

AHEAD OF THE STORM....

Preparing Toronto for Climate Change

DEVELOPMENT OF A CLIMATE CHANGE ADAPTATION STRATEGY

APRIL 18, 2008

PREPARED BY THE TORONTO ENVIRONMENT OFFICE IN COLLABORATION WITH THE CITY OF TORONTO CLIMATE ADAPTATION STEERING GROUP AND THE CLEAN AIR PARTNERSHIP

“While stopping the release of greenhouse gases remains our first priority, it's apparent that some degree of climate change has already begun. In developing an adaptation strategy, the City of Toronto is taking steps to prevent negative impacts associated with the realities of a changing climate while proceeding with actions designed to combat further change.”

Mayor David Miller
April 2008

TABLE OF CONTENTS

1. Introduction	3
2. Purpose and Goals	5
3. How Climate is Changing and What it Means for Toronto	5
▪ Temperatures are rising globally	6
▪ Winters are shorter and warmer	7
▪ Precipitation patterns are changing	9
▪ Extreme weather is increasing	10
▪ Inland lake and stream levels are dropping	11
▪ Sea levels are rising	13
4. Why Toronto Must Adapt to Climate Change	14
5. What Toronto is Already Doing	15
6. Planned and Proposed Short-term Adaptation Actions	17
7. Developing a Comprehensive Adaptation Strategy	21
▪ Create internal mechanisms and processes	22
▪ Engage the public, businesses and other stakeholders	27
▪ Incorporate climate change adaptation into policies	30
▪ Analyze how climate is changing	30
▪ Develop a citywide inventory of climate vulnerabilities	32
▪ Conduct a formal risk assessment to prioritize risks	34
▪ Identify and assess adaptation options	35
▪ Develop and Implement Adaptation Strategies	37
▪ Monitor and measure progress	38
8. Summary of Recommended Actions for Developing and Implementing a Toronto Climate Change Adaptation Strategy	40
9. How to Provide Comments on this Document	43
References	44
Appendix 1: City of Toronto Climate Change Adaptation Steering Group	46

1. INTRODUCTION

Toronto has responded to the need to address climate change through the Climate Change, Clean Air and Sustainable Energy Action Plan (the "Climate Change Action Plan") that was unanimously adopted by Toronto City Council in July 2007. The Climate Change Action Plan includes numerous initiatives that will reduce the emission of the greenhouse gases that are fuelling climate change. Toronto is now acting to implement that plan.

City Council's commitment to implement the Climate Change Action Plan is reflected in the over \$1 billion allocated for the next five years in the City's capital budget for projects that will help reduce greenhouse gas emissions. Key programs and investments include:

- \$67 million for the Better Building Partnership and the Sustainable Energy Funds, which are low interest revolving loan funds that support energy conservation and renewable energy;
- \$136 million for energy retrofits to and installation of renewable energy systems on City owned buildings;
- \$24 million for tree planting, in addition to the \$40 million a year operating budget for the City's Forestry Unit;
- \$36 million to accelerate implementation of the City's Bike Plan;
- \$20 million for the Live Green Toronto program which provides support for neighbourhood and community groups in taking action on Climate Change;
- \$10 million for continued conversion of traffic signals to LED lights;
- \$7 million for the Clean Roads to Clean Air street sweeping initiative;
- \$186 million for water efficiency and improved energy efficiency in Toronto Water operations that will achieve an annual avoidance of an estimated 14,000 tonnes of greenhouse gas emissions;
- \$21 million for methane gas capture and control at closed and operating landfills;
- \$67 million to build anaerobic digestion facilities that will capture biogas from collected Green Bin organic materials and generate enough electricity to power an estimated 1,700 homes;
- \$380 million to improve rapid transit services, such as, new light rapid transit lines, rapid transit routes for buses and an improved signalling system that will increase the capacity of the Yonge subway line;
- \$400 million for the purchase of electric-hybrid buses; and
- \$10 million plus for a range of initiatives including the Green Fleet Transition, the Eco-Roofs and Greenroofs Incentive programs, and support initiatives that promote production and consumption of locally grown food.

The development and establishment of a climate change adaptation strategy is one of the actions contained in the Climate Change Action Plan. This document presents an action-oriented framework that is designed to help members of the public and other stakeholders engage in the process of designing and implementing a climate change adaptation strategy for Toronto.

Responding to Climate Change

Toronto Council unanimously approved a comprehensive strategy to respond to climate change, known as the Climate Change, Clean Air and Sustainable Energy Action Plan. The City of Toronto's overall strategy is to focus on:

1. **Activities that reduce greenhouse gas emissions *and* help prepare for climate change (Mitigation and Adaptation).**
2. **Activities that reduce greenhouse gas emissions (Mitigation).**
3. **Activities that help prepare for climate change (Adaptation).**

Mitigation actions include efforts to: reduce energy use, switch to renewable sources of energy, capture landfill gases and other actions. Mitigation reduces the build-up of greenhouse gases in the atmosphere and slows climate change over the long term.

The City of Toronto has been actively reducing emissions for many years. In *Change is in the Air*, the City made additional commitments to reduce Toronto's greenhouse gas emissions 6% by 2010, 30% by 2020 and 80% by 2050.

Examples of actions that reduce greenhouse gas emissions (mitigation) are:

- *Increased use of public transit*
- *Energy efficiency programs*
- *Capturing landfill gas to generate energy*

Adaptation actions include programs that reduce the effects of heat waves, flooding from intense rainstorms, high winds, expanding range of insect pests, changes in lake levels and other impacts of climate change.

Examples of actions that protect against climate change (adaptation) are:

- *Upgraded storm drainage*
- *Health protection programs (e.g. West Nile Virus, Heat Alerts)*
- *Enhanced emergency and business continuity planning*

Mitigation *and* Adaptation actions reduce greenhouse gas emissions *and* protect against the climate changes that are already occurring.

*Examples of actions that reduce greenhouse gas emissions **and** protect against climate change are:*

- *Water conservation programs (saves electricity in pumping/ treating and saves water for other uses during drought)*
- *Installation of green roofs*
- *Expanding the tree canopy*
- *Local food procurement*

2. PURPOSE AND GOALS

This document has been prepared by the Toronto Environment Office in collaboration with the City's Adaptation Steering Group with assistance from the Clean Air Partnership (Appendix 1 lists the members of this group). The City recognizes that reducing greenhouse gases **and** preparing for climate change are both necessary. The focus of this document is on preparing for climate change.

The goals of the document are to:

- Provide a rationale for incorporating adaptation to climate change into City of Toronto policies, programs and activities;
- Build on existing partnerships to engage the City urban area, comprising small and large businesses, residents and other stakeholders, in actions to provide protection from climate change;
- Describe programs and actions already underway in the City that provide protection from climate change;
- Suggest further short-term actions that will increase protection from climate change and provide other benefits to Toronto; and
- Recommend a process to systematically assess the risks to Toronto of climate change, prioritize areas for action, and develop strategies to reduce the impacts and protect Toronto.

3. HOW CLIMATE IS CHANGING AND WHAT IT MEANS FOR TORONTO

The most recent reports from the Intergovernmental Panel on Climate Change (IPCC, 2007) provide a clear message that global climate is changing in many ways. Many of these changes are having a direct impact on Toronto and will continue into the foreseeable future. This section outlines a number of the changes that are occurring and some of the ways in which these changes will affect Toronto.

“Warming of the climate system is unequivocal, as is now evident from observations in global average air and ocean temperatures, widespread melting of snow and ice, and rising global mean sea level.

“At continental, regional and ocean basin scales, numerous long-term changes in climate have been observed. These include changes in Arctic temperatures and ice, widespread changes in precipitation amounts, ocean salinity, wind patterns and aspects of extreme weather including droughts, heavy precipitation, heat waves and the intensity of tropical cyclones (hurricanes and typhoons).”

Intergovernmental Panel on Climate Change (2007)

Climate changes are already being seen in Toronto. In the last decade, the City has been subjected to extreme heat, floods, drought, new insect pests, new vector-borne diseases and other problems made worse by climate change.

Even if the world is successful in getting emissions under control, climate scientists affirm that climate change will continue for many decades from long-lived greenhouse gases that have already accumulated in the atmosphere.

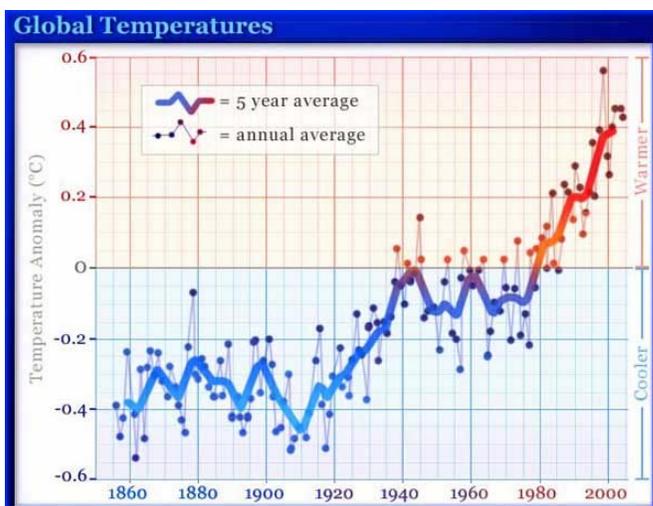
The need to adapt to climate change – to protect the city, its citizens, its ecosystems and its economy from the negative impacts of global warming – was identified in the Climate Change Action Plan as a matter of growing urgency. Toronto needs to develop adaptation strategies that will minimize the negative effects of climate change and take advantage of potential opportunities.

Because climate will continue to change over the next century, adaptation will not be a short-term effort. Adapting to climate change requires decision-makers to take climate change into account in their plans and programs on an ongoing basis. This framework document presents for discussion purposes a process that will help Toronto adapt.

Temperatures are rising globally.

Eleven of the 12 hottest years on record have occurred since 1995. Average temperatures globally have risen by 0.74°C over the last 100 years, though warming is much greater in the Arctic and sub-Arctic regions. Global average temperatures are expected to increase another 2 to 4°C by the end of this century, depending on emissions. As temperatures increase, impacts will expand. For example, temperature increases of 1.5 to 2.5°C will increase the likelihood of extinction of 20-30% of plant and animal species (IPCC, 2007).

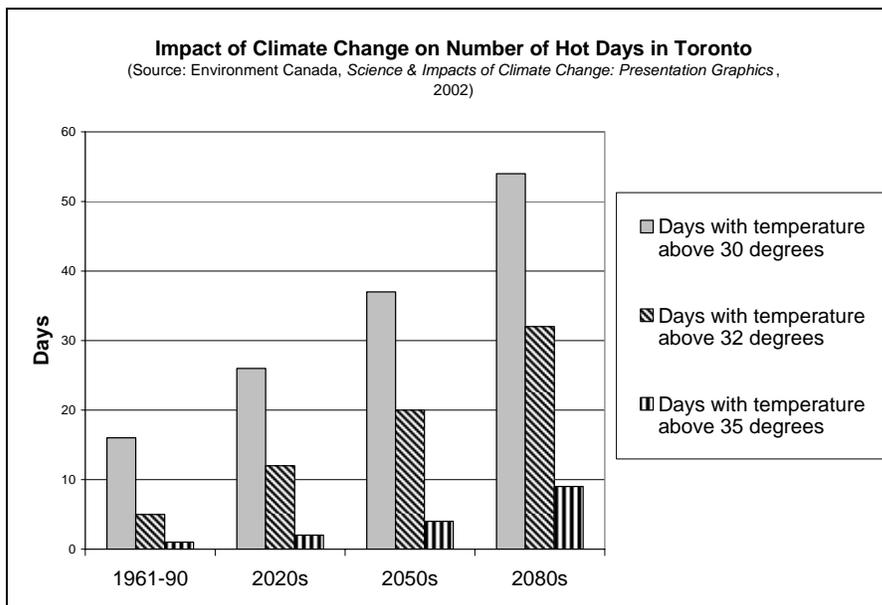
In addition to warmer average temperatures, hot days and heat waves are on the rise. The 2003 European heat wave raised summer temperatures by 3 to 5°C over most of southern and central Europe, leading to an excess of more than 30,000 deaths (United Nations Environment Program, 2004). This heat wave was accompanied by a drought that caused wildfires, reduced agricultural production, and lowered water levels in many major rivers to record levels.



Source: Intergovernmental Panel on Climate Change (2007)

What this means for Toronto

Toronto's hottest summer shows how climate change is likely to affect temperatures in the City. During the summer of 2005, Toronto had 41 days where the average temperature was over 30°C, almost three times the number of hot days experienced on average in the 1961-1990 period (Environment Canada, 2005). The City issued eight heat alerts and 18 extreme heat alerts. During this time, the Coroner identified six heat-related deaths among people who lived in rooming houses and boarding homes (Toronto Public Health, 2006). There were more than two hundred 9-1-1 calls for heat-related illness (Bassil et al, 2007).



Source: Environment Canada (2002)

Toronto Public Health estimates that in an average year 120 premature deaths are heat-related, and predicts that heat-related deaths will double by 2050 and triple by 2080 (Pengelly et al, 2005).

