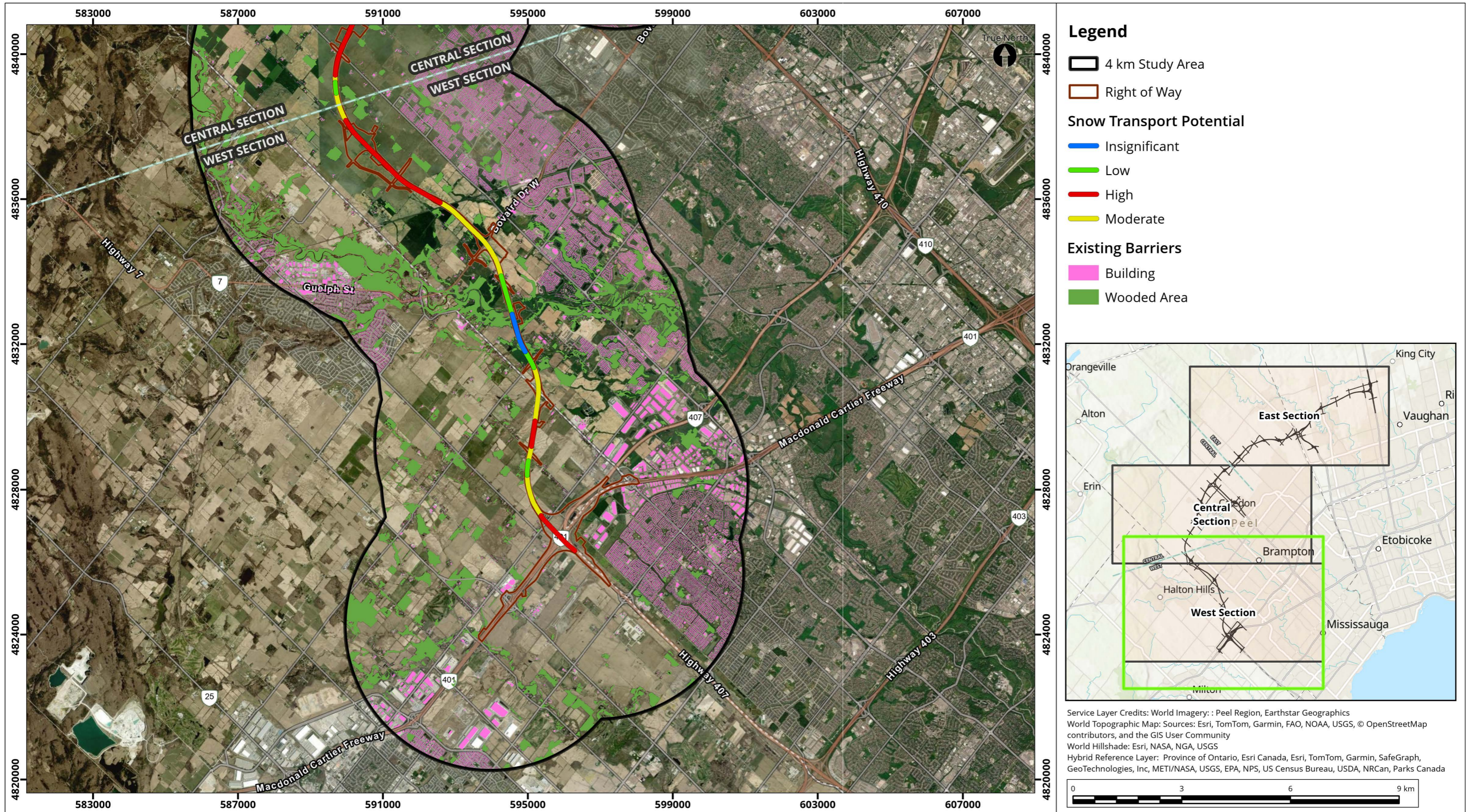
Drawn by: RCL Figure: A

Approx. Scale: 1:180,000

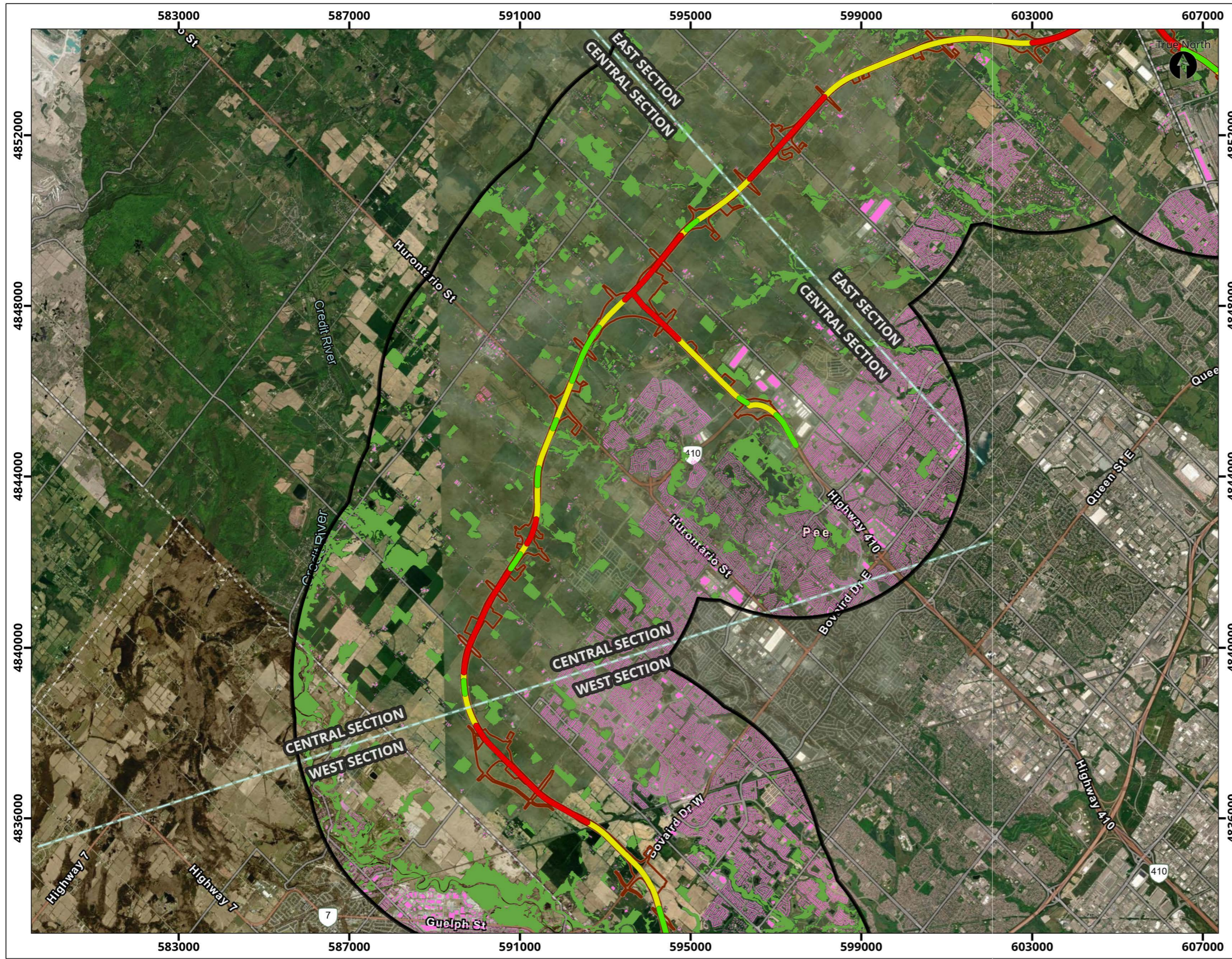
Date Revised: Sep 8, 2025

Project #: 1301992A





**Highway 413 Preliminary Design and Assessment**



**Legend**

4 km Study Area

Right of Way

**Snow Transport Potential**

Low

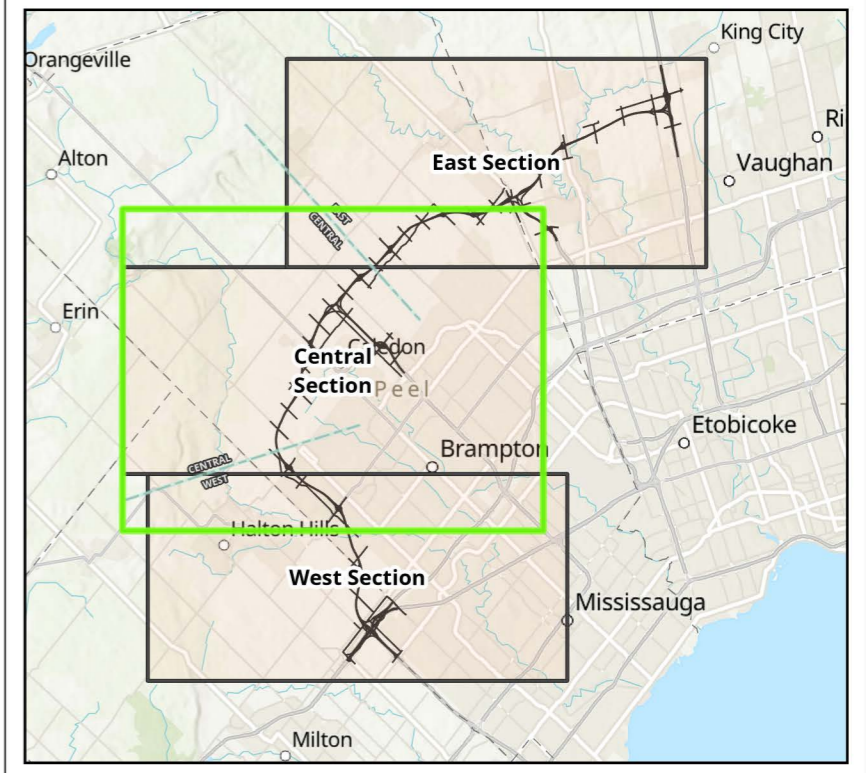
