

Chapter 20: Assessment Report in Context

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20 Assessment Report in Context

20.1 Climate Change

Over the past twenty years, there has been a great deal of concern around the world over climate change, its causes and potential impacts on humanity. One of the potential impacts of climate change will be related to water supply. It is therefore important to look at climate change in the context of Source Water Protection.

Climate change refers to changes over time in the climate of the planet, or of geographic regions therein. It describes changes in the average state of the atmosphere or the average weather over various long and short-term time scales. Changes in climate may arise from natural processes, such as the internal processes of the earth, external processes, such as variation in levels of energy received from the sun, or from anthropogenic processes. In recent years, discussion of climate change has mainly referred to the changes in modern climate, including global warming. It is now accepted that human activities have played a significant role in these recent changes.

The general theory of climate change is based on the increasing volume of greenhouse gases present in the atmosphere. For thousands of years, there has been a natural balance of greenhouse gases in the atmosphere. Carbon dioxide and other greenhouse gases are naturally produced in some processes, and consumed in others. However, since the industrial era, data suggest that this balance has been disrupted. Worldwide human activities such as the burning of fossil fuels, deforestation, and agriculture have added huge quantities of greenhouse gases to the atmosphere which natural processes are unable to consume, thus upsetting the equilibrium (IPCC, 2007). The three greenhouse gases of primary concern are carbon dioxide, methane, and nitrous oxide, due to their chemical properties and their association with anthropogenic activities. Global atmospheric concentrations of these three gases have been increasing since the industrial revolution in the 1750s and now far exceed pre-industrial values. The global increase in carbon dioxide concentration is due primarily to fossil fuel use and land use change, while those of methane and nitrous oxide are primarily due to agriculture (IPCC, 2007). Figure 20-1 illustrates the increase in atmospheric carbon dioxide and temperature over the past 1000 years.

Climate change can change both the quality and quantity of current and future drinking water sources. Warmer temperatures can raise the temperature of surface water sources creating ideal habitats for bacterial growth. Warmer temperatures also indicate that more evaporation and evapotranspiration will be occurring, particularly after a storm event. The increased evaporation rates mean that less water is available to infiltrate the ground, to recharge the

groundwater system. An increased frequency in storm events inherently leads to an increase in runoff, potentially introducing harmful pollutants to watercourses. Other potential impacts of climate change will be introduced throughout the section. Understanding how climate change has the potential to affect our water sources, is imperative to protecting the resource for future generations.

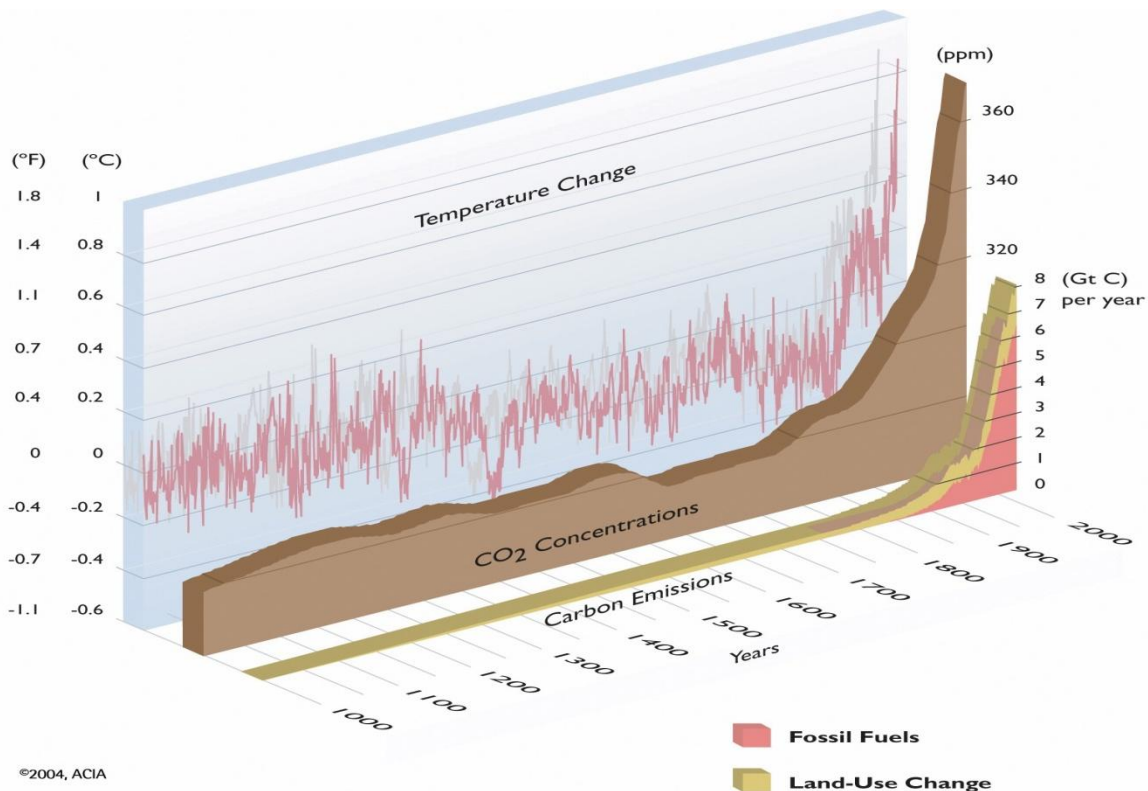


Figure 20-1: Atmospheric Carbon Dioxide and Temperature Change (Peltier, 2007).

20.1.1 Anticipated Climate Projections for the South Georgian Bay-Lake Simcoe Source Protection Region (SGBLS SPR)

To anticipate future impacts across the Source Protection Region, including those on safe drinking water, climate models are used to simulate potential future climate scenarios. Climate models are a numerical representation of the climate system based on physical, chemical and biological properties of its components, their interactions and feedback processes, and accounting for all or some of its known properties (IPCC, 2007a).

There are a number of climate change models around the world that are producing simulations of possible future climate scenarios. While many are used individually, research has shown that

by running multiple or an ‘ensemble’ of models together, the results are by and large better when projecting seasonal and annual precipitation and temperature. While an ensemble can increase the validity of the projections, there is still a very high level of uncertainty associated with them. For the most part this uncertainty is due to small-scale processes and feedbacks between the different parts of the earth that are not yet fully understood. An example of this is the impact and role of clouds. It is known that clouds play a large part in climate change, yet it is unknown what ensuing cloud responses will be from climate change (IPCC, 2007a). There is also an uncertainty associated with the amount of greenhouse gases (GHG) that will be released into the atmosphere in future years; therefore, climate models are run a number of times for different scenarios to give the best representation of possible outcomes.

In November 2009, the Expert Panel on Climate Change Adaptation released a report titled “Adapting to Climate Change in Ontario: Towards the Design and Implementation of a Strategy and Action Plan” (EPCCA, 2009) to the Minister of the Environment. In addition to providing over 50 recommendations to the Minister, a summary of climate change projections completed by Environment Canada (CCCSN, 2009) were provided. These model projections have been made for 63 grid areas across the province, with one of these grids roughly corresponding to the South Georgian Bay-Lake Simcoe (SGBLS) Source Protection Region.

The model results presented in the report (EPCCA, 2009) are the most current projections for 2050 (compared to 1961-1990 actual climate data) and are based on 24 models that were combined to provide a better estimation of climate conditions. The projections have been put into three groups (low, medium and high) based on future amounts of GHG emissions. It is recommended by the panel that ensemble projects should be used when developing adaptation policies.

Air Temperature

Using this model projection, Figure 20-2 illustrates the projected increase in average annual temperature in the 2050s (compared with 1961-1990) for Ontario under high GHG emissions. These values range from 2.5°C to 3.7°C across the province. For the SGBLS SPR (highlighted in red), the increase is predicted to be 3°C. Though this may not seem like a large increase, it is worth noting that a 2°C increase in the global average temperature is considered by many to be the “beginning of a socio-economically “dangerous” climate change” (EPCCA, 2009, p.15). A temperature increase of 2°C can lead to glaciers melting at faster rates, rising sea levels, changes in ocean currents, impacting people living in low lying areas around the coast lines. Changes in ocean currents and rising sea levels can lead to altered weather patterns worldwide, including the SGBLS SPR. A 2°C in global temperatures can increase the evaporation rates,

which increases a watershed's susceptibility to drought. This also causes a reduction in the volume of water available to recharge the groundwater system, affecting water supply for those municipalities which rely on groundwater for their source of drinking water.

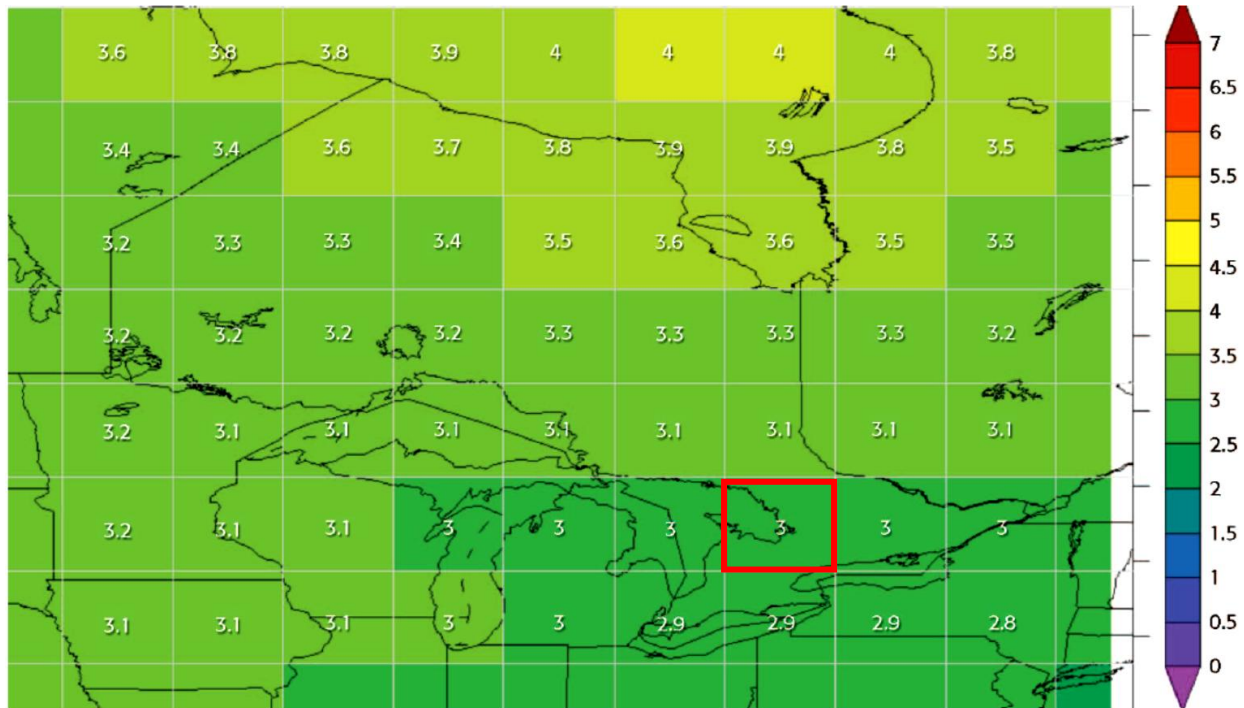


Figure 20-2: Projected increase in average annual temperature (°C) in the 2050's compared with 1961-1990 under High GHG emissions (CCCSN, 2009). Area highlighted in red roughly corresponds to the Source Protection Region.

Figure 20-3 and Figure 20-4 display the projected change in average winter and summer air temperatures for 2050 (compared to 1961-1990) for Ontario, under high GHG emissions. Across Ontario there is a predicted temperature increase of 3.1°C to 7.6°C during the winter months and a 2.3°C to 3.2°C during the summer months. Specifically in the Source Protection Region (highlighted in red), a 3.4°C increase in the winter months and a 2.9°C in the summer months is projected.

In summary, within the SGBLS SPR average annual air temperatures are projected to increase by 3°C by 2050, with similar projections for most seasons (Table 20-1).

Table 20-1: Summary of projected increase in Source Protection Region average annual temperature (°C) in the 2050s compared with 1961-1990 (CCCSN, 2009).

Season	Low GHG Emission Scenario (projected change in air temperature °C)	Medium GHG Emission Scenario (projected change in air temperature °C)	High GHG Emission Scenario (projected change in air temperature °C)
Annual	2.3	2.7	3.0
Winter	2.5	3.0	3.4
Spring	2.2	2.5	2.8
Summer	2.2	2.6	2.9
Autumn	2.3	2.6	2.8

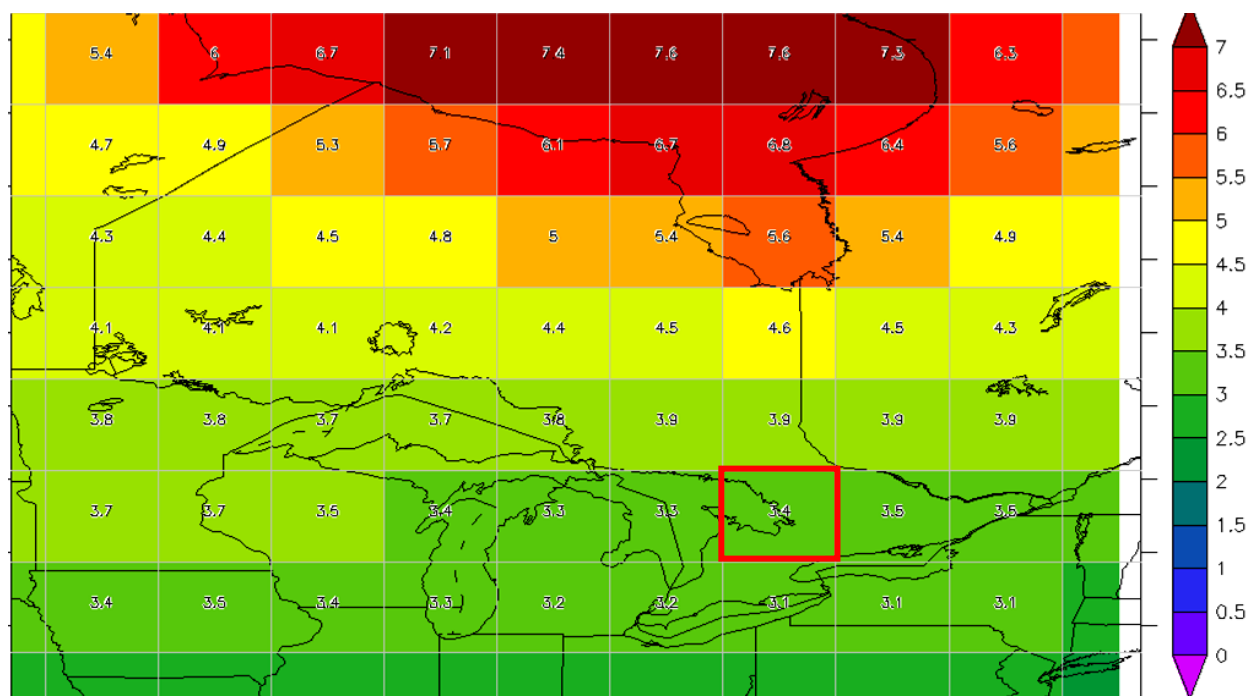


Figure 20-3: Projected change in average WINTER air temperature (°C) over Ontario for 2050s compared with 1961-1990 under HIGH GHG emissions. (CCCSN, 2009). Area highlighted in red roughly corresponds to the Source Protection Region.

