Chapter 9 – Climate Change Considerations

407 TRANSITWAY – WEST OF HURONTARIO STREET TO EAST OF HIGHWAY 400

MINISTRY OF TRANSPORTATION - CENTRAL REGION

TABLE OF CONTENTS

9. CLIMATE CHANGE CONSIDERATIONS

9.1. Introduction

As climate change is becoming a more predominant force and apparent in daily activities, design consideration for climate change is becoming more critical. It is important for infrastructure projects to be proactive and consider climate change in the early design phases to prevent under designing and large costs associated with redesigns in the future. As more data on climate change becomes available and technologies are innovated, including climate change considerations in transportation infrastructure projects has become a reality.

As the 407 Transitway project is a transit initiative, it can in-itself-be considered a climate change consideration as it will have a positive impact on reducing greenhouse gases and carbon emissions. As the Greater Toronto and Hamilton Area (GTHA) continues to rapidly grow, the demand on the surrounding transportation infrastructure will increase, creating a demand for efficient transit infrastructure to help reduce congestion on the road network, and more specifically on 407 ETR which runs in parallel with the future 407 Transitway. The 407 Transitway will help with this initiative, reducing the number of vehicles on the road by providing the population with regional transit connectivity.

This chapter has been prepared following the current MECP Guidelines. It includes and discusses potential effects of the 407 Transitway on climate change, potential effects of climate change on the 407 Transitway, and a summary of conclusions and recommendations for the implementation and operational phases.

9.2. MECP Guidelines Summary

The *Consideration of Climate Change in Environmental Assessment in Ontario Guide* (August 2016) was consulted during the development of climate change considerations for the 407 Transitway project.

9.2.1. Consideration of Climate Change in Environmental Assessment in Ontario, Guide (Rev. 0, August 2016)

The purpose of this guide developed by MECP is to outline how climate change considerations are to be incorporated into the EA and TPAP processes. This guide covers what climate change considerations should be taken into account when considering future infrastructure projects in Ontario. More specifically, the guide notes the following as items which must be included in infrastructure projects following the EA and TPAP processes:

"The Guide covers the considerations of:

- *The effects of a project on climate change;*
- *The effects of climate change on a project; and,*
- *Various means of identifying and minimizing negative effects during project design.*

The outcome of a climate consideration is an undertaking of project:

- *That has taken into account alternative methods to reduce its greenhouse gas emissions and negative effects on carbon sinks; and,*
- *That is more resilient to future changes in climate and helps maintain the ecological integrity of the local environment through an assessment of present and future environmental effects in the face of a changing climate."*

As such, the 407 Transitway TPAP climate change considerations have been broken into the sections as described in the above guide.

9.3. Potential Effects of the 407 Transitway on Climate Change

The following items discuss the impacts of the 407 Transitway on climate change. Each item is further discussed below.

- Greenhouse Gas Emissions; and,
- Effects of Vegetation Removals.

Mitigation measures that will contribute to the reduction of effects related to climate change are included in **Chapter 6: Impact Assessment, Mitigation, and Monitoring of this EPR**. Commitments for the future phases of implementation are included in **Chapter 10: Commitments to Future Action of this EPR.**

9.3.1. Greenhouse Gas Emissions

As discussed in **Chapter 1** of the EPR, the 407 Transitway is a rapid transit initiative that will be operated in an exclusive all grade separated right of way. The Transitway, when completed, will provide rapid transit service between Burlington and Highway 35/115, running parallel to 407 ETR.

An air quality and greenhouse gas (GHG) emissions inventory was completed for the future reference year 2031, with and without the proposed 407 Transitway. The air quality impacts of the proposed 407 Transitway were evaluated using detailed air dispersion modelling. Details of the results of this assessment are provided in **Chapter 6** and the Air Quality Impact Assessment Report is provided in **Appendix J**. In addition to modelling air contaminants of concern, the change in GHG emissions was also evaluated following the assessment approach outlined in MTO's *Environmental Guide for Assessing and Mitigating the Air Quality Impacts and Greenhouse Gas Emissions of Provincial Transportation Projects* (MTO 2012). As noted above, the effects of the 407 Transitway on climate change was considered and the assessment followed the draft guidance for the *Consideration of Climate Change in Environmental Assessment in Ontario* (MECP 2017).

