Transportation & Climate Change in Manitoba – 2003 Workshop

impacts  emission reductions  adaptation  outreach & awareness

Transportation & Climate Change in Manitoba –

A Primer

Prepared for:
Manitoba Transportation & Government Services

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Climate Change - Overview

Climate change leads to increases in the global mean temperature or global warming, and scientists have observed that the average global temperature is rising. Cycles of high and low temperatures are not considered to be climate change unless prolonged over many decades. The 1980s and 1990s were the warmest decades ever recorded,¹ and the years 1999 and 2001 are the warmest years on record.² There is a strong consensus among scientists that these changes in long-term weather patterns are far beyond natural climate variability.² It is expected that due to its northern location, Canada will experience a greater degree of warming than countries that are closer to the equator.³ Manitoba’s central location in North American and northern latitude means that we will face earlier and more severe climatic changes.³ Some of the changes that are expected include:

- Current research suggests that by 2080, summer temperatures in Manitoba could rise by 3-4°C, and that winter temperatures could rise by 5-8 °C. These would be the largest and most rapid changes in our climate of the last 100,000 years.¹
- **Manitoba and Climate Change: A Primer** (2001) predicts that Manitoba will experience warmer and wetter winters and springs, and longer, warmer, drier summers as a result of global warming. An increase in springtime precipitation of 5-10% is expected, and a decrease of 10-20% in summer precipitation.³
- Climate change will also increase the frequency of extreme weather events, such as thunderstorms, tornados, hailstorms, floods, heat waves, and droughts. It is expected that rainstorms will be less frequent and more severe, and that dry periods will be of longer duration. Cold spells are expected to be less severe.³
- Other problems that are likely to result from global warming include erosion of coastal regions, increasing risk of fires, pests, and disease to farms and forests, and compromising of Canada’s water and wetlands. Manitoba’s boreal forests are predicted decline in the south due to lack of moisture, and will not move further northward due to lack of suitable soil.

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¹ Kyoto and Beyond: A Plan of Action to Meet and Exceed Manitoba’s Kyoto Targets (2001)
² Climate Change Plan for Canada (2002)
Atmospheric concentrations of greenhouse gases (GHGs), such as carbon dioxide ($CO_2$), methane ($CH_4$), and nitrogen compounds, have been directly linked to global warming and increased frequency of extreme weather events.\(^3\) GHGs act like the glass on a greenhouse; they allow radiation from the sun to enter Earth’s atmosphere, but block this heat from escaping back into space, slowly raising global temperatures.

While GHGs do occur naturally, human activities are upsetting their natural balance. When fossil fuels are burned, their carbon content is oxidized and released as carbon dioxide. For every tonne of carbon burned, 3.7 tonnes of carbon dioxide are released into the atmosphere.\(^4\) Approximately 2.4 kilograms of carbon dioxide are produced for every litre of gasoline consumed by vehicles. For every litre of diesel, approximately 2.7 kilograms of carbon dioxide are produced.\(^5\) Globally, it is estimated that approximately 20 billion tonnes of carbon dioxide are released annually.\(^4\) The burning of fossil fuels accounts for 75% of the enhanced greenhouse effect. If current trends continue, it has been predicted that by the end of this century, GHG concentrations will have increased by 90-250% of what they were prior to the industrial revolution.\(^6\)

Although Canada only produces approximately 2% of the world’s GHG emissions,\(^7\) it is the second highest per capita producer of GHG emissions among industrialized nations.\(^8\) Transportation is the largest source of GHG emissions in Canada, accounting for approximately 25% of the total.\(^8\)

**Canada’s Third National Report on Climate Change** (2001) reports that Canada faces unique challenges in reducing its GHG emissions; energy intensive industries, natural resources, and exports are particularly important to the economy. This combined with Canada’s widely dispersed and sparse population, results in significantly higher energy use for freight transportation than most other nations.

According to **Canada’s Greenhouse Gas Inventory 1990-2000**, Manitoba GHG emissions from vehicles ranged between 6,100 and 6,900 kilotonnes per year, and represented over 30% of total provincial emissions in 2000. Projections within

4 http://climatechange.nrcan.gc.ca/english/Stories.asp?x=1&z=2
6 http://www.gov.mb.ca/conservation/climatechange/issues/whatis.html
8 http://www.tc.gc.ca/programs/environment/climatechange/menu.htm
Canada’s Emissions Outlook: An Update predict that Manitoba’s GHG emissions related to transportation will increase to 8,000 kilotonnes by 2010. Figure 2 presents a breakdown of transportation-related GHG emissions within the Province of Manitoba by year and by type of transportation. Table 1 presents the GHG emission rates for the Province of Manitoba for 2000 by type of transportation.