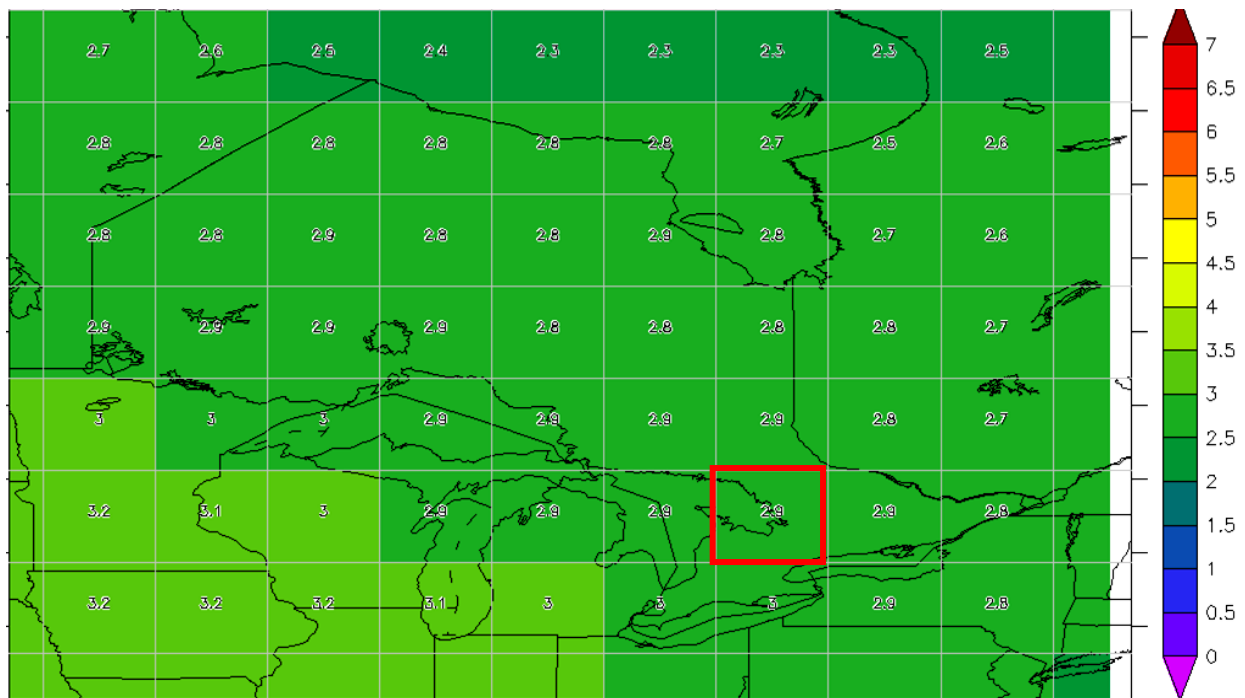


Figure 20-4: Projected change in average SUMMER air temperature (°C) over Ontario for 2050s compared with 1961-1990 under HIGH GHG emissions (CCCSN, 2009). Area highlighted in red roughly corresponds to the Source Protection Region.

Precipitation

Figure 20-5 illustrates the projected change in average annual precipitation (%) for the 2050s (compared with 1961-1990) in Ontario under high GHG emissions. These values range from 3.82% to 18.04% across the province. For the Source Protection Region (highlighted in red), the increase is predicted to be 5.51%.

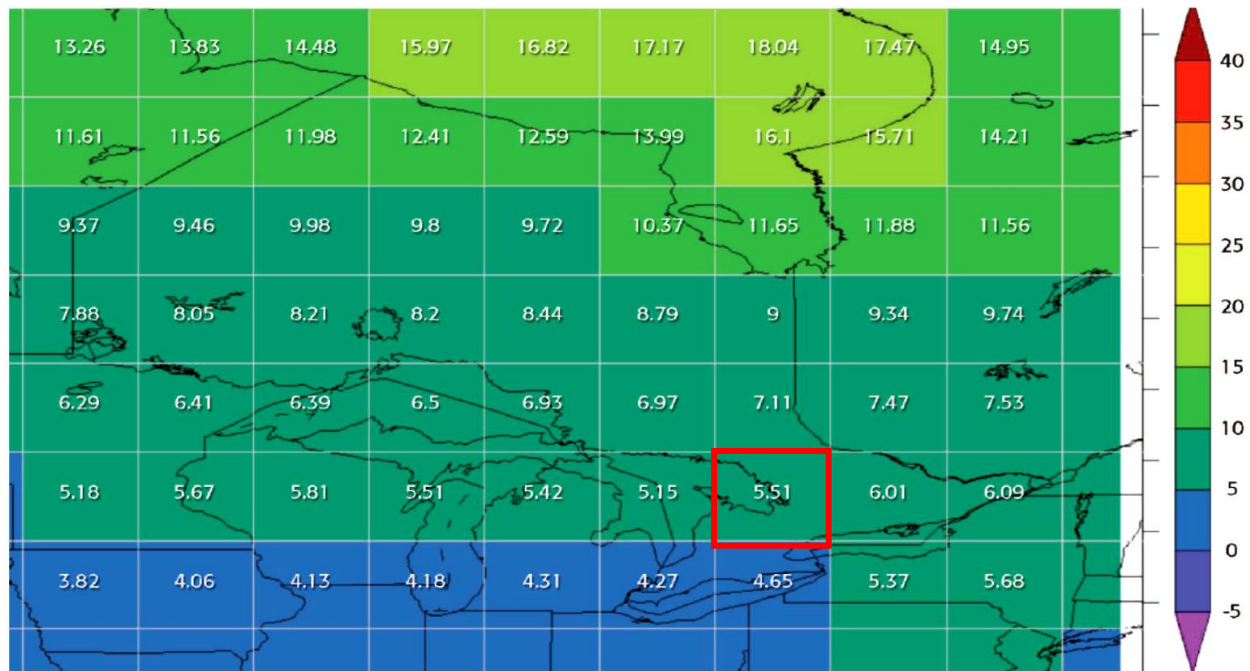


Figure 20-5: Projected change in annual average precipitation (%) over Ontario for 2050s compared with 1961-1990 under HIGH GHG emissions (CCCSN, 2009). Area highlighted in red roughly corresponds to the Source Protection Region.

Figure 20-6 and Figure 20-7 display the projected change in average winter and summer precipitation for 2050 (compared to 1961-1990) for Ontario, under moderate GHG emissions. Across Ontario there is a predicted precipitation increase of 8.62% to 42.59% increase during the winter months and a 3.18% decrease to 10.24% increase during the summer months. Specifically in the SGBLS SPR (highlighted in red), a 10.76% increase in the winter months and a 0.62% decrease in the summer months is projected. From this information it can be seen that the majority of the increase in precipitation occurs in the winter, while there is minimal change in the summer. The minimal increase in summer precipitation, combined with the projected 2.9°C temperature increase, raises the likelihood of more intense dry periods due to increased evaporation. Potential impacts to drinking water supply are further discussed in Section 14.1.3.

Table 20-2: Summary of projected increase in Source Protection Region precipitation (%) in the 2050s compared with 1961-1990 (CCCSN, 2009).

Season	Low GHG Emission Scenario (projected change in precipitation %)	Medium GHG Emission Scenario (projected change in precipitation %)	High GHG Emission Scenario (projected change in precipitation %)
Annual	5.15	5.45	5.51
Winter	9.38	10.19	10.76
Spring	8.58	9.1	9.65
Summer	0.92	0.11	-0.62
Autumn	3.06	3.79	3.82

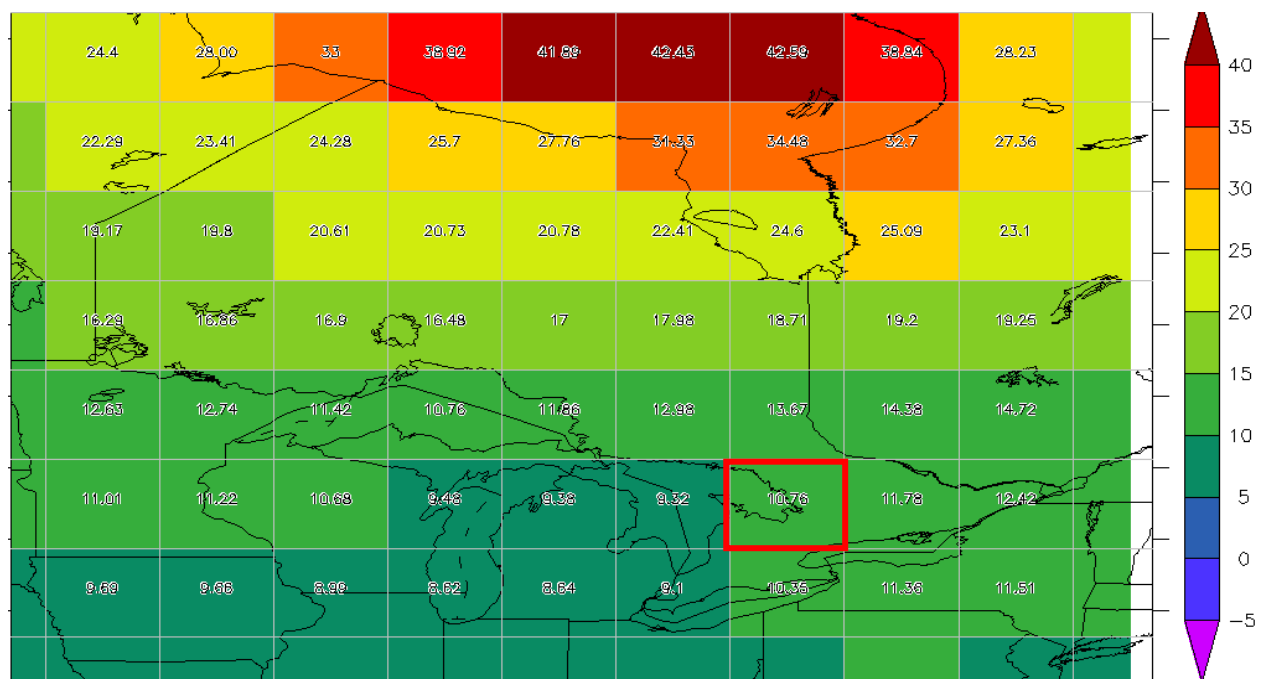


Figure 20-6: Projected change in average WINTER precipitation over Ontario for 2050s compared with 1961-1990 under HIGH GHG emissions (CCCSN, 2009). Area highlighted in red roughly corresponds to the Source Protection Region.

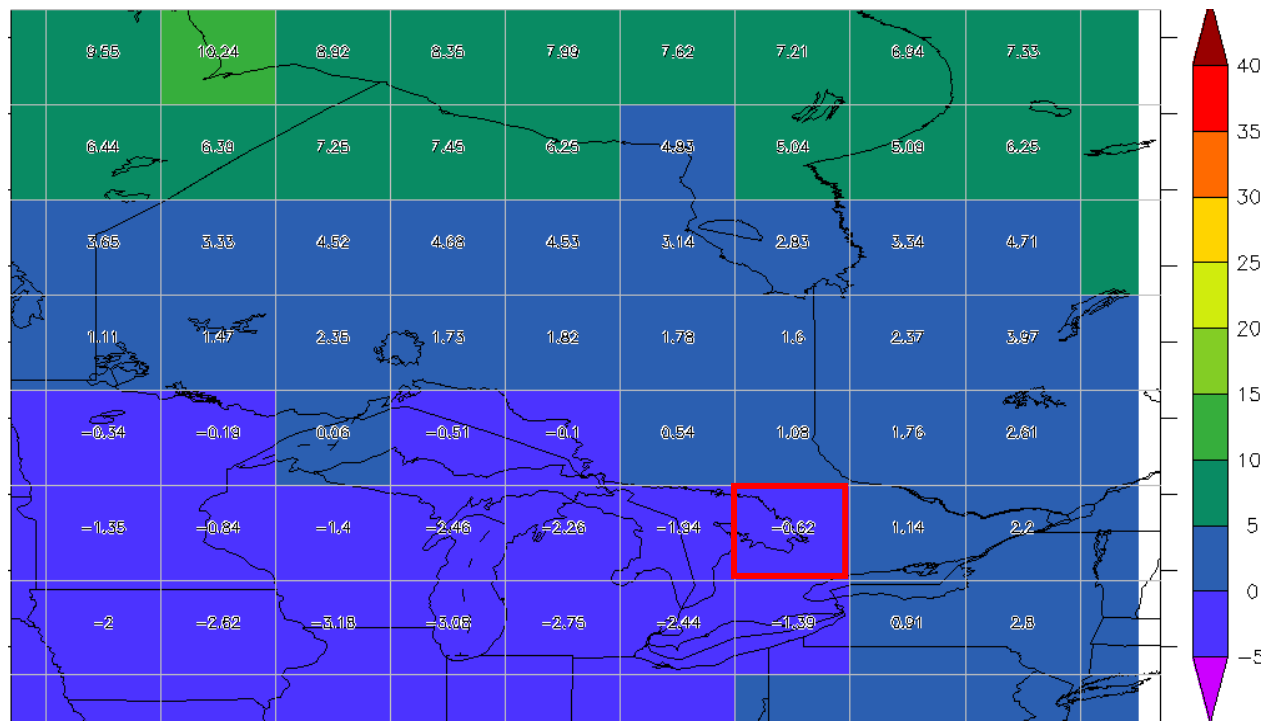
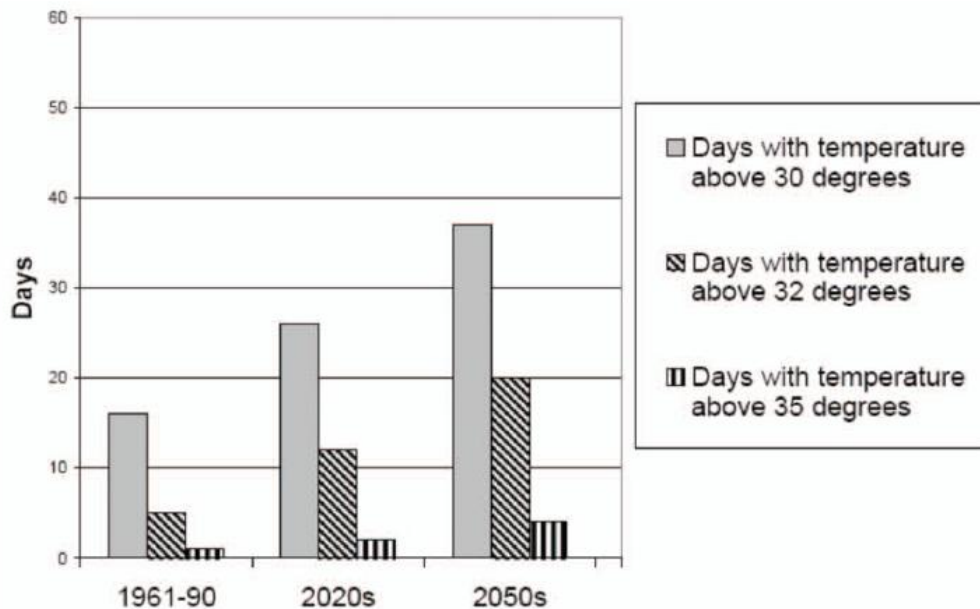