GREENHOUSE GASES AND ASSESSMENT

Fossil fuel combustion is the main source of GHG emissions related to this project, which results in emissions of carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). For a given mixture of different GHGs, the carbon dioxide equivalent (CO_2e) is the unit of measure used to describe the amount of CO_2 that would have the same global warming potential as a mixture of GHGs when measured over a time period (typically a 100-year period). The CO_2e for a gas is calculated by multiplying the mass of the gas by its global warming potential (GWP). For example, the GWP for CH_4 over 100 years is 25 and for N_2O is 298 (IPCC 2007). This means that the emission of 1 tonne of CH_4 is equivalent, in its warming potential, to the emission of 25 tonnes of CO_2, and the emission of 1 tonne of N_2O is equivalent to the emission of 298 tonnes of CO_2. There are no ambient air quality criteria for greenhouse gases.

The total annual quantities of carbon dioxide equivalent (CO_2e) released (in tonnes) for each assessment scenario (Existing Conditions, Future No-Build and Future Build), and percent change between scenarios are summarized in Table 9.1.

TABLE 9.1: ANNUAL CO_2E EMISSIONS FROM TRAFFIC

ASSESSMENT SCENARIO	TOTAL CO2E EMISSIONS (TONNES/YEAR)	% CHANGE FROM EXISTING CONDITIONS	% CHANGE FROM FUTURE NO-BUILD
Existing Conditions	775,461	-	-
Future No-Build	387,159	-50%	-
Future Build	383,013	-50%	-1.07%

CO_2e is shown to decrease by 1.07% in the Future Build scenario relative to Future No-Build and decreases by 50% in the Future Build scenario relative to Existing Conditions. The decrease in GHG emissions is attributable to the efficiency changes to vehicles, resulting in lower emission factors and the reduction in personal vehicles on the road as a result of the Transitway. Although GHG emissions are expected to decrease slightly for the specific Transitway study area, this is likely a worst-case (i.e., 100% diesel bus fleet) estimate of the project's impact on GHG emissions. The Future Build scenario is expected to minimize GHG emissions more than 1.07% with newer clean technology and by promoting an alternative option to personal vehicles.

According to Environment and Climate Change Canada's (ECCC) 2016 National Inventory Report, Ontario's GHG emissions were 182 and 170 million tonnes (Mt) in 1990 and 2014, respectively (ECCC, 2016). The GHG emissions target for 2030 is 115 Mt based on a 37% reduction below 1990 levels. Emissions therefore have to decrease by 55 Mt in 2030 relative to existing conditions. However, the project is estimated to decrease GHG emissions by 4,144 tonnes in forecast year 2031 relative to the Future No-Build scenario. As a result, the project as designed will positively affect progress towards the 2030 GHG target by approximately 0.007%. This minor decrease is the result of the worst-case scenario being evaluated, which includes increased traffic volumes and diesel-fueled transit buses on the Transitway.

IMPACTS OF 407 TRANSITWAY ON CLIMATE CHANGE

Transportation is Ontario's major contributor to GHG emissions with the GTA being the busiest and most developed area within Ontario. In 2011, 114 million trips were completed on the existing 407 ETR highway and every year since it has been growing. Ontario has identified the transportation sector to be an area to focus on reducing GHG emissions. As part of their plans, Ontario would like to provide lower emission vehicles and provide cleaner transportation options (MECP, 2017c). The 407 Transitway is following this action. The development of this transitway is promoting a cleaner transportation option by removing personal vehicles from the road and reducing pressure on the already congested roadways within the GTA. Even with the conservative approach of assuming the fleet will be diesel-fueled transit buses, the Transitway will still result in a decrease in the overall GHG emissions compared to future conditions without the project.

The Transitway system will run parallel to the pre-existing 407 ETR highway and has been assumed to operate only diesel-fueled buses. The Transitway will be designed as a rapid transit system with only a select number of stops. The diesel buses and passenger vehicles within the stations are the only direct GHG emission sources for this project. The passenger vehicle emissions from passenger pick-up and drop-off are insignificant relative to the emissions coming from the buses, and passenger vehicle travel within the stations, as this activity is expected to be very short term and only at certain intervals when buses are arriving and departing. The system will however create indirect emissions by consuming power from the grid for station lighting and heating, and transitway illumination. The diesel buses will contribute additional GHG emissions to the pre-existing environment, however, it is the intent that by introducing this new transit system, that it will encourage drivers to use public transit over their personal vehicles.