Figure 2: Manitoba Transportation GHG Emissions 1990-2000
(kt CO₂ equivalent)

Table 1: Transportation-related Manitoba GHG Emissions for 2000

<table>
<thead>
<tr>
<th>GHG Source</th>
<th>Kt CO₂ Equivalent</th>
<th>Percentage of total vehicle emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light-Duty Diesel</td>
<td>29</td>
<td>.4%</td>
</tr>
<tr>
<td>Propane/Natural Gas Vehicles</td>
<td>36</td>
<td>.5%</td>
</tr>
<tr>
<td>Heavy-Duty Gasoline</td>
<td>251</td>
<td>3.8%</td>
</tr>
<tr>
<td>Off-Road Gasoline</td>
<td>430</td>
<td>6.5%</td>
</tr>
<tr>
<td>Railways</td>
<td>311</td>
<td>4.7%</td>
</tr>
<tr>
<td>Aviation</td>
<td>554</td>
<td>8.4%</td>
</tr>
<tr>
<td>Off-Road Diesel</td>
<td>737</td>
<td>11.2%</td>
</tr>
<tr>
<td>Heavy-Duty Diesel</td>
<td>1360</td>
<td>20.6%</td>
</tr>
<tr>
<td>Light-Duty Gasoline/ Motorcycles</td>
<td>2894</td>
<td>43.8%</td>
</tr>
<tr>
<td>Total*</td>
<td>6600</td>
<td>99.9%</td>
</tr>
</tbody>
</table>

*Due to rounding, individual values may not add up to total.

9 http://www.ec.gc.ca/pdb/ghg/ghg_tables_2000_e.cfm
The Intergovernmental Panel on Climate Change has stated that it is not too late to work toward lessening the impacts of climate change. Reducing emissions and stabilizing their concentrations in the atmosphere would delay and reduce the damages attributable to climate change. This would mean that fewer regions of the world would be impacted by climate change, and that those who are impacted would be less severely so. The Province of Manitoba has outlined its GHG emission reduction strategy in the document *Kyoto and Beyond: A Plan of Action to Meet and Exceed Manitoba’s Kyoto Targets*.

**Impacts of Climate Change on the Transportation Industry**

Once thought of as a future concern, impacts on transportation systems are now being experienced in Manitoba that are consistent with what is predicted to result from climate change. The most obvious impact may be seen on transportation networks to remote communities. Warmer temperatures will put northern roads, railways, foundations, and other infrastructure at risk due to the thawing of permafrost and will also mean reduced winter road seasons. Changes of only 1-2°C can have a significant impact on permafrost. It has been predicted that areas that are currently discontinuous permafrost (localized or sporadic) will thaw completely. Continuous permafrost may thaw in some areas. Ground areas with high ice content will suffer the greatest impacts, which may include settling, creep, and slope failure. The Intergovernmental Panel on Climate Change reports that the ability of permafrost to bear weight has decreased with global warming, resulting in failures of pilings for buildings and pipelines, as well as roadbeds. Figure 3 presents railway tracks that have been warped by permafrost melting. Paved and snowplowed roads and airfield runways tend to absorb heat, which may intensify the effects of global warming on permafrost instability.

**Figure 3: Railroad Tracks Warped by Thawing Permafrost (near Gillam, MB)**

E. Nielson, Manitoba Geological Survey

The Government of Manitoba annually operates about 2400 km of winter roads (see Figure 4). In recent years there have been shortened operating windows due to

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12 http://adaptation.nrcan.gc.ca/posters/articles/pr_09_en.asp?Region=pr&Language=e
13 http://www.grida.no/climate/ipcc_tar/wg2/613.htm#162823
warmer winters, especially south of 55 degrees latitude. Due to warmer temperatures in 1997-98, $14M was spent (98% Federal funding) flying supplies into communities normally served by winter roads. In the winters of 2001-02 and 2002-03, warm temperatures have resulted in delays in building ice roads in Manitoba. Currently, winter roads are a more economically viable transportation alternative than permanent all season roads or reliance on air transportation. As climate change causes operating windows to shorten, and operating and building costs to increase, the economic viability of winter roads may become questionable.