Smog – which worsens in hot weather – was also a major problem in 2005. Toronto had smog advisories for a total of 48 days in 2005. Ozone is an important component of smog and is estimated to contribute to a third of the estimated annual 820 deaths related to air pollution in Toronto. Toronto Public Health estimates that air pollution related deaths will increase 20% by 2050 and 25% by 2080, largely because of increased smog from global warming (Pengelly et al, 2005).

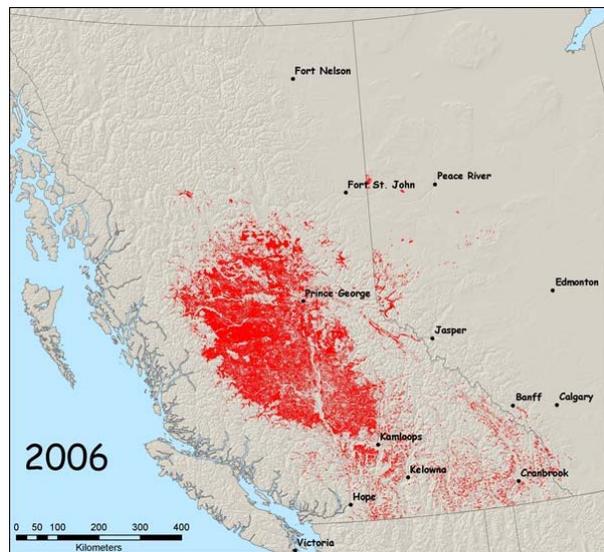
Winters throughout the Northern Hemisphere are shorter and warmer.

Many Canadians see shorter, warmer winters as a benefit of climate change. However, there are many problems associated with this trend. Currently, snow and ice reflect some of the sun's energy back into space. As the Earth warms, snow and ice cover decrease and more of the sun's energy is absorbed, which speeds up global warming. The extent of Arctic sea ice is shrinking and so is its thickness, endangering polar bears

and other Arctic life. Glaciers are retreating in most of the world. Snowpack – which is used as a source of drinking water in some parts of the world – is declining in many mountain areas (IPCC 2007). The loss of glaciers and snowpack is also affecting towns in the Canadian prairies that are dependent on river water.

Shorter, warmer winters also mean that insects that used to die off during winter cold spells are finding it easier to survive and to expand into more northerly areas (Hunt et al, 2006). The mountain pine beetle infestation that has devastated BC's forests in the past few years is an extreme example. At the current rate of spread, 50% of mature BC pine will be dead this year, and 80% by 2013 (Natural Resources Canada, 2008). The beetle has recently expanded into Alberta, and is expected to continue moving eastward through Canada's vast boreal forests.

Forests Devastated by the Mountain Pine Beetle



*Photo: Lorraine Maclauchlan, BC Ministry of Forests, Southern Interior Forest Region of BC
Map: Natural Resources Canada*

What this means for Toronto

Like the rest of the country, Toronto's winters are getting warmer. Most years, there will be less snow and more rain. Freezing rain will increase, at least for the next few decades. There will be more freeze-thaw cycles, which heave road surfaces and create potholes, create rooftop ice dams, and damage trees and plants (Lemmen and Warren, 2004).

Warmer winters also allow the expansion of insect vectors that carry infectious diseases such as the West Nile virus and Lyme disease. Both of these diseases are already present in the Toronto area, and are expected to increase in numbers and expand their range as winters continue to warm. Other infectious diseases that may reach Toronto with warmer winters include malaria, dengue fever, hantavirus, eastern equine encephalitis and St. Louis encephalitis (Chiotti et al, 2002).

Projected future range of the black-legged tick, carrier of Lyme disease



Source: Ogden et al, 2005

Insects that attack trees are also proliferating in Toronto. In recent years, warm winter temperatures have contributed to an increase in the spread of the European Gypsy Moth, putting at risk the oak trees that are most vulnerable to attack by this pest. Introduced species such as Norway maple and European buckthorn are well adapted to warmer climates and compete with native species that support biodiversity in Toronto ecosystems. Insects, disease and weedy competition contribute to the stress on the urban forest and the benefits it provides for the city – shade, cooling, absorption of air pollutants, reduced runoff, habitat for birds, the ability to sequester carbon and to provide an attractive environment.

Precipitation patterns are changing.

Precipitation is one of the more uncertain areas of climate change. Precipitation is naturally quite variable from season to season, year to year and region to region. Climate models do not completely capture some of the factors that affect precipitation. Climate change appears to be affecting precipitation differently in different parts of the world. It has become significantly wetter over eastern North and South America, Northern Europe and Asia over the last 100 years and dryer in the Mediterranean Basin, much of Africa and southern Asia (IPCC, 2007).

Seasonal precipitation patterns are also changing. Most climate change models predict that more precipitation will fall in winter and spring and winter precipitation will fall as rain rather than snow in southern parts of Canada (Klaassen, 2008).

Although annual average precipitation is increasing in many parts of the world, droughts are expected to become more frequent even in these areas. The area of the Earth's land stricken by drought more than doubled between 1970 and the early 2000s (National Center for Atmospheric Research, 2008). Southern Ontario suffered several drought years in the 1990's, 2001, 2002 and 2007.

What this means for Toronto



The summer of 2007 demonstrates the potential effect of dryer summers in Toronto. It was the driest summer in 50 years, with 95 consecutive days without significant rain. It was the lowest rainfall total since record-keeping began in 1959 (Environment Canada, 2007).

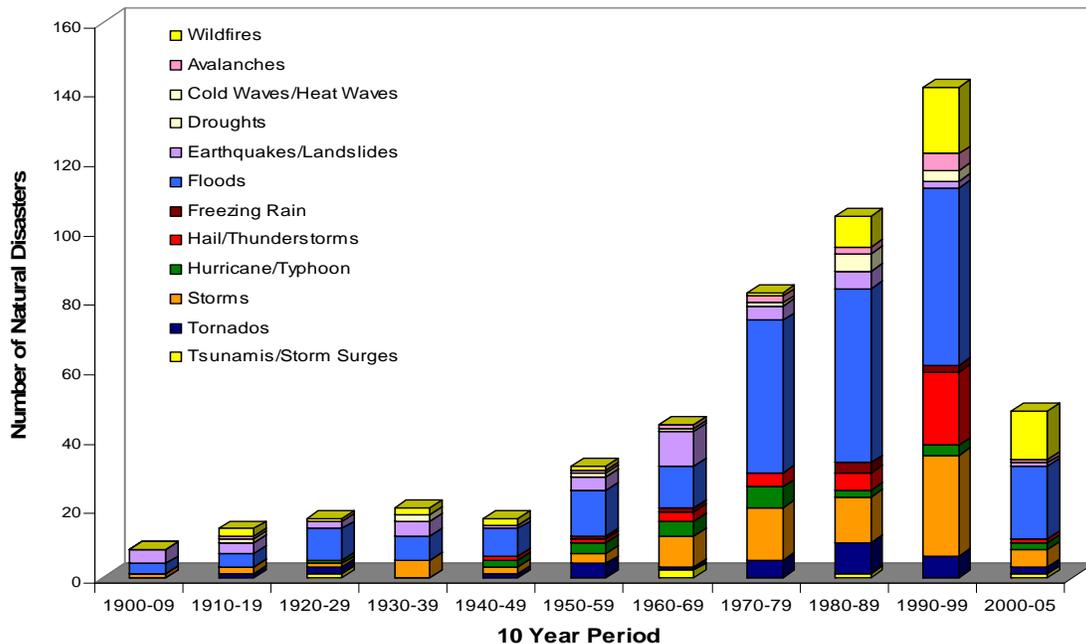
Scanty rainfall affected parks, lawns, gardens and trees throughout the city. Many trees died, while others were badly stressed, making them vulnerable to pests and disease.

Summer 2007: Stressed park grounds, Toronto.

Extreme weather is increasing.

Storms are driven largely by latent heat and are becoming stronger as the air becomes warmer with climate change. Severe thunderstorms, freezing rain events and windspeeds appear to be increasing. Intense storms and hurricanes – linked to warmer sea temperatures – have increased in the North Atlantic since about 1970 (IPCC, 2007). Warmer air holds more water vapour, which leads to more intense rainfall, which can lead in turn to local and regional floods.

Frequency of Natural Disasters in Canada (1900-2005)



Source: Heather Auld, Environment Canada, 2007. Note: The final bar in the graph only covers the first half of the decade and does not indicate a decline in numbers of natural disasters.

Environment Canada has monitored the number of natural disasters in Canada over the last century and shows the dramatic increase in extreme weather and related disasters in the graph below (Auld, 2007). The increases in tornados, storms, hail/thunderstorms, floods and wildfires are substantial and alarming.

Extreme weather is multiplying weather-related insurance losses – which increased globally by more 1300% from 1960 to 1999 according to the international reinsurance company Munich Re. Natural catastrophe losses reached an estimated \$75 billion in 2007, of which insured losses totalled \$30 billion in US dollars (Munich Re Group, 2007).

What this means for Toronto

We saw the potential effects of extreme weather on North Toronto during the intense rainfall on August 19, 2005, one of eight extreme weather events in the past 20 years. The storm washed out a part of Finch Avenue, and caused flash flooding to creeks, rivers and ravines, eroding streambanks and damaging trees and parks. More than 4200 basements were flooded. The damages to public and private property have been estimated at \$400-500 million – the most expensive storm in Toronto's history.

Finch Avenue, August 19, 2005



Photos courtesy of Jane-Finch.com

Strong windstorms and tornados may also be more likely to affect the Toronto area than in the past. Scientists in the US National Aeronautics and Space Administration (NASA) have done new climate modelling that indicates that the most violent severe storms and tornadoes will become more common as warming continues (Del Genio et al, 2007). Toronto is normally outside the Southwestern Ontario tornado corridor, but this may be changing (Maclver, 2006). A remnant tornado associated with the August 19, 2005 storm, damaged home, cars, trees and farm buildings from Stratford to Peterborough, and may have touched down in Toronto, though this was not confirmed by Environment Canada. Tornadoes also hit nearby Hamilton in 2005 and Newmarket in 2006.

More recently, on January 9, 2008, high winds demonstrated the impacts of stronger windstorms for Toronto as they swept construction materials from the roof of an office building into downtown streets, snapped off tree limbs, downed power lines, delayed commuter trains and closed the airport.

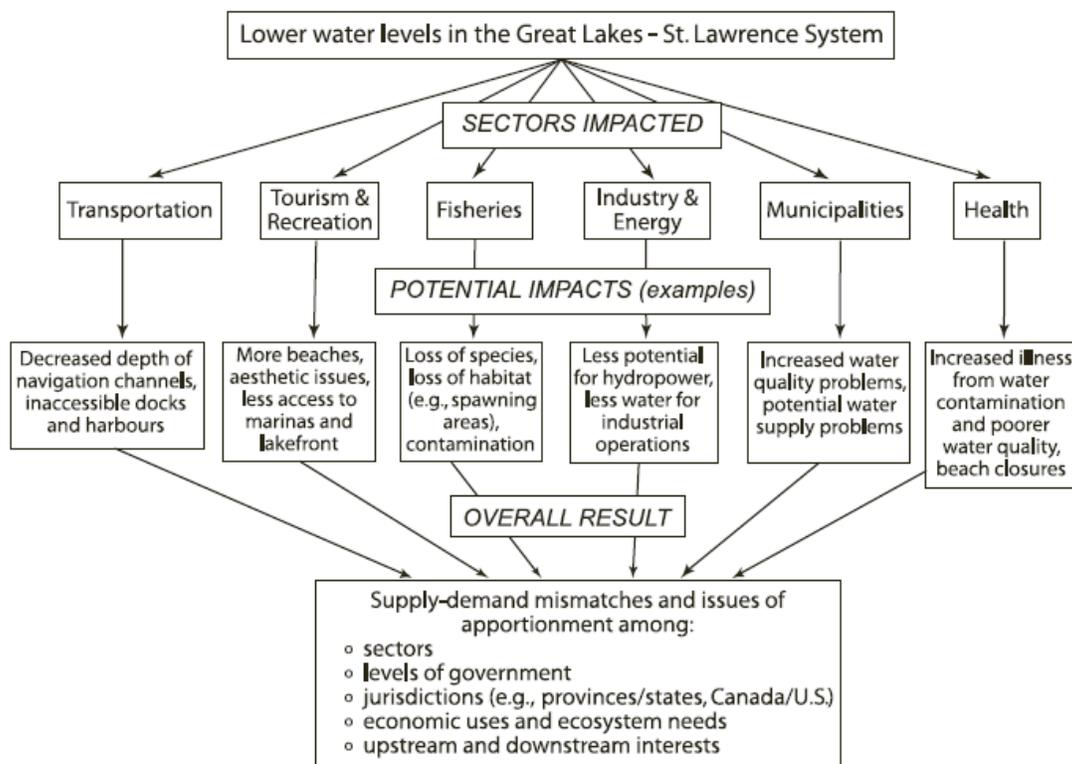
Inland lake and stream levels are dropping.