Figure 20-7: Projected change in average SUMMER precipitation over Ontario for 2050s compared with 1961-1990 under HIGH GHG emissions (CCSN, 2009). Area highlighted in red roughly corresponds to the Source Protection Region.

Extreme events

While average temperature and precipitation projections provide insight into trends, they do not capture the variability of weather and frequency of events that may be far from average. Weather patterns and events may include severe storms, droughts, heat waves and wind events. Current observations of extreme increases in event frequency are currently inconclusive in Ontario, but have been found in other places and can be expected in Ontario (EPCCA, 2009). Weather events that may become more frequent include summer droughts, heat waves, winter thaws and summer storms (Figure 20-8).



Source: Environment Canada, 2002

Figure 20-8: Past and future projection of hot days in the City of Toronto (Source: Environment Canada, 2002).

20.1.2 Current Climate Trends in the South Georgian Bay-Lake Simcoe Source Protection Region

The South Georgian Bay-Lake Simcoe Source Protection Region is located within two climatic regions. These include the Simcoe and Kawartha Lakes, and Muskoka regions. The majority of the Lake Simcoe and Nottawasaga Valley Source Protection Areas are located within the Simcoe and Kawartha Lakes Climatic Region. The southern and south-western parts of the Severn Sound Source Protection Area are also located within the Simcoe and Kawartha Lakes Climatic Region. The northern and north-western parts of the Severn Sound Source Protection Area and Black-Severn River watershed are located within the Muskoka climatic region.

The Simcoe and Kawartha Lakes climate region is characterized as having a mean annual total precipitation of 815 mm/year, a mean annual potential evapotranspiration of 585 mm/year and, a mean annual actual evapotranspiration of 535 mm/year (Brown et al, 1980). Local variations in climate across the watershed are mainly due to topography, proximity to large water bodies and prevailing winds.

Climate data is monitored at various locations throughout the province by different agencies. In the Lake Simcoe, Nottawasaga Valley, and Severn Sound watersheds, Environment [and Climate](#)

[Change](#) Canada (ECCC), Ministry of the Environment (MOE) ([now the Ministry of the Environment, Conservation and Parks \(MECP\)](#)), the Lake Simcoe Region Conservation Authority (LSRCA), the Nottawasaga Valley Conservation Authority as well as, the Severn Sound Environmental Association respectively, all collect meteorological data. Within the Black-Severn River watershed, ECCC and the MECP collect meteorological data.

The Alliston-Nelson climate station, located in the Nottawasaga Valley watershed and the Barrie WPCC climate station, located in the Lake Simcoe watershed were chosen for analysis due to their continuous period of record and because they were thought to be representative of the Source Protection Region. At each station air temperature and precipitation data were collected. The records include maximum, minimum and average daily temperatures in degree Celsius, and precipitation (as rain or snow). The period of record for each station varies for all parameters and some of the records may contain gaps. The data gaps were in-filled using methods carried out according to the methodology outlined in “Filling gaps in meteorological data sets used for long-term watershed modelling” (H.O Schroeter, D.K. Boyd and H.R. Whiteley) by Schroeter & Associates in 2009 (described in Section 3.2.3.1). Table 20-3 summarizes the Climate monitoring stations record period information. It should be noted that the analyzed results of two climate stations will differ from the EPCCA modeled results. The EPCCA climate model took into consideration many stations averaged over a large area, while the results analyzing the climate data from the Alliston-Nelson and Barrie WPCC stations are very localized.

Table 20-3: Climate Monitoring Station Information.

Agency	Station ID	Station Name	Period of Record- Precipitation	Period of Record- Air Temperature	Period of Record- After Data Infilling
Environment and Climate Change Canada	6110218	Alliston-Nelson	1973-2003	1977-2003	1950-2008
Environment and Climate Change Canada	6110557	Barrie WPCC	1968- Present	1977-Present	1950-2008

Air Temperature

The daily average air temperature for each station was averaged for each year to produce a graph of average annual maximum, minimum and average air temperatures, as well as a graph

displaying the trend for the average annual temperature (Figure 20-9 through Figure 20-12). These figures show that trends in air temperatures were slightly different between the two Climate Monitoring stations, perhaps reflecting local influences such as proximity to Lake Simcoe (Barrie).

Figure 20-9 gives a general overview of the averaged maximum, minimum and average annual temperatures at the Alliston-Nelson station, illustrating how all three appear to fluctuate in the same manner over the years. Figure 20-10 gives a closer look at the average annual temperature trend from 1950 to 2008. There is an apparent decreasing trend in temperature until the late 1970s, after which it begins to increase for an overall 0.67°C increase over the past 58 years.

In contrast, Barrie averaged maximum, minimum and average annual temperature displayed a more gradual increase over the entire time period, with perhaps a more pronounced increase in the 1980s to 2000s. A closer look at the average annual temperature trend from 1950 to present mostly confirms this with a slight decreasing trend until the 1970s and increasing thereafter (Figure 20-12) with an overall increase of 0.87°C over the past 60 years.

It should be remembered that this is a general assessment of temperature trends, and does not take into account all the different parameters that can alter temperature. While statistical analysis is required to determine if these trends are statistically significant, the coefficient of determination (R^2) for the average annual temperature analysis is low (close to 0) due to minimal slope and high data variability. In essence this means that any predictions of future air temperature based on this relationship would have a lot of associated uncertainty. The results from this analysis, that air temperature in the Source Protection Region could be increasing, loosely corresponds to the Canadian Climate Change Scenarios Network (CCCSN) 2009 climate projection of 3°C average annual air temperature increase under high GHG emission by 2050.

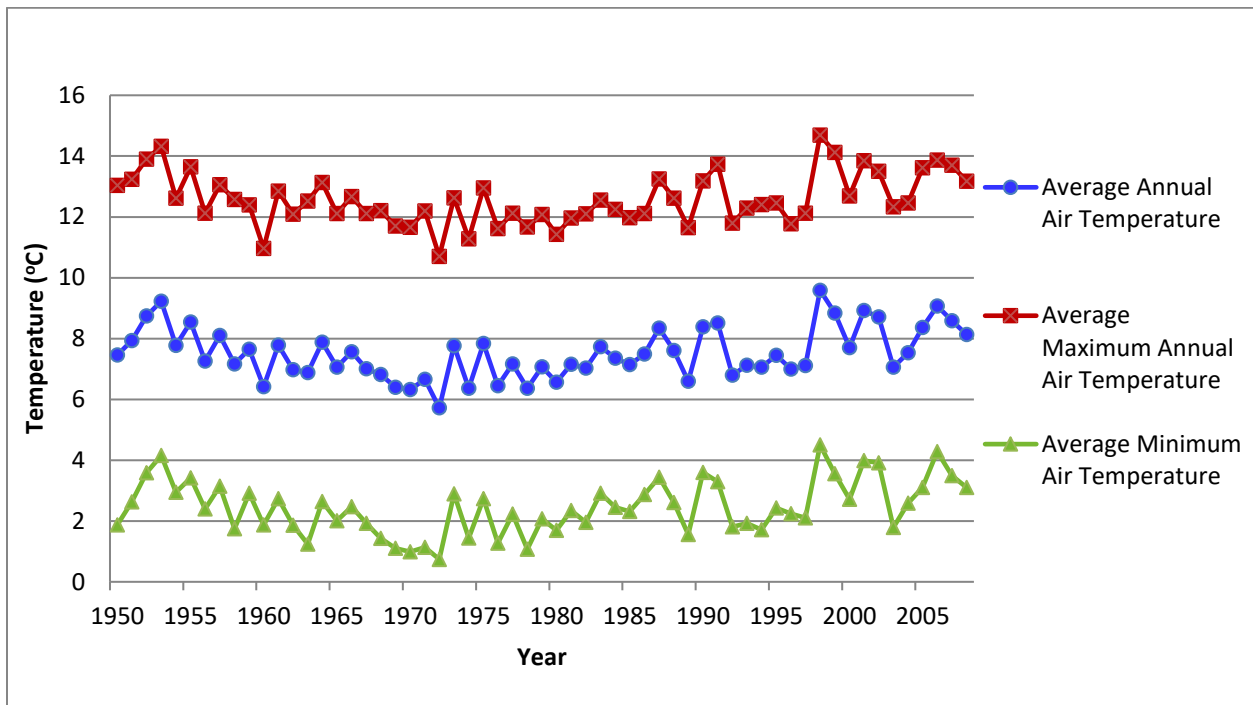


Figure 20-9: Comparison of the Average Annual, Maximum and Minimum Temperatures at the Alliston-Nelson Monitoring Station.

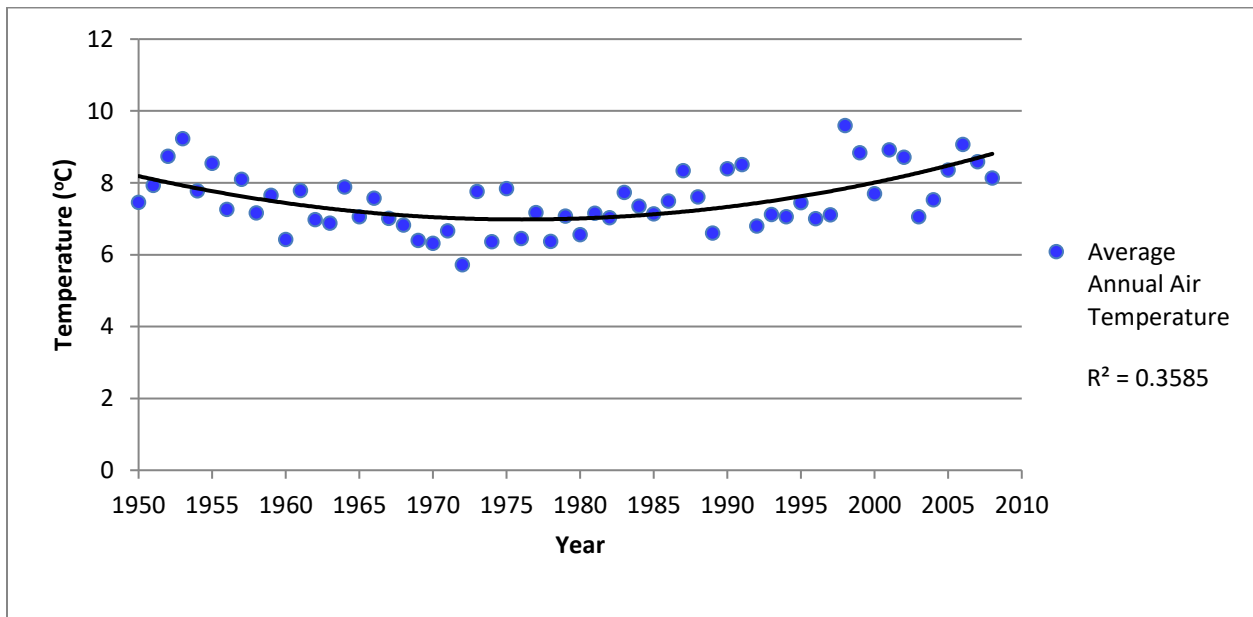


Figure 20-10: Average Annual Temperature at the Alliston-Nelson Meteorological Monitoring Station.