For the air quality impact assessment, the worst-case scenario was evaluated, however, as part of this climate change assessment, carbon-focused build scenarios were also considered. Rather than operating diesel fueled buses, an electric substitute such as a Light Rail Transit (LRT) or electric power buses were considered. In this scenario the number of vehicles operated within the 407 ETR would not change; however, no transit bus emissions would be present. The LRT or electric bus system would produce indirect emission from electricity consumption, however Ontario's electricity grid is primarily made up of renewable or emission free sources including (Ministry of Energy, 2017):

- Nuclear – 60%
- Hydroelectric – 24%
- Natural Gas – 10%
- Wind – 6%
- Solar & Biofuel – <1%

Therefore, when considering this carbon-focused scenario the only emission reduction is from the diesel-powered buses. Table 9.2 indicates that if an LRT or electrical bus system was implemented, there would only be a 1.3% reduction in GHG emissions as the diesel buses do not contribute a large portion to the overall GHG emissions within the study area.

TABLE 9.2: COMPARISON OF ANNUAL TONNES OF CO_2E: BUSINESS AS USUAL VS. CLIMATE FOCUSED

ASSESSMENT SCENARIO	CARS	MEDIUM TRUCKS[1]	HEAVY TRUCKS[2]	BUSES	TOTAL
Build Scenario (Diesel Bus)	272,121	47,748	58,186	4,957	383,014
Build Scenario (Carbon-Focused)	272,121	47,748	58,186	0	378,055
Percent Difference					**-1.3%**

Notes: [1]Based on medium trucks consisting of two-thirds of the overall truck volumes.
[2]Based on heavy trucks consisting of one-third of the overall truck volumes.

It should be noted that the above comparison is based solely on tailpipe emissions from buses. This comparison does not consider indirect emissions due to the sources used to generate electricity to power an LRT alternative or charge the electrical bus system. Such comparison will require a number of unknown inputs related to the expected grid mix in 2031.

To guarantee continual GHG reductions, the 407 ETR will ensure that all equipment is maintained and operated efficiently, to ensure no additional GHG emissions are developed. Stations will be designed to minimalize idling for passenger vehicles parking or dropping off as well as buses that are arriving and departing. To conclude, this new transitway system will provide a reliable and safe public transit system to the public, while providing a positive effect on climate change with reducing passenger vehicles and congestion within the GTA. Lastly, the Transitway is expected to withstand future extreme climate events such as high winds, high and low temperatures, and flooding by implementing maintenance and design features within the system.

MITIGATION

As noted in Chapter 6 of this EPR, during the operations/maintenance phase, there are many fuel and technology pathways available to reduce tailpipe emissions of the Transitway buses. Switching from diesel to alternative fuels such as natural gas or dimethyl ether can reduce tailpipe emissions. Another option is blending biological-based fuels such as biodiesel or hydrogenation-derived renewable diesel with conventional petroleum-based diesel. Moreover, upgrading transit buses from conventional internal combustion engine technology to hybrid or electric technology can improve fuel economy or eliminate tailpipe emissions altogether. These pathways would simultaneously reduce air pollution and GHG emissions.

The open space areas located along the transitway corridors and in the vicinity of station sites provide another opportunity to reduce greenhouse gas emissions and adapt to climate change. These areas of the land mass dedicated to the transitway facility will be planted with trees and shrubs to increase canopy cover, reduce overland flow erosion, and cool stream and wetland habitat areas. The climate change impacts of the station sites can also be mitigated through the use of permeable pavers, solar reflective surface materials and 'green' roof systems. These initiatives will assist in the reduction of climate change impacts of the undertaking.

9.3.2. Effects of Vegetation Removals

Changes to the landscape (i.e. removal of vegetation) affects the removal of carbon dioxide from the atmosphere and results in impacts to carbon storage which has the potential to contribute to climate change. Overall, there will be a loss of 102.47 ha of vegetation communities (including anthropogenically influenced lands such as agricultural and manicured land), as a result of the 407 Transitway including the removal of 0.94 ha of wetland communities and 0.12 ha of forest communities. Chapter 6 of this EPR provides further details regarding vegetation loss and the recommended environmental protection/mitigation measures for vegetation and vegetation communities.