Higher temperatures will bring with them increased evaporation from surface waters in many parts of the world. In the Northern hemisphere, reduced ice cover will increase this tendency by allowing more evaporation in winter months. This will contribute to lower lake, river and stream levels and reduced water in wetlands.

Lower surface water levels are likely to have an array of impacts, depending on the region and the extent of the decline. In areas where climate change appears to be reducing precipitation, higher levels of evaporation will be particularly problematic. Lake Chad, on the border of Cameroon, Chad, Nigeria and Niger, has shrunk to about 5% of its original size since the early 1960's, as a result of drought, evaporation and diversion of water from rivers that flow into the lake for irrigation purposes.

The diagram below, excerpted from the most recent report of the Intergovernmental Panel on Climate Change, outlines the potential impacts of lower lake levels in the Great Lakes region of Canada and the US.

.Interconnected Impacts of Lower Water Levels in the Great Lakes – St. Lawrence System



Source: Field, Mortsch et al, 2007 (modified from Lemmen and Warren, 2004)

What this means for Toronto

Doubling of carbon dioxide in the atmosphere is expected to increase evaporation enough to lower water levels in Lake Ontario by close to a metre (AMEC, 2006). This drop will have a number of direct and indirect effects on Toronto.

Lower water levels will affect Great Lakes shipping by reducing channel depths. Ships will need to reduce tonnage in order to float higher in the water, decreasing the amount of cargo they can transport and increasing the costs of each trip. This could negatively affect Toronto's port operations (Wieditz and Penney, 2006). Dredging may be necessary to deepen channels and the harbour (AMEC, 2006).

Reduced water levels in Lake Ontario may affect the footings of shoreline and submerged structures such as water intake and outflow pipes and piers, increasing wear and tear from storms. Lower water levels will also jeopardize access to marinas in the Toronto area and some may no longer be viable (AMEC, 2006).

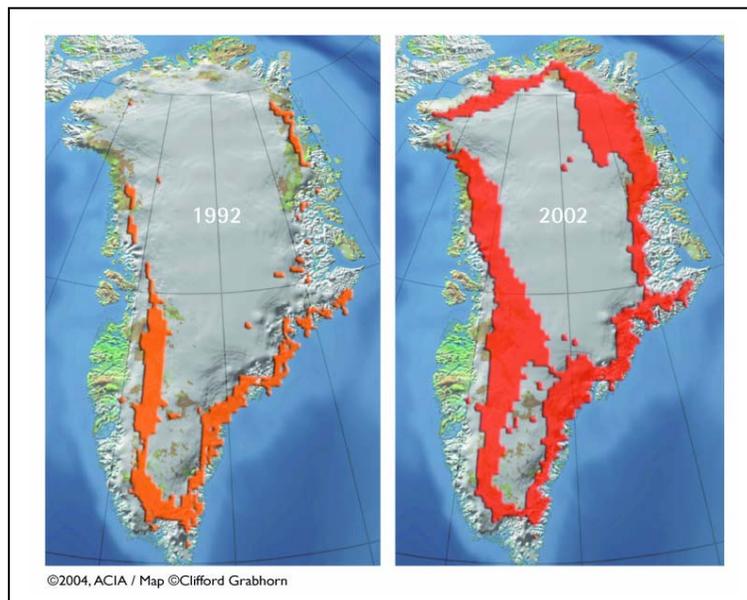
Lower lake levels may concentrate contaminants in the lake. Combined with higher lake temperatures, which increase the likelihood of algal blooms, this can create problems for water quality.

Lower lake levels will also stress coastal wetlands in the Toronto area, which currently provide habitat for several species of toads, frogs, turtles, snakes, birds and fish.

Sea levels are rising.

Ocean temperatures are rising. Warmer sea water expands and causes sea level to rise. Melting mountain glaciers also add to sea level. Over the last century, global sea level has risen by almost 2 mm annually, but since 1993 this has increased to 3 mm per year. The IPCC (2007) estimates that floods in low-lying Asian countries could affect as many as 94 million people annually by the end of the century. The Antarctic and Greenland ice sheets are thinning along their edges and adding water to the oceans. If either of these ice sheets melts completely, sea levels could rise 5 to 7 meters, flooding many of the world's coastal cities according to a recent report for the Organization for Economic Cooperation and Development (Nicholls et al, 2007).

Extent of Greenland Icesheet Melt in 1992 and 2002



*Source: Arctic Climate Impact Assessment / Grabhorn, 2004
Areas in orange and red show the extent of melting in the years indicated.*

What this means for Toronto

While higher sea levels won't affect Toronto directly, they will likely have a number of indirect effects. For example, damage to the Halifax, St. Lawrence and Vancouver seaports will affect important shipping hubs and affect the economy of Canada as a whole.

Coastal flooding from sea-level rise, long-term droughts and other climate change impacts will likely create many more international refugees. The IPCC (2007) estimated that climate change would create as many as 150 million new refugees by 2050. Toronto already takes in many refugees. Coastal flooding in other countries will increase their numbers and their needs, and increase pressure on the City's health, education and social services.

4. WHY TORONTO MUST ADAPT TO CLIMATE CHANGE

Municipalities have a significant role in climate change adaptation. Many of the impacts of climate change will affect services and infrastructure for which cities have primary responsibility, including: public health; water supply and stormwater management; local transportation; electricity distribution; parks and urban forests; social and emergency services.¹

The City of Toronto is undertaking a number of expensive capital projects and programs that are expected to serve the city over many decades. These include: stormwater management and sewage treatment systems; expanded electricity generation and transmission; improved transit and systems; waterfront development and major redevelopments in other parts of the city; tree planting and green space protection and enhancement. Increases in heat, extreme weather, summer droughts, insect pests and other effects of climate change could greatly impact these projects and programs over their lifetime.

The planning and implementation of these projects and programs needs to take climate change into account. Projects that incorporate climate change considerations may be more costly than those that don't, but the costs of *not* protecting against climate change could ultimately be much higher.

Toronto also has a special responsibility to those who are particularly vulnerable to climate change. Toronto's homeless people are the most exposed to extreme weather. Isolated and low-income seniors are very susceptible to heat. Other at-risk groups include people with chronic and pre-existing illnesses, including mental illness, and children. Low-income people without savings or insurance have greater difficulty recovering from extreme weather events that damage their housing, belongings or health.

¹ See Table 3 on page 32 for an outline of the expected impacts of climate change on Toronto and a broad range of city sectors that are likely to be affected.

5. WHAT TORONTO IS ALREADY DOING

As outlined on the next page, the City has a number of programs that that will help protect Toronto from climate change. Some of these programs were initiated to protect the city from existing patterns of extreme weather; some were primarily developed for other reasons. Many of these actions not only protect Torontonians from the impacts of extreme weather, but they also increase the overall liveability and sustainability of Toronto.

To protect against future climate change, it is likely that some or all of these programs will need to be expanded or enhanced. However, they are a good basis on which to build a comprehensive adaptation strategy.

Examples of Existing Toronto Programs That Reduce Vulnerability to Climate Change

- **Toronto's Heat Alert system and Hot Weather Response Plan.** Toronto Public Health issues heat warnings and works with community agencies to prevent illness and death during periods of extreme hot weather. Toronto Public Health has studied climate change and its effects on heat and air pollution in the City to help with planning for the future.
- **The Wet Weather Flow Master Plan.** This 25-year implementation plan is designed to reduce flooding from intense rainfall, and water quality and erosion impacts on streams and lake water. Toronto Water is using information from the August 19, 2005 storm to guide its implementation of this plan.
- **Basement Flooding Protection Subsidy Program.** The City is subsidizing the costs of installing back-water valves and sump pumps on household sewer connections in order to provide additional protection against flooding from sanitary sewers.
- **Flood Warning Forecasting.** The Toronto Regional Conservation Authority is improving the existing system to better prepare for flood emergencies and reduce damage to life and property.
- **The Green Roof Pilot Incentive Program.** This program provides an incentive for green roofs to be installed on new or renovated Toronto buildings. Green roofs capture and retain stormwater and they also cool the buildings on which they grow.
- **A Commitment to Double the Tree Canopy.** Parks, Forestry and Recreation is undertaking a major study of canopy potential and associated implementation strategy with Planning & Transportation Services. Expanding the tree canopy in Toronto will provide shade, lessen the urban heat island effect, and reduce runoff and other effects of climate change.
- **The Deep Lake Water Cooling (Enwave), Peaksaver and Keep Cool Programs (Toronto Hydro).** These and several other innovative programs that conserve energy, reduce peak electricity demand on hot summer days also reduce the risk of brownouts and blackouts during heat waves.
- **The Green Development Standard.** The Standard provides a set of performance targets for the design and construction of new developments in Toronto. The Standard will increase energy efficiency of buildings, reduce greenhouse gas emissions, reduce the urban heat island, conserve water, reduce stormwater runoff and enhance neighbourhood green space. Many of these features will contribute to reducing the impacts of climate change.
- **Green Parking Lots.** Draft design guidelines for greening surface parking lots have been prepared by City Planning and pilot projects are in progress. Greener parking lots are expected to reduce heat and runoff.
- **The Better Buildings Partnership.** This program works with building owners and developers to increase energy efficiency in existing buildings and in new construction, which decreases energy use and peak energy demand, reducing the vulnerability of the grid to brownouts and blackouts during heat waves.
- **Emergency Plan.** Toronto's Emergency Plan prepares the city to protect the health, safety and welfare of the community in the face of a variety of hazards, including several that may occur more frequently as a result of climate change (severe weather, floods, power failures, etc.).

6. PLANNED AND PROPOSED SHORT-TERM ADAPTATION ACTIONS

This report suggests two concurrent streams of activities for the City to take on climate change adaptation. The first is a series of short-term actions that build on existing programs and that will enhance climate change adaptation in recognized areas of vulnerability. These are outlined in the section below.

Over the longer term, the City also needs to more systematically assess its vulnerability to climate change; identify and evaluate adaptation options; and plan and implement a more comprehensive adaptation strategy. This process will be described in Section 7, starting on page 21. The short term adaptation actions outlined below in Table 1 are planned to begin in 2008.

Table 1: New Short Term Climate Adaptation Actions with Resources Approved for 2008/2009

SHORT TERM ADAPTATION ACTIONS	ANTICIPATED BENEFIT	CITY GROUP(S) RESPONSIBLE
Live Green Toronto	Direct engagement of communities in greening projects, including projects to reduce climate change impacts. Development of Climate Change Preparedness Information Kits for citizens and small businesses. (Pilot in 2008)	Toronto Environment Office (TEO) Parks, Forestry & Recreation
Improved “All Hazards Emergency Planning” for Micro, Small and Medium Size Businesses	Conduct focus groups to seek input on 72 hour emergency and business continuity planning for households and businesses.	TEO Office of Emergency Management
Future Climate Prediction Modelling	Improved information on expected climate extremes and gradual changes to permit better decision making on adaptation planning. Models will also be used for next generation watershed plans.	TEO, TRCA Environment Canada Toronto Water Region of Peel Adaptation Steering Group (includes Public Health)
Climate Change Vulnerability and Risk Assessment of City Operations	Improved understanding of where vulnerabilities are and ranking of risks will help prioritize needs for adaptation actions.	TEO Insurance & Risk Mgmt Adaptation Steering Group (includes Public Health)
Participation in the Greater Toronto Incident Management Exchange	Help plan for recovery from wide scale business disruptions or disastrous events including severe weather.	Office of Emergency Management
Don and Waterfront Trunk Sewers, and Combined Sewer Overflow Control Strategy Project	Assess effects of extreme weather on performance of drinking water and wastewater facilities, and attainment of water quality goals.	Toronto Water

Table 1 Continued

SHORT TERM ADAPTATION ACTIONS	ANTICIPATED BENEFIT	CITY GROUP(S) RESPONSIBLE
<p>Development of regional extreme precipitation intensity, duration and frequency curves</p> <p>Review of Urban Flooding issues</p>	<p>Improves ability to design storm drainage infrastructure for extreme runoff events.</p> <p>Identification of future policy and program requirements for flood protection.</p>	<p>TRCA Environment Canada Conservation Ontario GTA municipalities</p>
<p>Scan of methods used in other jurisdictions for assessing vulnerability to heat</p> <p>Evaluation of the Air Quality Health Index (AQHI) Pilot</p>	<p>To develop heat-related vulnerability assessment tool to provide strategic direction for the City's Hot Weather Response Plan.</p> <p>Evaluation will help identify behaviour changes that citizens are making as a result of the AQHI and identify improvements in education initiatives that can help maximize health benefits when air quality is poor.</p>	<p>Toronto Public Health</p>
<p>New winter weather technologies to improve monitoring for snow and freezing rain conditions</p> <p>Combination ploughing and salting vehicles</p>	<p>These innovations will allow:</p> <p>a) better use of salt; and</p> <p>b) reduced accident claims and service delivery costs in freezing rain episodes expected to increase under climate change.</p>	<p>Transportation Services</p>
<p>Analysis of when and where green roofs could be required</p>	<p>This analysis will support recommendations for a new Green Roof by-law. Green roofs assist in reducing demand for air conditioning and in reducing storm water runoff.</p>	<p>City Planning</p>
<p>Green Development Standard: Anticipating impacts of climate change on built form</p>	<p>Promotes resilience in built form and sustainable development.</p>	<p>City Planning</p>
<p>Urban Heat Island research to inform land use planning policy approaches to "cooling" the City</p>	<p>Identification of Toronto's "hotspots", what causes them, and planning strategies to reduce them.</p>	<p>City Planning Clean Air Partnership</p>
<p>City of Toronto Integrated Energy Strategy</p>	<p>An integrated strategy is under development that will incorporate plans to increase the resilience of the City's energy supply, taking climate change into account.</p>	<p>Toronto Hydro Energy Efficiency Office Toronto Env. Office</p>

In addition to adaptation actions that are already in progress, several City divisions and agencies have recommended a number of actions that could enhance existing programs and services and increase their resilience to climate change. These recommendations are listed in Table 2 on the next page. More recommendations are forthcoming from other divisions and agencies.