**Figure 4: Winter Roads**

On the positive side, *Manitoba and Climate Change: Investing in Our Future* (2001) states that the port of Churchill may experience growth as the ice-free season increases due to global warming. However, climate change may increase navigational hazards for marine shipping, as shoreline erosion may lead to more sediment along coastlines.14

Global warming will result in an increase in the frequency and severity of extremely hot days, while reducing the number of extremely cold days. This may result in pavement problems, such as buckling, softening, and rutting, becoming more common. Generally, this will increase maintenance costs and be a safety issue, though some savings may be seen in terms of fewer incidents of thermal pavement cracking during winter.

Climate change is not only associated with global warming, but as stated earlier, it is also associated with increased frequencies of severe weather events. For Manitoba, this will likely mean increased frequency and severity of floods and storms (both rain and snow). These events will have impacts on the safety and availability of transportation routes (see Figure 5). As well, increased precipitation will result in accelerated deterioration of transportation infrastructure due to weathering.

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Some of the indirect impacts of climate change on the transportation industry may include changes in location and timing of demands for transport of freight commodities (e.g., changes in agricultural production due to drought). Climate change may also impact on tourism, regional growth, energy production, and immigration.

**Mitigating transportation-related GHG emissions**

Mitigation refers to the process of reducing global greenhouse gas emissions. Mitigation could slow the growth in greenhouse gas emissions and eventually stabilize the amount of greenhouse gases in the atmosphere. These actions are critical to slow the rate of climate change and reduce the risk of negative impacts. Three approaches to mitigation were considered by the Transportation Climate Change Table in their *Foundation Paper on Climate Change* (1998): (1) technological improvements to vehicles, fuels and infrastructure; (2) changes in the way transportation is used; and (3) transportation demand management.

Future technological improvements within the trucking industry may include advances in aerodynamics, materials, tires, insulated engines, and fuel cells/hybrid vehicles. Improvements in diesel engines and fuel cells may also be applied to railroad locomotives. Future improvements to aircraft are predicted to primarily involve advances in engines and airframes, and using larger aircraft. Fuel cells may be an option for reducing aircraft emissions and improving fuel efficiency. Enhancements to infrastructure, such as more efficient traffic management systems for road and air traffic, pavement technology, and intermodal road-rail freight facilities, may play a role in emission reduction. Diesel electric systems and gas turbines seem to offer the most promise in terms of increasing the efficiency of marine modes of transportation. Advances in fuel must be dealt with in tandem to changes in vehicle technology, so that the technologies are compatible. Possible alternatives to conventional fuels include electricity, methanol, natural gas, propane, ethanol from wheat or bio-mass fibre, and biodiesel.

Transportation usage changes that will act to reduce GHG emissions have primarily been of two types: increasing usage of public transportation and shifting modes of freight transportation (see Figure 6). Although it is difficult to compare fuel efficiency between modes of freight transport due to differences in freight hauled, shipment size, length of haul, and special requirements of shippers, marine and rail modes are generally four to five times more fuel efficient (per tonne-kilometer) than trucks. Trucks may be advantageous, however, in urban areas and areas where rail or marine transport are not options, and in cases where volumes are too small for other...
modes and cases where service characteristics favor trucks. Reduction of GHG emissions from the trucking industry may involve training operators to be more efficient, the use of longer trucks, and load matching (i.e., ensuring trucks travel with a full load). Other ways of reducing emissions within the transportation sector include reduction of empty backhauls; proper vehicle maintenance; retiring older, less efficient vehicles; and choosing more fuel efficient vehicles when purchasing.

**Figure 6: Modes of Freight Transportation**

Transportation demand management involves implementing strategies that reduce the need for personal vehicles for urban transportation and encourage other forms of transit. Urban sprawl (e.g., suburb development) in tandem with the near reliance on personal vehicles for transportation presents a significant challenge to GHG emission reduction. To address this problem, urban planning polices should discourage low-density residential areas, encourage concentration of activities, and promote the integration of public transport facilities into new developments. Methods of urban planning that mix land use for residences, jobs, and services may reduce traffic and encourage other means of transportation, such as walking and bicycling. These “greener” methods of transportation (see Figure 7) should be encouraged, and urban design should take into account the needs of those who use them. Other measures that could be promoted in order to reduce GHG emissions include telecommuting, intermodal transfer nodes for passenger transport, parking management, alternative work schedules (i.e., to reduce traffic congestion), increased passenger loadings per vehicle, road pricing, road supply management, and car sharing (time-sharing of vehicles).