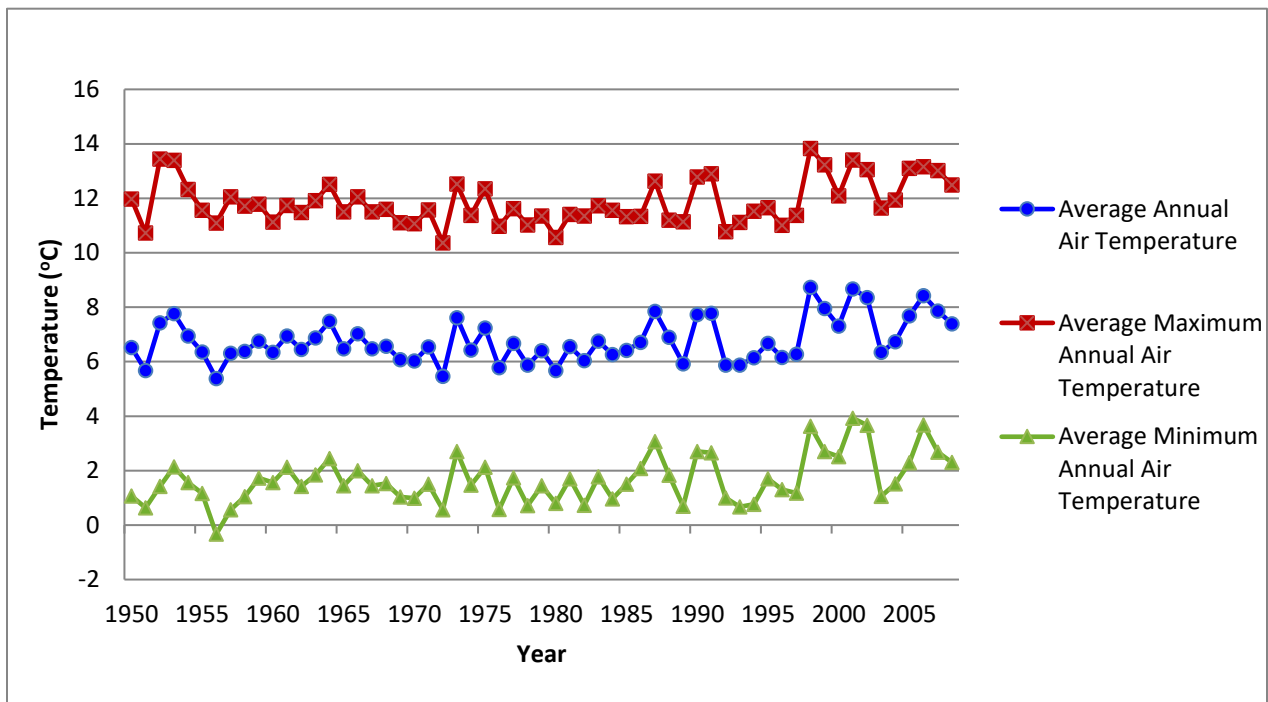


Figure 20-11: Comparison of the Average Annual, Maximum and Minimum Temperatures at the Barrie WPC Meteorological Monitoring Station.

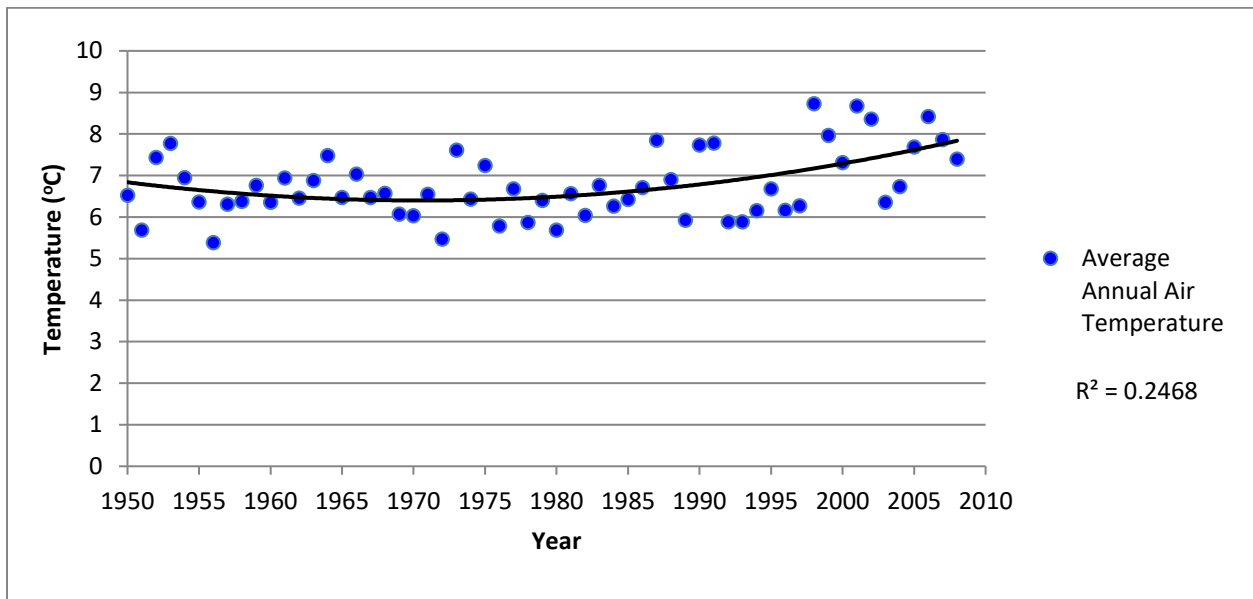


Figure 20-12 : Average Annual Temperature at the Barrie WPCCC Meteorological Monitoring Station

Precipitation

The CCCSN (2009) projected that by 2050 total annual precipitation will likely increase by 5.5% and average winter precipitation by 11% in the Source Protection Region. To determine if past conditions correspond to these projections, total annual precipitation for the Alliston-Nelson and Barrie Meteorological stations were plotted (Figure 20-13 & Figure 20-14). Total annual precipitation at both stations showed that there could be a slight increasing trend. While these results somewhat mimic the CCCSN projection, further analysis is required to determine if a trend is in fact there.

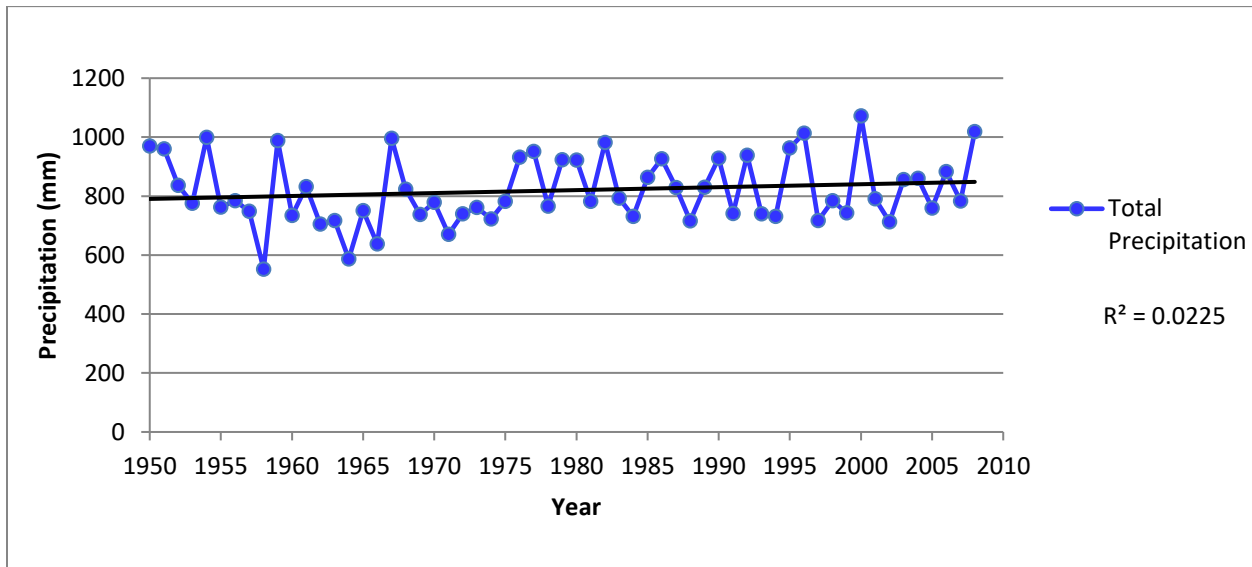


Figure 20-13: Total Annual Precipitation at the Alliston-Nelson Meteorological Monitoring Station.

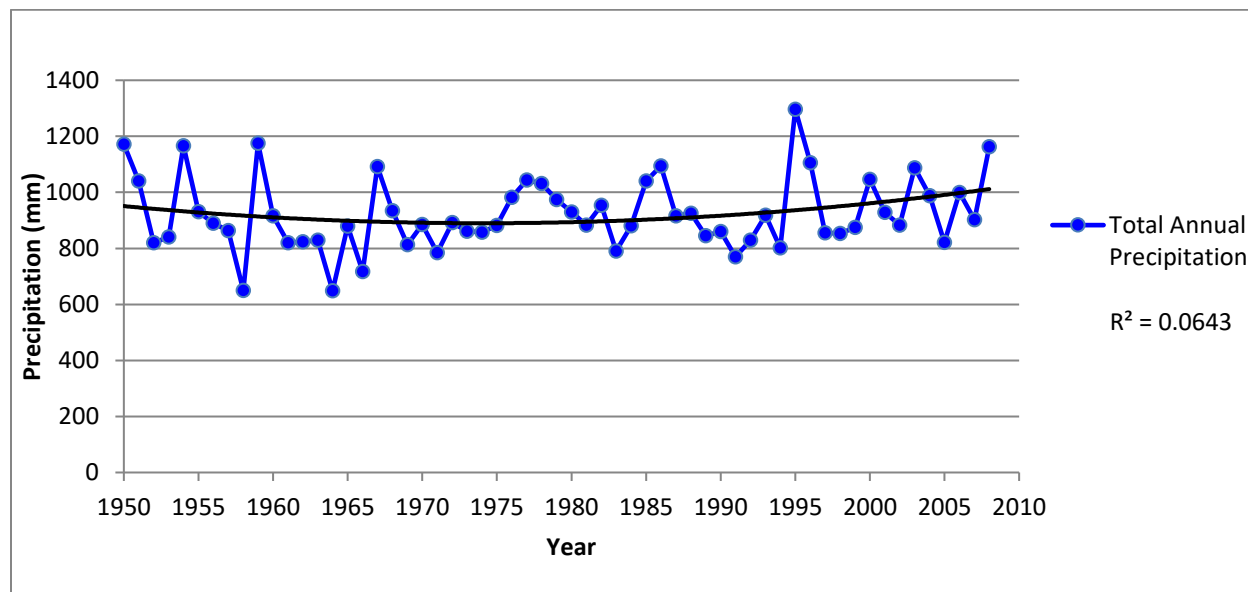


Figure 20-14: Total Annual Precipitation at the Barrie WPCC Meteorological Monitoring Station.

In contrast, the average winter precipitation trends did not match the 2009 CCCSN projections at either of the stations. Results from the Alliston-Nelson station (Figure 20-15) show that little to no change has been observed in the volume of precipitation received in the winter over the past 60 years. What has changed is the percentage of snow received has decreased over the years, coinciding with the observed warmer than average winter temperatures. With the projected, and perhaps measured, increases in winter air temperatures it can be expected that the proportion of precipitation that falls as rain, and not snow, could increase during the winter. This in turn can affect surface flow and groundwater recharge characteristics. Figure 20-16 indicates that as the temperature increases the type of precipitation received in the winter shifts from snow to rain.

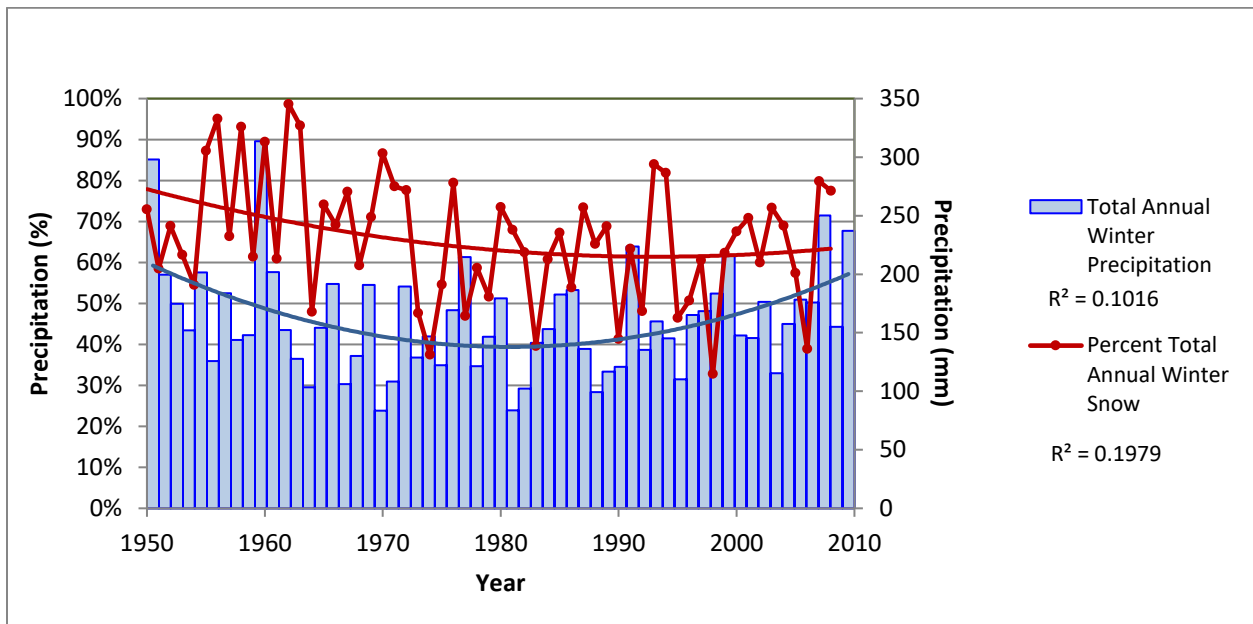


Figure 20-15: Percentage of Annual Winter Precipitation (snow) vs. Total Annual Winter Precipitation at the Alliston-Nelson Meteorological Monitoring Station.