The recommendations in Table 2 are not listed in any particular order, and are not currently funded. Both internal and external sources of funding should be considered for these initiatives. Staff will need to develop the appropriate business case and financial impact statements for the formal recommendation of individual actions included below.

Table 2: Short-term Climate Adaptation Actions Recommended by City Divisions

SHORT TERM ADAPTATION ACTIONS	ANTICIPATED BENEFIT	CITY GROUP(S) RESPONSIBLE
Evaluation of the City of Toronto Hot Weather Response Plan	Evaluation of the Hot Weather Response Plan would help identify improvements in City and community responses to extreme heat and maximize health benefits of the Plan.	Toronto Public Health (Subject to Health Canada funding).
Climate Change Vulnerability Risk Assessment of major road culverts and bridges	Reduce the risk of infrastructure failure due to extreme weather; Improved design standards. Avoid disruption to the public; Avoid significant insurance claims.	Transportation Services Toronto Water TRCA
Expand the Integrated Plant Health Care Program (IHPC) Increase systematic tree pruning services	Provides ground cover, provides cooling and reduces storm water runoff. Systematic maintenance promotes healthy tree growth, reducing long term maintenance costs; Stronger trees are more likely to survive climate stresses such as drought and wind.	Parks, Forestry & Recreation
Expand parkland naturalization and naturalization of lands surrounding water and wastewater facilities	Decreased storm water runoff. Increased canopy cover in our parks and open spaces, from the existing 30% to over 50%; Reduced use of fossil fuels for maintenance of cut grass;	Parks, Forestry & Recreation Toronto Water TRCA
Introduce a new standard for supporting healthy tree growth by continuous soil trench systems in commercial areas	Extending the life of trees from 6 years to 35 years in commercial areas, increasing shade, reducing energy demand for cooling.	Transportation Services City Planning Parks, Forestry & Recreation
Increase street tree planting	Reduce urban heat island effect; Reduce stormwater runoff.	Transportation Services Parks, Forestry & Recreation
Increase enforcement of tree protection and planting requirements for private lands during development review	Tree protection during development and education of residents to promote healthy tree growth is necessary for sustaining and increasing the tree canopy.	Parks, Forestry & Recreation City Planning

Table 2 Continued

SHORT TERM ADAPTATION ACTIONS	ANTICIPATED BENEFIT	CITY GROUP(S) RESPONSIBLE
<p>Species Recovery Planning</p> <p>Expanding Regional Watershed Monitoring and Reporting to include climate change</p>	<p>Develop species recovery areas to aid in the survival of species threatened by climate change (and other stressors).</p> <p>Expanding the scope of the existing monitoring program to evaluate the changes arising from climate change to terrestrial and aquatic systems.</p>	<p>TRCA</p>
<p>Expand Pools, Cooling and Misting Stations</p>	<p>Provides summer heat escape locations for City dwellers and tourists.</p>	<p>Parks, Forestry & Recreation & TRCA</p>
<p>Expand Sustainable Technologies Evaluation Program (STEP) to monitor green building technologies</p>	<p>Provide data and analysis to support implementation of roof top gardens, permeable pavement, bio retention swales, rainwater harvesting systems, erosion and sediment control ponds and bio filtration systems all of which will help adapt to extreme rain and droughts expected under climate change.</p>	<p>Multi agency partnership involving</p> <ul style="list-style-type: none"> -TRCA - MOE -Toronto Water - Other regional municipalities
<p>Citywide Mandatory Downspout Disconnection</p> <p>Uninterrupted Power Supply for Water Treatment</p> <p>Assess Design Standards for Wet Weather Flow Master Plan</p> <p>Assess Effects of Extreme Weather, Droughts and Heat on Water Quality of Area Watercourses and Beaches</p>	<p>Reduce flooding, and pressure on stormwater systems.</p> <p>Develop enhanced contingency plans to operate critical water treatment and distribution systems and waste water treatment systems during extended power outages.</p> <p>Assess new design standards to help identify tradeoffs between storing water on site & getting water off the lot. Establishing & assessing new design standards will reduce property flooding in the long term.</p> <p>Confirm simulations of recent modelling exercises with real data from Rouge and Humber River watershed studies, to define the extent to which climate change affects water quality.</p>	<p>Toronto Water</p>
<p>Elimination of New Reverse Slope Driveways</p>	<p>Reduce flooding during extreme precipitation events.</p>	<p>Toronto Water City Planning Toronto Buildings</p>
<p>Source Water Protection</p>	<p>Further studies on the impacts of warmer lake water on algae growth and the possible increase in taste, odour and water quality issues for water treatment plants.</p> <p>Assess the vulnerability of water intakes to spills from sewer breaks and discharge plumes from extreme runoff events.</p>	<p>Toronto Water MOE Regions of Peel, Durham, Halton, Hamilton-Wentworth, and Niagara TRCA</p>

RECOMMENDED ACTION #1: DIVISIONS AND AGENCIES THAT HAVE IDENTIFIED AND PROPOSED SHORT TERM ADAPTATION ACTIONS SHOULD MAKE THE BUSINESS CASE FOR IMPLEMENTING THESE ACTIONS AND SEEK THE APPROPRIATE APPROVALS TO ENSURE IMPLEMENTATION.

7. DEVELOPING A COMPREHENSIVE ADAPTATION STRATEGY

While a number of short-term actions can help reduce Toronto's vulnerability to climate change, the City also needs to develop a comprehensive longer term adaptation strategy that addresses problems that climate change presents for long-lived infrastructure and long-term planning. This larger strategy needs to be based on current climate science and rapidly-developing knowledge about the most effective ways to reduce climate impacts. Because climate change will touch so many City operations and services, it will also be important to prioritize areas for action. The development of a comprehensive adaptation strategy should involve the following steps:

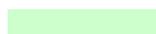
1. Create the internal mechanisms and processes for the development of a comprehensive, multi-year adaptation process;
2. Engage the public, business and other stakeholder groups;
3. Incorporate climate change adaptation into city policies and high level plans;
4. Use best available science to analyze how climate is changing locally and what the future is likely to bring;
5. Use this analysis to identify Toronto's vulnerabilities to climate change;
6. Conduct a risk assessment to identify priority impacts requiring adaptation action;
7. Identify and assess adaptation options to reduce the risk;
8. Develop and implement climate change adaptation strategies;
9. Monitor climate change, evaluate the effectiveness of adaptation initiatives in protecting the City from continuing changes, and adjust strategies when necessary.

The Schedule on the next page provides a general timeline for carrying out these steps. Timelines are approximate, but do indicate a multi-year process with activities that can run simultaneously. Although this process requires research, it is not meant to suggest that the City should delay enhancing or expanding existing climate change adaptation activities such as those mentioned on the previous pages.

Approximate Schedule for Climate Change Adaptation Strategy Development

	2007	2008	2009	2010	2011
1 Create internal mechanisms for adaptation process	Light Green	Dark Green			
2 Engage public, business & other stakeholders		Dark Green			
3 Incorporate climate change adaptation into policies		Dark Green	Dark Green	Dark Green	
4 Analyze how climate is changing locally		Dark Green	Dark Green	Dark Green	
5 ID Toronto's vulnerabilities to climate change		Dark Green	Dark Green	Dark Green	
6 Risk assessment to ID priority impacts requiring action		Dark Green	Dark Green	Dark Green	
7 ID & assess adaptation options to reduce risk	Light Green	Dark Green	Dark Green	Dark Green	
8 Develop & implement adaptation strategies	Light Green	Dark Green	Dark Green	Dark Green	Dark Green
9 Monitor & evaluate adaptation actions & adjust as needed			Dark Green	Dark Green	Dark Green

Legend:



Actions already underway prior to mandate suggested in this document



Actions suggested in this document.

Step 1: CREATE INTERNAL MECHANISMS AND PROCESSES FOR DEVELOPMENT OF A COMPREHENSIVE ADAPTATION STRATEGY

Climate change will affect all of the City's population and most of its services. Getting organized to reduce the impacts will require:

- Ongoing leadership from City Council and champions among senior managers;
- Assessing and allocating needed staff and budgetary resources;
- Enhancing and empowering the citywide Adaptation Steering Group;
- Creating issue-based adaptation working groups;
- Increasing the adaptation capacity of City staff;
- Mobilization of existing local expertise;
- Collaboration with regional, national and international adaptation networks and programs;
- Increasing the awareness and engagement of public and private stakeholders.

a) Ongoing Leadership from City Council and Champions among Senior Managers

In *Change is in the Air*, the City's Climate Change, Clean Air and Energy Action Plan, City Council committed to developing a climate change adaptation strategy. Since that time, the City's Executive Environment Team has added adaptation to its agenda. The Toronto Environment Office created and leads an Adaptation Steering Group with representatives from most of the City's divisions. This group will need the continued support of senior managers to develop and implement an effective adaptation strategy.

RECOMMENDED ACTION #2: ESTABLISH A MECHANISM TO ENSURE THAT THE CITY'S LEADERS ARE REGULARLY UPDATED ABOUT CLIMATE CHANGE IMPACTS AND ADAPTATION PLANNING TO ENSURE CONTINUAL PROGRESS.

RECOMMENDED ACTION #3: MAKE CLIMATE CHANGE A KEY MANDATE OF THE EXECUTIVE ENVIRONMENT TEAM AND COMMIT TO COORDINATING CLIMATE CHANGE PLANNING ACROSS THE CITY'S AGENCIES, BOARDS, COMMISSIONS, CORPORATIONS AND DIVISIONS TO ENSURE EFFICIENT AND EFFECTIVE IMPLEMENTATION.

b) Assess and Allocate Staff and Budgetary Resources

Currently, one staff person from the Toronto Environment Office is mandated to work close to full-time on climate change adaptation. The City also has staff from five divisions informally assigned to work on adaptation up to a day a week in an inter-divisional working group. The Clean Air Partnership and the Institute for Catastrophic Loss Reduction are also providing short-term assistance. For continued progress on climate adaptation, however, more staff time will need to be allocated to this work.

The Toronto Environment Office has budgeted funds in 2008 for predictive computer modelling on the Toronto area climate, which will provide decision makers with better information on future severe weather scenarios. Budget is also available in 2008 to obtain expert assistance in vulnerability and risk assessment. Additional funds may be necessary in the future to identify the costs and benefits of effective adaptation strategies, and other investigative tasks recommended in this report. Funds will also be needed for expanding activities and programs that reduce the impacts of extreme weather such as heat waves, intense rainfall and droughts.

City programs have already experienced significant budget pressures and over-expenditures as a result of extreme weather. The record snowfall of 2007/2008, for example, caused Transportation Services Winter Maintenance Budget to be overspent by more than \$10 million. The creation of an Extreme Weather Reserve Fund could provide funding for situations where programs incur extraordinary weather-related uninsured costs that result in an operating deficit.

RECOMMENDED ACTION #4: ENSURE THAT DIVISIONS LIKELY TO BE SIGNIFICANTLY AFFECTED BY CLIMATE CHANGE HAVE STAFF TIME ALLOCATED TO IMPACTS ASSESSMENT AND ADAPTATION OPTIONS REVIEW.

RECOMMENDED ACTION #5: ALLOCATE FUNDS FOR INVESTIGATING AND PILOTING PROMISING ADAPTATION STRATEGIES.

RECOMMENDED ACTION #6: DEVELOP A COMPREHENSIVE FUNDING STRATEGY FOR THE CITY'S CLIMATE CHANGE ADAPTATION INITIATIVES, INCLUDING ESTABLISHMENT OF AN EXTREME WEATHER RESERVE TO LESSEN THE EXPENDITURE IMPACTS OF EXTREME WEATHER ON THE CITY'S ANNUAL BUDGETS.

c) Enhancing and Empowering the Citywide Adaptation Steering Group

The City has established a City cross-divisional Adaptation Steering Group with representatives from 15 City divisions, as well as the Toronto Region Conservation Authority and the Clean Air Partnership.

The members of the Steering Group should serve as a conduit for climate information to divisional managers and staff and engage them in thinking about climate change implications for their operations and services. They should also provide informed input from City divisions, agencies and sectors into the assessment of climate change impacts for Toronto and the development of an adaptation strategy.