Environmental compensation has been included as a key component of this project.The removal of wetland and forest communities required to accommodate the 407 Transitway infrastructure will be offset/compensated for through restoration as well as through the enhancement of nearby vegetation communities. Compensation/offsets will be provided at a rate determined through further discussion with regulatory agencies (e.g., MNRF, TRCA), as part of implementing the project. A number of sites along the 407 Transitway facility will be protected for future environmental compensation including restoration of suitable forest/wetland habitat. Please see Chapter 5 of this EPR for further details and the location of these protected sites.

9.4. Potential Effects of Climate Change on the 407 Transitway

The following section discusses the impacts of climate change on the 407 Transitway. Each item is further discussed below.

- Extreme Weather Events;
- Erosion and Sediment Control; and,
- Increase in Lake and River Water Levels.

9.4.1. Extreme Weather Events

An important impact of climate change is the variation in precipitation events in the GTHA. Based on a study conducted by the City of Toronto in December 2011, it was identified that the expected maximum rainfall during classified "extreme events" would increase from 66 millimeters (data from years 2000-2009) to 166 millimeters during the period of 2040-2049. Aside of data in these forecasts, the number of significant rainfalls within the past 5 to 10 years in the Toronto area which have caused flooding and infrastructure damage has increased significantly. More specifically, a rainfall event occurring in the Toronto area on July 8th, 2013 surpassed the previous record held by rainfall events caused by Hurricane Hazel in 1954.

Extreme precipitation events have the potential to negatively affect the transitway facilities by flooding the stations and runningway (as a result of low porosity of concrete and asphalt) resulting in infrastructure damage and transit service disruptions.

In response to these concerns, the 407 Transitway design includes design considerations to mitigate these extreme precipitation events. Considerations include the following:

- Increased SWM pond capacity to accommodate larger rainfall events;
- Inclusion of permeable asphalt/pavements in the design to minimize stormwater runoff. This will help to reduce the required SWM pond sizes and thus, the required SWM facilities footprint; and,
- Inclusion of stormwater storage onsite which can temporarily hold stormwater to be later managed after large storm events. This will help to reduce the 407 Transitway's impact on existing municipal infrastructure during surge events as well as ensure the stormwater ponds have sufficient capacity.

Extreme weather events can also include changes to the freeze/thaw cycle, increase in heat waves, and high winds and lightening. This can result in many different weaknesses and damages within the proposed Transitway, as well as in the natural environment around the study area.

The change in freeze and thaw cycles can cause concrete or asphalt to fail leading to cracks and crumbling of roadways. Cracks can be damaging to private and commercial vehicles as well as lead to pot holes and in extreme situations, sink holes. The Transitway system will be built to ensure longevity and will be maintained to minimize cracking and potholes.

Ontario is predicting that the average temperature within Southwestern Ontario will rise 5 to 6 degrees in the next 80 years. Within these temperature extremes, the public will rely more on their personal vehicles to travel in comfort. By implementing a comfortable and reliable Transitway, the number of personal vehicles operating within these extremes can decrease. Buses within the 407 Transitway will receive consistent maintenance and will be operated to encourage efficiency in order to reduce its carbon footprint. High temperatures can also lead to expansion of the roadway resulting in cracks and surface abnormalities. Temperatures will be monitored, and roadways will be visually checked for abnormalities to confirm safety for buses and passengers, as part of the regularly scheduled maintenance.

Wind and lightning can result in power lines being compromised, resulting in power loss to roadways and signs. The Transitway system will be constructed so that the buses can still operate in scenarios where power is not available. The Transitway will also have reflective markers to provide support to buses when power is lost or fog is present. All material within the Transitway will also be secured to ensure that in high wind scenarios items remain fixed and safe for passengers.

The 407 Transitway system has been designed to operate parallel to the existing 407 ETR highway. As such, it has been designed to lessen the negative impact on the natural environment by mimicking the pre-existing environment.