**Figure 7: “Green” Methods of Urban Transportation**
Adaptation Strategies

It is necessary to plan adaptation responses to actual and expected impacts of climate change. Adaptation strategies are aimed at minimizing negative impacts and utilizing opportunities to lessen environmental, economic, and social costs related to climate change. There are five basic categories of adaptation measures: prevent loss (reduce vulnerability), tolerate loss, spread or share loss/burden (e.g., across systems or populations), change the activity (stop activities that are no longer sustainable and substitute with other activities), and change the location.

An example of an adaptation strategy designed to prevent loss involves new infrastructure designs that take into account future climactic conditions that may occur within the design's expected lifetime. Potential rises in sea level due to climate change were taken into account when the Confederation Bridge between Prince Edward Island and New Brunswick was designed and built. However, climate change may occur considerably earlier than has been forecasted, making efforts to account for its effects difficult. Another example of adaptation to climate change is that permanent stream crossings for northern winter roads are being added as budgets allow. This is done to lengthen the time the road is open and for environmental considerations. As well, over-ice-roads are being relocated to land areas to reduce risk and because of the potential for future construction of all weather roads using the same routes. In Manitoba, southern winter roads have been most severely impacted by global warming; the road from Norway House to Wasagamack has been rerouted this winter through a more northern route in order to extend its operating window. In response to the unreliability of southern winter roads, the Province of Manitoba is working with the Government of Canada to examine the option of building an all-weather road on the east side of Lake Winnipeg.

Some new information regarding climate trends affecting winter roads has just been produced at the University of Winnipeg. More information is required. For example decisions regarding winter roads are constrained by lack of information in several areas, for instance about biophysical characteristics of permafrost and social impacts and adaptation options.

Manitoba Transportation Industries Taking Up the Challenge

Some Manitoban transportation-related companies are already working toward solutions to the challenges presented by climate change. For example:

- Krause Global, Winnipeg is an international leader in the development and export of manufactured alternate fuel and hydrogen-dispensing technologies that offer vast potential to reduce greenhouse gas emissions from transportation fuels.
- Bison Transport has registered with Canada's Climate Change Voluntary Challenge and Registry. Bison Transport reports that emissions have been reduced by nearly 20% through fuel-efficiency training programs for drivers and technological improvements.
- In December of 2002, Hydrogenics Corporation, New Flyer Industries, Maxwell Technologies, Dynetek Industries and ISE Research, working with the Province of Manitoba and the Government of Canada announced a new $8 million hybrid fuel cell transit bus project.
• New Flyer currently offers “clean air”, low emitting (ghg) versions of their buses that are fully tested and operational in commercial markets. These include compressed natural gas (GNG), liquid natural gas (LNG), and hybrid-electric versions of their buses.

Some of the other transportation companies that have registered with Canada’s Climate Change Voluntary Challenge and Registry include: Air Canada, Canadian National Railway Company (CN), Canadian Pacific Railway (CPR), Central Manitoba Railway, Southern Manitoba Railway, and VIA Rail Canada Ltd.

**Provincial Initiatives**

Manitoba Transportation and Government Services (MTGS) is participating in other initiatives that are relevant to responding to climate change. These include:

• MTGS’ consultation on Vision 2020;
• the Sustainable Development Procurement and Implementation Plan;
• Fleet Services initiatives;
• the provincial ethanol and hydrogen initiatives;
• the 2003 National Transportation and Climate Change Workshop;
• Canada’s Climate Change Plan for Canada;
• Action Plan 2000;
• the work of the Transportation Issue Table;
• the recommendations of the Manitoba Climate Change Task Force; and
• Manitoba’s climate change action plan 2002 *Kyoto and Beyond*.

Components and elements from these policy and program initiatives will be integrated into MTGS’ Transportation & Climate Change: Impacts, Emission Reduction and Adaptation Workshop.

Transportation measures to reduce emissions, to adapt to climate impacts and changes on infrastructure, and to increase awareness and outreach programs to update public information are being coordinated in MTGS’ provincial climate change strategy. This provincial transportation & climate change strategy is being developed in consultation with provincial transportation stakeholders.

**National Climate Change Strategies**

In December 2002, Canada announced its ratification of the Kyoto Protocol. Strategies designed to help Canada achieve its targets and commitments include:

• **Action Plan 2000** will reduce Canada's greenhouse gas emissions by 65 megatonnes per year by the period 2008-2012. The plan aims to further reduce GHG emissions in all sectors; expand the use of low or non-emitting energy sources; increase the use of ethanol in gasoline; invest in refueling infrastructure for fuel cell vehicles, infrastructure enhancing opportunities to store carbon in agricultural soils and forests; investigate the potential of geological storage of carbon dioxide; assess impacts; identify adaptation needs; and analyze policy options.