RECOMMENDED ACTION #7: ESTABLISH A FORMAL MANDATE, WORKPLAN AND RESPONSIBILITIES FOR THE CITY'S ADAPTATION STEERING GROUP. ENSURE THAT ALL SECTORS LIKELY TO BE STRONGLY AFFECTED BY CLIMATE CHANGE, AND/OR ESSENTIAL FOR ADAPTION ARE REPRESENTED AND ACTIVE.

RECOMMENDED ACTION #8: SET UP A MECHANISM FOR REGULAR REPORTING OF THE WORK OF THE ADAPTATION STEERING GROUP TO MANAGEMENT.

d) Create Issue-Based Adaptation Working Groups

Some other cities have created formal sectoral working groups that bring together practitioners and climate researchers to evaluate the specific risks of climate change for a sector, assess whether existing operations and plans provide enough protection, and map out detailed strategies for adaptation. Typically, sectoral working groups are formed in areas such as: water management, energy demand and supply, buildings, transportation, health, ecosystems, health and social impacts (Penney and Wieditz, 2007).

Some divisions in the City of Toronto have already formed informal working groups that are currently analyzing specific climate related impacts. Other divisions are planning to establish such groups to work on division-level adaptation planning. These are very positive developments.

In addition to working groups within divisions facing significant impacts from climate change, interdepartmental working groups should be created to work on issues that affect several divisions and agencies in the City. (In the case of the long-established emergency planning group, their mandate should be expanded to include climate change considerations.)

Divisional and interdepartmental working groups should help guide climate change risk assessments in different sectors or issue areas, identify best practices and develop the business case for specific adaptation programs. They should communicate this work and results to the Citywide Adaptation Steering Group. The Toronto Environment Office should continue in a Coordination role on climate change adaptation.

RECOMMENDED ACTION #9: ESTABLISH OR ENHANCE ISSUE BASED ADAPTATION WORKING GROUPS IN AREAS THAT ARE ALREADY EXPERIENCING IMPACTS FROM EXTREME WEATHER, OR ARE AT HIGH RISK OF IMPACT, INCLUDING: WATER, HEALTH, INFRASTRUCTURE, ENERGY, URBAN ECOSYSTEMS (e.g. FORESTRY/GREEN SPACE), AND EMERGENCY PREPAREDNESS.

e) Increase Awareness and Climate Change Adaptation Capacity of City Staff

Staff support and knowledge is essential for the planning and implementation of adaptation. Efforts need to be made to increase the general awareness of staff about climate change impacts and adaptation options by means of a dedicated website, workshops, webinars, and other media.

Staff will also be engaged in identifying vulnerabilities of the City to climate change, assessing risks and proposing and implementing solutions. Involvement in these tasks will increase the awareness and knowledge of staff about the impacts of climate change and about protective strategies. However, City staff will also need training to:

- Access and interpret climate projections
- Use geo-spatial information systems to identify areas of the City and infrastructure at risk from climate change;
- Apply risk assessment tools for identifying impacts and prioritizing adaptation programs; and
- Undertake emergency management and business continuity planning in relation to climate impacts, among other tasks.

RECOMMENDED ACTION #10: DEVELOP A COMMUNICATIONS PLAN AND IMPLEMENT INREACH ACTIVITIES SUCH AS WORKSHOPS, WEBINARS AND ELECTRONIC COMMUNICATIONS TO INCREASE THE AWARENESS OF STAFF ABOUT THE LOCAL IMPACTS OF CLIMATE CHANGE AND ADAPTATION.

RECOMMENDED ACTION #11: ENGAGE STAFF IN STUDIES OF CLIMATE IMPACTS ON SPECIFIC CITY SERVICES AND INFRASTRUCTURE, AND INVOLVE THEM IN PROGRAMS TO EVALUATE PROTECTIVE SOLUTIONS.

RECOMMENDED ACTION #12: ESTABLISH A WORKING GROUP WITHIN THE ADAPTATION STEERING GROUP TO IDENTIFY TRAINING NEEDS AND OPPORTUNITIES FOR STAFF INVOLVED IN CLIMATE CHANGE RISK ASSESSMENTS AND ADAPTATION STRATEGIES.

f) Mobilize Existing Expertise

Canada has a large network of researchers who have been studying climate change, investigating impacts and proposing potential responses. Some of these experts work in the government sector – for Environment Canada, Natural Resources Canada, Health Canada, Ontario Ministry of the Environment, Ministry of Natural Resources and others. Some are in agencies such as the Toronto Region Conservation Authority. Many local university researchers have done internationally recognized work on climate impacts and adaptation issues. Several environmental non-governmental organizations also have valuable knowledge. Many of these experts make their home in Toronto and are eager to help the City understand and act on their knowledge.

The City has already formed an Expert Panel of climate change related experts, who have made presentations to City Council's Parks and Environment Committee. It will be important to invite and consider their input as strategies are developed and implemented. One member of the Expert Panel has recommended that the City promote the development of a formal Urban Climate Research Group to facilitate this process. The Research Group could provide Toronto with ongoing help in climate modelling, mitigation and adaptation planning and implementation.

RECOMMENDED ACTION #13: ESTABLISH MECHANISMS FOR REGULAR COMMUNICATIONS AND CONSULTATION WITH LOCAL AND REGIONAL CLIMATE CHANGE AND ADAPTATION EXPERTS. ONE TOOL SHOULD BE A WEB ENABLED "MUNICIPAL CLIMATE CHANGE REFERENCE COLLECTION".

RECOMMENDED ACTION #14: PROMOTE THE FORMATION OF AN URBAN CLIMATE CHANGE RESEARCH GROUP TO FACILITATE NEEDED CLIMATE CHANGE RESEARCH FOR TORONTO AND FOR OTHER TOWNS AND CITIES IN THE GTA.

g) Collaborate with Regional, Provincial, National and International Adaptation Networks and Programs

There has been a recent explosion in new networks and programs to support urban adaptation. Toronto should participate in the programs that provide useful opportunities for networking, new knowledge, and access to funds that support the City's adaptation process. Relevant programs include:

i) Networks of Cities that are Developing Adaptation Strategies

In the last 6-7 years, a number of cities have begun to assess the local impacts of climate change and develop adaptation strategies. Several networks have been created to help cities learn from one another. The Alliance for Resilient Cities is one such network in Canada. The Urban Leaders Initiative is another active network of local and regional governments working on climate change adaptation in the US. The City of Toronto is already involved with both these networks. The Federation of Canadian Municipalities and ICLEI Canada are also developing programs on climate change adaptation.

ii) Regional Initiatives

The Toronto and Region Conservation Authority is very involved in a number of initiatives linked to both greenhouse gas emissions reduction and climate change adaptation. The City of Toronto is already involved with many of these initiatives. TRCA staff are very knowledgeable about climate change impacts on the area's ecosystems, are currently represented on the Adaptation Steering Group, and should continue to be integrated in adaptation planning for the City.

Other municipalities and regional governments in the Greater Toronto Area are also beginning to consider climate change impacts and adaptation. It will be important to seek opportunities for collaboration with other local governments in the region and to look for opportunities to reduce duplication of effort.

iii) National Associations Conducting Research and Developing Guidelines to Plan for Climate Change

Canada has at least two national initiatives that are of potential value to Toronto. One of these is the Public Infrastructure Engineering Vulnerability Committee (PIEVC), set up by Engineers Canada. PIEVC is developing tools to evaluate the vulnerability to climate change of buildings, roads and associated structures, water resources, stormwater and wastewater systems. PIEVC is testing these tools in several Canadian cities and has conducted an information session for City staff.

The Canadian Institute of Planners (CIP) has also launched a Climate Change Impacts and Adaptation Program for municipal planning staff. CIP is developing a national planning policy on climate change adaptation and designing training programs to increase the capacity for planners to incorporate climate change considerations in their work.

iv) Initiatives by Other Orders of Government

Natural Resources Canada, Environment Canada, Infrastructure Canada and Health Canada have all made contributions to understanding the impacts of climate change on Canada and to identifying protective measures. Several of these departments provide funding to support studies in specific cities or regions to evaluate impacts and adaptation strategies.

The Province of Ontario recently set up an Expert Panel on Climate Change Adaptation to advise the Province on adaptation strategies. Ontario's Ministry of the Environment and Ministry of Natural Resources both have climate impacts and adaptation initiatives. The Province also recently provided funding for the Ontario Centre for Climate Impacts and Adaptation at Laurentian University in Sudbury, which will be holding stakeholder workshops across the province, disseminating information on adaptation, and is looking at creating a toolkit for municipalities to encourage mainstreaming of climate change into decision-making processes.

RECOMMENDED ACTION #15: PARTICIPATE IN THOSE ADAPTATION NETWORKS AND OTHER GOVERNMENT INITIATIVES THAT CAN PROVIDE USEFUL NEW KNOWLEDGE AND NETWORKING, RESEARCH AND FUNDING OPPORTUNITIES TO SUPPORT TORONTO'S ADAPTATION AGENDA.

Step 2: ENGAGE THE PUBLIC, BUSINESSES AND OTHER STAKEHOLDER GROUPS

An essential part of developing an adaptation strategy is to ensure that the public, businesses and other stakeholders are aware of the impacts of climate change, and engaged in thinking about and implementing solutions.

This means, among other things, developing a broad communications and outreach strategy and inviting the participation of non-governmental organizations and businesses in adaptation planning. As an initial step in this process, City Council's Parks and Environment Committee on January 22, 2008, hosted a large public meeting to hear several climate experts speak about climate change impacts on Toronto and how the City might organize to adapt.

a) Work with the Public on Preparing for Climate Change

The City can use several channels to increase awareness and engagement, including a website and other forms of public communication, public meetings on key impact assessments and proposed adaptation strategies, and supports for solutions at the neighbourhood level.

The public has a strong interest in the City's efforts to prepare for climate change. They will be affected by the heat waves, storms, insect pests and other manifestations of climate change. The public has a need to be informed about the City's plans for adaptation by means of web-based and printed information as well as media coverage. They will also have the opportunity to be involved in and contribute to the adaptation process through public meetings, commentary on web boards and other mechanisms.

The City can expect more climate refugees from around the world. The City will need to work with refugee organizations to help with the expected influx of new residents to Toronto.

Those organizations that support especially vulnerable people (the homeless and low-income seniors for example) also need to be engaged in helping the City think about the best ways of protecting them from climate change and to safely get through extreme weather events.

The City of Toronto has endorsed 72-hour emergency preparedness. The City could assist the public in preparing for extreme weather events by identifying the basic items that households should have on hand to be ready for emergencies. The City of Vancouver has initiated neighbourhood stockpiles of emergency supplies. The City of Halifax has undertaken bulk purchase of emergency radios to be sold at a low cost to households. Toronto will monitor these programs and assess them.

Individual citizens and families have their own responsibilities in this effort. Just as we call upon individual households to reduce their energy use and greenhouse gas emissions, members of the public need to do their part to protect themselves and their neighbours from the impacts of climate change. There are many things that individual households can do. For example:

- Reduce their consumption of water and energy to take pressure off these systems
- Make their private walkways and driveways from permeable materials
- Participate in the planting and care of trees in their neighbourhoods
- Participate in community stewardship organizations to enhance local parks and orphan spaces
- Ensure their homes can resist flooding by installing backflow valves and sloping the ground away from the house
- Keep a 3-day emergency kit on hand in case of blackouts or weather emergencies.

RECOMMENDED ACTION #16: DEVELOP AND IMPLEMENT A PUBLIC AND STAKEHOLDER AWARENESS AND ENGAGEMENT STRATEGY INCLUDING:

- CREATION OF A TORONTO CLIMATE CHANGE IMPACTS AND ADAPTATION WEBSITE WITH UP-TO-DATE INFORMATION ON CLIMATE CHANGE AND HOW IT IS LIKELY TO AFFECT TORONTO, ON HOW THE PUBLIC AND LOCAL BUSINESSES CAN PROTECT THEMSELVES, AND ON THE CITY'S DEVELOPING ADAPTATION STRATEGY;

- PUBLIC MEETINGS TO DISCUSS CLIMATE CHANGE IMPACTS AND PROPOSED ADAPTATION STRATEGIES AS THEY DEVELOP;
- SUPPORT FOR COMMUNITY AND NEIGHBOURHOOD GROUPS TO TAKE ACTION TO REDUCE CLIMATE CHANGE IMPACTS SUCH AS HEAT WAVES, INTENSE RAINFALL AND MAJOR STORMS ON THEIR NEIGHBOURHOODS.

RECOMMENDED ACTION #17: WORK WITH ORGANIZATIONS THAT SUPPORT VULNERABLE PEOPLE IN TORONTO TO MAKE AND IMPLEMENT PLANS THAT REDUCE THEIR RISKS TO CLIMATE IMPACTS.