9.4.2. Erosion and Sediment Control

As noted above, one of the impacts of climate change is the increased extreme precipitation occurrences including unpredictable, frequent and extreme rain events. Extreme rain events taking place during soil disturbance associated with construction activities and the use of construction equipment may result in the increased and unpredictable erosion of, and sedimentation to, sensitive receiving watercourses located in close proximity to the study area. Appropriate erosion and sedimentation control measures will be implemented prior to and during construction and will remain in place until construction is complete and soils have been re-stabilized. This will greatly reduce the potential for soil erosion and impairment of surface water quality during extreme rain events during construction. Chapter 6 of this EPR describes the recommended erosion and sedimentation control measures in more detail.

9.4.3. Increase in Lake and River Water Levels

Climate change poses a challenge to adapting and improving the resiliency of transportation infrastructure. As a consequence of extreme precipitation events due to climate change, water levels in lakes and rivers may increase in a short period of time temporarily or change the baseline conditions permanently. Therefore, the design of the transitway structures over existing watercourses and floodplains are considering a higher freeboard water level to ensure they can accommodate future water levels.

9.5. Recommendations for Implementation and Operational Phases

Table 9.3 identifies measures to be considered as part of the Implementation and Operational Phases of the project.

TABLE 9.3: MITIGATION MEASURES

PRE-CONSTRUCTION	DURING-CONSTRUCTION	OPERATIONAL
▪ Design Incorporation of Roof Solar Panels. ▪ Design Incorporation of Green Roof Systems on Infrastructure. ▪ Design Incorporation of Permeable Asphalt/Pavements. ▪ Design Incorporation of Vegetation to minimize Sun/Heat reflection on pavements and within station facilities. ▪ Consideration of Natural Lighting in Infrastructure (e.g. Stations) Design. ▪ Design Incorporation of Fuel Cell Units. ▪ Design Incorporation of Heat Resistant Asphalt or Concrete Paving.	▪ Use of Recycled Construction Materials, when possible. ▪ Use of Efficient Equipment (e.g. Alternative Fuel or Electric Equipment Technologies). ▪ Use of Pre-fabrication, when possible, to reduce work being completed onsite (point source versus non-point source pollution). ▪ Consistent maintenance of buses.	▪ Alternative Fuel or Hybrid/Electric Vehicle Technologies. ▪ Blending biological-based fuels with conventional petroleum-based diesel. ▪ Use of LED Lighting.

PRE-CONSTRUCTION	DURING-CONSTRUCTION	OPERATIONAL
▪ Design Incorporation of Rain Water Storage on site. ▪ Design Incorporation of Active Transportation Infrastructure (e.g. Bicycle Racks, Multi-Use Trails etc.).		

As noted in the MECP Guidelines, the evaluation of "Business as Usual" versus "Climate Change Considerations" should be considered either qualitatively and/or quantitatively to fully understand the benefit a climate change consideration has on the 407 Transitway project. Table 9.4 discusses the impacts of implementing climate change initiatives in comparison to the "do nothing" approach.

TABLE 9.4: BUSINESS AS USUAL VS. CLIMATE CHANGE CONSIDERATIONS

ITEM	IMPACT WITH BUSINESS AS USUAL	IMPACT WITH CLIMATE CHANGE CONSIDERATION
Vehicle Selection	Diesel and Fossil Fuel vehicles utilized are considered catalysts to climate change due to Greenhouse Gas Emissions.	Reduction in Greenhouse Gas Emissions with the use of alternative fuel or hybrid/electric vehicles.
Pavements Types	Larger ponds required.	Stormwater runoff will be reduced by using permeable pavements.
SWM Ponds	Extreme rainfall events may exceed capacity the SWM ponds.	Extreme rainfall events will likely not exceed capacity of SWM ponds if ponds designed with additional increased capacity.
Structures over watercourses and floodplains	Structures designed based on current flood lines may be impacted by extreme precipitation events.	Structures designed with a higher freeboard water level will likely accommodate potential higher water levels.
Vegetation Removals	Removal of wetland and forest communities can impact carbon absorption and carbon storage, and contribute to climate change.	Compensation for vegetation removals (through the restoration and enhancement of nearby vegetation communities in protected sites as well as landscape plantings throughout the 407 Transitway corridor) will reduce greenhouse gas emissions/allow for more carbon absorption and ensure no contribution to climate change.