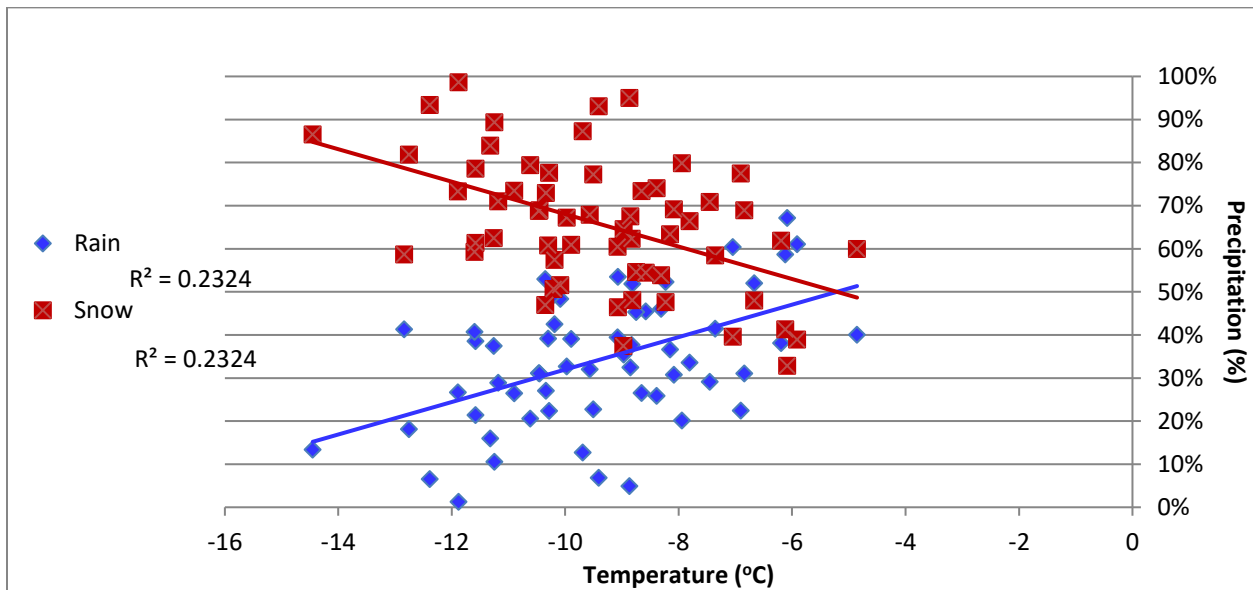


Figure 20-16: Percentage Annual Winter Precipitation (rain & snow) Vs. Average Annual Winter Temperature at the Alliston-Nelson Meteorological Monitoring Station.

Results from the Barrie station displayed a slight declining trend (Figure 20-17) in both total precipitation and the percentage of winter snow over the past 60 years. This trend is opposite to the one projected by the CCCSN for the next 40 years. While there is the appearance of a shifting pattern in precipitation trends, the change is not significant enough to suggest any departure from existing climate conditions. It should be noted that fluctuations in the volume of winter precipitation are more frequent at the Barrie WPCC station, compared to the Alliston-Nelson station. This could be due to Barrie being in close proximity to Lake Simcoe, causing lake effect precipitation events. With the projected, and perhaps measured, increases in winter air temperatures it can be expected that the proportion of precipitation that falls as rain, and not snow would likely increase during the winter. This in turn can affect surface flow and groundwater recharge characteristics. Figure 20-18 indicates that as the temperature increases the type of precipitation received in the winter shifts from snow to rain.

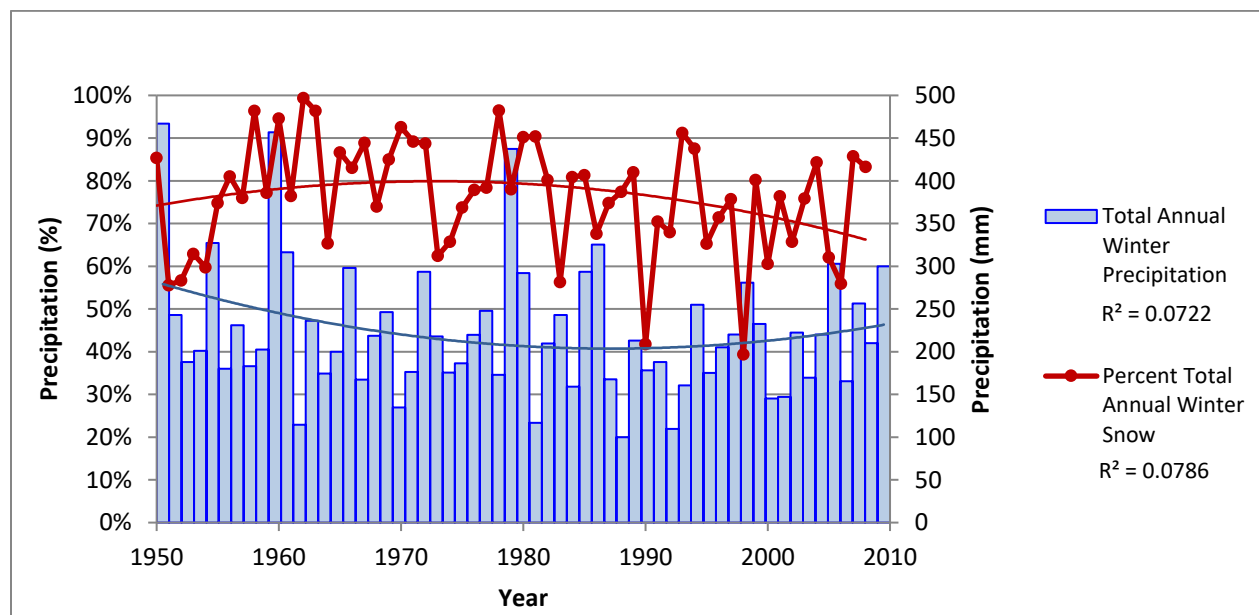


Figure 20-17: Percentage of Annual Winter Precipitation (snow) vs. Total Annual Winter Precipitation at the Barrie WPCC Meteorological Monitoring Station.

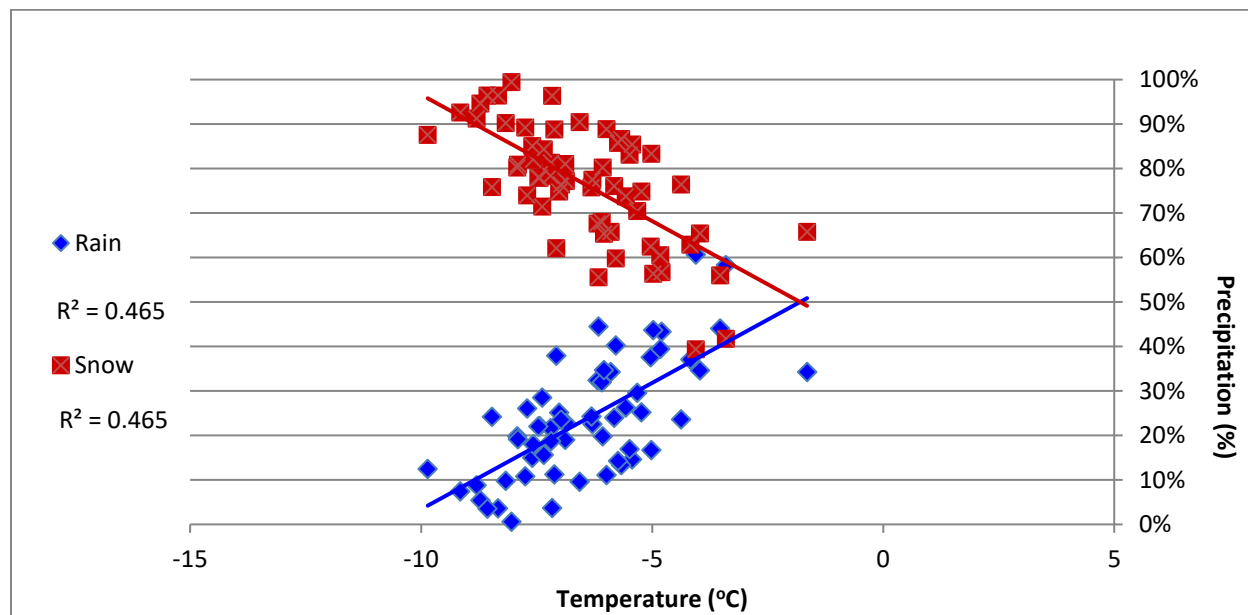


Figure 20-18 Percentage Annual Winter Precipitation (rain & snow) Vs. Average Annual Winter Temperature at the Barrie WPCC Meteorological Monitoring Station.

Within the Lake Simcoe Source Protection Area the EPCCA climate projection study indicated there will likely be little change in summer precipitation (-0.62%) (EPCCA, 2009). The data collected from the Alliston-Nelson station somewhat coincides with this, showing a very marginal increase in total annual summer precipitation (Figure 20-19).

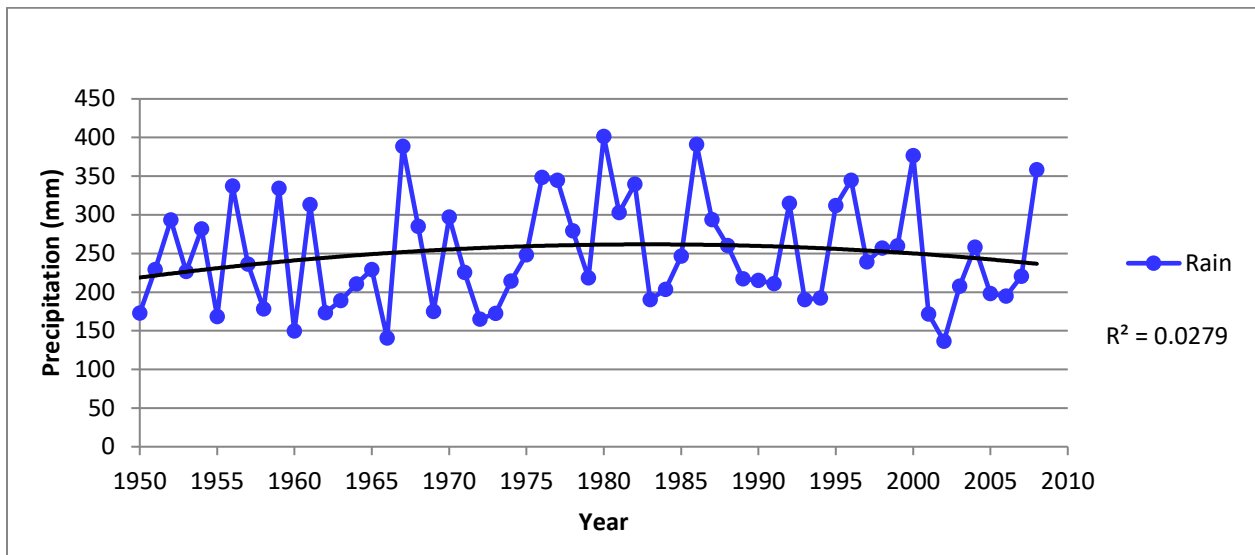


Figure 20-19: Total Annual Summer Precipitation (rain) at the Alliston-Nelson Meteorological Monitoring Station.

The Barrie WPCC station also showed a slightly increasing trend in the total annual summer precipitation up until the 1980's where it appears the average amount of precipitation received levels off (Figure 20-20).

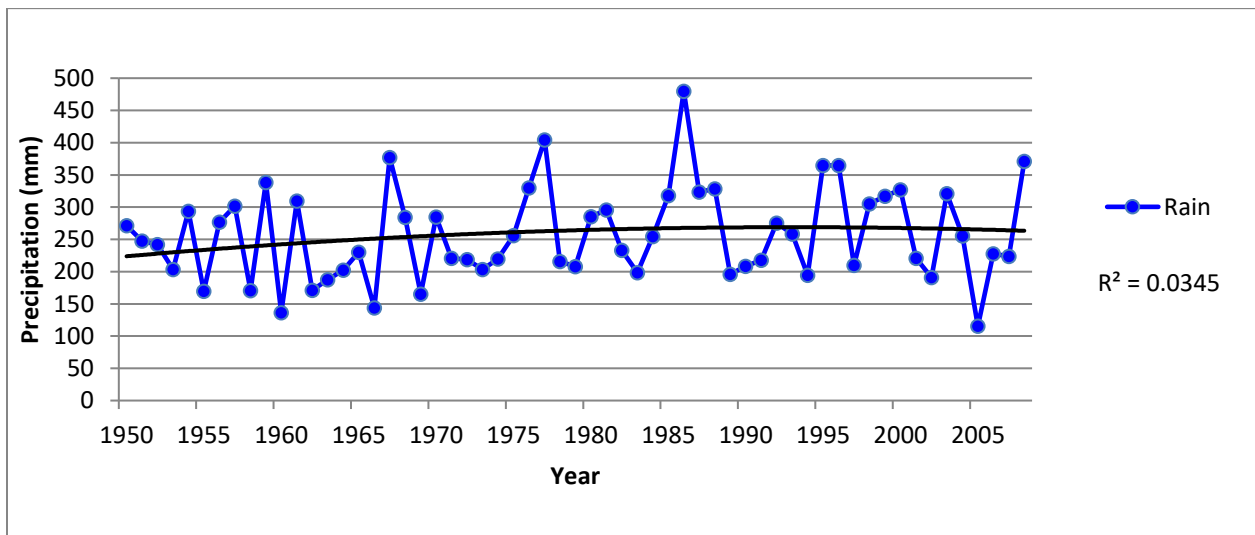


Figure 20-20: Total Annual Summer Precipitation at Barrie WPCC Meteorological Monitoring Station.

Despite the fact that the results for the two meteorological monitoring stations were not always consistent with the CCCSN projections, it should be kept in mind that these were simple evaluations that did not address all the possible conditions in the area. Only two stations were looked at for the SGBLS SPR, while the projections provided by the Canadian Climate Change Scenarios Network cover a much larger area. Even though the results have a high uncertainty associated and should be considered with care, the purpose of this section was not to provide an in-depth evaluation, but to give a general assessment of the existing climate conditions within the Source Protection Region.

20.1.3 Anticipated Implications of Climate Change to Assessment Report Conclusions

Climate change may have many direct and indirect influences on protection of clean drinking water. In addition, climate change may also impact factors such as water quantity and quality, ecosystems integrity, agriculture, human health and recreation, all of which are interrelated and can influence source water. The projected changes in air temperature, precipitation and extreme events need to be identified, described and assessed in terms of their potential implications on Source Water Protection. The following section outlines how some of the conclusions of this Assessment Report may be influenced by climate change in the SGBLS SPR.

20.1.3.1 Water Quantity

The projected increase in air temperature, winter precipitation, storm intensity and frequency are some of the effects of climate change that could change the quantity of water available for surface intakes and well supplies.