RECOMMENDED ACTION #18: IDENTIFY AND PROMOTE ACTIONS THAT INDIVIDUAL HOUSEHOLDS AND COMMUNITY ORGANIZATIONS CAN DO TO REDUCE VULNERABILITY TO CLIMATE CHANGE.

b) Work with Businesses and Labour on Preparing for Climate Change

Businesses too will be affected by climate change. The City needs to build awareness among businesses and engage key business sectors and organizations in thinking about and preparing for climate change. Organizations such as the Board of Trade, Toronto and York Labour Council, Toronto Association of Business Improvement Associations, the Insurance Bureau of Canada and utilities such as Toronto Hydro and Enwave need to be involved. Green businesses that can contribute to our adaptation capacity should also be engaged in climate adaptation planning. One way to initially engage businesses in this effort is to organize a Toronto summit with business leaders and organizations to discuss climate impacts, strategies and possibilities for long-term cooperation on climate change adaptation.

Some other cities have begun to successfully engage some business sectors – especially banking, insurance and the development industry – in assessing the economic impacts of climate change and in adaptation planning. Toronto should look at how these cities have engaged business and at the plans that resulted from this process to gain insights about how to proceed.

Businesses can also contribute to meeting City tree canopy and stormwater targets – planting trees in employment lands, reducing runoff by installing permeable pavements in parking lots and other initiatives.

In addition to developing proactive strategies to reduce the impacts of climate change before they happen, businesses need to think about business continuity during and after weather emergencies. The Institute for Catastrophic Loss Reduction (a research and advocacy group supported by the insurance industry) has produced a guide for a disaster recovery plan that could help small businesses recover after a severe weather event. The City could benefit from coordinating with the Institute for Catastrophic Loss Reduction and Toronto business associations on the elaboration and distribution of these kinds of plans, and also from including business representation in emergency response planning.

Consideration should be given to the “ChicagoFirst” initiative which involves a consortium of businesses working together to prepare for emergency situations (such as severe weather); a representative of this group is present at Chicago’s emergency operations centre for communications purposes during an emergency.

RECOMMENDED ACTION #19: WORK WITH LOCAL BUSINESS LEADERS AND ASSOCIATIONS TO DISCUSS CLIMATE IMPACTS, STRATEGIES AND POSSIBILITIES FOR LONG-TERM COOPERATION ON CLIMATE CHANGE ADAPTATION.

Step 3: INCORPORATE CLIMATE CHANGE ADAPTATION INTO CITY POLICIES AND HIGH-LEVEL PLANS

Climate change will affect nearly all aspects of Toronto's life. As a result, it is important to incorporate climate considerations into planning of most City operations and services. Internationally, this is known as "mainstreaming" climate adaptation.

To ensure that climate change considerations are incorporated into planning, programs and budgets, we need to include explicit mention of the challenge of climate change in overarching City policies and plans. A description of the challenges posed by climate change for the city, and goals for both mitigation and adaptation should be incorporated into relevant plans, strategies and programs.

RECOMMENDED ACTION #20: INCLUDE CLIMATE CHANGE CONSIDERATIONS AND EXPLICIT GOALS FOR ADAPTATION IN PLANS, PROGRAMS, STRATEGIES AND ASSESSMENT PROCEDURES, INCLUDING:

- TORONTO'S OFFICIAL PLAN
- WET WEATHER FLOW MASTER PLAN
- TRANSIT CITY PLAN
- PARKS, FORESTRY AND RECREATION STRATEGIC PLAN (*Our Common Grounds*)
- URBAN FOREST MANAGEMENT PLAN
- EMERGENCY PLAN
- HOT WEATHER RESPONSE PLAN
- GREEN DEVELOPMENT STANDARD
- BETTER BUILDINGS PARTNERSHIP – EXISTING BUILDINGS and NEW CONSTRUCTION PROGRAMS
- GREEN ECONOMIC SECTOR DEVELOPMENT STRATEGY
- TORONTO HYDRO'S PLANS AND STRATEGIES
- DEEP LAKEWATER COOLING
- ENVIRONMENTAL ASSESSMENTS OF NEW CAPITAL PROJECTS
- LONG TERM FISCAL PLAN.

Step 4: ANALYZE HOW CLIMATE IS CHANGING LOCALLY AND WHAT THE FUTURE IS LIKELY TO BRING

Assessing Toronto's vulnerability to climate change requires gathering up existing knowledge about the impacts of extreme weather and climate change on operations and services in the city, and doing some targeted new research.

a) Collect and Review Existing Analysis of Impacts and Adaptation

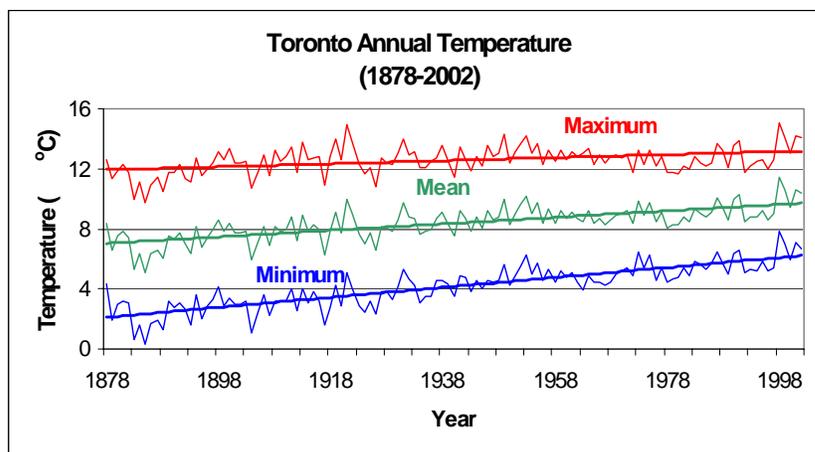
As a result of existing research on climate change in Ontario and the Great Lakes Region, we already have a broad overview of the climate changes that can be expected in the Toronto area over the next century, though many uncertainties remain. In the last few years, there has been a rush of new research on climate trends and impacts. With the help of the Institute for Catastrophic Loss Reduction, the Toronto Environment Office

is collecting and cataloguing many of these reports and will be making links available to them on a web-based resource site.

b) Analyze Historical Climate Trends for the Greater Toronto Area

Environment Canada, the Ontario Ministry of Natural Resources, Toronto Public Health, Toronto Region Conservation Authority, university-based researchers and others have conducted a variety of studies on trends over the last 50-100 years for a range of climate variables such as temperature, hot days and heat waves, precipitation, extreme weather events, windspeeds and changes in the length of seasons. Information on historical trends – such as the mean annual temperature graph shown below – can be very helpful in showing how climate has already begun to change.

Trends in Toronto Average Annual Temperatures, 1978-2002



Source: Environment Canada, 2004

c) Create Future Climate Projections for the Region

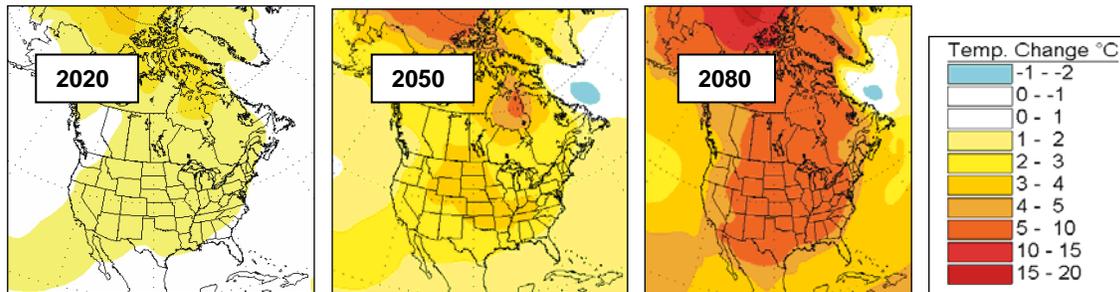
Global climate computer models have been developed to project climate change into the future. These models are tested by how well they correspond with actual changes to climate over the last century. The models have steadily improved in the last few years. Still, while these models tend to describe global and continental climate reasonably well, they do not have a high enough resolution to provide good projections for local climates, which are affected by nearby bodies of water, prevailing winds, landform, landuse and other local and regional features.

Regional climate models that take these local conditions into account can provide useful projections of future climate for assessing vulnerability, though some uncertainties remain. The City has already committed funds to develop downscaled climate projections for Toronto and is seeking a partnership with Environment Canada, the Toronto and Region Conservation Authority and other possible partners to develop these projections.

These projections should produce predictions for changes in seasonal temperature, precipitation, windspeeds and other important climate variables for specific periods in the

future (e.g. 2020's, 2050's, and 2080's), but at a local level. The graphic below shows these kinds of projections at a continental level. These projections will provide valuable information that various sectors in the City – transportation, water, hydro, health, parks and urban forestry, and others – can use to assess their extent to which their services could be affected by climate change.

Projected Changes in North American Annual Temperature Relative to 1975-1995



Source: Canadian Centre for Climate Modelling and Analysis, 2005

d) Analyze Recent Extreme Events that Foreshadow Expected Climate Impacts

Case studies of recent extreme weather events or crises related to climate can also supply important information on the potential impacts of climate change on City services and infrastructure. For instance, Toronto Water and the Toronto Region Conservation Authority have both reviewed the August 19, 2005 storm and identified a number of vulnerabilities for the City from very intense rainfall events. Toronto Water is using the information as a new benchmark for implementing its Wet Weather Flow Master Plan and TRCA has incorporated the lessons into its watershed planning. Using a climate change lens to review the impacts of the 2003 blackout, the heat waves of 2005, and the drought during 2007 could also provide important information for evaluating Toronto's vulnerability to climate change and the potential costs of similar future climate-related events.

RECOMMENDED ACTION #21: UNDERTAKE RESEARCH TO ANALYZE KEY HISTORICAL CLIMATE TRENDS IN THE TORONTO REGION, PRODUCE DOWNSCALED CLIMATE PROJECTIONS, AND CASE STUDIES OF RECENT KEY CLIMATE EVENTS THAT PROVIDE LOCAL CLIMATE DATA AND PRACTICAL INFORMATION ON CLIMATE CHANGE AND ITS LOCAL IMPACTS.

Step 5: DEVELOP A CITYWIDE INVENTORY OF CLIMATE VULNERABILITIES AND RISKS

Existing scientific research has already identified many of the expected impacts from climate change and key sectors that are likely to be affected in Toronto. A number of these are shown in Table 1 on the next page.

With information about historical climate trends, regional climate projections for the future, and reviews of recent climate events, staff will be able to develop a more comprehensive inventory of potential impacts and vulnerabilities. The City's Adaptation

Steering Group can lead the development of this inventory in consultation with City divisions and other stakeholders.

Table 3: Potential Local Impacts from Local Climate Changes

Projected Local Changes	Some Impacts Expected in the Toronto Area	Some Affected City Sectors
Hotter Summers	<ul style="list-style-type: none"> ▪ Increased number of hot days, hot nights and heat waves ▪ Increased smog ▪ Increased illness and deaths due to heat waves and to smog ▪ Possible increase in food-borne illnesses ▪ Rising electricity demand for air conditioning and pressure on the grid ▪ Increased demand for water ▪ Increased stress on city trees, shrubs, turf cover and gardens ▪ Possible increase in violence and crime ▪ Increased heat stress on outdoor workforce 	Public Health Toronto Water Transportation Services Hydro Planning Facilities & Real Estate Shelter, Support & Housing Parks, Forestry & Recreation Police Emergency Services TRCA
Milder Winters	<ul style="list-style-type: none"> ▪ Energy use likely to decline in winter ▪ More disease-bearing insects will survive the winter and expand the range of certain infectious diseases ▪ Insect pests that attack trees will expand their range ▪ More freeze-thaw cycles that can damage roads and other transportation infrastructure, as well as plants and trees 	Facilities & Real Estate Public Health Parks, Forestry & Recreation TRCA Transportation
Dryer summers	<ul style="list-style-type: none"> ▪ Increased demand for water ▪ Stress on urban trees and other vegetation ▪ Increased maintenance services (water, mulch, replacement) to sustain trees and park landscapes ▪ Reduced electricity generation from hydro 	Toronto Water Parks, Forestry & Recreation Hydro
More intense precipitation	<ul style="list-style-type: none"> ▪ Increased pressure on the stormwater management system ▪ Flooding of basements and low-lying areas ▪ Increased wear and pressure on culverts, bridges and other transportation infrastructure ▪ Contamination of streams and lake from runoff ▪ Erosion of rivers and streams 	Toronto Water Public Health Transportation Services Emergency Services Legal Services Planning
More extreme weather, storms and increased windspeeds	<ul style="list-style-type: none"> ▪ Damage to buildings from heavy winds, tornadoes, heavy snowfalls, freezing rain ▪ Damage to other infrastructure ▪ Damage to transmission lines and electricity blackouts ▪ Damage to trees, parks and natural areas ▪ Erosion of beaches, waterfront areas and stream banks 	Facilities & Real Estate Transportation Toronto Hydro Emergency Services Parks, Forestry & Recreation Public Health Shelter, Support & Housing Planning
Water level drop in Great Lakes Basin	<ul style="list-style-type: none"> ▪ Increased concentration of contaminants in Lake Ontario ▪ Reduced capacity for Great Lakes shipping ▪ Loss of wetlands 	Toronto Water Port Authority Parks, Forestry & Recreation TRCA Planning Public Health

Some geographical areas of the city, and some people – the low-income elderly, for example – are likely to be at higher risk for specific climate effects such as extreme heat. It will be important to consider these issues in the process of developing an inventory of climate vulnerabilities and risks.