• **Budget 2000** announced new initiatives designed to promote technology innovation; enhance climate change and atmospheric research; help municipalities take action; expand purchases of green power; build capacity and
reduce emissions abroad; and renew the Climate Change Action Fund, energy efficiency, and renewable energy programs.

- **The Climate Change Plan for Canada** (2002) builds on current emissions reduction efforts and sets out a framework for enhancing these efforts. With regard to transportation, the federal government commits to working with automotive manufacturers to improve new vehicle fuel efficiency and proposes steps to encourage consumer demand for more efficient vehicles; commits to new investments to increase the use of public transit and manage growth in vehicle use; sets the goal of increasing the amount of gasoline containing 10 percent ethanol blend to 35 percent of the market, in collaboration with the provinces and territories, and the amount of biodiesel production to 500 million litres; and proposes improved performance targets and best practices for all freight transport, and enhanced intermodal infrastructure.

Many individual federal government departments are also involved in climate change.
Climate Change Internet Resources

www.climatechange.gc.ca
The Government of Canada’s climate change site.

http://web2.gov.mb.ca/est/climatechange/
The Province of Manitoba’s climate change site.

www.gov.mb.ca/conservation/climatechange/
Manitoba Conservation Climate Change Branch site.

http://www.ec.gc.ca/climate/home-e.html
Environment Canada's climate change site has links to many reports and publications, as well as the GHG and greenhouse effect sites.

The Natural Resources Canada climate change site contains publications for various sectors of the economy as well as policy information.

http://www.tc.gc.ca/environment/menu.htm#climatechange
Transport Canada’s site lists specific emission reduction programs for each transportation mode.

www.c-ciarn.ca/
The Canadian Climate Impacts and Adaptation Research Network site has links to projects undertaken across Canada.

http://adaptation.nrcan.gc.ca/
The government of Canada’s climate change impacts and adaptation site has a searchable database of C-CAIRN projects and online posters describing impacts and adaptations in various regions of Canada.

http://www.climatechangeconnection.org/ccc.html
The climate change connection site has Manitoba climate change information and news

http://www.cantruck.com/f_issues-e.html
CTA represents the industry's viewpoint on national and international policy, regulatory and legislative issues that affect trucking.
Reports

Canada’s Greenhouse Gas Inventory: 1990-2000 contains information on emission trends by industry and by gas type.

The Transportation Table’s Foundation Paper on Climate Change is an in-depth examination of the transportation sector’s emissions and possible reduction efforts.

http://nrcan.gc.ca/es/ceo/update.htm
Canada’s Emissions Outlook: An Update provides past emissions data as well as future forecasts at both national and provincial levels.

http://www.ec.gc.ca/pdb/ghg/ghg_tables_2000_e.cfm
This site contains tables that list provincial and national emissions by sector for each year from 1990-2000.

http://www.climatechange.gc.ca/english/3nr/index.html
Canada’s Third National Report on Climate Change provides information on Canadian climate change policy, GHG emissions, impacts, and adaptation and mitigation efforts.

Manitoba and Climate Change: A Primer describes the science of climate change and the impacts that it will have on Manitoba. Possible opportunities and challenges are also addressed.

Manitoba and Climate Change: Investing in Our Future addresses the climate change-related issues facing Manitoba, and discusses the recommendations and strategic direction put forth by the Manitoba Climate Change Task Force.

Kyoto and Beyond: A Plan of Action to Meet and Exceed Manitoba’s Kyoto Targets contains proposals for emission reduction, an accounting of accomplishments and new programs intended to address the many challenges posed by climate change.

http://climatechange.gc.ca/plan_for_canada/plan/index.html
The Climate Change Plan for Canada provides a national framework and proposes initiatives designed to reduce GHG emissions.

http://www.ligi.ubc.ca/_media/_publications/030115A_Sustainable_Climate_Policy.pdf
A Sustainable Climate Policy examines core concerns of industry and existing regulations, and presents policy options that could be employed to reduce GHG emissions.
http://www.climatechangeconnection.org/pdfs_ccc/barriers.pdf
A report on promoting climate-friendly transportation choices.

A response from the Rail Association of Canada on the 'Discussion Paper on Canada’s Contribution to Addressing Climate Change'.