Less frequent summer showers, longer continuously dry periods, and increased evaporation can cause a reduction in both surface water and groundwater. While water levels in Lake Simcoe and Lake Couchiching are regulated through the Trent-Severn Waterway, surface intakes within the lakes could be affected by declining water levels. Water levels in many lakes are projected to decline because of increased evaporation from open water swept by stronger winds during a longer ice-free season (EPCCA, 2009). Lower water levels have the potential to increase the vulnerability of surface water intakes, especially those in shallow water that are more susceptible to surface contamination. Surface water intake pipes may need to be moved or redesigned to be able to draw in the water required for these communities.

Summer groundwater recharge rates could be reduced as a result of the projected increased intensity of summer storm events, causing more water to runoff at the surface. The implications of this hydrologic change can lead to less water discharging to streams as baseflow, leading to a reduction in the amount of coldwater habitat. Wetland areas may decline or

diminish resulting in impacts on the diversity of plants and wildlife. As well a decline in water quality could occur, as the filtering capacity of the wetlands becomes compromised (Warren et al., 2004). In addition, reduced recharge to groundwater could cause a significant decline in aquifer levels. This could result in shallow wells drying up and/or municipal wells needing to be drilled deeper into the aquifer, or it may be necessary to find an alternate source of water to sustain consumption rates. On the other hand warmer conditions in the fall and winter will delay ground frost; therefore, enhancing infiltration during wet months. Similarly, an earlier spring will allow for more infiltration to occur, as the winter snowpack thaws.

Average annual precipitation is projected to increase by 5%, and the pattern of fall is predicted to change to fewer; more intense storms. This projected change in precipitation patterns increases the likelihood of localized flooding. During the winter, the probability of flooding is further increased by a projected 10% increase in precipitation, and increased probability of winter thaws due warmer air temperatures. Flooding puts a strain on existing storm sewers, with most pipes designed to accommodate a 25 year storm event, but it is highly likely that there will be many more storms exceeding this intensity. In Ontario alone, there were ten 100 year storm events that occurred between the years 2000 to 2005 (Fortin, 2009). Upgrades may be necessary to avoid flooding such as that observed in Barrie in 2005, Newmarket in 2006, Angus in 2008, and Coldwater in 2009.

Despite the increased risk for flooding due to the changing precipitation characteristics, water shortages are expected throughout southern Ontario, as the expected increase in temperature could increase the demand for water in many sectors (e.g. agricultural irrigation and municipal supply). Water restrictions are already observed in some municipalities during the summer months when the water supply decreases. The frequency and duration of water shortages are anticipated to increase as the climate warms. All together this could mean a net decrease in the fresh water supply for those living within the South Georgian Bay-Lake Simcoe Source Protection Region. The expected severity of this over the next 25 years is currently unavailable, but it is likely that with an increasing population and a decreasing amount of potable water available, water use restrictions could become more frequent. A discussion on the simulated results of the water balance within the Source Protection region is found within Chapter 3: Water Budget and Water Quantity Risk Assessment. The chapter discusses the results of future simulated water demand scenarios: including average climate conditions, a 2 year drought simulation, and a 10 year drought simulation.

20.1.3.2 Water Quality

The projected changes in air temperature, precipitation and extreme events all have repercussions to future water quality. While hypothesizing how changing climatic patterns may broadly influence water quality in the future is possible, determining the extent and specific impact is considerably harder. It is also likely that many potential impacts to water quality are unknown due to both the uncertainty of the future climate and the complexity of interacting processes. For the purpose of this Assessment Report, some of the potential impacts of climate change on source water quality are identified in terms of the potential hazard of an activity. It is this hazard rating (combined with the vulnerability score) that ultimately identifies if a source of drinking water is at a high risk of contamination. Those factors used to assess these hazards include the environmental fate of the parameter, quantity of the parameter and method of release to the natural environment. Whether climate change affects these processes, and if so, to what degree, depends on the land use activity (e.g. industry, residential, agriculture) and parameters (type of chemical or pathogen) of concern.

Release of contaminants

The most significant impact to drinking water relates to changes in the probability of a contaminant being released to the environment. As already discussed, climate change may lead to an increased frequency and severity of events such as storms, floods and droughts. Increased severity and frequency of weather events may lead to more accidental releases of contaminants due to factors such as:

- damage to buildings or infrastructure housing contaminants resulting in their release;
- overflow of retention areas – some activities rely on retention areas to hold contaminants until they can be processed (for example waste treatment facilities or storm water management ponds), during extreme events the capacity of the retention areas may be exceeded due to the volume of water entering , leading to overflow and contamination of local waterways; and
- mobilization of surface contaminants – in many cases a contaminant may not be considered a hazard as it is relatively immobile. However, with sufficient surface flow or flooding these contaminants can be transported into local waterways where they impact water quality.

This last example is one of the contributing factors of the Walkerton Tragedy. In Walkerton, an extreme rainfall event that lasted for around 5 days led to intense runoff from fields that had been spread with manure (an accepted best management practice). This runoff contained

pathogens (*E.coli* 0157:H7 and *Campylobacter*) and ultimately ended up in the municipal water system. Due to the inadequate water disinfection treatment, seven people died and over 2000 became ill (Chitotti and Lavender, 2008).

Fate of and transport of contaminants

Extreme events can also affect a contaminants' fate. High surface water flow and floods can transport contaminants much greater distances than under normal flow conditions, therefore potentially increasing the exposure of surface intakes and groundwater intakes under direct influence (GUDI) of surface water to contamination. To help plan for the potential impact of floods surface and GUDI intakes have specified vulnerable areas, called IPZ-3s, ~~and WHPA-F respectively.~~ In the Lake Simcoe watershed, the entire watershed has been identified as an IPZ-3. While the IPZ-3 for the Port Severn intake is the entire Black-Severn River and Lake Simcoe watersheds. In Severn Sound's watershed, the Orillia intake's IPZ-3 encompasses all of the Lake Couchiching and Lake Simcoe watersheds, whereas the IPZ-3 for Tay just extends to the area immediately to its west. The IPZ-3 for the Collingwood intake in Nottawasaga Valley extends to the northwest of the intake. ~~modelling has not yet been completed for the Nottawasaga Valley and Severn Sound Source Protection Areas.~~

Fate of pathogens such as *E coli* may also be influenced by rising temperatures resulting from climate change. Warmer temperatures are likely to make the surface waterways more hospitable to pathogens and other waterborne diseases. This more suitable habitat may increase the concentration and potential sources of pathogens.

Quantity of a contaminant

For the most part, climate change could have an impact on the quantity of a contaminant, by influencing those activities related to application and storage of road salt, the storage of snow, and the management of runoff that contains chemicals used in the deicing of aircraft. With the projected 10% increase in winter precipitation the application of road salt may lead to an increase surface and groundwater exposure to chloride and sodium. With sodium and chloride already being identified as an issue for some wells in the region (e.g. Barrie), the effects of increased application of road salts needs to be closely monitored to ensure they do not become issues in other areas. Frequency and extent of airplane deicing is also an activity that may change as a result of increase winter precipitation. Deicing can release contaminants such as Ethylene Glycol and Dioxane-1,4, however there are few, if any, airports in the Source Protection Region that have deicing facilities.

20.1.4 Anticipated Effects of Climate Change on the South Georgian Bay-Lake Simcoe Source Protection Region Environment

20.1.4.1 Natural Vegetation – Wetlands, Woodlands and Riparian Areas.

According to the United Nations Environment Programme (UNEP, 2007), wetlands and forests are among ecosystems that are particularly vulnerable to climate change. Table 20-4 is from the UNEP’s Sensitive Ecosystems Analysis (2000):

Table 20-4 UNEP’s Sensitive Ecosystems Analysis (2000) (Source: UNEP, 2000).

Ecosystem	Key Climatic Variable	Implications for Biodiversity
Wetlands	<ul style="list-style-type: none"> • Mean summer temperatures • Mean annual precipitation • Flooding 	<ul style="list-style-type: none"> • Increased variability in hydrological cycle, leaving inland wetlands to dry out with lower species diversity • Warming of 3-4°C could eliminate 85% of all remaining wetlands
Forests	<ul style="list-style-type: none"> • Changes in rainfall, temperature and potential evapotranspiration • Increased frequency of fire and storms 	<ul style="list-style-type: none"> • Major changes in vegetation types, forests may disappear in certain areas at a rate faster than the potential rate of migration to or re-growth in new areas

As mentioned above, with a decrease in groundwater recharge, wetland areas could be reduced resulting in a loss of biodiversity within these areas. These natural features provide necessary habitat for some species, including the various types of fish that use wetlands as nursery and breeding grounds. For example, wetlands, including swamps, bogs and marsh only occupy approximately 13% of the Lake Simcoe watershed, an 85% (see table above) decrease would leave under 2% left in the watershed.

The woodland communities in the Source Protection Region could possibly be altered as a result of climate change. Changing weather patterns and the availability of water could affect the ability of trees to survive and ecosystems could change in accordance with the tolerance of the trees to these conditions. Changes in growing seasons, such as a shorter winter dormancy period and earlier onset of warm weather will potentially place stress on these systems. For example, earlier warm weather may result in earlier bud burst, which may expose young

growth to frost damage, thus limiting tree growth. Incidences of forest diseases and pest infestations will likely increase, as the warmer temperatures and shorter, warmer winters could reduce the amount killed off in the winter and increase the ranges of these pests.

The migration of tree species is generally limited; wind dispersed seeds do not move far and the prevailing wind is from the northwest (and would therefore carry seeds in a south easterly direction, towards warmer temperatures, not cooler). Seeds carried by birds and other animals are either stored near the tree or if they are transported by migratory species they will generally be moved in a southerly direction, where conditions are likely not ideal for growth. An added problem with the migration of tree species is that a seed needs to be deposited at an ideal site for growth, and then needs to successfully germinate and grow to maturity before it can produce seeds. The anticipated rate of climate change far exceeds the ability of many species to migrate and survive. Species that are unable to migrate or cope with the changing conditions will eventually die off, and will likely be replaced by habitat generalists and invasive species.

20.1.4.2 Aquatic Habitat

The low water levels expected as a result of climate change will likely impact the Source Protection Region's aquatic ecosystems. Low water levels will result in the disappearance of small streams and a reduction in the area and quality of wetlands. If streams dry up, the fish and other aquatic animals that live there will either have to migrate to locations which may have less than ideal habitat, or they may become extirpated (Warren *et al.*, 2004).

Increased air temperatures will also result in rising water temperatures. This will impact sensitive species of fish and aquatic invertebrates, as the capacity of the water to carry dissolved oxygen decreases as the temperature increases. The result will be changes in fish and benthic communities and the northward migration of species (provided barriers to migration do not exist), as well as the potential for local extinctions of the more sensitive species. The ability of a species to migrate will depend on the presence of physical or thermal barriers, and the presence of appropriate habitat conditions. The potential negative impact to coldwater fish communities within the tributaries is prevalent if flows are reduced and water temperatures are increased and potentially could lead to extirpation.

Furthermore, the lake's aquatic habitat could be impacted in several ways by sustained climate change, both in the immediate and long-term future. Shifts in seasonal ice cover would affect the lake's productivity as ice cover controls the availability of light and dissolved oxygen concentrations. Since the concentration of dissolved oxygen declines during the ice cover period, a decrease in ice cover could reduce winter mortality due to low oxygen conditions.

Evidence of impacts from a reduced ice cover period of time is beginning to emerge through recent work from Dr. David Evans. His research indicates the trend of reduced ice cover on Lake Simcoe is potentially causing impacts on juvenile lake trout survivability (Evans, 2007).

A report by the International Joint Commission (IJC) indicates that climate change could result in the earlier onset of stratification, an extended summer stratification period, changes in the volume of the thermal layers, as well as possibly reducing the frequency and regularity of lake turnovers (IJC, 2003). Some species are already under pressure due to the small size of the hypolimnion during the lake's stratified period, so any decrease in size or dissolved oxygen concentrations could be devastating to their populations (Evans, 2007). These changes could alter the dominant species found in the lake and may cause extirpation of some fish species.

20.1.5 Other Effects of Climate Change

20.1.5.1 Agriculture

Climate change is likely to have both positive and negative impacts on agriculture in southern Ontario. Although there is a great deal of uncertainty, a number of benefits are anticipated, including an extended growing season, an extension of the range of more southern crop species that are currently grown in the United States into this region, and a potential decrease in cold stress during the winter months. However, negative impacts are also anticipated. Soil moisture deficiencies could reduce crop yield; the benefits expected from reduced cold stress could be offset by the potential for damaging winter thaws as a result of the reduction in the amount of protective snow cover; extreme heat could have impacts on crop yield, particularly if it occurs during crucial points of the life cycle of the plant; and the incidence of pests and diseases is expected to increase.

Warren *et al.*, (2004), states climate change may also have positive and negative impacts on livestock operation in Canada, although little research has been conducted to determine how warmer temperatures will affect this economically important sector. However, the limited research to date suggests that positive impacts could include lower feed requirements, increased survival of the young and reduced energy costs (Rötter and van de Geijn, 1999). Climate change, through heat stress, could affect milk production, dairy cow reproduction, and animal weight gain (Rosenzweig and Hillel, 1998).

20.1.5.2 Recreation

It will be important to manage those impacts of climate change so that we are able to maintain Lake Simcoe's and Georgian Bay's recreation industry, which is estimated to generate revenue in the hundreds of millions of dollars for the economies of the municipalities within the Source Protection Region, could be severely impacted by the changes that could arise from climate change. To manage these impacts, watershed managers will need to take science based local actions as well as recognize opportunities to support work to reduce climate change where these opportunities may exist.

Ice conditions in southern Ontario are expected to deteriorate in the coming years, a trend that has already recently been observed to an extent. The ice season will become shorter, and it is likely that there will be years without ice cover (Lemke *et al.*, 2007). These changing conditions will deal a serious blow to the businesses and communities that rely on ice fishing and other ice-related activities. Possible change in the fish community could impact Lake Simcoe's and Lake Couchiching's reputation as a fishing destination. Climate change impacts may also include a decrease in the amount of expected snow cover (Trenberth *et al.*, 2007), which will affect activities such as snowmobiling, skiing, and snowshoeing, which could also result in lost revenues.