In addition to identifying potential risks and impacts, the Adaptation Steering Group should guide an initial assessment of the adaptive capacity of the City. To what extent do current plans and programs already take into account current climate variability or future climate change? Even if they don't explicitly take climate change into account, to what extent do they provide a buffer against climate impacts? What additional resources or programs are needed to plan for and protect against expected climate changes. What additional skills or training does staff need?

RECOMMENDED ACTION #22: DEVELOP A CITYWIDE INVENTORY OF CURRENT CLIMATE VULNERABILITIES AND THE EXTENT TO WHICH CURRENT ACTIVITIES PROVIDE PROTECTION.

Step 6: CONDUCT A FORMAL RISK ASSESSMENT TO PRIORITIZE IMPACTS FOR ACTION

While developing an inventory of climate risks and vulnerabilities is an important step, the City will not be able to tackle all potential impacts. It will be important to prioritize the risks according to the probability of their occurrence, and the severity of the impacts.

One way of assessing and prioritizing impacts for action is through a risk assessment process. A simplified version of this is shown in the table below.

Simplified Risk Matrix for Prioritizing Climate Impacts

		PROBABILITY		
		LOW	MEDIUM	HIGH
SEVERITY OF IMPACT	HIGH	M	H	H
	MEDIUM	L	M	H
	LOW	L	L	M

The risk assessment will investigate the probability or expected frequency of each impact identified in the inventory of climate vulnerabilities. Each impact will also be evaluated for the potential severity of the impact on the physical and natural environment of the city, the health and well-being of Toronto's citizens, and costs to the economy. Staff will need knowledge of climate trends and projections to conduct this risk

assessment, and will bring to it their expert knowledge about how City infrastructure and operations work.

These assessments are not an exact science, but can be very helpful in identifying high priority climate impacts that need to be addressed soon from those that can be addressed later. When this risk assessment process is completed and reported to Council, the City will have a shorter list of high priority climate impacts on which to focus its energies and resources.

RECOMMENDED ACTION #23: UNDERTAKE A CITYWIDE RISK ASSESSMENT PROCESS OF IDENTIFIED VULNERABILITIES TO PINPOINT SIGNIFICANT CLIMATE IMPACTS THAT THE CITY SHOULD PRIORITIZE FOR DEVELOPING ADAPTATION STRATEGIES.

Step 7: IDENTIFY AND ASSESS ADAPTATION OPTIONS

For each of the risks that climate change poses for Toronto, a variety of protective actions are possible. Local climate researchers and those in other cities and regions have been identifying a variety of possible adaptation actions and strategies. Some of these are outlined in the table on the next page.

The adaptation literature has many practical and theoretical examples of adaptation options and strategies. These should be uncovered as the City collects and reviews existing research. The risk assessment process – Step 4 above – will also generate adaptation options for specific vulnerabilities. For some priority areas, the City will find out more about what other cities have done to reduce vulnerability to climate change and to assess these options in a Toronto context.

Many of the adaptation actions identified here provide multiple benefits. Toronto has begun implementing many of these actions, though it is not clear that the level of implementation will provide the protection that is needed as climate change progresses and climate impacts mount. There are also many other adaptation options that are likely to be identified by task forces or working groups examining specific local vulnerabilities.

RECOMMENDED ACTION #24: FOR HIGH PRIORITY RISKS, IDENTIFY AND EVALUATE A RANGE OF ADAPTATION OPTIONS THAT COULD REDUCE VULNERABILITY TO SPECIFIC CLIMATE CHANGE IMPACTS, AND THAT COULD BE IMPLEMENTED IN A COMPREHENSIVE ADAPTATION STRATEGY.

Table 2: Selected Adaptation Options for Some Toronto Sectors

SYSTEM	SOME EXAMPLES OF ADAPTATION OPTIONS
Stormwater/ Flooding	<ul style="list-style-type: none"> ▪ Expand the implementation of sustainable urban drainage systems including permeable pavements, green roofs, stormwater retention ponds, constructed wetlands and swales ▪ Create natural eco-system buffers for vulnerable water bodies & low-lying areas ▪ Expand capacity of storm sewers, overland flow routes to manage extreme weather events ▪ Flood-proof buildings in vulnerable locations ▪ Educate the public on the need for proper grading to drain water away from their homes
Energy	<ul style="list-style-type: none"> ▪ Expand conservation and demand side management to reduce peak loads during heat waves that make transmission systems vulnerable to blackouts ▪ Increase street tree planning and maintenance, green roofs and high-albedo surfaces to reduce urban heat and unsustainable energy demand for air conditioning ▪ Implement weatherization programs to reduce building loads, especially for low-income ▪ Expand distributed energy systems to reduce vulnerability to transmission interruptions from storms and high winds
Transportation	<ul style="list-style-type: none"> ▪ Evaluate the vulnerability of port facilities and associated infrastructure due to changes in water level and increased wave activity ▪ Assess and retrofit vulnerable transportation infrastructure systems such as culverts, tunnels, bridges, subway entrances, etc. ▪ Ensure critical components such as switch gear or substations are above flood levels
Buildings	<ul style="list-style-type: none"> ▪ Take account of the increased risks of flooding, heat waves, intense storms, windspeed and other climate change effects in building development standards ▪ In areas with flooding potential, use ground-floor spaces for flood-compatible uses such as car parking, or raise the ground floor above likely flood levels ▪ Design buildings for improved natural ventilation ▪ Ensure roof systems and cladding materials can cope with higher wind speeds
Urban Ecosystems	<ul style="list-style-type: none"> ▪ Protect existing ecosystems (parks, tree stands, waterways, ponds, lakes, ravines, wetlands, etc.) and develop connected greenway system to allow natural species migration ▪ Create and preserve green spaces in low-lying areas for flood management ▪ Increase shoreline buffers to protect against increased runoff from more intense storms ▪ Enhance conditions for street tree survival and growth (increase space for roots, control soil compaction, increase watering and maintenance, plant appropriate species) ▪ Monitor and control pests and invasive species that can expand with warmer winters
Health	<ul style="list-style-type: none"> ▪ Conduct public education on climate-related health threats (vector-borne diseases, heat, air pollution, floods and storms) and prevention ▪ Interventions to reduce heat island effects including street tree planting, green roofs, high albedo roof and road surfaces ▪ Interventions to reduce air pollution including emissions reduction measures and air quality warning systems ▪ Interventions to prevent impacts from expansion of vector-borne diseases ▪ Interventions to reduce health and security impacts from extreme weather events

Step 8: DEVELOP AND IMPLEMENT ADAPTATION STRATEGIES

Once a full range of adaptation options has been identified for priority impacts and risk areas, the City will have to consider how to choose from among the range of options and create and implement strategies. As a priority, the City should look at incorporating adaptation into major infrastructure projects that are expensive, long-lived and will have to operate under changing climate conditions.

The City will need to develop criteria to help in selecting among identified options and developing adaptation strategies. These criteria could include:

- The effectiveness of the adaptation action in providing protection for vulnerable populations;
- The extent to which proposed adaptation options protect against loss of life or major economic losses;
- Whether the adaptation option reduces stress on vulnerable systems;
- The cost of the adaptive action compared to the cost of alternative strategies, or the potential cost of not acting;
- The extent to which adaptation options also reduce greenhouse gas emissions or provide other benefits that increase the sustainability and liveability of the City.²

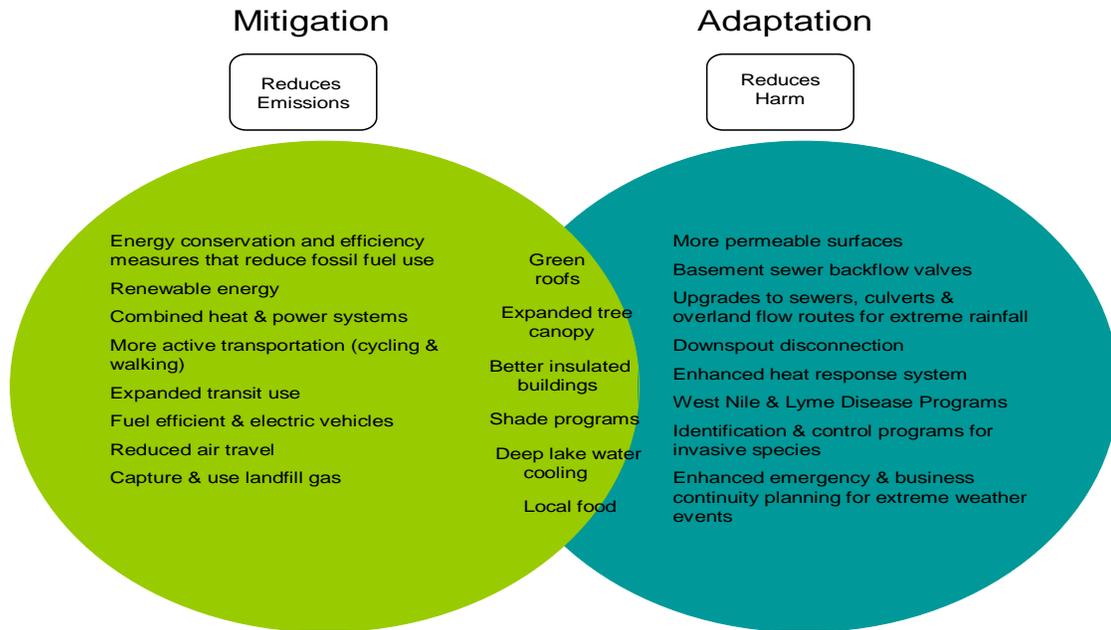
The diagram on the next page shows some examples of climate change mitigation and adaptation options and some activities that reduce emissions *and* protect from some of the impacts of climate change.

In creating its adaptation strategy, the City can build on a number of programs such as the Heat Alert and Hot Weather Response system and the Wet Weather Flow Master Plan. (See page 11 for more examples.) Some of these programs are designed to protect the City from current weather extremes. Others are aimed primarily at reducing energy consumption and greenhouse gas emissions. However, these programs have the added benefit of providing some protection against the impacts of a changing climate.

These activities make sense even in the absence of climate change. However, climate change makes these programs even more necessary and will probably require that we expand them. The City can build on these programs to develop a more comprehensive climate change adaptation strategy.

Another area that requires consideration is the consideration of weather extremes in emergency and business continuity planning of City divisions and services.

² Examples of adaptation actions with multiple benefits include: increasing the number of Toronto's green roofs and increasing the tree canopy and turf areas to reduce stormwater runoff, contribute to energy conservation and help cool neighbourhoods; or increasing insulation in existing and new buildings to improve the comfort of users, decrease energy costs and reduce the vulnerability of the grid to blackouts during heat waves.



RECOMMENDED ACTION #25: DEVELOP CLEAR CRITERIA FOR CHOOSING AMONG ADAPTATION OPTIONS AND STRATEGIES. CONSIDER OPTIONS THAT HAVE MULTIPLE BENEFITS, INCLUDING THE ABILITY TO REDUCE GREENHOUSE GAS EMISSIONS AND INCREASE THE OVERALL SUSTAINABILITY AND LIVEABILITY OF THE CITY.

RECOMMENDED ACTION #26: INCORPORATE EXPLICIT CLIMATE CHANGE CONSIDERATIONS INTO EXISTING PROGRAMS THAT WERE DESIGNED TO PROTECT AGAINST CURRENT CLIMATE EXTREMES, AND ADJUST PROGRAMS TO PROVIDE ADDITIONAL PROTECTION WHERE NECESSARY.

RECOMMENDED ACTION #27: ALL CITY AGENCIES, BOARDS, COMMISSIONS AND DIVISIONS SHOULD CONSIDER CLIMATE CHANGE IN THEIR EMERGENCY MANAGEMENT AND BUSINESS CONTINUITY PLANNING.

Step 9: MONITOR AND MEASURE PROGRESS

It will be important to periodically assess the progress that Toronto makes in preparing for climate change. This assessment should look at the:

- Level of public, staff and stakeholder awareness about climate change and its impacts and support for actions to protect against climate change;
- Vitality and perseverance of collaboration between the City, its communities, researchers, non-governmental organizations and other levels of government on solving climate change issues;
- Technical capacity to assess the risks of climate change;
- The extent to which climate change considerations have been incorporated into high level policies, plans and practical programs in priority impact areas;
- The extent to which climate change adaptation strategies reduce stress on vulnerable systems;
- How implemented adaptation strategies worked in extreme weather events.

The climate information which forms the basis for climate adaptation planning will have to be periodically reassessed. Climate is not static; new information is continually emerging and projections change. Climate surprises are very likely.

Climate change adaptation cannot be a one-time effort. It is a *process* that will need to be in place for the foreseeable future. Many of the actions that we can take to prepare for climate change, however, can make our city a safer, more sustainable place to be **“ahead of the storm”**.