High

Moderate

**Existing Barriers**

Building

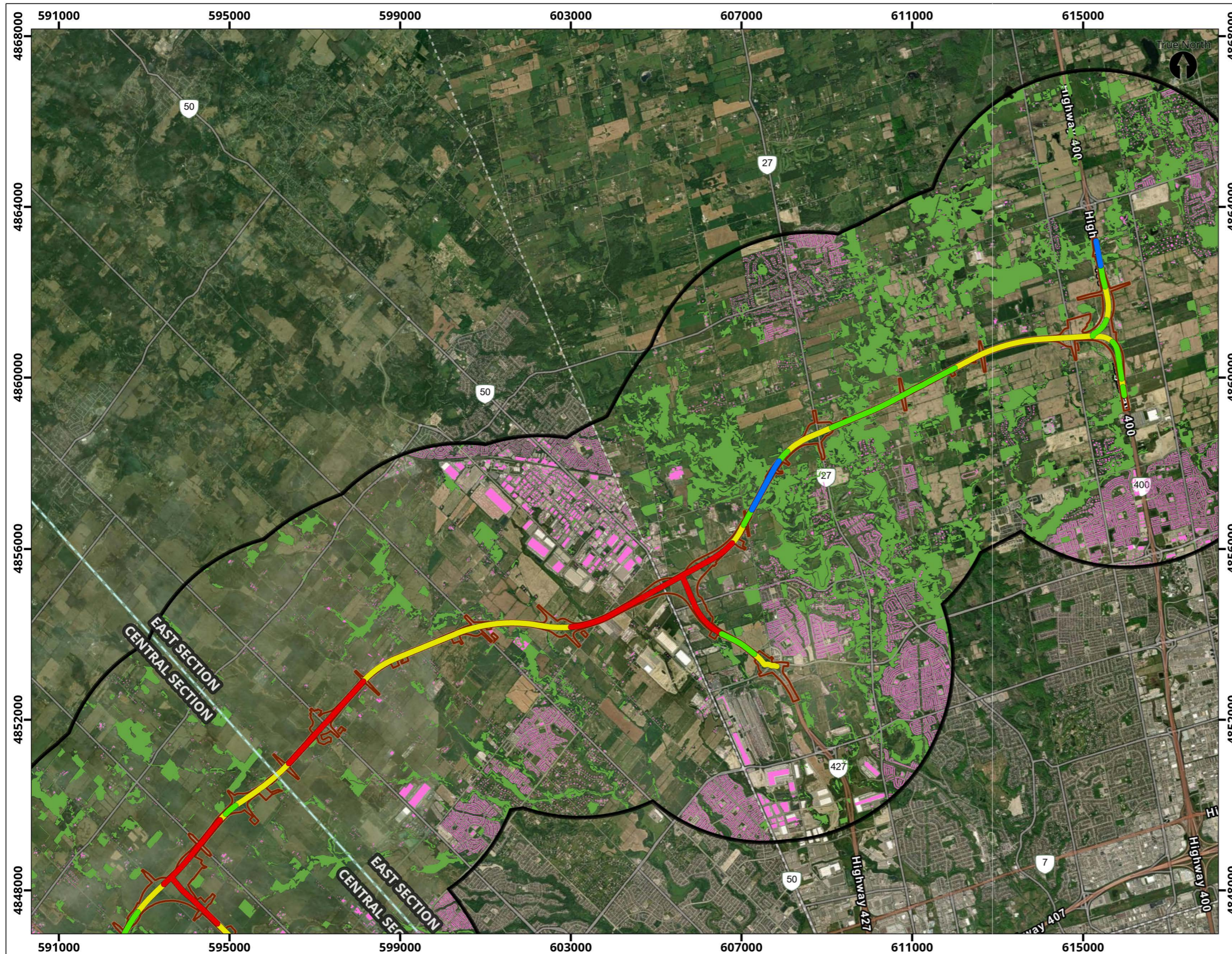
Wooded Area



Service Layer Credits: World Imagery: : Peel Region, Earthstar Geographics  
 World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community  
 World Hillshade: Esri, NASA, NGA, USGS  