With warmer summer temperatures, it is expected that the interest in swimming and other water-related activities will increase. However, low water levels, warmer air temperatures and warmer water combined with increased concentrations of nutrients and pollutants could deter people from undertaking in-water recreation. Boating activities may also be impacted by low water and weeds, and marina operators may need to dredge their harbours and channels to be able to continue to operate because of low water levels.

20.1.5.3 Human Health

The elevated atmospheric concentrations of green house gases associated with climate change can have a negative impact on human health. People with underlying medical conditions such as (but not limited to) cardiovascular and respiratory diseases will be more prone to feeling the effects of climate change. Extreme and pro-longed thermal events (heat waves) can lead to premature death in the very young and old as their bodies cannot readily adjust to higher core body temperatures. Many symptoms of underlying medical conditions also become more exaggerated in extreme temperature situations (Duncan *et al.*, 1998). The increased frequency and severity of extreme weather events will likely allow for the migration of water-borne diseases such as malaria, and other mosquito-borne diseases (Duncan *et al.*, 1998). Warmer temperatures combined with the increased frequency and severity of storm events can create

ideal habitats for bacteria and parasites to flourish, as well as allowing for the spread of vector-borne diseases including; eastern, western and St. Louis encephalitis, Lyme disease, and snowshoe hare virus to name a few (Duncan et al., 1998).

The warmer temperature conditions predicted by the CCCSN (2009) indicate that the number of days the ground is frozen could decrease. A decrease in the number of days the ground is frozen could lead to rising water table elevations due to enhanced infiltration rates, particularly during the spring melt. The elevated water table levels can introduce contaminants stored in the shallow subsurface into the groundwater system. Toxins from air pollution fallout can accumulate in agriculture lands and water courses, leading to the bioaccumulation of toxins up the food chain.

In general, there are numerous potential risks to human health that can be linked to rising atmospheric concentrations of greenhouse gases associated with climate change, many of which are linked to drinking water contamination. The potential risks to human health including, food and water supplies puts into perspective the importance of addressing climate change now rather than later. Examples of how climate change is being addressed, on an international, national and provincial scale is provided in Section 14.1.6.

20.1.6 Science and Research

As has been discussed, it is still difficult to tell with certainty what the impacts of climate change will be in the Source Protection Region. Most predictions are made on a regional scale, which can give some idea of what can be expected, but it is still difficult to know specifically what will happen. This uncertainty can create difficulty in moving forward with management alternatives, as decision makers may be reluctant to implement the large scale changes that may be necessary to deal with the potential impacts. It is known that as changes occur in the climate, updates to modelling and related vulnerability zones, water budgets and policies will be required.

The following sections give examples of how climate change is being addressed internationally, nationally and provincially. While impacts on drinking water may not be expressed explicitly, any progress in planning to decrease the extent of the changes that will occur, as well as plans to adapt, will in turn help to protect drinking water.

20.1.6.1 International

Intergovernmental Panel on Climate Change (IPCC)

The Intergovernmental Panel on Climate Change (IPCC) was established in 1988 by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO). Considered to be the leading scientific body on climate change, it aims to provide the global community with an un-biased view on the current state of climate change. Its role is to review and assess the most up to date scientific, technical and socio-economic research on climate change, contributed (voluntarily) from scientists around the world and address potential environmental and socio-economic consequences that may be a result of climate change. The IPCC is currently working on the preparation of the Fifth Assessment Report (AR5)

Reports/Sources of Information:

- Fourth Assessment Report (AR4), 2007. Consists of 4 volumes – the AR4 Synthesis Report and three IPCC Working Groups (WG) Reports:
 - WG I The Physical Science Basis
 - WG II Impacts, Adaptation and Vulnerability
 - WG III Mitigation of Climate Change

United Nations Framework Convention on Climate Change (UNFCCC)

Commencing in 1992, the United Nations Framework Convention on Climate Change (UNFCCC) was accepted as the foundation for a global response to the increasing concentrations of GHG and their resulting impacts on climate. Part of this Convention is the Kyoto Protocol (1997). The Conference of the Parties (COP) is the prominent body of the UNFCCC, that comes together annually to review the implementation of the Convention. This past year (2009), the conference took place in Copenhagen, Denmark.

Reports/Sources of Information:

- For more information on the United Nations Framework Convention on Climate Change and the results of this year's conference, go to: <http://unfccc.int/2860.php>

Asia-Pacific Partnership on Clean Development and Climate

~~The Asia-Pacific Partnership on Clean Development and Climate (APP) was first established in 2005 and has grown to be a partnership between seven countries: Australia, Canada, China, India, Japan, South Korea and the United States. The overall aim of the APP is to increase the development, use and international trade of new and innovative clean energy technologies. By~~

~~supporting the investment in these technologies it seeks to address climate change while simultaneously, encouraging sustainable economic growth and a reduction in poverty. When Canada joined in 2007, it made a \$20M investment over the following three years to help carry out its APP projects.~~

~~*Reports/Sources of Information:*~~

- ~~• To learn more about the APP and Canada's involvement go to:
http://climatechange.gc.ca/pap_app/default.asp?lang=En&n=FFB91B5D-1~~

20.1.6.2 National

Government of Canada

To address the issues of climate change, the Government of Canada has set a number of targets for itself to minimize its ecological footprint and to set an example for the global community. One of these targets is to have a 20% reduction from 2006 levels in total GHG emissions by 2020, and a 60-70% reduction by 2050. This target is similar to the one set by the United States. The Government of Canada recognizes the importance of aligning climate change policies with our neighboring country due to its geographic proximity and the close integration of the two economies.

Canada is currently initiating a number of policies and actions to attain its GHG emissions target. An example of some of these measures include:

1) Regulating Emissions

- ~~• Developing a cap-and-trade system for Canada through the partnership of provinces and territories~~
- ~~• For details about the *Canadian Greenhouse Gas Offset Credit System Regulations -as of Spring 2022:* (<https://www.canada.ca/en/environment-climate-change/services/climate-change/pricing-pollution-how-it-will-work/output-based-pricing-system/federal-greenhouse-gas-offset-system.html>)~~
- ~~• Have released the draft rules for "Canada's Offset System"
(<http://www.ec.gc.ca/creditscompensatoires-offsets/default.asp?lang=En&n=109DDFBA-0>)~~
- Initiating new regulations for the auto industry, that are parallel to the national standards of the United States, starting with 2011 models.

2) Enhancing Energy Efficiency

- Have had past success and continues to support its “ecoENERGY programs” through to the end of March, 2011. (<http://www.ecoaction.gc.ca/ECOENERGY-ECOENERGIE/index-eng.cfm>)

3) Increasing the Share of Renewable Energy in the Overall Energy Mix

- Roughly 73% of Canada’s total electricity mix is low carbon energy. Of this, around 60% is from hydroelectricity. Other resources include nuclear, biomass, wind and solar.
- By 2020, Canada seeks to improve this to 90% of its electricity coming from clean-energy sources.

4) Reports/Sources of Information

- From Impacts to Adaptation: Canada in a Changing Climate 2007
- Canada’s 2007 Greenhouse Gas Inventory.
 - Monitors six gases and provides an analysis of the factors underlying the trends in emissions since 1990

20.1.6.3 Provincial - Ontario

Ministry of the Environment, [Conservation and Parks](#)

The Ministry of the Environment, [Conservation and Parks](#) (MECP/OPÉ) has a Climate Change Action Plan, specific to Ontario, which includes:

1) Green Targets

- Achieve in Ontario, a 6% below 1990 levels reduction of GHG emissions by 2014, 15% by 2020 and an 80% reduction by 2050

2) No More Coal

- Ontario is phasing out coal-fired electricity – the only jurisdiction attempting to do so – eventually reducing Ontario’s carbon footprint (that is attributable to electricity) by 75%. This ambitious single-measure endeavor is considered to be one of the largest in North America.

3) Cap and Trade

- Is part of the collaboration of provinces and territories to develop a common trading system.

4) Climate Change Adaptation

- As climate change is unavoidable, the Ontario's Expert Panel on Climate Change was selected to provide guidance on ways we can plan ahead and prepare for the impacts of climate change. From the recommendations that were provided in their submitted report, the need for an adaptation strategy and action plan was stressed.

5) Move Ontario 2020

- To reduce the amount of automobile emissions, the government has initiated the largest investment plan for transit in Canadian history by providing \$11.5 billion for 52 public transit projects in the Greater Toronto Area and Hamilton.

6) Green Power

- Ontario's Green Energy and Green Economy Act aims to increase clean-energy use in Ontario through wind, solar, hydro, biomass and bio gas energy sources. Furthermore, a "smart" power grid is to be introduced to support current and future renewable energy technologies.

Reports/Sources of Information:

- (Ontario's) Climate Change Action Plan. Annual Report 2008-09
- Moving Forward: A Greenhouse Gas Cap-and-Trade System for Ontario, 2009
- Adapting to Climate Change in Ontario, 2009

➤ [In 2020, this was replaced with the Made-in-Ontario Environment Plan \(https://www.ontario.ca/page/made-in-ontario-environment-plan\)](https://www.ontario.ca/page/made-in-ontario-environment-plan)

Ministry of Natural Resources

The Ministry of Natural Resources (MNR) is working to increase awareness of the potential impacts of climate change on the natural resources and ecosystems in Ontario, while supporting the development of practices that will help to mitigate them. The MNR also seeks to assist those living in Ontario adapt to climate change.

Reports/Sources of Information:

- Our Sustainable Future. Ministry of Natural Resources, Strategic Directions. 2005.

- Climate Change and MNR: A Program-Level Strategy and Action Plan
- Naturally Resilient: MNR's Natural Resource Climate Adaptation Strategy (2017-2021)
- (<http://www.mnr.gov.on.ca/198258.pdf>)

Ontario Ministry of Agriculture Food and Rural Affairs (OMAFRA)

The Ontario Ministry of Agriculture Food and Rural Affairs is running a voluntary environmental education and awareness program through the Ontario Farm Environmental Coalition. The program provides funding to farmers to develop and implement a plan to implement greener practices into everyday farming operations. As well, OMAFRA has a summary of their presentation on Climate Change and Insects posted on their website.

Reports/Sources of Information:

- <http://www.omafra.gov.on.ca/english/environment/efp/efp.htm>
- ~~<http://www.omafra.gov.on.ca/english/crops/hort/news/hortmatt/2006/04hrt06a5.htm>~~

20.2 How The Great Lakes Were Considered

Section 14 of the *Clean Water Act, 2006* requires that if a Source Protection Area contains water that flows into the Great Lakes a consideration of the following documents must occur during the completion of Assessment Reports and Source Protection Plans. The documents are as follows:

- 1) The Great Lakes Water Quality Agreement of 1978 between Canada and the United States of America signed at Ottawa on November 22, 1978, including any amendments made before or after this section comes into force.
- 2) The Great Lakes Charter signed by the premiers of Ontario and Quebec and the governors of Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania and Wisconsin on February 11, 1985, including any amendments made before or after this section comes into force.
- 3) The Canada-Ontario Agreement Respecting the Great Lakes Basin Ecosystem 2002 entered into between Her Majesty the Queen in Right of Canada and Her Majesty the Queen in Right of Ontario, effective March 22, 2002, including any amendments made before or after this section comes into force.
- 4) Any other agreement to which the Government of Ontario or the Government of Canada is a party that relates to the Great Lakes Basin and that is prescribed by the regulations. 2006, c.22, s.14 (1).

Within the South Georgian Bay-Lake Simcoe Source Protection Region (SGBLS SPR) all three Source Protection Authorities have waters which drain directly into the Great Lakes. This section of the assessment report will discuss how the Great Lakes agreements were considered in the work undertaken to complete the Assessment Report.

20.2.1 Great Lakes Water Quality Agreement of 1978

The Great Lakes Water Quality Agreement (GLWQA) is an agreement between Canada and the United States of America which aims to restore and maintain the chemical, physical, and biological integrity of the waters within the Great Lakes Basin ecosystem. The GLWQA was amended in 1987 to include annexes which target, identify and address specific areas of concern. Two of which may have a bearing on the Source Water Protection Process.

Annex 1: Specific Objectives

The overall goal of Annex 1 is related to the goal Annex 12 (Persistent Toxic Substance) which calls for strategies to be developed by the parties of the Agreement to control and prevent the

input of persistent toxic substances into the Great Lakes Basin. While Annex 1 and 12 do not directly discuss a relation to drinking water reducing the concentrations of toxic substances within the Great Lakes Basin will improve the overall drinking water quality for the communities within the SGBLS SPR relying on Georgian Bay as a source of drinking water.

Annex 1 contains specific goals and objectives aimed at removing and/or reducing the concentration of toxic chemical substances within the Great Lakes Basin. The Annex has grouped all toxic chemicals into three categories:

- 1) Persistent Substances (organic and inorganic);
- 2) Non-persistent (organic and inorganic); and
- 3) Other Conventional Water Quality Parameters.

It should be noted that Annex 1 came about when some of the popular chemicals of the 1970's were being banned from use (DDT, PCB's and more), and that with the passage of time the concentrations of some these chemicals within the Great Lakes Basin are below the water quality objectives outlined in the Annex. The International Joint Commission is currently investigating the idea of revising Annex 1 to include chemicals used in modern day industrial practices, and change the water quality objectives to match our current day understanding of the chemicals (Limno-Tech, 2001).

Annex 2: Remedial Action Plans and Lake-wide Management Plans

Annex 2 of the GLWQA allows the International Joint Commission (IJC) to evaluate and report on activities occurring within the Great Lakes Basin to the Canadian and American Federal Governments as well as, the Provincial and State Governments which border the Great Lakes. Annex 2 requires that Remedial Action Plans (RAPs) and Lake-wide Management Plans (LaMPs) be developed to clean up areas of concern and open lake waters. The RAPs and LaMPs document all of the planning and restoration activities occurring within the Great Lakes Basin. The highlights of the RAPs and LaMPs are incorporated into the IJC's biennial reports and/or special reports. Two Remedial Action Plans and One Lake-wide Management Plan cover waters within the SGBLS SPR.

Collingwood Harbour and Seven Sound were identified as areas of concern under Annex 2 and were required to complete Remedial Action Plans. Both areas were identified due to noticeable nutrient enrichment and habitat destruction. In addition, the sediments within Collingwood Harbour were found to be contaminated. The Remedial Action Plans for Collingwood Harbour and Severn Sound were approved by the International Joint Commission and submitted to the Government of Canada and the Province of Ontario in August of 1994 and June 2002,

respectively. The approval of these documents resulted in delisting both Collingwood Harbour and Severn Sound as Areas of Concern. It should be noted that while these plans addressed water quality concerns within Georgian Bay the objectives of these plans were not directly related to drinking water.