RECOMMENDED ACTION #28: ALL CITY AGENCIES, BOARDS, COMMISSIONS, CORPORATIONS AND DIVISIONS IDENTIFY IN THEIR 2009 BUDGET SUBMISSIONS SPECIFIC ACTIONS AND PROGRAMS THEY PLAN TO UNDERTAKE REGARDING CLIMATE CHANGE MITIGATION AND ADAPTATION.

RECOMMENDED ACTION #29: ESTABLISH A FORMAL MECHANISM FOR PERIODIC REVIEW OF PROGRESS ON CLIMATE CHANGE ADAPTATION WHICH IS COMMUNICATED TO DECISION-MAKERS AND THE PUBLIC TO HELP ENSURE CONTINUAL PROGRESS.

8. SUMMARY OF RECOMMENDED ACTIONS FOR DEVELOPING AND IMPLEMENTING A TORONTO CLIMATE CHANGE ADAPTATION STRATEGY

The following is a listing of all the recommendations in the overall plan. The recommendations are sorted according to major themes.

ACTIONS TO ESTABLISH A STRONG ONGOING ADAPTATION PROCESS

#1: City operated groups that have identified and proposed short term adaptation actions should make the business case for implementing these actions and seek the appropriate approvals to ensure implementation.

#2: Establish a mechanism to ensure that the City's leaders are regularly updated about climate change impacts and adaptation planning to ensure continual progress.

#3: Make climate change a key mandate of the Executive Environment Team and commit to coordinating climate change planning across the City's Agencies, Boards Commissions, Corporations and Divisions to ensure efficient and effective implementation.

#4: Ensure that divisions likely to be significantly affected by climate change have staff dedicated to impacts assessment and adaptation options review.

#7: Establish a formal mandate, workplan and responsibilities for the City's Adaptation Steering Group. Ensure that all sectors likely to be strongly affected by climate change, and/or essential for adaptation, are represented and active.

#8: Set up a mechanism for regular reporting of the work of the Adaptation Steering Group to Management.

#9: Establish or enhance issue based adaptation working groups in areas that are already experiencing impacts from extreme weather or are at high risk of impact, including: water, health, infrastructure, energy, urban ecosystems (e.g. forestry/green space) and emergency preparedness.

#10: Develop a communications plan and implement inreach activities such as workshops, webinars and electronic communications to increase the awareness of management and front-line City staff about the local impacts of climate change and adaptation.

#12: Establish a working group within the Adaptation Steering Group to identify training needs and opportunities for staff involved in climate change risk assessments and adaptation strategies.

#20: Include climate change considerations and explicit goals for adaptation in plans, programs, strategies and assessment procedures, including:

- Toronto's Official Plan
- Wet Weather Flow Master Plan
- Transit City Plan
- Parks, Forestry and Recreation Strategic Plan, *Our Common Grounds*

- Urban Forest Management Plan
- Emergency Plan
- Hot Weather Response Plan
- Green Development Standard
- Better Buildings Partnership – Existing Buildings and New Construction Programs
- Green Economic Sector Development Strategy
- Toronto Hydro's plans and strategies
- Deep Lake Water Cooling
- Environmental Assessments of new capital projects
- Long Term Fiscal Plan.

#26: Incorporate explicit climate change considerations into existing programs that were designed to protect against current climate extremes, and adjust programs to provide additional protection where necessary.

#27: All City agencies, boards, commissions and divisions should consider climate change in their emergency management and business continuity planning.

#29: Establish a formal mechanism for periodic review or progress on climate change adaptation which is communicated to decision-makers and the public to help ensure continual progress.

CITY ACTIONS TO IDENTIFY & PRIORITIZE RISKS AND ADAPTATION OPTIONS

#22: Develop a citywide inventory of current climate vulnerabilities and the extent to which current activities provide protection.

#23: Undertake a citywide risk assessment process of identified vulnerabilities to pinpoint significant climate impacts that the City should prioritize for developing adaptation strategies.

#24: For high priority risks, identify and evaluate a range of adaptation options that could reduce vulnerability to specific climate change impacts, and that could be implemented in a comprehensive adaptation strategy.

#25: Develop clear criteria for choosing among adaptation options and strategies. Consider options that have multiple benefits, including the ability to reduce greenhouse gas emissions and increase the overall sustainability and liveability of the Toronto as a first priority.

RESEARCH

#14: Promote the formation of an Urban Climate Change Research Group to facilitate needed climate change research for Toronto and other cities and towns in the GTA.

#11: Engage staff in studies of climate impacts on specific City services and infrastructure and involve them in programs to test and evaluate possible solutions.

#13: Establish mechanisms for regular communications and consultation with local and regional climate change and adaptation experts. One communication tool should be a web-enabled "Municipal Climate Change Reference Collection".

#21: Undertake research to analyze key historical climate trends in the Toronto region, produce downscaled climate projections and case studies of recent climate events that provide local climate data and practical information on climate change and its local impacts.

FUNDING

#5: Allocate funds for investigating and piloting promising adaptation strategies.

#6: Develop a comprehensive funding strategy for the City's climate change adaptation initiatives, including establishment of an Extreme Weather Reserve to lessen the expenditure impacts of extreme weather on the City's annual budgets.

#15: Participate in those adaptation networks and other government initiatives that can provide useful new knowledge and networking, research and funding opportunities to support Toronto's adaptation agenda.

#28: All City agencies, boards, commissions, corporations and divisions identify in their 2009 budget submissions specific actions and programs they plan to undertake regarding climate change mitigation and adaptation.

CAPACITY BUILDING IN THE COMMUNITY

#16: Develop and implement a public and stakeholder awareness and engagement strategy, including:

- Creation of a Toronto climate change impacts and adaptation website with up-to-date information on climate change and how it is likely to affect Toronto, on how the public and local businesses can protect themselves, and on the City's developing adaptation strategy;
- Public meetings to discuss climate change impacts and proposed adaptation strategies as they develop;
- Support for community and neighbourhood groups to take action to reduce climate change impacts such as heat waves, intense rainfall and major storms on their neighbourhoods as part of the Live Green Toronto program.

#17: Work with organizations that support vulnerable populations in Toronto to make and implement plans that reduce their risks to climate impacts.

#18: Identify and promote actions that individual households and community organizations can do to reduce vulnerability to climate change.

#19: Work with local business leaders and associations to discuss climate impacts, strategies and possibilities for long-term cooperation on climate change adaptation.

10. HOW TO PROVIDE COMMENTS ON THIS DOCUMENT

The City of Toronto is interested in obtaining comments from all interested parties towards plans on Climate Change Adaptation. If you would like to provide comments on this document, you have various options:

1) Attend one or more of the scheduled public meetings.
Please see www.Toronto.ca/involved for details on these meetings.

2) Submit written comments by Monday May 5, 2008 at 4:00 PM to:

Changeisintheair@toronto.ca or

David MacLeod
Senior Environmental Specialist
Toronto Environment Office
21st Floor East, City Hall
100 Queen Street West
Toronto, ON
M5H 2N2

Fax: 416 338-0808

3) Call the 24-hour Comment Line for the City of Toronto Climate Change Adaptation Project at 416 338-3095.

4) Provide a personal deputation to the City Council's Parks and Environment Committee scheduled for Wednesday May 21, 2008. To schedule a deputation, you may make initial contact via the internet at pec@toronto.ca, or

Submit a written deputation to:

Dela Ting
Committee Administrator
City Clerk's Office
10th Floor West, City Hall
100 Queen Street West
Toronto, ON
M5H 2N2

Fax: 416 392-1879

Or, call the City Clerk's Office at 416-392-6662.

The deadline to schedule a personal deputation and/or submit a written deputation is Tuesday May 20, 2008 at 4:00 PM.

REFERENCES

AMEC Earth and Environmental, 2006. *Coastal Zone and Climate Change on the Great Lakes*. Report for Natural Resources Canada, Ottawa. Available on-line at: http://adaptation.nrcan.gc.ca/pdf/d64015448bd64429b04d01910ed75a7a_e.pdf.

Auld, H., 2007. Disaster risk reduction under current and changing climate conditions. Presentation to Environment Canada Science Seminar Series, December 11.

Bassil, K., D.C. Cole, R. Moineddin, W. Lou, and E. Rea, 2007. The association between temperature and 911 calls for heat-related illness: Potential for syndromic surveillance. *Advances in Disease Surveillance* 4:234.

Chiotti, Q., I. Morton and A. Maarouf, 2002. *Towards an Adaptation Action Plan: Climate Change and Health in the Toronto-Niagara Region*. Pollution Probe, Toronto.

Coe, M. and J.A. Foley, 2001. Human and natural impacts on the water resources of the Lake Chad basin. *Journal of Geophysical Research* 106:D4.

Del Genio, A.D., M.S. Yao, and J. Jonas, 2007. Will moist convection be stronger in a warmer climate? *Geophysical Research Letters* 34:L16703.

Environment Canada, 2007. Canada's top ten weather stories for 2007. Available on-line at: http://www.environment-canada.ca/doc/smc-msc/m_110/toc_eng.html.

Environment Canada, 2005, Historical heat-related events. Available on-line at: http://ontario.hazards.ca/historical/Heat_Ontario-e.html.

Field, C.B., L.D. Mortsch, M. Brklacich, D.L. Forbes, P. Kovacs, J.A. Patz, S.W. Running and M.J. Scott, 2007. North America. *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Available on-line at: <http://www.gtp89.dial.pipex.com/14.pdf>.

Hunt, S., J. Newman, and G. Otis, 2006. Threats and impacts of exotic pests under climate change: Implications for Canada's forest systems and carbon stocks. BIOCAP Canada. Available on-line at: http://www.biocap.ca/rif/report/Hunt_S.pdf.

Intergovernmental Panel on Climate Change. 2007, *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group 1 to the Fourth Assessment Report of the IPCC. Available on-line at: <http://www.ipcc.ch/ipccreports/ar4-wg1.htm>.

Klaassen, J., Meteorological Service of Canada, 2008. Personal communication.

Lemmen, D. S. and F.J. Warren, eds., 2004. *Climate Change Impacts and Adaptation: A Canadian Perspective*. Natural Resources Canada, Ottawa.

Maclver, D. 2006. Climate change impacts. Presentation to Decision-Makers Workshop organized by the Clean Air Partnership, Toronto, June 26.

Munich Re Group, 2007. Natural catastrophe figures for 2007. Available on-line at: http://www.munichre.com/en/press/press_releases/2007/2007_12_27_press_release.aspx.

National Center for Atmospheric Research, 2008. Topics in climate research: Drought and wildland fires. Available on-line at: <http://www.ncar.ucar.edu/research/climate/>.

Natural Resources Canada, 2008. Forest Forward: Moving beyond the pine beetle. Available on-line at: http://mpb.cfs.nrcan.gc.ca/index_e.html.

Nicholls, R.J., C. Herweijer, N. Patmore, S Hallegatte, J. Corfee-Morlot, J. Chateau, and R. Muir-Wood., 2007. Ranking port cities with high exposure and vulnerability to climate extremes. *Environment Working Papers No. 1*. Organization for Economic Cooperation and Development, Paris.

Ogden, N.H., C.J. Bigras-Poulin, I.K. O'Callaghan et al, 2005. A dynamic population model to investigate effects of climate on geographic range and seasonality of the tick *Ixodes scapularis*. *International Journal for Parasitology* 35:375-389.

Pengelly, D., C. Cheng, and M. Campbell. 2005. *Differential and Combined Impacts of Winter and Summer Weather and Lar Pollution due to Global Warming on Human Mortality in South-Central Canada*. Toronto Public Health. Toronto

Penney, J. and I. Wieditz, 2007. *Cities Preparing for Climate Change: A Study of Six Urban Regions*. Clean Air Partnership, Toronto.

Toronto Public Health, 2006. *Hot Weather Response Plan – Update, Toronto Staff Report, February 13*. Available on-line at: <http://www.toronto.ca/legdocs/2006/agendas/committees/hl/hl060227/it013.pdf>.

United Nations Environment Program. 2004. Impacts of summer 2003 heat wave in Europe. *Environment Alert Bulletin – 2. Nairobi*. Available on-line at: http://www.grid.unep.ch/product/publication/download/ew_heat_wave.en.pdf.

Wieditz, I. and J. Penney, 2006. *A Scan of Climate Change Impacts on Toronto*. Clean Air Partnership. Toronto.

APPENDIX 1: City of Toronto Climate Change Adaptation Steering Group

Project Sponsor: Lawson Oates, Director, Toronto Environment Office

*David MacLeod	Toronto Environment Office (Chair)
*Ilza Andzans	Toronto Water
*Valerie Cassells	Communications
*Bob Davis	Public Consultation
*Lisa King	Planning
*Melanie Lalani	Toronto Public Health
*Jennifer Penney	Clean Air Partnership
John Alderdice	Economic Development
Denise A. Campbell	Social Development
Naz Capano	Transportation Services
Ruby Chui	Corporate Financial Strategies
Erik Gawlik	Insurance & Risk Management
Lawson Oates	Toronto Environment Office
Mike McCoy	Facilities & Real Estate
Chandra Sharma	Toronto & Region Conservation Authority
Jennifer Smysnuik	Office of Emergency Management
Diane Stevenson	Parks Forestry & Recreation

* Indicates Core Steering Group Member