 Hybrid Reference Layer: Province of Ontario, Esri Canada, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA, NRCan, Parks Canada



**Highway 413 Preliminary Design and Assessment**



**Legend**

4 km Study Area

Right of Way

**Snow Transport Potential**

Insignificant

Low

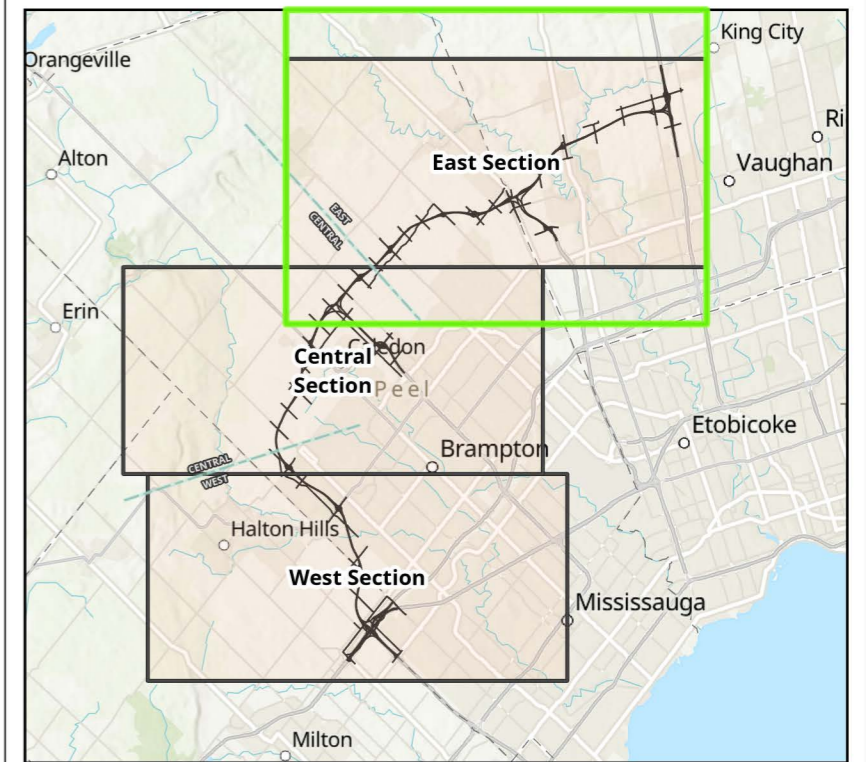
High

Moderate

**Existing Barriers**

Building

Wooded Area



Service Layer Credits: World Imagery: : Peel Region, Earthstar Geographics  
 World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community  
 Hybrid Reference Layer:  
 World Hillshade: Esri, CGIAR, USGS Province of Ontario, Esri Canada, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA, NRCan,



**Highway 413 Preliminary Design and Assessment**