A Lake-wide management plan for Lake Huron (including Georgian Bay and the North Channel) has not yet been developed. When completed, the Lake-wide Management Plan will aim to improve the environmental quality of the open waters of the lake, with a focus on Critical Pollutants identified in the Great Lakes Water Quality Agreement.

20.2.2 Great Lakes Charter

The Great Lakes Charter was signed in 1985 by Premiers and Governors of the Provinces and States that border the Great Lakes. The charter recognizes the importance of conserving and protecting the water resources found within the Great Lakes Basin, by recognizing that the Great Lakes function as one complete hydrologic system.

The charter contains five guiding principles for protecting the water resources:

- 1) Integrity of the Great Lakes Basin
- 2) Cooperation among jurisdictions
- 3) Protection of the water resources of the Great Lakes
- 4) Prior notice and consultation
- 5) Cooperative programs and practices.

The charter specifically discusses the permitting and consultation process for large water takers and water diversion projects within the basin (over 19 million liters per day average in a 30 day period). Since Technical Rule 4 for the completion of the Assessment Report excludes the Great Lakes from being considered stressed in the water budgeting process, the regulations of the Great Lakes Charter currently do not apply to Source Water Protection initiatives within the SGBLS SPR.

20.2.3 Canada-Ontario Agreement

The Canada-Ontario Agreement (COA) is a framework through which the Governments of Canada and Ontario work together with Aboriginal communities and other partners to restore, protect, and conserve the Great Lakes Basin ecosystem. The COA establishes an action plan to delegate roles and responsibilities between the Federal and Provincial Ministries to help Canada meet its commitments under the Great Lakes Water Quality Agreement. The parties of

the COA will complete the tasks outlined in the COA through the implementation of four annexes.

- Annex 1: Areas of Concern
- Annex 2: Harmful Pollutants
- Annex 3: Lake and Basin Sustainability
- Annex 4: Coordination of Monitoring, Research and Information

Annex 1: Areas of Concern

Annex 1 of the COA targets the restoration and protection of environmental quality in the remaining 15 Areas of Concern on the Canadian side of the Great Lakes. The Annex recognizes that Collingwood and Severn Sound were Areas of Concern that have been delisted.

Annex 2: Harmful Pollutants

Annex 2 of the COA targets the reduction and prevention of the release of harmful pollutants within the Great Lakes Basin. The Annex also seeks to eliminate persistent bioaccumulative toxic substances from the Lakes. Canada and Ontario are working to accomplish the goals of the Annex by participating in the Bi-national Toxics Management Strategy. This strategy encourages industry sector reductions in identified substances and emerging substances of concern.

Annex 3: Lake and Basin Sustainability

Annex 3 of the COA focuses attention on better stewardship of a healthy, prosperous and sustainable Great Lakes Basin ecosystem. The Annex encourages the integration of these stewardships practices into the everyday lives of the citizens within the Great Lakes Basin. Activities under this Annex may relate to stewardship activities under the Source Water Protection Program and will be addressed in the Source Water Protection Plan. Goal 6 of this Annex commits Canada and Ontario to making significant progress towards the development and implementation of locally-created, science-based Source Water Protection Plans to identify and mitigate risks to drinking water sources in the Great Lakes Basin. This Goal directly applies to the Source Water Protection Plan development under the Clean Water Act in the SGBLS SPR.

Annex 4: Coordination of Monitoring, Research and Information

Annex 4 of the COA aims to coordinate the monitoring and research programs occurring within the Great Lakes Basin.

20.2.4 Other Agreements

There are no other formal agreement in addition to the Great Lake Water Quality Agreement, Great Lakes Charter and the Canada-Ontario Agreements in which Ontario and/or Canada is an acting party, and that relate to the Clean Water Act. However, there are some initiatives that may prove to be useful in the development of Source Water Protection plans.

- 1) Lake Huron-Georgian Bay Watershed: A Canadian Framework for Community Action
- 2) Collingwood Harbour and Severn Sound Remedial Action Plans
- 3) International Upper Great Lakes Water Levels Study

Lake Huron-Georgian Bay Watershed: A Canadian Framework for Community Action

The Lake Huron-Georgian Bay Watershed: A Canadian Framework for Community Action is an initiative to get everyone living along the shores of Lake Huron including Georgian Bay to help improve the health of the Lake. Their website (<http://www.lakehuroncommunityaction.ca/>) provides links for users to see current and ongoing stewardship initiatives within the community to improve the health of the Lakes. Since there is no advisory committee established for the Lake Huron-Georgian Bay Watershed: A Canadian Framework for Community Action initiative there are no specific policies that apply to the Source Water Protection program; however, the outcome of stewardship activities aimed at improving lake health could improve the water quality and; therefore, the quality of drinking water for those people who depend on the Great Lakes for drinking water.

Collingwood Harbour and Severn Sound Remedial Action Plans

Specific water quality and fisheries habitat data from the Remedial Action Plans were used in the watershed characterization phase of the Assessment Report development.

International Upper Great Lakes Water Levels Reference Study

During the development and preparation of the draft Assessment Report, the International Upper Great Lakes Water Levels Study was completed, and was made available for public consultation. Although the outcomes of this study were not available in time for use in this assessment report, the study will be useful for future Source Water Protection Initiatives. The Water Levels Study sets out to answer important questions posed by the IJC regarding the water levels throughout the Great Lakes Basin. The study outcomes will aid in future water level management initiatives and assist in establishing current and future risks to drinking water

Intake Protection Zones (IPZs). Overall, the study found that climate is the main driver of lake level relationships overtime within the Great Lakes Basin.

20.2.5 Information Sources

The websites and references listed below can be accessed for more detail on any of the Great Lakes Agreements and Initiatives discussed above.

Environment Canada. “Canada-Ontario Agreement Respecting the Great lakes Basin Ecosystem”. <http://www.ec.gc.ca/CEPARRegistry/documents/agree/Fin-COA07/framework.cfm> (22 June, 2010)

Great Northern Technical Services. “Lake Huron-Georgian Bay Watershed A Canadian Framework for Community Action”. <http://www.lakehuroncommunityaction.ca/> (23 June, 2010)

International Great Lakes Study Governed by the International Joint Commission. “International Great Lakes Water Levels Study”. <http://www.iugls.org/> (22 June, 2010)

International Joint Commission. “The Great Lakes Water Quality Agreement Review”. http://www.ijc.org/en/activities/consultations/glwqa/guide_4.php (22 June, 2010)

Limno-Tech, Inc. 2001. Review of Annex 1 of the Great Lakes Water Quality Agreement, *Prepared for Parties Implementation Work Group Great Lakes Science Advisory Board International Joint Commission.*

20.3 Additional Items Raised ~~by the~~ **Source Protection Committee**

Within the Technical Rules there are a few instances where the Source Protection Committee has the authority to request additional information be included or excluded within the Assessment Report. The following points describe areas where the Technical Rules explicitly state that a SPC ruling is required:

- Technical Rule 119: The intent of Technical Rule 119 is to enable the SPC to include activities that are not prescribed in ~~Part XII of the Technical Rules (December 2021) the Table of Drinking Water Threats~~ in the assessment. To be considered by the Director any activity has to be identified as a potential threat to a drinking water system.
 - At this stage the SPC has not requested additional activities be considered, however, as noted below a number of activities have been identified that may be considered for future versions.
- Technical Rule 15.1: Use of alternate methods or approaches for gathering information or for performing tasks that depart from those described in the rules (Rule 15.1). The following alternate methods were requested and approved under this rule.
 - Rules require a separate 1km² grid for each Source Protection Area when determining the total impervious surface area. Alternate method approved by the Director allows a single grid to be used for the entire Source Protection Region.
 - Rules require livestock numbers to be calculated by interpreting aerial photography to estimate the capacity of a farm to house livestock. Alternate method approved by the Director allows livestock density to be determined using Census of Canada livestock data within the Source Protection Region, with the census data of actual animal numbers being converted to nutrient units for the use of the calculations. This method was used to assess the livestock density for regional vulnerable areas (HVA and SGRA) only, while drinking water system vulnerable areas were assessed using the prescribed approach.
 - Rules require that the vulnerability of the groundwater within a source protection area be assessed using one or more of the four prescribed methods. Alternate method approved by the Director allows the consideration of local scale features such as ‘windows’ in the confining unit, which are not always accounted for in the regional nature of the AVI scoring. This includes the use of water quality information as a verification tool to reassess the groundwater

vulnerability in the WHPAs and determine where the groundwater vulnerability should be amended. This alternative method was used in the City of Barrie, Township of Essa and the Town of Wasaga Beach.

Letters with Director's Approval for the above mentioned Rule changes are available in Appendix ARC.

- Species at Risk assessment should only be included if the SPC is of the opinion that the watershed characterization should include a discussion for the purposes of informing the public about species at risk in the Source Protection Area.
 - The SPC carried the motion that Species at Risk should not be included in the Assessment Report.

Throughout the process of completing the Assessment Report members of the SPC have also identified a number of items that do not directly fit within the Assessment Report framework but do warrant mention. These items are:

Orillia Multi-Use Recreational Facility (MURF)

The site for the MURF project is a vacant parcel of land located on West Street, just south of Barrie Road and adjacent to the downtown core. From the early part of the 20th century to 1986, the site was used for a variety of industrial uses, including foundry operations. As a result of the foundry operations, both the soil and the groundwater on the site have been impacted by inorganic and organic chemicals. The site is now considered to be a "brownfield" which requires careful environmental assessment and risk management. The proposed MURF site is approximately 600m from the Orillia well 1 and 2 WHPA, and adjacent to, but not within, the Orillia IPZ-2, which; therefore, excludes the property from being evaluated as a potential drinking water threat under the *Clean Water Act, 2006*.

Proposed Site 41 Landfill site

The proposed Site 41 landfill in the Township of Tiny was raised as a concern by members of the SPC. Members of the Committee were concerned that the landfill could contaminate the Elmvale drinking water supply aquifers despite reassurances from other sources that the landfill site would be contained. Groundwater modeling in the area showed that the Elmvale Well Head Protection Area is orientated towards the east while Site 41 is located approximately 5 km to the North. This analysis showed that Site 41 is not in a WHPA and therefore not a significant threat to any municipal drinking water supplies in the area, under the *Clean Water Act, 2006*. Since the raising of these concerns at the SPC meetings, a decision was made by the Simcoe County Council to not use Site 41 and the Certificate of Approval was withdrawn.

Lake Simcoe Regional Airport drinking water system in Oro-Medonte

The drinking water supply to the Lake Simcoe Regional Airport in Oro-Medonte was included in the draft Terms of Reference for the Lake Simcoe-Couchiching Black Source Protection Area. Subsequently the system was removed as it was not a municipal residential system as required by the *Clean Water Act*. SPC members were concerned about the proximity of a Non-Agriculture Source Material storage site that is located adjacent to the supply well. While the Lake Simcoe airport drinking water system was removed from the Terms of Reference (and hence this Assessment Report), MOE and Health unit liaisons were asked to investigate the risk to that well system.

Contaminants treated at a water supply facility may not be identified as an issue

A drinking water supply is deemed to have an issue if the presence of a parameter at the intake or monitoring well is either above Ontario Drinking Water Standards or is tending to be above the Standards. Subsequent guidance from the MOE has advised that if a contaminant in the raw water can be effectively treated, bringing the contaminant below the Standards, then the SPC may consider not categorizing the parameters as a drinking water issue. In considering whether a contaminant can be effectively treated, MOE advised that the assessment should consider the systems excess treatment capacity, whether the system could get overwhelmed during an event and how sustainable the treatment is for that parameter.

SPC members were concerned that including the capacity for a contaminant to be treated in the issues evaluation process is contrary to the intent of the Clean Water Act and the Source Water Protection ethos. The SPC has recommended that all Issues associated with TCE be identified as an Issue, even if effective treatment is in place. The SPC has also requested that any other parameter or pathogen that has not been classified as an issue, due to effective treatment, still needs to be identified in the Assessment Report.

Large quarry proposal in Dufferin County

SPC members brought to attention a proposal to establish a large quarry in Dufferin County, north of the Shelburne Well Supplies. Several aggregate companies have acquired land in the region and have undertaken extensive advance work, including technical investigation and public consultation. Municipalities and residents have expressed concern over potential impacts to private wells and the environment. Further investigations will be conducted to determine if the proposed quarry sites are in vulnerable areas.

Transportation corridors (Roads and Highways)

Transportation corridors have not been included in the list of prescribed activities within the Tables of Drinking Water Threats. They were not included as they were deemed by the Province not to fit within the semi-quantitative risk assessment process and the current rules around the addition of threats and circumstances do not provide a method for their inclusion. That being said, specific activities taking place within a transportation corridor could be identified as a threat at the discretion of the Director under Technical Rule 119 and if requested by the SPC.

The SGBLS SPC acknowledges there are a number of locations in the Region where it may be prudent to include transportation corridors in the Assessment Report, for example where highway 400 crosses the Severn River. The SPC debated the merits of including transportation corridors on a case-by-case basis in the current Assessment Report versus delaying their inclusion so that a more consistent approach across the region could be developed for future version of the report. In the interim the committee chose to proceed with the technical assessment of transportation corridor impacts (through on-going projects), and to engage the emergency management / first responders in communications efforts.

Further to these discussions the SPC also noted that the current manner of assessing threats does not account for the mobile nature of threats associated with road construction.

Future potential local threats

Technical Rule 119 allows for the SPC to add local threats—i.e. identified threats that are not listed in [Part XII of the Technical Rules \(December 2021\)](#), ~~the Table of Drinking Water Threats~~. To be considered a local threat, information from the director needs to indicate a hazard rating greater than 4. While no additional local threats were include in this round of the assessment report, members of the SPC did identify a number of potential local activities that should be further investigated and consider in future versions of the assessment report. Potential local threats identified by the committee include:

- Pathogen threats related to pets, especially originating from businesses such as kennels and vets;
- Chemical threats (e.g. formaldehyde) originating from cemeteries
- Transportation corridor threats (as noted above)